Front End Management for New Product Development

Portland State University

Fall 2009

User-Oriented Design:
Literature Review of Process and Methods and a Case Study

By:

Jeff Belding
Saeed Assiri
Randy White
Hari Sharma
Inthrayuth Mahaphol
Abdulaziz Al-anazi

12/8/2009

Table of Contents

Table of Tables

Table of Figures

Summary

One of the most important steps in new product development (NPD) is involving the user in the design to ensure the product aligns with their needs and wants. Identifying the right users for a new product and involving them in the right part of the project can be found in the literature under several names: User-Oriented Design (UOD), User-Centered Design, or Human-Centered Design. This paper focused on how to get user involve in the new product development process in a mission to examine the impact of UOD in the NPD process on a case study.

The paper starts with an introduction to UOD highlighting the importance of this approach, and discussing the advantage and disadvantage of its implementation. After that three processes were analyzed, one of which was chosen for the case study based on important criteria. Then six methodologies were examined, and two of those methods were selected for the case study.

The case study that was chosen for this project is a web-based product called "TFDEA". To implement UOD in a web interface research tool, we used relevant processes from the literature to develop a framework to be used for a NPD web interface. Among the methods found in the literature, Interviews and Participatory Design were selected to assess user needs and wants. In order to show the impact of our UOD process and selected UOD methods, we apply the principles on an initial product concept and show the improvements.

The implementation of UOD on the case study shows a positive impact on the NPD process. The developers are encouraged to continue the process and incorporate additional methods as the project continues in order to meet the customer's needs and wants. The proposed UOD process is then evaluated against the identified evaluation criteria. The case also identifies the importance of identifying the right users and involving them at the right time in the project. Future research is needed to aid in choosing, or creating, a UOD process, appropriate UOD methods, and how to know when to involve users in the project.

Literature Research

Introduction to UOD

Design plays an important role in the success of a new product. It is used to position and differentiate the product from its competitors. For many years marketing experts proclaimed that design provides companies with a competitive edge [1]. However, the traditional approach of developing a new product in organizations may not consider product design (industrial design) as a strategic resource for the business. Traditionally organizations view industrial design as a service that can be outsourced with no harm to the future of the new product. Nevertheless, that has changed in today's competitive market environment. NPD mangers and design mangers have made industrial design part of the NPD process. It has become an important discipline along with R&D, engineering, marketing research, and so on. Industrial design and marketing research are focused on creating the most value for users from a technology that was developed in R&D. The Industrial Design Society of America (IDSA) defined the discipline of industrial design as "the professional service of creating and developing concepts and specifications that optimize the function, value, and appearance of products and systems for the mutual benefit of both user and manufacture" [1]. In today's dynamic market product design is used as a competitive advantage for most organizations, but the question is how can companies design what the users really want or need?

To answer this question the concept of User-Oriented Design (UOD) was developed. UOD is a new product design approach in which the needs, wants, and limitation of end users are given extensive attention at each stage of the NPD process [1]. This approach of design was discussed by many researchers using different terms such as Human-Center Design, Customer-Center Design, and User-Centered Design [1]. The main focus of this design approach is to have user as the focal point of new product design. This design approach has been proven to have a positive impact on new product development [1]. However, the implementation of this design approach remains challenging. The need for deep customer understanding and product complexities make it difficult for organizations to balance maximizing customer experience and value proposition. The table below (Table 1) highlights advantages and disadvantages of UOD.

Advantage	Disadvantage
Products are more efficient, effective, safe, and enhanced customers' satisfaction.	It is more costly and takes more time.
Users develop a sense of ownership for the product.	May require the involvement of additional design team members.
Products require less redesign and generate creative design solutions to problems.	May be difficult to translate some types of data into design and also too specific for more general use.

Table 1 - Advantage and Disadvantage of UOD

This paper explores the literature to see the impact of UOD in a NPD process. It examines the processes and methods that could be used to develop a web-based product. Traditional data-driven website designing process has not met the user's requirement and has necessitated a new process that incorporates users more into product design. A literature review shows users are not consulted frequently in data-driven process and resulted in 'web crises' because most user requirements were not met. As a result most of the websites reviewed were not visited more than once [3, 4]. With intense competition and the rapid growth of online businesses UOD is now an indispensable element for a successful website [5]. For commercial websites, usability of web applications and information content determine the frequency of users' visit in particular and the success of business objectives in general. Thus, website designers are compelled to involve users' perceptive into the design process.

UOD Process

Introduction & Analysis

There are several processes cited in literature for the involvement of users in website design [6, 7, 8]. Most literature searches reveal that the usability from the users' perspective is paramount for the success of new website design development. A website's purpose varies from user to user. However the inclusion of users at the start of modeling process is seen as more critical than with the traditional data driven process - which ignores the involvement of users at the beginning of modeling. Additionally, uncovering the latent needs of customers and incorporating these needs into the NPD process is becoming increasingly common among leading companies, as a competitive advantage [9]. Following are the frequently used user-oriented processes for designing of new website.

1. WSDM (Web Site Design Method) Process
2. User-based Design Process
3. Human-centered Design Process

1. WSDM (Web Site Design Method) Process

WSDM process considers potential user at the start of modeling and the available data is modeled in the viewpoint of the different users [3]. This process provides greater usability and satisfaction to the intended users than the traditional data driven methods. This process is divided into the following four phases. The systematic flow chart of the WSDM process is shown in Figure 1

1. *User-modeling phase*

This phase consists of two attributes, user classification and user class description. User classification allows identifying and grouping the potential users into different user classes as per their needs. User classes are group of users who want similar information on the website. User

class description is aimed at finding the information requirements and perspectives of information of different user classes. Thus, this phase helps to describe the information requirement and usability requirement.

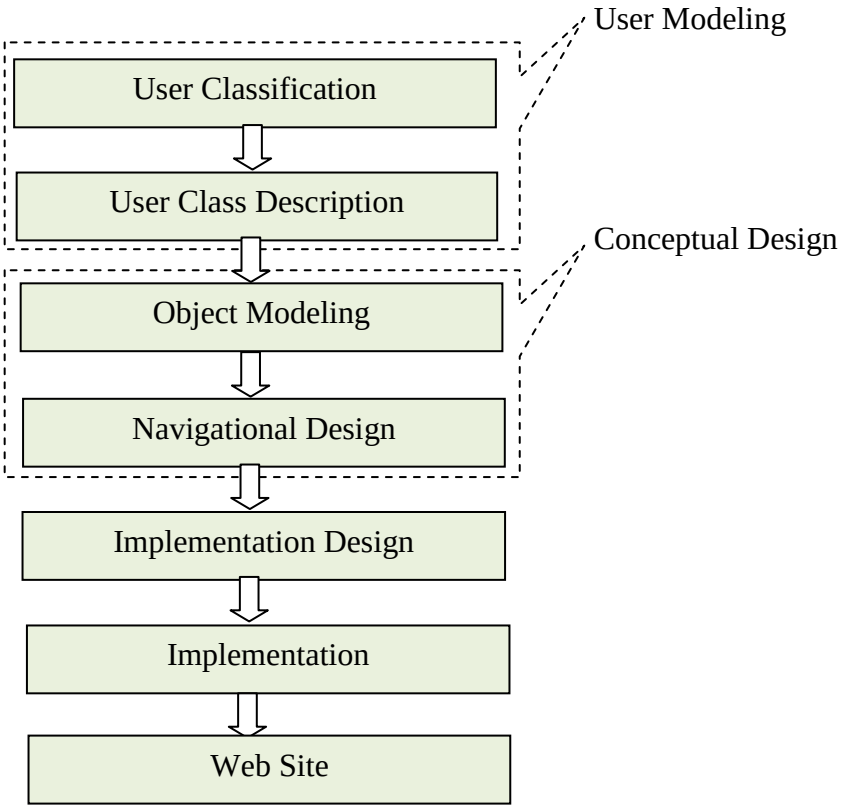


Figure 1 – Overview of WSDM (Web Site Design Method) Process

2. *Conceptual design phase*

This phase addresses the issues of object modeling and navigational designing. Object modeling helps to describe at length the information requirements and perspectives of different user classes. Navigational design phase helps to formulate the designing aspect of navigational tool for different users through the website.

