

Methodological Approach to Design Problem and Usability

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Abstract: Problems in user-centered design are often not specified precisely because of the inability of the client to understand the exact requirement or because a complete clarification requires inevitable initial exploration. However, an imprecise specification should not prevent initiation of the problem. It is important that designer and client continuously communicate during the entire design process to make sure that they agree with the desired outcome. In this paper we present and illustrate a methodological approach for the user interface design problem. Most software engineering methods follow a common methodological tradition that normally seek to control the complexity and fluidity of design through techniques that filter the information to decompose the problems under consideration. In this article, we suggest that the solution to the design problems consists of a complete specification of the set of components and their relations that together describe an artifact that delivers the functions and satisfies the constraints.

Keywords: *User-centered Design, Human computer interaction, Prototype, Electronic signature, and Usability Evaluation*

I. Introduction

Like any other software activity, design work takes place in different social contexts: corporations, industries, technology development centers and so forth. In each context there may be constraints on possible methods or solutions. Many constraints in design originate in the organizational structures within which design work is developed. Schedules and resources are often assigned in ways that create on-going conflicts between developers and engineers. The discordant of these constraints can leave designers in a difficult position with respect to their primary goal of meeting the needs and concerns of the people who would use the system. Many companies, despite considerable investment in latest technologies, still have difficulties to achieve the best user friendly design in practice. According to Page et al. [1], Microsoft has more than 50 usability labs worldwide. More than 8,000 people participate in their usability studies yearly.

Yet they release software with many usability problems. Users' needs frequently change. Building systems with adaptive capabilities requires providing flexibility as the need changes, without having to wait for the next version of the software. Even the best systems in the market are futile until people understand the software capabilities and can use the software with ease.

Ultimately design problem solving is a complex activity involving a number of subtasks and potential alternative methods for each subtask. We proceed to investigate the available methods and the knowledge and inference requirements for these methods. Understanding human computer interaction will allow the interface designer to produce interfaces that are more users friendly, thus, extending the impact of computing and communication to a diverse set of users within many domains. The full process of artifact development typically encompasses numerous subsidiary processes such as conceptual design, task analysis, prototype testing, and usability evaluation. There can be little doubt about the benefits of insight into the underlying principles involved in complex user and system characteristics and behavior which can help us understand how to better an interface, if it was not set right previously. Such an understanding can inform design before prototyping and user testing are set, and can also highlight the reasons for users' problems.

Ceaparu [2] suggests the importance of proper analysis, design, and an understanding of human behavior to create a successful interface design. Thus, it is important to empathize with customers, understand their needs, know the tools and technologies they tend to use, and visualize their social and organizational context. According to Carroll [3], designers of information systems and applications face a disturbing reality of identifying the problems in the anticipated software design. Even though the designers have plenty of opportunities to create systems that make a huge difference, it is the real problems that need to be resolved are never clear. Further, it is inevitable to unequivocally identify and suggest solutions to these interactive problems, especially when there exists plenty of available opportunities

to correct them. Maintaining a continuous focus on such situations and the consequences from human work and activity promotes learning the structure and dynamics of problem domains, observing usage situations from different perspectives, and managing tradeoffs to reach usable and effective design outcomes [4], [5].

II. Literature review

The growth in human computer interaction (HCI) field has contributed to the quality of interaction and has affected different branches of its own history. The system should present clear information to the user. Although various interfaces are available, it is important to realize that an effective interface goes a long way toward addressing key HCI concerns, including easy learning, efficient to use and effective to use. It is clear that most sophisticated devices are worthless unless they can be used effectively to their full potential. This basic argument leads to the main terms to be considered in the design of HCI, namely, functionality and usability [6]. Functionality is basically defined as the complete set of actions or services proved to the user. Whereas, usability is defined as the range and degree to which the user can utilize the system. However, the effectiveness of a system is achieved only when there is a proper balance between the functionality and usability. The goal of user centered design is to produce systems that have a high degree of usability. Furthermore, Aspinall [7] the systems should be designed for the needs and capabilities of the users for whom they are intended.

