User Interface Design – Methods and Qualities of a Good User Interface Design

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MASTER'S THESIS

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Summary

User interface (UI) plays a vital role in software. In terms of visibility, its design and precision holds the primary importance for depicting the exact amount of information for the intended user. Every minor decision taken for the designing of UI can contribute to the software both positively and negatively. Therefore, our study is intended to highlight the strategies that are currently being used for successfully designing UIs, and make appropriate suggestions for betterment of UI designs based on case studies and research findings.

Acknowledgement

I choose this thesis work as a part of my Masters of software Engineering program. The successful completion of this thesis work involves dedication, sincerity, intense research study and encouragement by many people including my family, friends who have been my emotional backbone and all my teachers since my childhood who have helped me reach this far.

I also owe a debt of gratitude to the university staff. This thesis work stands completed virtually as a result of teamwork and all the attributes already spelled above. For me it has been a wonderful and satisfying experience, and the output of the dedicated efforts leaves me successfully motivated to involve in this research thesis and complete it with a touch of excellence.

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1 Introduction

User interface is the representation of the software or business to the user. It is displayed in terms of pictures, sounds, colors and text. The communication with the user on behalf of a system is performed by using a UI. Therefore, the minor details in designing as well as displaying the UI plays a vital role in creating an impact of the entire system to the user. There are various aspects involved for the measurement of whether a UI design is successfully communicating the intended impression to the user or not. [1, 2]

For designing a good UI that can represent the intended amount of information to the end user, it is very important to maintain the involvement of the intended user of the system throughout the designing process. In this way, the design will be made according to the expectations of the user and thus will be successfully utilized. [3, 4]In order to represent the intended message of the website or software, it is important that the UI design is made by taking the objectives of the website or software under consideration. Otherwise, the intended message will not be conveyed to the user and the results can affect the expected outputs of the system at hand.

A good UI design is always expected to have a good error handling strategy, so that the end-user is not irritated by repeated attempts for doing a task. It is also important to let the user know exactly what error occurred so that he can take further steps accordingly. This factor is extremely important for doing online transactions. Security is a very important feature for E-commerce websites and therefore, while designing the transaction pages the user should be clearly shown about the security status. It is important that a UI design is tested against varied platforms so that when it is viewed by a user, it should display all the information as originally designed. Proper manuals for the usage and help instructions should be given to the users, so that the new users of the system can be appropriately accommodated. It is important for a UI good design to have 'appropriate' information displayed in it. This information should not be too much or too little. It should just be enough to represent what is intended to be conveyed to the user. [5, 6]

The contribution of this study will be towards the compilation of the current strategies for designing UI. The primary focus will be given to the successful methods and techniques that can be applied with focus on a set of recommendations after detailed analysis of a set of different systems.

The study will also discuss the UIs of E-commerce websites, used for online shopping, bank transactions, online stores etc), Commercial websites (Magazines, TV channels, etc), User applications (Microsoft PowerPoint, Excel, Word, etc.). In this way the detailed data regarding the negative and

positive aspects of all the designs will be gathered along with the strategies applied on each design. In the end, the results will be based on the actual results from the data collected after the study of UI from varied categories.

The main goal of the thesis is to investigate different aspects of a UI design that play a vital role in depicting the software quality. In addition to this, the study will also discuss in detail all the software quality measures and techniques. Based on the measures and techniques to determine software quality, the UI designs will be evaluated. The study also aims to take into account UIs systems belonging to varied genre for checking the characteristics of a successful UI design.

In this paper, a step by step procedure is followed. In section 2 the background concepts regarding software quality, user interface design etc., were introduced and later in the same section different scenarios are evaluated under the introduced criteria. In section 3 the method followed is described, discussion regarding all the thesis work is done in section 4. In section 5 the thesis work is concluded and future work is discussed in section 6.