3. *Implementation design phase*

This phase is aimed at designing the visual and appearance of website so that the users can feel a sense of satisfaction and appreciation of the website. It is basically a polishing touch on the conceptual design.

4. *Implementation phase*

The phase consists of comprehending actual website by converting it into chosen implementation environment (like, converting into HTML source).

2. User-based Design Process

Initially, in this process users and the criteria that users want to consider in using website are identified [4]. Importance is given from the viewpoint of users rather than from the viewpoint of the designer – as in traditional methods. Consequently, users become the integral part of website designing process, resulting in increase usability by trapping adequate information that the intended users want to see on website. Here, the information from potential users is collected and used in three different times in the process of website designing. This process consists of four following distinct phases. The overall process flow of user-based design process is depicted as in Figure 2.

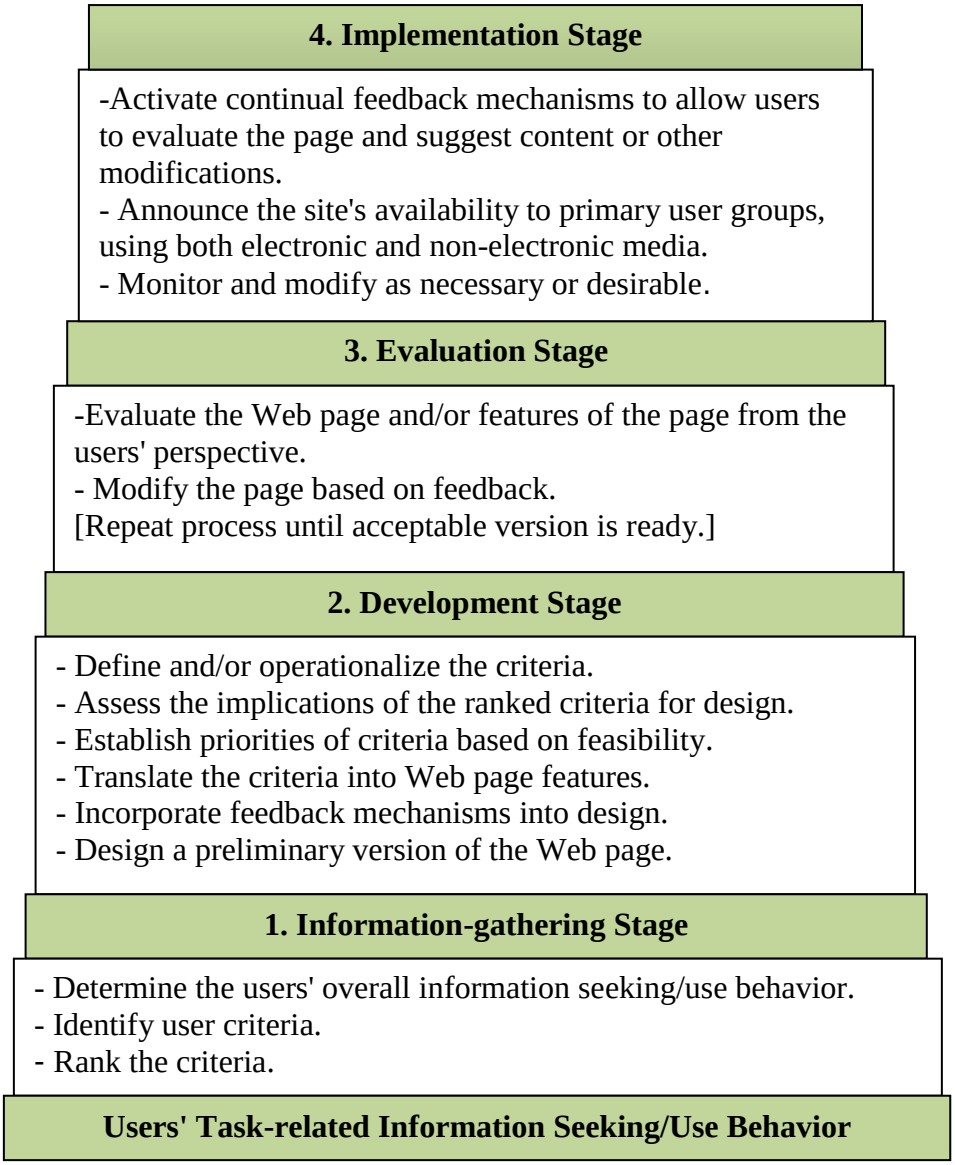


Figure 2 - Overview of User-based Design Process

1. *Information gathering phase*

In this phase, users' are asked to identify their desired features and information for the website. The users' overall information and behavior are collected through a set of questionnaires, interviews or other primary research method. Based on the survey results, a set of criteria for the website usage are developed and prioritized.

2. *Development phase*

The set of criteria collected in earlier phase are defined and assessed to find out the implication and feasibility for being incorporated into the website. These criteria are translated into web page features. Users are solicited for feedback and necessary changes are incorporated in designing process. During the end of this phase, a draft version of preliminary web page is developed.

3. *Evaluation phase*

Users are asked to evaluate the draft version of preliminary web page in order to verify the usability and to determine all important users' criteria are included on web pages. User groups are solicited to use the website and provide feedback for improvement through specific questions and interviews. This process is iterated until an acceptable version of web site is ready from the user's perspective.

4. *Implementation phase*

During this phase, the site availability is formally announced to targeted users using both electronic and non-electronic media. A continual improvement mechanism for modification is placed, so that feedback from the users can be incorporated into website.

3. Human-centered Design Process

This process describes the general approach for user involvement in new product development process [10]. It has been certified as International Standard (ISO 13407: Human-centered design process) for incorporating users' perspectives (like usability, form factors, content, etc.) throughout the development of a new product. However, the model can be customized according to the needs of actual end-users and type of new products. It consists of four general steps to gather and incorporate the users' behaviors and perspectives into the final product design:

1. *Specify the context of use*

This phase deals with identifying the intended users, users' perception on the new product and final product characteristics. This step guides early design decisions and form a foundation on how product usability is evaluated. This process helps to define a clear match between the technology and form-factor of a product through a series of discussions and consensus with the stakeholders and developers, before the product concept is designed.