According to Myers [8], the Interface improvements, more than anything else, have triggered explosive growth in HCI. Furthermore, the research that will lead to the user interfaces for the future computers is getting developed at universities and some corporate research labs. These future Interfaces are likely to be one of the main value-added competitive advantages of the future, as both hardware and basic software become common-place commodities. Hardeep et al. [9] pointed out that software users are frustrated when confronted with unreasonably structured information, inappropriate name-structures with unclear or even unknown vocabulary, vague instructions, inscrutable dialogues, and missing feedback Human-centered designs should learn from what we know about human-human communication as first order approximation of information transfer and adopt this knowledge. According to Sharp et al. [10], computer systems should be designed for the needs and capabilities of the users for whom they are intended. A good user interface caters to the needs of end users and supports them in the tasks they wish to undertake. Some attributes of a good user interface are (a) the ease to adapt, (b) minimal training requirements, (c) fewer error situations, (d) proper error recovery, (e) flexibility and (f) makes the system use friendly Sharp et al. [10] further suggest that there are three key characteristics of interaction design process: focus on the user, specific usability criteria, and iteration.

Recognizing the importance of HCI, Greenburg [11] suggests that the training of human-computer interaction involves examining design, implementation, and evaluation as a continual, integrated, and iterative process. In other

words, there is a continuous cycle ranging from of designing to meet specifications, various types of implementation of the design—either prototype or full—and finally, an evaluative process that examines if the planned requirements have been satisfied. It is obvious that a variety of methods like usability testing, usability engineering, evaluation and user centered design should focus on designing computer systems with user involvement. Shneiderman and Plaisant [12] recommend visual display to be a key component for successful interface designs. A dense, cluttered display might result in user dissatisfaction, and inconsistency in format might inhibit user performance.

The next step is to exercise the user-centered iterative design lifecycle as the framework (see Figure 1) within the development of these systems. The developers should create user friendly systems and in the process, should consult potential users early and often. Definitely, user friendliness is the salient feature that determines the extent to which a system can be used to achieve specified goals and satisfaction. Bevan and Spinhof [13] suggest that the definition of usability can be extended to encompass user experience by interpreting satisfaction as likability, pleasure, comfort and trust. However, according to Hassenzahl et al. [14], researchers are yet to reach a consensus to define the concept of “user experience.” In reality, it is inevitable to consider the participation of potential users in a design process.

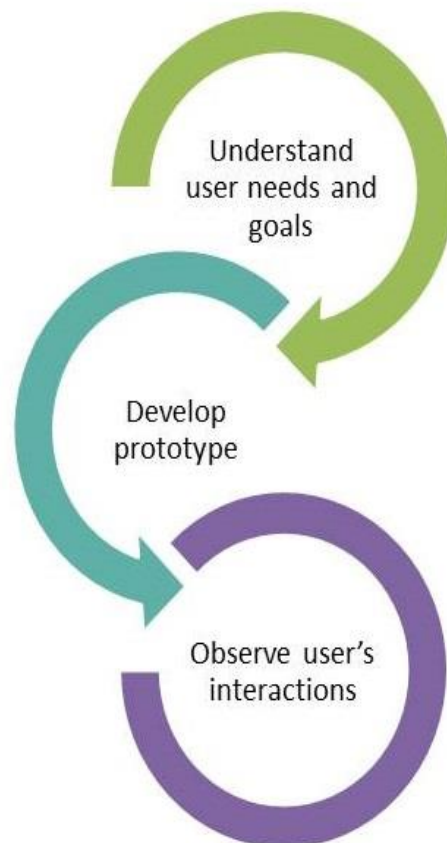


Figure 1: Framework of user-centered design

Prototypes provide the means for examining design problems and evaluating solutions. Leonard and Rayport [15] suggest that prototyping is promoted as a design practice within the business community as a key element in innovation to provide users a working model to get feedback on evolving designs, so as to give much clearer picture of the system to be developed. The technique of prototyping helps to reduce development time and to minimize cost for development [16].

Shackel [17], identified four usability evaluation criteria focusing on how users accomplish their tasks in using a system; learnability, flexibility, effectiveness, and user attitude. In his usability test study, Lee [18] adopted multiple usability criteria like usefulness, effectiveness, satisfaction, supportiveness, and intuitiveness. In this paper we requested usability testers to allow us to observe them in the process of evaluation that gets progressively closer to their daily work activities, and then asked them to perform those activities as usability test tasks [19]. According to Andre et al. [20], the User Action Framework, would provide a highly consistent means for a detailed grouping of usability problems by a hierarchical structure of usability attributes, locating a usability problem instance very specifically within the usability or design space.