2 Background

The present study is in view of various aspects to ensure that the user interface design is positively affecting the software quality. But in order to proceed further, we need to understand what software quality is, and what are the good or bad implications of a UI design on it.

2.1 Software Quality

Although there are several definitions for software quality, yet largely the crux always states that the quality of software is measured in the following two ways:

- ➢ How good is the design of the software in relation to the requirements of the client.
- ➢ How good the actual software is in relation to the design made for it. [7]

In order to ensure the above two, there are several factors that are taken into account. Reliability, efficiency, conciseness, portability, consistency,

maintainability, and understandability to name a few. These factors will be described in detail in the following paragraphs. [8]

2.1.1 Factors Involving Software Quality

As pointed earlier, the following factors play a vital role in determining the quality of software.

➢ **Reliability**

Reliability deals with the way the software performs in the longer run. When a user uses a software, there are certain expectations associated with it. These expectations are present due to the behavior of the software in the past. Reliable software should be able to perform the same way and with the same precision and pattern. [9]

➢ **Efficiency**

Efficiency is the measure of how well the resources are managed by the designed software. An efficient software should be able to perform the best of its capabilities with the least utilization of resources. In other words, no extra execution time, memory space or delays should be present. [8]

➢ **Conciseness**

Conciseness is the measure of how well the software is designed and developed by considering the necessary information only. Concise software doesn't present additional information or excessive lines of coding that are un-necessary.

➢ **Portability**

Portable software should be able to run on varied platforms without any problem.

➢ **Consistency**

Consistency is the measure of how the software maintains a similar code for notations, abbreviations and naming conventions throughout. [8]

➢ **Maintainability**

As the software and hardware keep on getting updated from time to time, maintainable software should be able to upgrade according to the recent requirements. For this matter, we need proper documentation to enhance

the design, and consistent and well-written code in order to make the development level changes.

➢ **Understandability**

At the end of the day, the software has to be understood by the user, otherwise, it will not present the intended benefits. An understandable design should not only be usable by the user but also well documented and consistent that the modifiers of the design should feel no problem in understanding the actual system. [10, 11]

2.2 Importance of Software Quality

The understanding and implementation of the software quality factors is extremely important for the success of a system that is delivered in the market. Non- compliance with these factors can cause serious harm to the reputation and credibility of the developer and designer. [12, 13, 14]

In the software market, we see many products that are appreciated and used widely around the world. If we take a closer look at the products, we will find out that these products are designed and developed by keeping all software quality factors in mind. [15]

Delivering a low quality product means that in one way or the other; the user will not be satisfied and hence feel discouraged to use the software again for the purposes that it was designed for. Many next versions will not be able to restore the lost trust of the intended user in the product. [16, 17]

Sometimes, the design as well as the development is crucial, and its impact is serious, for the user. E-commerce is again a good example. If a user is unable to get the precise and concise information, within an understandable system, he might not use the application in future. The result will be a loss to the company and consequently to the software product. [10]

2.3 User Interface (UI) Design and Software Quality

In order to represent the software and all its intended objectives, the UI design plays a crucial role. Software will not be communicated to the user for its possible benefits if the UI design is not created with relevant and significant amount of information. [18]

Many other factors that are used to measure how well the UI design has been created will be discussed in the subsequent sections. However, for ensuring the software quality, it is a key factor that the user should be able to understand the system fully for utilization. Hence, the UI design is the

only face of the software which is visible to the user and hence, if the user is unable to understand and make use of it fully then he will not be able to use the developed software at all. In addition to this, for any good quality software, its UI design should clearly show what are the main features and functionalities of the system. Therefore, it holds an important place for the quality of the software. [19, 20, 21, 22]

As already discussed above, UI design and software quality are closely knit together. Therefore, in order to understand whether a UI design is good or bad, we will be studying various aspects by keeping in view the software quality factors in the following section.