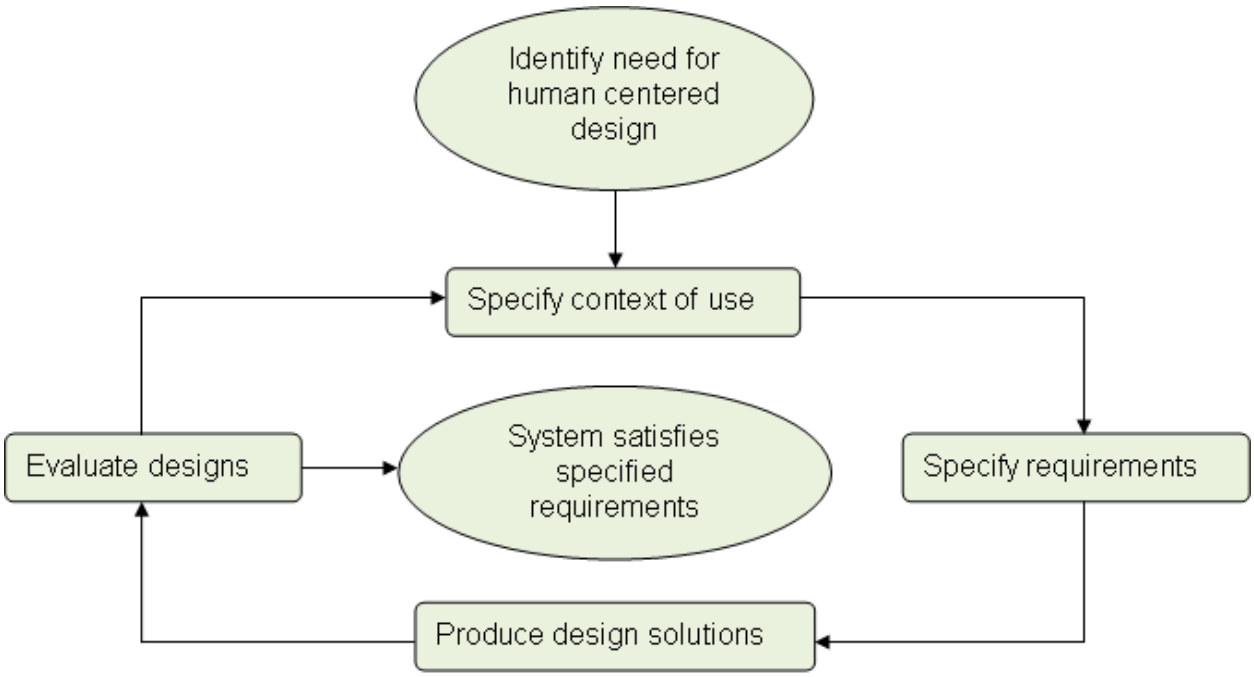


Figure 3 - Overview of Human-centered Design Process

2. *Specify requirements*

This stage helps to define the specification and functional requirements of a product. Robust usability criteria are set with appropriate trade-offs identified between different requirements. Criteria for evaluating minimum effective performance requirements, success or failure of task performances and user satisfaction of a product are determined during this phase.

3. *Create design solutions*

This phase begins with designing of the conceptual prototype. Simulating tools or paper prototypes are generally used to concretize the design solutions. Intended users are solicited to use the prototypes and are asked to give feedback for further improvement. This process is iterated until a design objective and a set of criteria agreed in the earlier phase are attained.

4. *Evaluate designs*

Evaluation aims at collecting users' feedback for incorporating into the design process and to assess whether users' objectives are met. A group of potential users are provided with working prototypes and are asked to provide feedback. This process is repeated until an acceptable level of user's satisfaction is attained. This is important process because incorporating feedback into designing process becomes more expensive once the product is fully defined. In early designing phase important is given for obtaining feedback and once the designing process attains more realistic prototype, emphasis is given to assess whether users' objectives are attained or not. The overall process flow of human-centered design process is depicted in Figure 3

Process Taxonomy

The following table (Table 2) is a summary of all the processes discussed above;

Process Name	Description	Stages	User Involvement
WSDM **(Web Site Design Method) Process.**	Users are classified into user classes and available data is modeled from the viewpoint of the different user classes.	1. User-modeling phase. 2. Conceptual design phase. 3. Implementation design phase. 4. Implementation phase.	Users are involved in first phase only.
User-based Design Process.	Users are involved at each step of the designing process.	1. Information gathering. 2. Development phase. 3. Evaluation phase. 4. Implementation phase.	Users are involved in all development stages.
Human-centered Design Process.	This process describes the general approach for the involvement of users in new product development process.	1. Specify the context of use. 2. Specify requirements. 3. Create design solutions. 4. Evaluate designs.	Users are involved in all stages.

Table 2 - Process Taxonomy

Process Selection

All three processes overlap in many areas and all of them can be used in our case study. However, we selected the User-Based Design Process to apply in our case study for its compatibility, clarity, and user involvement in the process. User-Based Design is a common process for web-based product development and this article uses a web-based tool as an example. Secondly, this process provides clear guidelines of how and where users can be involved in the development process. Finally, this process was chosen because of the structured involvement of user at each step of the development process. As you can see in Figure B, users are involved in each step of the process and that is very important for the development of our case study.

UOD Methodology

Introduction & Analysis

The user-oriented design process models discussed previously encompass how users can involve in new product development process. As the first stage of user-based process, developers need to gather user information by identifying and prioritizing user behavior and user criteria. To collect user data, developers have to apply appropriate methodologies. According to literature reviews,

there are six well-known methodologies to accumulate information in a user-oriented design process:

1. **Focus groups**

A focus group method is a group of invited participants that contribute to share their thoughts, feeling, attitudes and ideas on a topic that determined by researchers [11]. According to the elements of focus (Table 3), the focus group usually involves a group of 6-12 participants discussing a range of topics that led by a well experienced moderator [11, 12]. The output from focus groups will provide directly into future design and strategy decisions. Focus groups are an ideal way to find out what information users want and do not want in our design, discover things that our design should be doing, gather feedback on existing ideas for our design, and get into the minds of users. There are some benefits of a focus group that participants are able to develop more ideas when other participants in a focus group come up with their idea. Additionally, participants discuss and comment on each other ideas [11]. Due to these reason, participants will be able to point out weakness or limitation of those ideas.

Element	Focus Groups
Format	Group session
Size	8-12 per session; invite twice as many
Length	1.5 to 2 hours
Number of sessions	Varies; should be more than 1
Participants	1. Selected; by invitation only 2. Similar characteristics
Forms of data	1. Conversation, including tone of voice 2. Silences (words and issues) 3. Body language
Data collection	1. Audiotape 2. Transcribe
Moderator	1. Flexible yet focused 2. Uses interview guide; modify based on early sessions
Formats for reporting	1. Selected quotations 2. Analysis of repeated themes

Table 3 - Elements of focus groups [12]

The focus group has some limitations such as each participant response is not considered independent or unbiased, the moderator needs to have experience in both managing the session and analyzing results [11, 16].

2. **Usability testing**

Usability testing offers an opportunity to receive feedback from the target users. This method usually places emphasis on user requirements, users practical measurement, and users interface design [13, 14]. Usability tests are conducted in usability area such as laboratories that are operated by people who are experts in user-interface design and testing. These laboratories are

equipped with an area that allows the designers to observe the testers overlooked. This method is used in large technology companies such as Apple, Microsoft and IBM [13]. Commonly, a focus group takes place in prepared room including microphones, cameras, speakers, and other observing and recording equipment. An observation room can be viewed next door with a large one-way mirror or a remote that can be observed real-time. Negatively, due to the operating cost of usability testing, this method isn't practical for start-ups or small organizations with low budgets.

There are many techniques that can be used with usability testing. First, Think Aloud technique, the invited users will be asked to express all steps of their actions during the test. Next, videotaping is a technique used for reviewing activities of the participants in order to extract information that direct researchers or developers to problems in their designs. In addition, interviews and questionnaires, these two techniques can be acquired to gain more insight into user satisfaction. The researchers and developers will be able to understand and evaluate activities that can help solve design problems [14, 15, 17].

The test takers are observed by researchers and developers in order to gather information as much as possible when the tests have been accomplished. After that, the researchers and developers should ask the participants for recommendations to gain more insight into their thoughts.

3. Card Sorting

Card sorting is a technique to discover how users group information into categories. Participants are asked to categorize and organize content in a way that makes sense to them [17, 19]. For example, participants review card items of website categories and then group these items into categories in a way they like. As a result, the sorted card will reveal relationship that helps developers reorganize and improve their site content. Furthermore, card sorting helps designers and developers learn how users think about content and how they would organize the information on designed website [17, 18].

There are two types of card sorting that can be used, open and closed card sort. In open card-sorting participants are asked to organize the cards into groups that make sense to them and then name each group. This type is typically used for investigative analysis of a category and illustrates how users group and understand the labels. On the other hand closed card-sorting allows participants to organize items into pre-defined categories. This type is suitable when developers have a set of categories and they want to know how users sort content item into each category [19, 20].

4. Participatory design

In participatory design, users who are involved in product development process are considered co-designers [23]. Users and developers can often misunderstand each other because of cultural differences. Sometimes the users are unable to understand the language of the designers. Using prototypes such as mockups, a paper-based outline of the screen of a webpage, or a product help reduce gap between users and designers [21]. Participatory design is most effective early in the

design process [21, 22]. It is always used to iteratively create the emerging design, which itself simultaneously forms and extract the research results by the designers, developers, and the participants who will use the design.