III. Description of Settings

Even though very common in almost every industry, we discuss interface design problem in a front office setting using off-the-shelf application software. Precautions were taken to ensure that the software was not related to any particular vendor or product. Evidently, every business needs are unique and require frequent enhancement to business processes and techniques to effectively manage the organization is required. It is strenuous to choose the right software to suit the specific needs of the business. Consequently, every business will have to decide whether to build a custom software that exactly fits the needs of the business or choose an off-the-shelf software that meet most of its needs.

Usually, off-the-shelf application software will have many inbuilt features that the business organization might need. Occasionally, businesses would be required to change their process to fit the software requirements. Thus, it is important to decide whether the effectiveness of the off-the-shelf application software to meet the needs of the business can be easily achieved or should the business should build a custom application to meet its needs.

IV. Problem Scenario

We conducted our study in an organization in which, the IT staff recently updated their web based off-the-shelf application with a new feature to store electronic signatures on an electronic form. One of the benefits of off-the-shelf product is that the sponsor site will declare frequent upgrades free of cost or at a reduced price. In this study, when a customer approaches the front desk of the business, the customer's identification is established through the web

application using any of the approved identification number. Once the front desk staff finds the relevant record they will open the online consent form and request the customer to sign on the electronic signature pad. Usually, business organizations will have testing procedures in place before upgrading their production servers, but occasionally, lack of test time would prevent them to perform a test to ensure all the features of the upgrade are working perfectly. This would lead to a strenuous situation for the front-desk-staff to test the software feature in the field, just prior to serving a customer or even worst, when they encounter their first customer. The result of such situations might lead to a situation as described in Figure 2. In this particular case, the testing failed because they were not able to save the signature. When the staff click the submit button on the consent form they were getting an error message like in Figure 2, "The document could not be signed". The office staffs tried the feature several times, logged off and logged back into the application, but still ended up in the same error.



Figure 2: Error Message

It is imminent that designers should assume and foresee all the possible errors in the design and should cater to meet all the flaws in the design. Sometimes, many such situations are overlooked, as clearly seen in the scenario described above. Norman [21] asserts that the success of a software product lies in the ability of the designer to make the operation clear, to project a good image of the operation and to take advantage of related concepts known to everyone using the software.

V. Analysis

When we investigated further, we found that e-sign works only with a particular version of Adobe Acrobat professional. In addition, the feature needs certain adobe plug-ins (same version of Adobe Acrobat) to initiate the signature pad. The developers, obviously, failed to send out instructions to acquire the necessary plug-ins that users the business need to install to enable them to save e-signatures. Evidently, the application designers and developers seem to add a new feature to impress the business to buy their

product rather than to support the business with the new feature.

In an ideal environment, the business would expect that the e-sign to work with any Adobe Acrobat version. According to Alexander [22], the methodological steps can be abstracted down into two major processes. First, the designer is involved in an *analysis* of the problem, a kind of ‘breaking down’ activity. That is, to seek to break down the initially ill-defined and unstructured area of the design problem into more manageable constituents. Next, the designer is involved in synthesis of a solution. This stage is a ‘building up’ activity, in which the designer builds upwards towards a solution to the overall design problem by solving each and every part of the set of smaller problems found during analysis. Beyer and Holtzblatt [23] suggested that building today’s systems requires an intimate understanding of user’s business model than ever before. It is important that any customer-driven process should build in the awareness of the business and the business procedures into the design team, and continue providing feedback throughout the life cycle of the software program.

VI. Solution to the problem

Step 1: Download adobe plug-ins from the signature pad manufacturer website, Figure 3.