2.3.1 System Status Visibility

It is important to understand that the involvement of a user is extremely crucial to the success of a UI design. [23] A typical user is interested in knowing the system status at all times during the correspondence and communication. This aspect is very sensitive in terms of online transactions where the truncation, cancellation and refreshing a transaction can cause real time damage to the end user. Therefore, the system status visibility will be studied in order to check whether the updated information is available to the user or not. However, criticality of this feature will be studied under the light of the fact that whether the system status can cause damage to the user or not.

2.3.2 System Consistency

Consistency is an extremely important feature for the positive impact on a UI design of the system. Consistency has to be maintained for a single system across all the UIs as well as in terms of platforms. All the UIs developed for a single system should have the similar kind of design, choice of colors and platform. The UI should follow the certain theme and objective of the larger software system, so that the proper message and intention of the system can be communicated to the user. [24, 25, 26, 27]

2.3.3 Error Handling

It is important for a UI design to provide the end-user with a convenience that the run-time errors can be handled. In this context, even if the user is unaware of the errors that are possible to occur at the back-end of the

system still the UI design should be capable of catching as well as providing a solution for these errors. [28, 29, 30]

These errors can be of two categories run-time and compile time errors, but for a UI design the run-time errors are of utmost significance. The UI design should cater all possible forms of inputs that a user can enter and a design should be finalized after testing the UI for all possible error types.

2.3.4 Feedback System

With the growing utility of the online content and systems, the users are getting involved in running the businesses as well as general online surfing. The awareness of the end-user about the system at hand is growing as each day progresses. In this scenario, it is important for a designer to consider that the UI design is basing its updates as well as construction on the user feedback. [17, 31] For this matter a constant involvement of the end-users should be made sure during the designing process. Even after the final product should be launched, still the improvements and later versions of the UI should be based on the feedback it has got from its potential users. This process helps in constructing and designing the UI in such a way that it becomes more *user friendly*. The feedback system generally helps the organization as well for developing more user oriented UIs so that their company aims and mission is highlighted. [32, 33]

2.3.5 Memory Loading

The size of a particular UI plays a vital role in issues related to the web space as well as cost of the entire website. It should be kept in mind during the design that even if high resolution images are appended in the UI still, it should always present the lowest possible memory size. It should waste unnecessary web space just for making the UI more attractive. Sometimes, if the images are too large or there is too much scrolling on the page, the users also get weary of the concept. Therefore, it is important to consider how much extra space a UI is taking, so that the system does not have to compromise a lot on the cost for something that is hardly necessary. [23, 34, 35]

2.3.6 Promptness of Action Against Request

For a UI design the most important thing the user is interested in its *speed* or *promptness*. No matter what is the speed of the connection of internet

that the user is using, he would always want the response to be fast. Many users are found to be engaging themselves in the websites that are not very attractive looking but provide faster access. A very good example is Google Mail. The interface is plain, simple and loads at a higher speed than many of the other systems. The result is the higher number of joining users for Google Mail. [36]

It is important to note at this point that even if the system running behind a UI has a high speed server, still the user and the internet connection is slow, it shows the same result. To avoid this situation a UI should be tested by keeping in view the worst case scenario in which the user has slowest possible connection. An alternative strategy could be displaying the time that is required for a page to be loaded with respect to different internet speeds available. In the latter strategy however, the information gets redundant across pages and the user gets tired after getting the repeated information. Therefore, the former should be used for the design.

Another important consideration in this context is the appropriateness of the displayed content. The UI should not have a lot of redundant and meaningless images that increase the loading and response time for the user. [37, 38]

2.3.7 Efficiency

The efficiency of the UI is measured in terms of the amount of related information it brings to the user. If a user visits a particular page, he has certain requirements and expectations in his mind. An efficient system will bring to the system all the requirements that he wishes and most of *where* he wishes.

The placement of information in the light of a users requirements plays a vital role in making the system efficient. Only the UI that has the best sorted information will provide it to the user in ideal time and with precision. [15, 39, 40]

The implications are very huge to the software system. If a UI fails to provide the information that the user is expecting from it, then it will be a negative impact to the system as users will get discouraged to use the system in future.