According to our literature review, participatory design is done in three basic stages: Initial exploration of work, Discovery processes, and Prototyping [23]. Initial exploration of work brings developers and users together to know each other. This can be done through observing work routines and workflow and team building activities. Discovery processes are used to prioritize workflow and clarify users' requirements. This stage is generally conducted on-site or in a conference room. Lastly, prototyping will be done by using information from discovery processes stage to create prototype products.

Using participatory design for product development processes have several benefits:

- Usable design will be improved by using Voice of Customer (VOC)
- Participants' skills can be both technical and non-technical
- Designer and developers have an opportunity to work and understand users
- Creating new technique that can be applied in future activities

5. Questionnaires

Questionnaires are a set of structured questions that are asked in a survey process. This gathering data method is one of the most widely used methods. Not only can this method be used for marketing research but it's also used for initial research such as Fuzzy Front End of New Product Development. Simplicity and complexity of questionnaires vary depending on the subject of a survey. The questions must be clear on the objectives of the questionnaire to avoid out of focus answers [24, 25]. The answers to these questions can give researchers valuable and useful information for developing products or services such as a website user interface.

6. Interviews

An interview provides valuable and useful sources of information. This method can present opportunities for valuable insight and perspectives of the participant [26]. The interview communicates experience and intuition of participants in the tasks that are directed by pre-designed questions. The questions should be managed within the related subject to avoid out of scope answers [25]. Interviewers should have at least two persons. The reason is one interviewer can conduct a listed question; therefore, the other can take notes during the session. The second interviewer who takes notes will not interrupt communication between the first interviewer and the interviewee.

After the session end, rough draft of the topic covered the information acquired immediately. This helps to ensure that interviewers memorize the key points of the discussion. Subsequently, interviewers can compose further aspect of the conservation from the outline.

Methodology Taxonomy

All six methodologies together, taxonomy, Table 4, can be created to illustrate potential and capabilities of each method. Each method can be used in different focus or stages depend on

purpose. For example, usability testing is mainly used to get user's feedbacks while they try new products that will be release to markets. The user's feedback may reveal some overlook problems that will be solved prior to launch the product.

Method	Cost	Output	Sample size	When to use	Pros	Cons
Focus groups	Low	Non-statistical	Low	Data gathering	- New ideas can be generated during a session - Get specific results from targeted group	- Weak results due to lack experienced moderator - Complicated results - Dominated Ideas
Usability testing	High	Statistical & Non-statistical	Low	Design & evaluation	- Overlooked problems can be point out - New solutions can be found during a session	- Location of testing - Overwhelmed information - Take time to analyze
Card Sorting	High	Statistical	High	Design	- Categories can be improved by rearranging - Adding or removing categories	- Lack of well categories can make complicated to participants
Participatory design	Low	Non-statistical	Low	Design	- Achieve most of participants' needs	- Design can be bias due to small sample size - Too many needs
Questionnaires	Low	Statistical	High	Data gathering & evaluation	- New solutions can be found on open-end questions	- Low responded rate - Results will be combined with viable and sloppy
Interviews	High	Non-statistical	Low	Data gathering & evaluation	- Quick respond - Depth interviews - New ideas can be generated - Flexible of schedules	- Bias results can be considered when sample size is small

Table 4 - Methodology taxonomy

UOD Method Selection

Due to time constraints on this project and the uniqueness of our case study we have selected only two methods out of the six methods discussed earlier. The two selected methods are interviews and participatory design. Interview is one of the most common methods for collecting data in qualitative research. This method has been chosen for the following reasons:

- It allows participants to provide rich, contextual descriptions of using the tool.
- It is valuable and useful sources of information.
- It can present opportunities for a personal and variable inside perspective of the participant.
- Brings to the surface the deeper factors about complex situations

- It is flexible method
- Interview guides are easier to develop than surveys
- Can capture non-verbal information
- Interviewer has the opportunity to clarify questions

The participatory design method was chosen because some of the current users are capable and willing to participate in the development process.

Literature Review Key Findings

In general User-Oriented Design is a user driven approach in which the user is the focal point in new product design. It focuses on providing solutions for user and enhancing the external design of the product. UOD focuses on user experience and views quality from the user point of view. It relays on user measurement throughout the new product development process. The UOD focus on current and future customers and develop just user validated designs [1]

In regards to users, there are three types of users: primary, secondary, and tertiary [2]. Primary users are those persons who actually use the product; secondary users are those who will occasionally use the product or those who use it through an intermediary; and tertiary users are persons who will be affected by the use of the product or make decisions about its purchase. The successful design of a product must take into account the wide range of stakeholders of the new product. However, not everyone who is a stakeholder needs to be represented on a design team, but the effect of the product on them must be considered.

Involvement of users' in new product development process has become important for the new product success. UOD designing approach on new website development process essentially helps to add functionality on new websites that are not envisioned solely by a company's design team. This is a multidisciplinary activity, where users' viewpoints are the center of focus for the design process and iterated simultaneously between the design and evaluation stages of new website development cycle. The iterative process helps to add the users' feedbacks and comments on a new websites design process. UOD approached also has the following benefits for both users and product designers:

1) Enhance the usability of new website and users' satisfaction.
2) Decrease company's expenditure on technical support, training, and advertising cost particularly on usability.
3) Competitive advantages.
4) Reduce the cost on redesigning.
5) Increase market share.

In order to capture and incorporate the views of users in new website design process, a structural UOD framework should be developed with an iterative mechanism between the different stages of development for incorporation of users' feedback. The appropriate methods that help to

transfer the users' views into the new websites should be selected as per the goal and objective of developing websites.

The Limitations of UOD in developing new products are as follows:

1. In practice user input is commonly only solicited at the beginning and end of the product creation process.
2. User participants may not represent all customers.
3. Usability problems are uncovered during the Beta Testing Phase, these problems are nearly impossible to address at this stage in the development process.
4. Lead Users may not represent mass customers.
5. Costly, lengthy, and complex process.

Evaluation Criteria

From the literature review we developed a UOD Evaluation Criteria, shown in Table 5, that will be used to evaluate the implementation in our case study.

Criteria	Evaluation
Identify appropriate user type	
Solution focus (user needs, wants, and limitations)	
Prime focus on user measurement user priority of product and features	
User view of quality	
Focus on externals design	
Develop only user validated designs	
Add functionality to the new product	
Enhance usability	
Reduce redesigning cost	
Provide a competitive advantages for the company	
Effectiveness of Process Selected	
Effectiveness of Methods Selected	

Table 5 - UOD Evaluation Criteria

The Case Study

Abstract

This case study uses the literature findings to create a UOD process for a web based research tool for Technology Forecasting using Data Envelopment Analysis (TFDEA). The process uses methods, identified in the literature, to collect the user's needs, wants, and limitations. We show how an initial TFDEA product concept changes over a single iteration of our process. We then evaluate our implementation against the Evaluation Criteria from the literature findings. The evaluation is shown to be a useful aid and is recommended as an addition to the process. Based on the impact of UOD, the TFDEA project is encouraged to continue the UOD process, incorporating the Evaluation Criteria, to produce a solid concept and prioritized product feature list and product roadmap.

When the case study began, there was already a working web based technology forecasting tool created and used for research by Lane Inman and Tim Anderson (Inman, Anderson, & Harmon, 2006). Anderson provided us with a product concept [Appendix D] for what he envisioned the tool to be. With two PhD students, Anderson was continuing research into further uses of TFDEA, research to extend and improve the tool, and efforts to provide the tool to the public.

A Brief Introduction to TFDEA .

TFDEA is a technology forecasting tool developed by the Engineering and Technology Management (ETM) department at Portland State University (PSU) as an extension of Data Envelopment Analysis (DEA). DEA is a benchmarking tool that, when given the right inputs and outputs, can quickly process vast amounts of data to identify the best among the items compared. TFDEA utilized this feature of DEA and added a time dimension. By running DEA multiple times over a given time period, instead of using regression (a technique for identifying trends), TFDEA was able to accurately identify a trend that could then be used in forecasting.