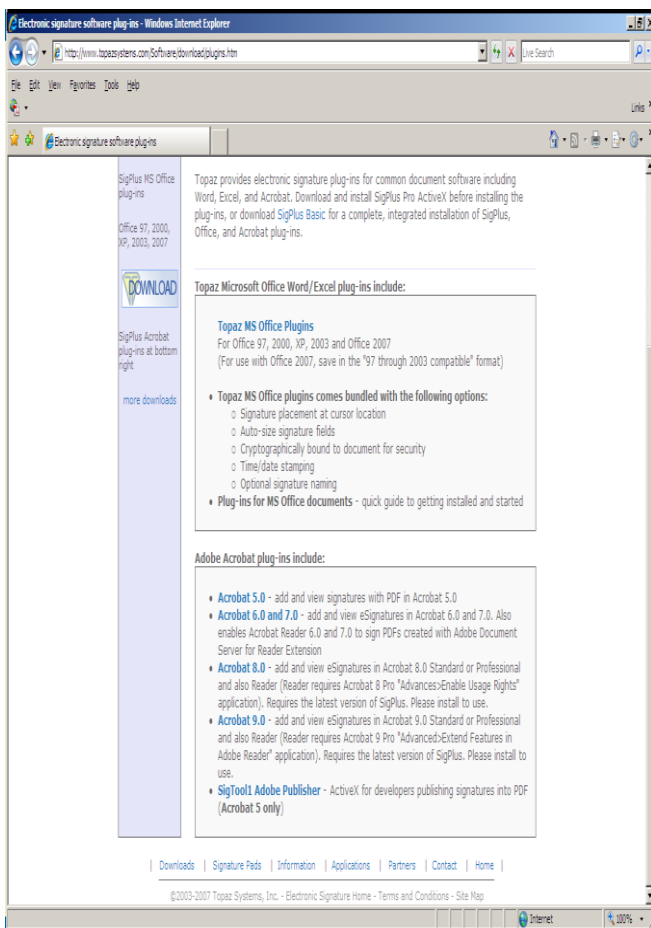


Figure 3: Signature pad website

Step2: It came to our attention that if the “Display PDF in browser” box is checked in Adobe Edit menu Preferences –

Internet, it might not show up the adobe tool bar as illustrated in Figure 4.

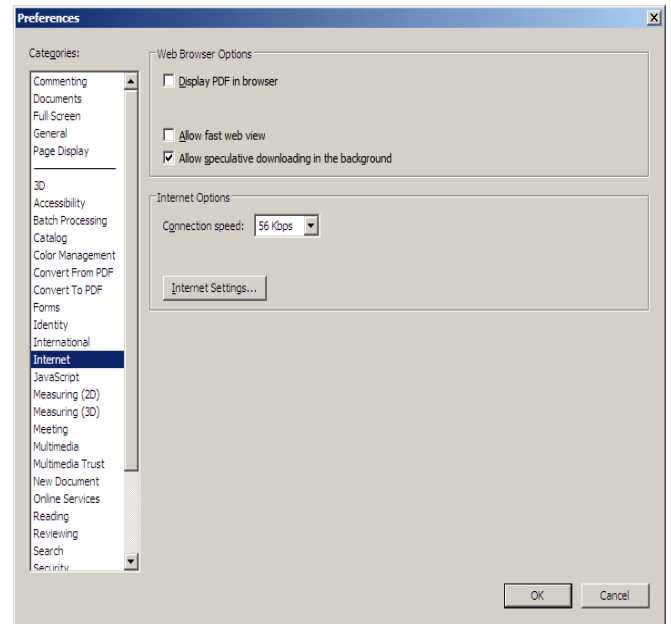


Figure 4: Adobe –Preferences - Internet

Step3: Make sure the correct signature pad is selected.