2.3.8 Availability of Documents and Manuals

As for the development of software, working before hand is important. Similarly, it is extremely important to visualize and document all the steps that are involved in the construction and design of the UI system. [28]

There are two stages in which the UI system has to be documented. The first stage is when the UI is being designed and visualized. The second step is when the UI design is being implemented. In both the scenarios, the documentation plays a very important role. In order to maintain a UI design one needs to refer to the documentation for knowing the strategy and reasoning behind its particular way of implementation. For the same reason, at all steps of a UI design this documentation should be an integral part of the process. [41, 42]

In addition to the documentation, the user manuals and help options are extremely important. A system can encounter a variety of users ranging from new users to experts. But normally if we take the average user, still the help option and user manual for the UI is a very important part of a UI design. There should be proper content prepared for each problem that the user will encounter during usage of the system. It is again very important here for the designer team to point out the mistakes that a user can occur and all the possible scenarios for eliminating these mistakes. [43]

2.3.9 Compliance of UI Design with Software Objectives

The UI design should clearly show and depict the software system objectives. The user should be able to distinguish between the websites he is visiting. For an e-commerce website, the design should clearly show the user what the website is about. In this way, the user will be able to surf faster and extract the related information quickly without having to go through the entire text, just to find out what the website or the system is all about. [3]

In addition to this, the objective of the system has to be kept in mind during the design of the UI. The user should be shown what the system supports and what it does not support. For a political website, it should clearly show that it is meant for political purposes and not some general public opinion. So that the user is not mislead by the displayed information and gets the benefit that was intended by the system during its formation. Another way of showing this is to clearly indicate the objectives of the UI so that the user is aware of the issues related to it.

2.3.10 Compatibility with Varied Platforms

During the UI design it is important to consider if the UI is compatible at a variety of platforms. Sometimes a user views the information presented in the UIs using different browsers. This normally occurs when the system is web based and not installed on the user's computer. [22, 44] In this way, sometimes due to the different adjustments of the browsers, the compatibility is lost. A good UI design should be tested across varied platforms to see if it is displayed in the same way or not. [45, 46, 47]

2.3.11 Proper Amount of Displayed Information

A user is always looking for the *proper* amount of information that is being displayed on the UI. If too little information is displayed, a user might get tired in looking for the relevant information. If there is too much information displayed, a user might get perplexed in accessing the relevant portion. The result, at the end, is the bad impression of the system for which the UI was designed. [48]

Therefore, it should be kept in mind that how much information should be provided and how many UIs should be generate on a single subject. If the user has to traverse across a wide number of pages, it causes frustration. Also, if the system's relevant information is too much for the user, he might try to switch to another website that presents the information in an organized manner. [1, 49]

Therefore, for the benefit of the users and the system at the larger scale, a UI should display the right amount of information that is required by a user. Again, over here as well, the user has to be involved in the process of designing. So that the information is gathered by keeping in view how much of it is actually necessary for the particular end-user. A UI will only be accepted by the end-user if they find it matching to their requirements. [50]

2.3.12 User Involvement During Design

It is important to involve the user and get proper feedback at all stages during the design of the UI. Even after the design has been deployed, it is important to know what the users are expecting with the growing information about varied systems across the internet and otherwise. [51, 52] Especially, this scenario is important after the deployment of the system, if

the users are suggesting to improve or change a certain field or property of a UI, and then this should be catered in the later versions of the design so that the UI is always as per the intended user wanted. The result will always be a positive impact towards the system that the UI is representing. As the users will see the UI evolving according to their expectations and requirements, they will engage themselves more and more into the process and the system will have more responses in future for changes as well as improvements.[53,54, 55]

2.3.13 Relevance of Content

It is important that a UI design has only the relevant material shown. A user is always looking for the *right* amount of information displayed in a *right* manner. But there is not any certain definition of the '*right amount'* itself. Therefore, the UI design has to be tested for feedback in all stages to know if the required content has been displayed to the user or not. [1, 56, 57]
In addition to this, it should be decided before the design what appropriate content has to be displayed; this process should be done under the light of the main objectives of the system.