For a more complete understanding of TFDEA see Inman, Anderson, & Harmon, 2006 *[27]*

UOD Process

From the literature we selected User-based Design Process because it was evident the users were involved in each step. However, when we began the case we found we wanted a clearer way of conveying the process and goals to the user group, so we created the process diagram in Figure 4 to clearly show the users how UOD was going to be implemented. Starting from the left the users are the focal point and, as the process progresses to the right, they provide their Needs, Wants, and Priorities through the implemented methods. The next step is to combine the feedback and update the product concept for the users to review. This cycle continues until the users agree on a concept proposal for the project. Once the users agree on the concept and priorities of the product features, the Process exits to a proposal and the prioritized feature list is converted to a roadmap. The roadmap is intended to clearly convey the project goals and the needed timing for each feature.

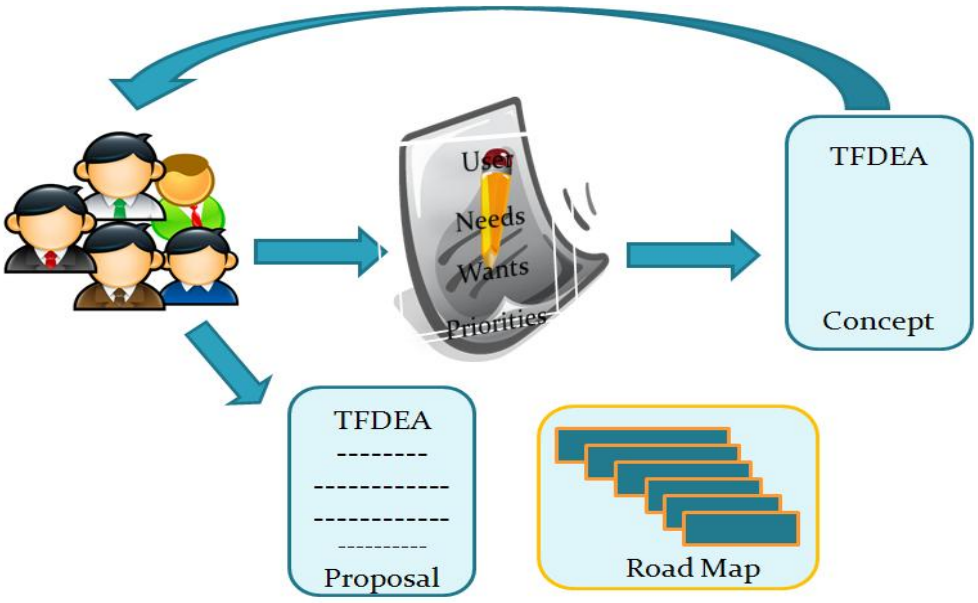


Figure 4 - UOD Process for Case Study

UOD Methods Used

From the literature we identified two UOD Methods, Interviews and Participatory Design, that would be appropriate for the first iteration of the above UOD process. These methods are used understand the users needs, wants, and limitations. Collectively, they will allow the end product to be what the users want.

Interviews

The following stages outline our interview process. The interviews also served as a platform for Participatory Design. Dr. Anderson and Sunny are both users that are involved in the ongoing development of this tool. It is understood that their feedback may be somewhat biased toward their interests, but we tried to mitigate this by including AnnMarie who is simply using the tool and we suggest conjoint analysis be used in future iterations of the process.

1- Setting the interview context
2- Making plan for the interview
3- Constructing questions
4- Starting and finishing the interview
5- Carrying out the interview
6- Managing data collecting during the interview

1- Setting the interview context:

Anderson played an important role in explaining the project. He pointed us to TFDEA articles to better understand what the tool can be used for, as well as provided an initial product concept. This preparation provided a good understanding for us to formulate appropriate questions for the interviews.

2- Making plan for the interview:

It is important to identify the content you would like to get from the interviews. We new the product would be a web based design, so we felt comfortable with any general topics that might come up in the interview related to this kind of interaction. The main topics we needed described by the users were, how the tool should be used and how the tool should work. We wanted the users to focus on what they thought and try to separate it from the technical implantations and restrictions known today. The following individuals were identified as the user group. Anderson is very involved at all levels of the project, Sunny would like to develop new variations of the model and quickly interact with the model, and AnnMarie would like to run a lot of data through the tool and find new applications for TFDEA. We decided to conduct the interviews individually, and in a comfortable conference room, to get each user's perspective and less restricted responses.

1- Dr. Tim Anderson - founder of TFDEA
2- Sunny – graduate student working on extending TFDEA model.
3- Ann Marie - graduate student interested in working with the TFDEA tool.

3- Constructing questions:

The questions and responses can be found starting in Appendix A. We asked the users general questions like, "What is the goal of TFDEA". These opened the users up to describe their understanding and what they expect the tool to do. A lot of information we gathered from the interview was based on free form discussion.

4- Starting and finishing the interview

One person was responsible for leading the interviews. Each interview was scheduled for a particular time and began with letting the user know the intended duration of the interview and what we were looking for as a result of the interview. We let them know that we would like to understand their opinion and preferences for how this tool should work and what it should do. The interviews were completed on time and by reviewing what we discussed and thanking the user for their participation.

5- Carrying out the interview

At the beginning of each interview we made sure the users were not restricting their thought to what web technologies are today or what the concept defines, but rather what they would like the tool to do if there were no technical restrictions. This seemed to really open up the users to think freely and quickly identify what they wanted. We then started the questions we developed and encouraged the user to express whatever came to mind. We filled in the responses to questions, sometimes from general discussion, and completed the interviews by summarizing what we talked about and then asking for the user to prioritize the features according to their needs.

6- Managing data collecting during the interview:

In each of the three interviews, at least one of the interviewers took notes. We then reviewed the responses as a group to analyze the feedback. Table 6 summarizes the questions and responses for each interview session, Actual questions and responses can be found in Appendices A, B, and C.

Interview Results and Findings

The interview results are organized in three categories: Compatibility, User Support and Data Flow, and compiled in Table 6. Note the three concept features required by all three interview participants consisting of data upload capability, model selection and downloading of results and tool configuration.

	Dr. Anderson	Sunny	Ann Marie
Version Control/Compatibility			
GLPK, submit/request new models	V	V	
Roadmap, prioritization of new developments	V		
User Support			
Disclaimer and copyright	V		
User Guide (incl'd terms and GUI options)	V		
Trouble ticket tracking (user submits issues/requests)	V		
Quickly accessible on any computer		V	V
Immediate results		V	V
Data Flow	V		
Data upload capability	V	V	V
Intial data verification prior to processing	V		V
Data includes source reference	V		
Select model	V	V	V
Login requirement for uploading data	V		
Allow other users to use existing data in tool	V		
Data public by default with option to make private	V		
Data size requirement	V		
Save configuration	V	V	
Download results/configuration	V	V	V
Add/edit Zotero citation	V		
Change output settings (numerical/graphical)		V	V
File upload or manual data input		V	

Table 6 - Feedback categorized for each user

One of the key findings in the case study was that the original concept did not contain all of the content identified in the interviews. This suggests UOD was not previously implemented. Table 6 also identifies agreement of features among users in the user group. The agreement among features revealed two things; 1) users had slightly different priorities, for example Version Control/Compatibility section. 2) The users are describing two different timelines for the tool. Anderson is describing his long term goals for the project, which all users were encouraged to do, but the other two users were focused on using the tool and how they would like to interact

with it. The difference in scope is important to identify, because some of the features Anderson identified will require input from additional users. This limited feedback for some features and it is recommended that additional users are identified to give proper feedback.