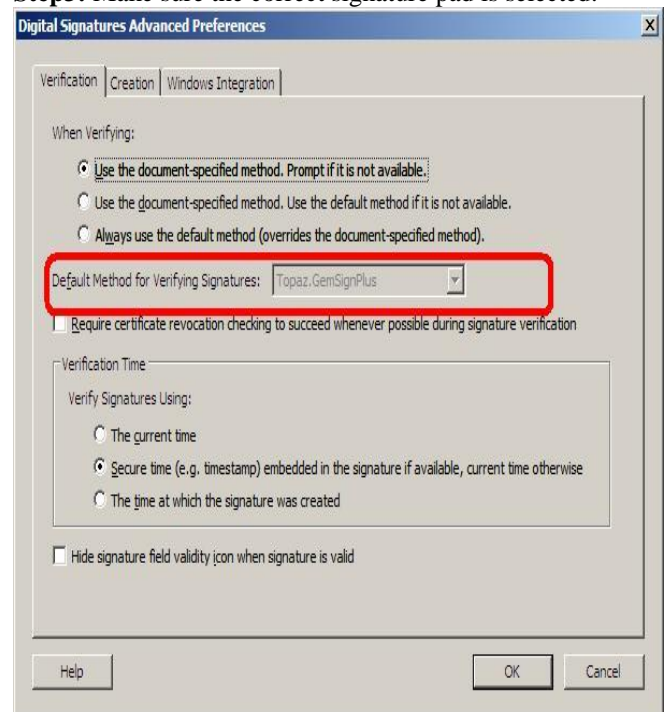


Figure 5: Digital Signature Advanced Preferences

VII. Usability evaluation

The purpose of usability evaluation was to identify whether the actual user is satisfied with the performance of the new feature (electronic signature) on the web application based on the usability evaluation framework (figure 6), as well as to detect any serious problems prior to go live with the new feature. In [24], Hackos and Redish conducted specific and frequently quantitative data on usability or factors directly

affecting usability, such as environment, documentation, and training. Neilson [25] recommends that three to five evaluators performing an expert evaluation will find a majority of the most severe usability problems. Neilson [25] further recommended that fewer evaluators would identify only a small subset of problems and advised that more evaluators would produce diminishing results at higher costs. According to [26], [27] task identification needs to be done by interacting with users. Identification of the tasks users needs to perform, usually as part of task analysis. Profiling normally includes task frequencies and other characteristics.

Equipment and Platform Requirements

- Computer – Inter quad core processor with at least 8 GB DDR2 RAM
- We recommend: Internet Explorer 10.
- Operating System: Windows 7 or higher
- Electronic Signature Pad – LCD screen

Design Usability Goals

The evaluation focused on determining if the needs of the user were met in an easy to understand, useful, and productive manner. The usability evaluation of the new e-sign feature evaluated the potential for errors and difficulties involved in using the application.

Evaluation Scenarios

Each participant were provided a computer for the evaluation. There was an application icon on the desktop. Participant clicked the icon to open the web application login page. Each participant were provided with a temporary

username and password for logging into the system. Once logged in, the web application opened the main menu. The participant selected the customer demographic module form the main menu.

The next step was to select a temporary customer record from the system using last name /first name (Example Dummy, Dummy) for recording the electronic signature. The find/search button on the application was able to perform this search. Once the participant found the record, they opened the online consent form and allowed the customer to put the signature on the electronic signature pad. The final step was to save the record by clicking the submit button.

Target Audience

Actual end users of off-the-shelf application software

Findings

The performance evaluation consisted of a series of tasks (ease of use, number of mouse clicks, time required to save e-sign record etc.) that were evaluated separately and sequentially.

- All participants were able to log into the system without any error.
- Participants were able view the electronic signature before saving the record.
- If the signature was not clear, the participants were able to remove the signature and request for a fresh one.
- Participants had to make 6 mouse clicks to save electronic