2.3.14 Appropriate Outlook

If we have a UI design that is not displayed in a proper format, using the appropriate colors and choice of outlook, a user will get distracted. Sometimes a combination or a contrast is chosen for a website that is irritating to the eyes of the users. Such sharp contrasts should be avoided so that the user does not ignore the relevant content just because of the way it is displayed. Normally the user is interested in the UI if it displays the information in a simple and minimalistic form. In this way the maximum impact can be obtained because the user is not confused by too flashy a layout. [7, 36]
For a software system to achieve its planned spectrum of achievements, it should always present the best available outlook keeping in view the feedback and requirements of the user.

2.4 User Interface Design

The main purpose of user interfaces is that they should match and satisfy the skills and expectations of its users. A system will always be judged by its users not by its functionality, but by its interface design. Many software systems are never used because of the poor interface design as this will confuse the users and will lead to many catastrophic errors.

2.4.1 Human factors in interface design

There are many human factors which should be considered before designing an effective interface. These factors could be like limited memory as most of us cannot remember more than seven things at one go and if a user is presented with more than seven things to remember instantaneously he is more sucesseptible to make mistakes. It is natural that users make mistakes when they use new interface software and things like alarms or messages might panic the user and will become the reason for more mistakes. There are different kinds of people who think differently and prefer different things like pictures, special audibles, menu style, text etc. and there are people with different physical and mental capabilities and a designer should keep all this in mind before designing an effective user interface which can be used and appreciated by everyone. [2, 5, 22, 24]

2.4.2 UI design principles.

There are some principles which when followed will make a developer a good interface designer. The user interface should look familiar to the user i.e. it should be based on the use terms rather than computer concepts like documents, folders which can be replaced by directories, file identifiers etc. consistency should be followed when commands and menus are taken into consideration. They should appear similar in format and punctuation. There should not be any confusion to the user when using or operating a command and he should be able to predict the operation and consequences of commands. Users should be having the options of recoverability to allow them to overcome their errors. These include things like an undo and redo facility. The interface program should be provided with manuals to guide the user and user diversity should be observed to make the interface to support different users. [19, 36]

2.5 Usable Design

An effective usable design includes three different designs that are important for each aspect. They are,

➢ Interaction Design
➢ Information Design
➢ Interface Design

To achieve a perfect design all the three designing characteristics should be included and overlapped. Failure of any one of these designs will lead to the failure of the whole design. A system with good information and interface design will not be successful unless there is a good interaction with the user. This is represented in figure 1.
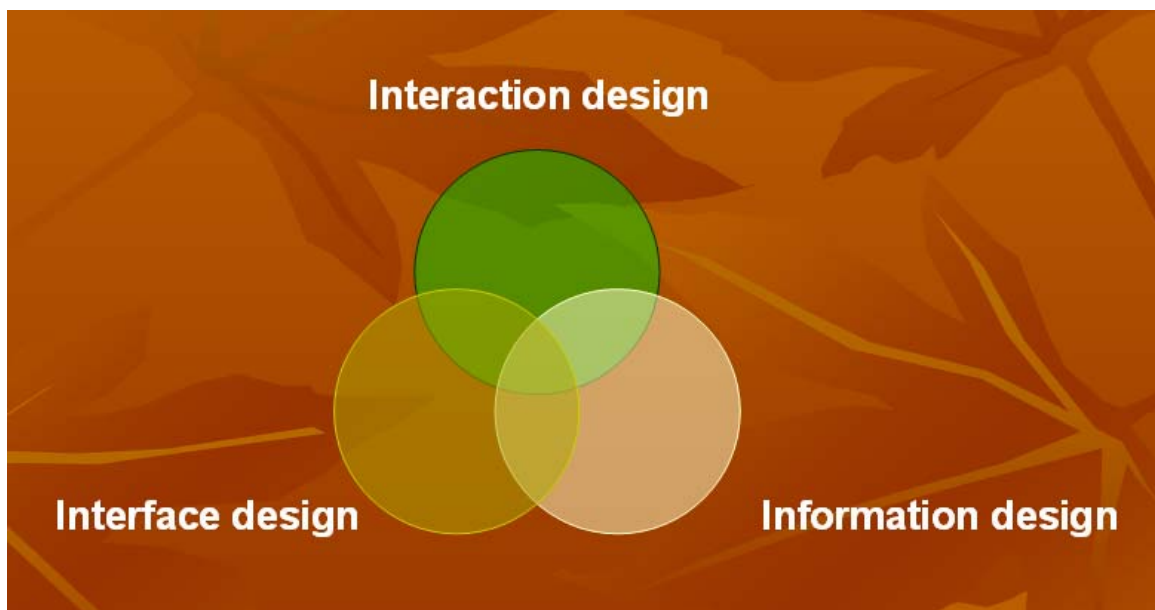