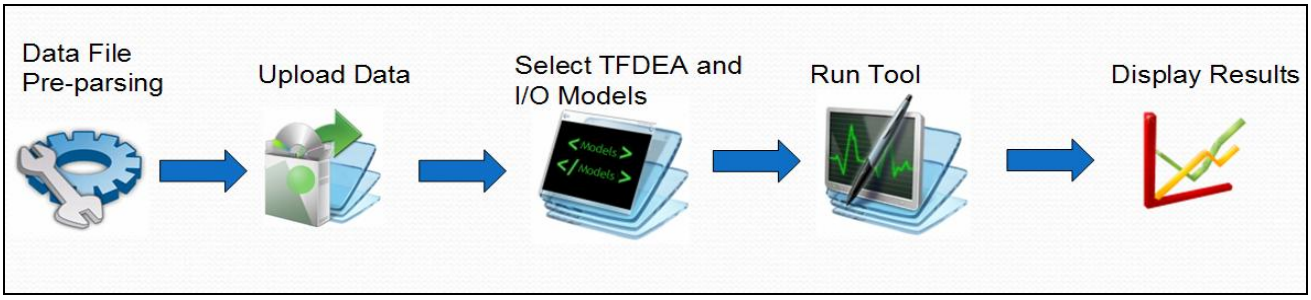


Figure 5 - TFDEA concept

In order to better understand the tool we create a flow diagram to show what the users would have to do to interact with the tool. Our flow analysis of the original concept Anderson provided, shown in We felt this was, requires 5 steps to run the tool. We felt this was too cumbersome to facilitate the way users are accustomed to interacting with web pages. Our analysis of the flow determined it would take 5 steps to run the tool.

Next, we incorporated the interview feedback into the product concept [Appendix E] to develop a new flow. You can see in the number of steps is reduced from 5 steps to 3. This is done by grouping the tasks that would likely be done at a given state. By making to major states, one for user input and the other for working with the results, the user can interact with the needed features and then move between states when necessary

After a single iteration of the process the users have a new flow to evaluate and a more complete set of features to prioritize.

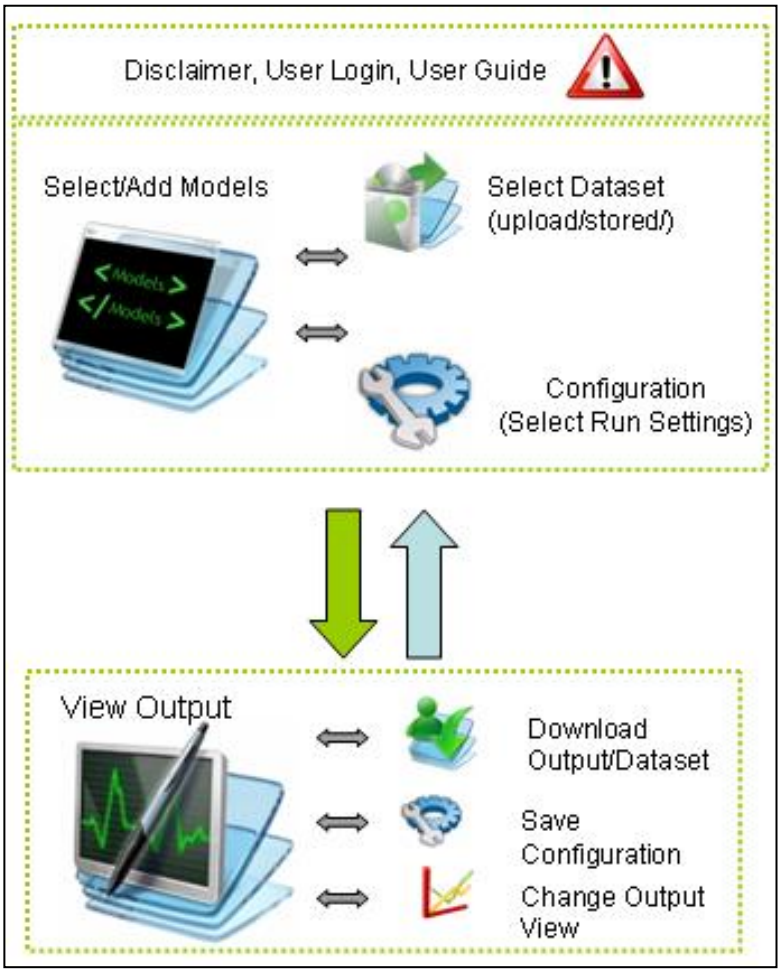


Figure 6 - Concept Flow from first iteration

Evaluation of Our Process

The positive impact of our UOD implementation is clear from the case study results. In Table 7 we show the results of an evaluation against the Evaluation Criteria we described above in the literature findings.

Criteria	Evaluation
Identify appropriate user type	Based on the user feedback, there is a short term and long term scope. For the short term scope the appropriate users were involved. For the long term scope, additional users must be identified.
Solution focus (user needs, wants, and limitations)	Each user provided feedback on what they need the product to do.
Prime focus on user measurement user priority of product and features	Each user was asked to prioritize the features of the product and we recommend additional methods to be used to further aid in this process.
User view of quality	The iterative nature will allow the users to evaluate the product quality as the concept progresses.
Focus on externals design	Users involved only know how they would like to use it, but as the product is accessible to more users the product may not be considered to be sufficiently designed.
Develop only user validated designs	Users are asked to score the product features, this focuses the design on the features that the users want.
Add functionality to the new product	The product concept clearly changed once the user feedback from a single iteration was incorporated. It is clear there was missing functionality.
Enhance usability	The concept flow was significantly improved from the user feedback. The reduction of needed steps to use the tool was reduced from 5 to 3.
Reduce redesigning cost	The continuation of this implementation will allow the project to create a concept that the intended users need and will provide a roadmap for developing the product according to the features ranked most important. This will minimize the redesign cost, because the users are defining the product they want.
Provide a competitive advantages for the company	The long term scope is intended to identify PSU ETM Department as the home for TFDEA research.

Effectiveness of Process Selected	The transformation of the concept shows this process is already helping. The addition of this evaluation as part of the cycle should be a good improvement.
Effectiveness of Methods Selected	The methods identified were effective. Additional methods were also identified to be incorporated in future iterations. This evaluation would aid in this process.

Table 7 - UOD Evaluation of Implementation

The evaluation was a helpful exercise to critically evaluate the implementation. We recommend that this evaluation should be added to the process to help facilitate a good UOD implementation throughout the project.

Future work

As project continues the project team should re-evaluate using additional methods such as Card Sorting, Focus Groups, and Usability Testing. The above direction, to add the evaluation to the process, could ensure that this question is asked and other methods are considered. Card Sorting would be a good method to add in the next couple of iterations to aid in prioritizing features. Though the user base is small, it is one technique that could help the users prioritize the features.

Another method to consider is conjoint analysis. For the first concept iteration a simple Depth interviewing technique was used. This technique uses an open, semi-structured approach to gather information during the interview sessions. During the meetings the interviewees were asked a set of simple questions regarding the product. If further clarification was needed additional questions were asked to probe further. Another technique that should be considered for future work is the conjoint method. The conjoint method would present the user with a variety of features and capabilities. This list, which could vary in order and type throughout the interview, should be comprehensive and include prior feedback from the first interview sessions. Using regression techniques we can then better infer the optimum or higher valued product requirements

Focus Groups and Usability Testing could also be incorporated as the project progresses from concept to functional content. As the users agree on a concept and they follow the process to create a proposal, they will have a prioritized list of new content that must be developed. As the proposed framework shows, this prioritized list can then be used to create a roadmap for the project development\

.

Conclusion

User-Oriented Design is a new product design approach in which the needs, wants, and limitation of end users are given extensive attention at each stage of the NPD process. UOD has a positive impact on New Product Development when it involves the right Users at the right time, with the right Process and Methods. The implementation of UOD can make or break the NPD process.

The first part of this paper looked into how users could be involved in the NPD process and presented three processes and six methods. The processes are the framework or structure that illustrate when to get user involve. The methods are the ways by which user needs, wants, and limitation are captured. The second section of this report is a case study that examines the impact of a UOD implementation on a web based product. A literature based evaluation shows the implementation is currently appropriate, and the transformation to the product concept with UOD shows the importance and benefit of using UOD.