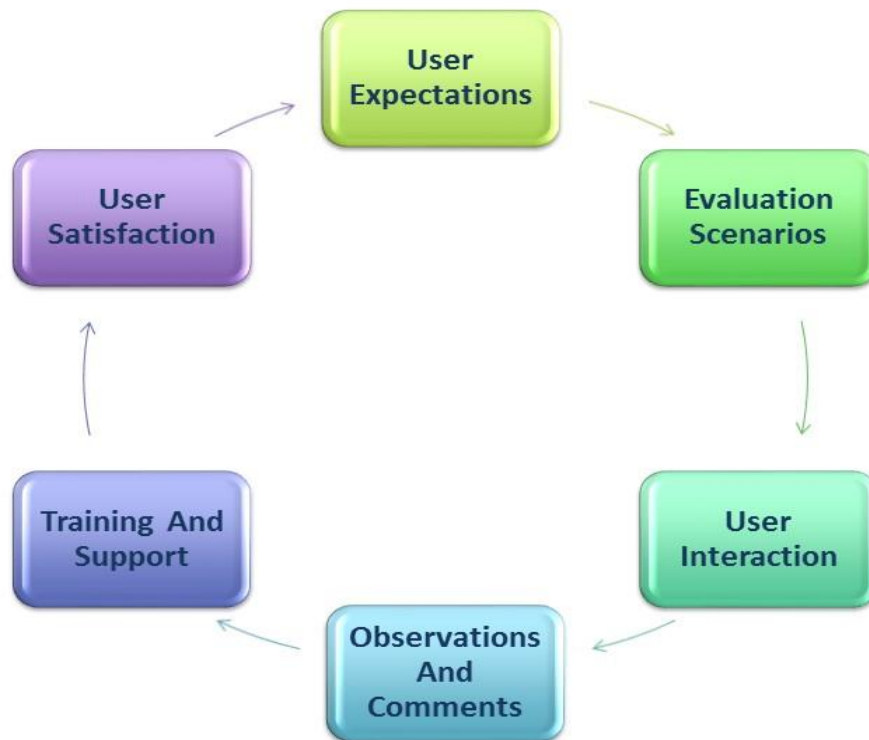


Figure 6: Usability Evaluation Framework

signature.

- On one computer, popup was blocked so the participant was not able to see whether the record was saved or not.

Observations and comments: The usability expert took notes when participants had any difficulty, when an unusual behavior occurred, or when a cause of error became obvious.

One of the participants was unhappy with the number of clicks she had to make to save the record. She immediately said “this is not a user friendly system; we don’t have time to do so many clicks”.

Another participant said that she was “excited to have an electronic signature in the system, even though it had many mouse clicks to perform”

Non-critical error: A participant made a mistake by selecting the wrong customer record but was able to recover from the error during the next task in the fixed time.

Critical error: A participant made a mistake and was unable to recover and complete the task on time. This participant selected the wrong consent form and did not realize whether a mistake had been made.

Out of the three, one participant indicated frustration with the new feature while others were happy. All participants gave subjective opinions about the usability evaluation and two participants expressed aesthetics of the product design.

Sometimes huge amount of information may be presented on the screen in order for the users to monitor the system. Therefore, designers need to be careful as not to impose a cognitive workload to the users when interacting with the system. According to Preece et al. [28], an important preparation before evaluating an existing system is identify the required evaluation of the system. The usability of the system and the requirements analysis on the functionality are two critical aspects in the system development lifecycle and need to be emphasized and implemented effectively.

VIII. Reflection

The design problem posed by technological advances is enormous. The ever developing and the introduction of new technology would always prompt us to add more functionality to the product. Whenever the number of functions and required operation exceeds the number of controls, the design becomes arbitrary. The same technology that was designed to simplify life by providing more functions in each device would instead start to complicate the process by making device non-user-friendly. This is an imminent paradox of development in technology.

In order to be successful in design, it is important to be able to take the other person's perspectives, to understand user’s background and interests, and to make the work fit the powers and limitations of human cognition. A good designer and a good writer have to share certain characteristics, among the most important being "empathy."

Many times customers never know what they want until they have had a chance to use it. We need a system

wide approach of the design in full context of its use, one that starts with the user and ends with the technology. The problem is that design is really an iterative process. Iterative development actually means rapid prototyping. So the designers should work with the intended users, get an idea of their needs, do a quick mock-up at the earliest, and try it out before releasing the new product or feature.

Design is all about conveying information appropriately. Representations and their interpretations play an important role in design because designers, in various ways, need to externalize design proposals and present them to others-fellow designers, users, or managers. Designs should be tested with real users performing real tasks and where possible in the actual user environment. The results of usability testing may force a designer to revisit decisions made regarding use-related hazard in the design. We suggest the usability analysis can be used primarily to realize what important tasks should be further analyzed for a detailed evaluation. The usability principles should guide the identification of those important tasks.

There should be a formal, human-centered product process where the process should propose and be built around an iterative design and study process. And finally, it should extend beyond the final release date of the product in order to collect field data and user feedback on performance, repair and service, usability and functionality that will drive the next release.

Definitely, the information need, want and demand changes rapidly; the need for today is not always the need for tomorrow. Customer-centered approach should be an ongoing process to overcome the limitation at least to some extent to benefit both the designer and the client. As always it is very difficult to satisfy all customer needs, designer should foresee the limitations for the improvements in the design. In addition, Brooks [29] rightly pointed that requirements always would trigger changes, when designs incorporate rapidly evolving technologies.

We might come across several constraints during the design phase as illustrated in the case of the e-sign problem discussed above, that might be affected by external factors like electronic signature pad model, scanner model, acrobat adobe version and so on. Additionally, product development has different needs that might require different attributes, and sometimes-different targets. At worst, they could replace other user centered methods, ongoing data collection, or product evaluation. It may seem more logical to focus directly on scenarios, which after all, would describe the actual work processes one aims to support.

IX. Conclusion and future directions

This paper aims to depict the user interface design problems of the web based off-the-shell application system. We believe that design in human computer interaction (HCI) should be more sensitive towards and aware of the human society and values. Considering the diverse number of researches and technological breakthroughs, HCI should

integrate itself with several adjoining disciplines. Hence, the main agenda for HCI developers should focus on understanding human desires, expectations, and aspirations in tune with ethics and values prevailing in the user's society. The biggest challenge for HCI continues to be its struggle for credibility. Many of the tools and techniques that have been developed within HCI research cannot be scaled up to meet the challenges posed by industry and commerce. The best way to move forward in interface design problems is to follow two main steps: (1) determining usability problems through usability testing and evaluation, and (2) categorizing known usability problems into general and specific categories which then lead to developing design requirements based on user interface guidelines.

User-driven innovation requires cross-functional approaches. The incorporation of user perspectives enables the profiting from user insights and customer experience. Finding innovative ideas for products in an early stage of the improvement cycle, Creating new product concepts, and Enhancing product generations would help to meet this goal. It was identified from the problem analysis that the product was not tested thoroughly before releasing to the clients. A successful design should focus on the product appeal of the user from various perspectives including performance, ease of use and so on. This process inevitably requires a user centered approach. Subsequently, the ultimate goal of an ideal user-friendly software interface should be to design a product that supports the user's needs rather than to make the user to adapt already designed software. Software designers know from their experiences that, it is impossible to fathom all the consequences and interdependencies, even though they aim to produce such a user-friendly software interface. However, it will be great if the designers should ponder over the possibilities of making improvements to achieve maximum user-friendliness, thus eliminating many concerns of the problems of user-friendly software interface. Task-centered system design is a very effective discount usability engineering method suitable for many interface development problems. As technology continues to drive changes in off-the-shelf systems, there is a need for detailed usability evaluations of new features added to off-the-shelf systems. Usability evaluations of these systems need to be just as dynamic as the technology itself to meet the demand of the users.

The most popular recommendations to design usable user interfaces have been user interface design guidelines as they are widely published, used, and accepted. However, as computer systems get more complex, the problem of usability becomes more serious. According to Jones and Marsden [30], an important question to interaction designers is: how do designers optimize the users' interactions with the interactive system and operating environment so as to identify the users' needs and match their supported activities? It is obvious that the task of design is not trivial, and designers need considerable support in their endeavors. Moreover, since there are no flowcharts that reliably inform us on cognitive capacities at a higher level, we need to use design processes of iterative refinement, with regular testing, and such a process needs the best available support from every facets of the design development.

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technology based student response systems in the learning achievement of math students. In addition, Dr. Manuel uses a wide variety of technology in his classrooms, including web 2.0 tools, various educational apps to enhance learning experiences of his students.

Author Biographies

Anish Abraham Padath, MS (Auburn, Washington) received his BS from Mahatma Gandhi University, India (1992), Master's Degree in Computer Application from Bharathidasan University, India (1996) and Masters Degree in Information Management (Specialized in Information Assurance and Security) from University of Washington (2011). Mr. Padath is a senior member of Association of Computing Machinery (ACM). He has over 19 years of experience in System Analysis, Project Management, Application Management and Support, Healthcare Project Implementation, Risk Assessment, and Training.

Austin Kureethara Manuel, Ph.D., with 19 years of experience in teaching mathematics to high school students, received his Baccalaureate of Science in mathematics from Mahatma Gandhi University, India in 1992. After receiving Baccalaureate in Education (Mathematics), Dr. Manuel was appointed as a math teacher in a public school in India, where he continued his teaching until he migrated to the United States in 2007. Dr. Manuel continued his education and earned a master's degree in Secondary Mathematics Education (2012) and a Ph.D. in Curriculum and Instruction (2015) from Mercer University, Atlanta, with his dissertation focused on the effectiveness of using