More research is needed to guide those implementing UOD to select a process, methods, when to use UOD, and the right users for the project at hand. Methods seem to be fairly well defined in the literature with examples, pros and cons, but they are useless if the correct users are not selected. The users selected for UOD must represent the intended customer. For example lead users can provide comprehensive details about how a product could be used but unless the assumed use cases represent the target market the information may be misleading.

To successfully implement UOD requires additional time and commitment. This should not be a deterrent, but rather an emphasis to add the needed time to the project schedule. Though more time is needed for the process, it is clear from the case that even a single iteration of a simple UOD process can accelerate the process of identifying what is expected by the users. The iterative nature of UOD then allows the involved users to respond to their own feedback, increasing accuracy and clarity of user needs, wants, and limitations to bring a more successful product to market.

References

[1] Veryzer, R., & Borja de Mozota, B. (2005). The Impact of User-Oriented Design on New Product Development: An Examination of Fundamental Relationships. Journal of Product Innovation Management, 22(2), 128-143. http://search.ebscohost.com.proxy.lib.pdx.edu,

[2] Eason, K. (1987) Information technology and organizational change. London: Taylor and Francis.

[3] O.M.F. De Troyer and C.J. Leune, *WSDM: a user centered design method for web sites*, Computer Networks and ISDN Systems 30 (1998) 85-94

[4] Eileen G. Abels, Marilyn Domas White and Karla Hahn, *A user-based design process for Web sites*, Internet Research: Electronic Networking Applications and Policy, Volume 8 · Number 1 · 1998 · 39–48

[5] Olga De Troyer, Audience-driven Web Design, WISE Research group, Vrije Universiteit Brussel

[6] H. Maurer. Hyper-G, *The Next Generation Web Solution*, Addison-Wesley, Reading, MA, 1996

[7] J. Nielsen, *Multimedia and Hypertext the Internet and Beyond*, Academic Press, New York, NY. 1995

[8] D. Sano, *Designing Large-Scale Web Sites*, Wiley Computer Publishing, New York, NY, 1996

[9] Robert W. Veryzer and Brigitte Borja de Mozota, *The Impact of User-Oriented Design on New Product Development: An Examination of Fundamental Relationships*, Product Development & Management Association, Journal of Product Innovation Management, J PROD INNOV MANG 2005; 22:128-143

[10] *Usability Professionals' Association, promoting usability concepts and techniques worldwide*, Available at: http://www.upassoc.org/usability_resources/about_usability/what_is_uc... Retrieved on 25 October 2009

[11] D.L. Morgan, "FOCUS GROUPS," *Annual Review of Sociology*, vol. 22, 1996, pp. 129-152.

[12] N. Grudens-Schuck, B.L. Allen, and K. Larson, "Focus Group Fundamentals," *Iowa State University, University Extension*, May. 2004.

[13] C. Abras, D. Maloney-Krichmar, and J. Preece, "User-Centered Design," *Berkshire encyclopedia of human-computer interaction*, Berkshire Publishing Group LLC, 2004, pp. 763-767.

[14] W. Brinkman, R. Haakma, and D. Bouwhuis, "Component-Specific Usability Testing," *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions*, vol. 38, 2008, pp. 1143-1155.

[15] Evolt.org, "Getting Started with Usability Testing" [Online], Available: http://www.evolt.org/article/Getting_Started_with_Usability_Testing/4090/1604/ Retrieved on 11/05/2009.

[16] Webcredible, "Focus Groups" [Online], Available: http://www.webcredible.co.uk/user-friendly-resources/web-usability/focus-groups.shtml Retrieved on 10/25/2009.

[17] Michael D. Levi and Frederick G. Conrad, "Usability Testing of World Wide Web Sites", Bureau of Labor Statistics (BLS) [Online], Available: http://www.bls.gov/ore/htm_papers/st960150.htm Retrieved on 10/25/2009.

[18] Gerry Gaffney, “What is Card Sorting?,” *Usability Techniques series*, Information & Design, 2000.

[19] E. Olmsted-Hawala, “Card sorting, information architecture and usability: Adding in our users' perspective to re-design the census bureau Web site,” *2006 IEEE International Professional Communication Conference, IPCC, October 23, 2006 - October 25, 2006,* Saratoga Springs, NY, United states: Institute of Electrical and Electronics Engineers Inc., 2006, pp. 27-33.

[20] R. Sinha and J. Boutelle, “Rapid information architecture prototyping,” *DIS2004 - Designing Interactive Systems: Across the Spectrum, August 1, 2004 - August 4, 2004,* Cambridge, MA, United states: Association for Computing Machinery, 2004, pp. 349-352.

[21] F. Kensing, J. Simonsen, and K. Bødker, “MUST: A Method for Participatory Design.,” *Human-Computer Interaction*, vol. 13, Jun. 1998, p. 167.

[22] F. Kensing and J. Blomberg, “Participatory Design: Issues and Concerns,” Computer Supported *Cooperative Work: The Journal of Collaborative Computing*, vol. 7, Aug. 1998, pp. 167-185.

[23] C. Spinuzzi, “The Methodology of Participatory Design,” *Technical Communication*, vol. 52, May. 2005, pp. 163-174.

[24] Management Alternatives Pty Ltd, “Questionnaires” [Online], Available: http://www.mapl.com.au/questionnaires/quest2.htm Retrieved on 11/20/2009.

[25] C.E. Wilson, “Designing useful and usable questionnaires: you can't just "throw a questionnaire together",” *interactions*, vol. 14, 2007, pp. 48-ff.

[26] M.H.N.M. Nasir, N.H. Hassan, and M.K.M. Nor, “Participatory user centered design techniques for a web information system for stroke,” *2008 International Symposium on Communications and Information Technologies, ISCIT 2008, October 21, 2008 - October 23, 2008,* Vientiane, Laos: Inst. of Elec. and Elec. Eng. Computer Society, 2008, pp. 557-562.

[27] Inman, T.R. Anderson, and R.R. Harmon, “Predicting U.S. jet fighter aircraft introductions from 1944 to 1982: A dogfight between regression and TFDEA,” Technological Forecasting and Social Change, vol. 73, Nov. 2006, pp. 1178-1187

[28] Mayhew, D. J. (1999). The usability engineering lifecycle. San Francisco, CA.: Morgan Kaufmann Publishers, Inc.

[29] Lai, H., Lin, Y., Yeh, C., & Wei, C. (2006). User-oriented design for the optimal combination on product design. International Journal of Production Economics, 100(2), 253-267. http://search.ebscohost.com, doi:10.1016/j.ijpe.2004.11.005

[30] Abels, E.G., White, M.D., Hahn, K. (1997a), " A user-based design process in Web site design", College Park, MD: College of Library and Information Services, University of Maryland

Appendix

Appendix A: Interview Responses (User 1 – Dr. Anderson)

What is the goal of the TFDEA tool and how will it be implemented?

TFDEA is provide a tool for people outside PSU to run DEA/TFDEA and other models accurately and correctly as well as being a research tool for furthering the field of DEA and TFDEA to keep one step ahead of the community. Must be something that can be built upon.

Define the current TFDEA tool concept and use case?

TFDEA is an extension of DEA. DEA is a benchmarking tool that, when given the right inputs and outputs, can quickly process vast amounts of data to identify the best among the items compared.

Which features are necessary and which ones are good to have?

The necessary features:

- Internal usable tool for research
- Web accessible version for internal use
- Proven Provide a way to upload data
- Data should have reference to source of data
- Ability to submit/request new models
- Allow other users to use existing data in tool
- Login requirement for uploading data
- Data should be public by default, but must be able to be private
- Web interface for outside users

The optional features:

- Possibly prelim data check
- Data may have a list of references where the data is sited
- Ability to output the recipe for publication use
- Help info for terms and options in interface

What are the risks associated with this product?

- Software packages versioning compatibility
- Licensing need
- False blame for user mistakes
- Mitigated by ability to output of configuration
- For research purposed, provided at no charge
- Publishing work by other authors

How should new models and data be incorporated in the tool?

- Data uploaded capability
- Initial data verification prior to processing
- Data include data references
- Submit/request new model
- Login requirement for uploading data
- Allow other users to use existing data in tool
- Data size requirement
- Export and download results

How should the results be presented to the user?

- Web accessible version for internal use
- Proven Web interface for outside users

What form of security is required (login, domain user, etc.)?

- Trouble ticket tracking (user submit issues/requests)
- Login requirement for uploading data
- Initial data verification prior to processing
- Save software configuration (model options/field selection) per run/recall each run per timestamp
- Data should be public by default, but must be able to be private

What expectations do you have for support?

- GLPK, new models
- backward compatibility
- Roadmap, priorities of new development

Appendix B: Interview Responses (User 2 – Sunny)

What is the goal of the TFDEA tool and how will it be implemented?

Help people adopt TFDEA as the tool for forecasting

Which features are necessary and which ones are good to have?

The necessary features:

- Provide a way to upload data
- Ability to edit program
- Get results
- Ability to modify code/program to improve/change TFDEA methodology
- Different ways of showing the results: Show Lambda, phi, or both
- Ability to remember previous selection
- View results on screen and ability to download data (comma delineated)

- upload and download dataset
- Ability to submit/request new models
- Export and download results
- Run independent of internet/network connection

The optional features:

- Quickly accessible on any computer
- Immediate results
- Choose model to run
- Compare different times while the tool is running
- Input data by hand
- Easier to open and close program (no installing)

How should new models and data be incorporated in the tool?

- Quickly open TFDEA, add new data, select model and options
- Different ways of showing the results: Show Lambda, phi, or both
- Input data by hand

How should the results be presented to the user?

- View results on screen and ability to download data (comma delineated)
- Easier to open and close program (no installing)
- Upload and download dataset
- Different ways of showing the results: Show Lambda, phi, or both

What form of security is required (login, domain user, etc.)?

- Ability to modify code/program
- Save software configuration (model options/field selection) per run/recall each run per timestamp

What expectations do you have for support?

- GLPK, new models
- Roadmap, priorities of new development

Appendix C: Interview Responses (User 3– Anna Marie)

What is the goal of the TFDEA tool and how will it be implemented?

TFDEA to be used in government and/or private for technology forecasting and risk assessment.

Which features are necessary and which ones are good to have?

The necessary features:

- Provide a way to upload data
- Initial data verification prior to processing
- State of the Art (SoA)
- Rate of Change (RoC)
- Independent from network connection
- Away from VM
- Ability to submit/request new models
- Export and download results
- Run independent of internet/network connection

The optional features:

- Quickly accessible on any computer
- Immediate results
- Graphing output
- Download Output
- Statistical Error checking
- Start forecast date
- Show Super Efficiency
- Well formatted output

How should new models and data be incorporated in the tool?

- Data uploaded capability
- Initial data verification prior to processing
- Submit/request new model
- Export and download results

How should the results be presented to the user?

- Graphing output
- Input dataset and download dataset
- Well formatted output
- Immediate results

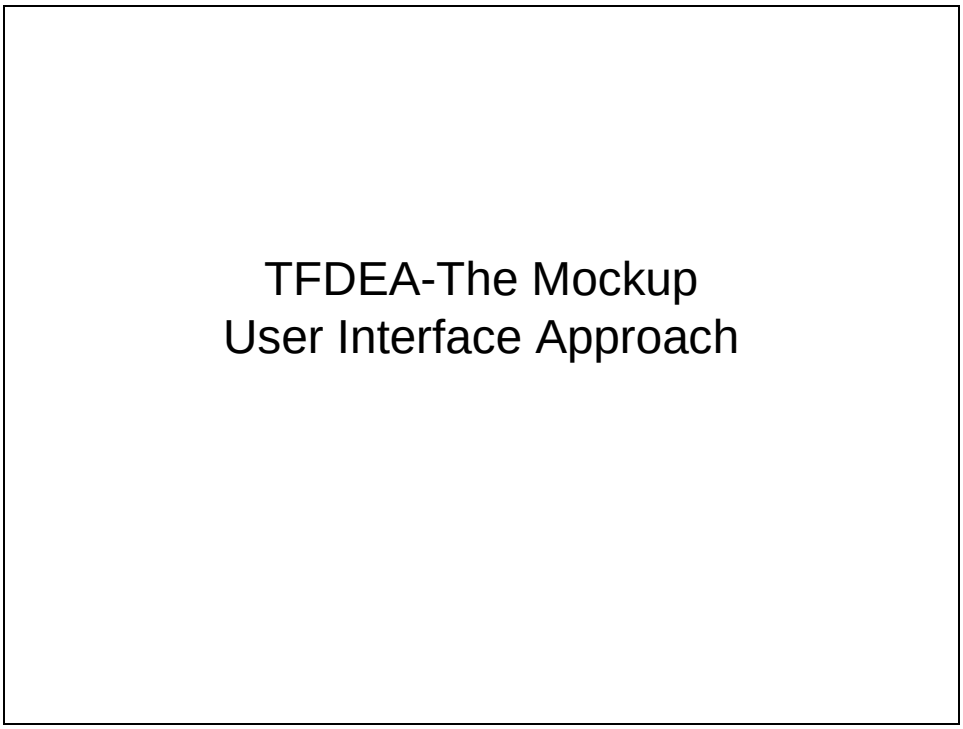
What form of security is required (login, domain user, etc.)?

- Run independent of internet/network connection
- Quickly accessible on any computer

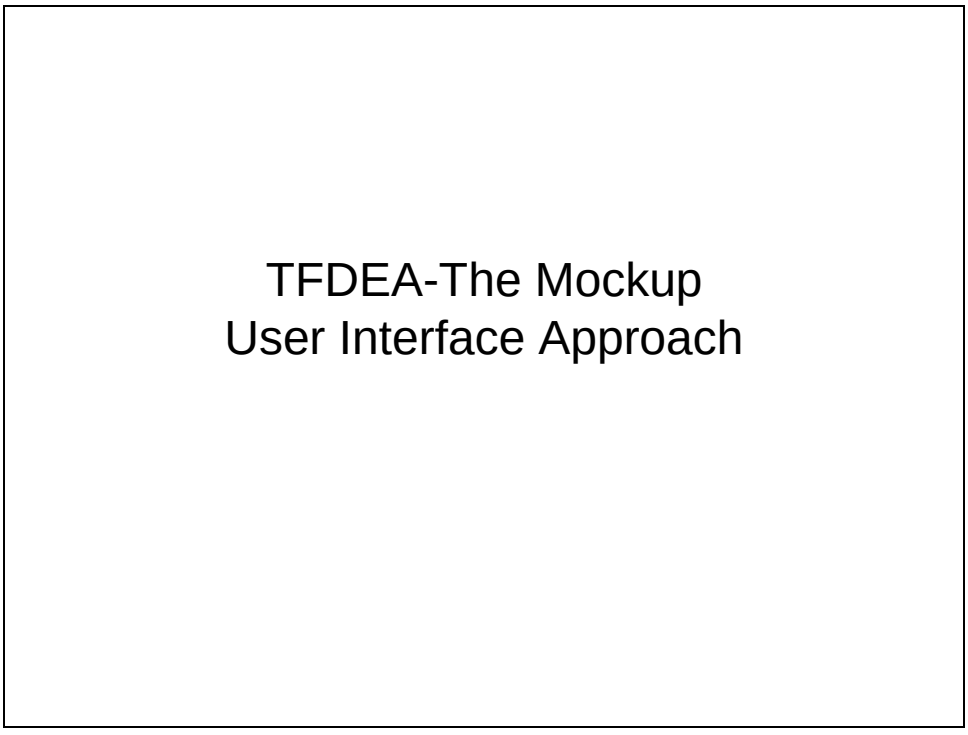
What expectations do you have for support?

- GLPK, new models
- Roadmap, priorities of new development

Appendix D: Anderson's Original Concept ***(embedded ppt)***



Appendix E: UOD Adjusted Concept (*embedded ppt)*



A Print out of the PowerPoint is attached