Figure 1: shows the usable design. [Linn, G. *user interface design*, Software Engineering, lecture notes, university west, Sweden]

2. 5.1 Interface design

An interface should be designed with proper colors and objects. Colors should be used restrictively with a meaning. Proper color pairing should be observed and at the same time people with color blindness should be taken into consideration. Objects like buttons, menus, and icons should be used.

Navigation should be made easy. Proper style of interaction should be followed with proper language and symbols. A bad interface will produce a useless system. [3, 5]

'Golden' rules to be followed in creating an effective interface design.

Rule 1	Consistency of the software
Rule2	Shortcuts for the convenience of frequent users
Rule 3	Feedback information
Rule 4	Designing dialog boxes to show the status
Rule 5	Recoverability to minimize errors
Rule 6	Action reversal- undo
Rule 7	Design in a way that the user is in control of the software
Rule 8	Minimize instructions and information to make it easy for the user to remember things.

Table 1: represents 'Golden' rules to be followed in creating an effective interface design.

2.5.2 Information Design

Present the information properly so that the user finds it easy as to who is the intended recipient, adaptation of information, text, graphical objects, photos, diagrams. Information regarding the relationship between values and change of information must be present. Use of colors should be in a proper way when showing the change in the system status and color coding can be used to let the users know about the task they are performing. Colors should be used restrictively when it comes to dark colors and they should be used in a thoughtful and creative way. Proper color pairings should be observed. The system should be able to predict what the user is doing and give messages relevant to the situation, experienced users would not like long messages and new users might not be able to get enough information from short sentences so both types of users should be taken into consideration and allow them to use message conciseness. Messages should be given out in way that different classes of users should be able to handle

it depending on their skills. When expressing a thought in a message they should be tailored in a way that it gives out the message in a positive way and it should not sound funny. When giving out messages the designer should be aware of the culture followed in the country where the system is being sold to give a proper representation as different countries follow different cultures. [5, 48, 49, 50]

2.5.3 Interaction Design

When designing an interface system things to be taken into consideration are like the age, culture and background of the user, the users computer knowledge should be assessed and also his ability to adapt to the system. Navigating and finding help should be made easy for the user when searching for information. Help should be provided for the function, to interact and learn. Use of different lighting, sounds can be done to attract the user. The user should not feel any stress or pressure. [2, 26, 28]

2.6 The UI design process

The UI design is a process where the users interact with the designers. There are three important essential activities in this design process. [5, 8]

2.6.1 User analysis

In this analysis process we develop a task that the users do in other words understanding what the users do with the system. To develop an effective interface we have to understand what the users want to do with the system. User analysis should be described in such a way that it is easily understood by the users and other designers. Scenarios are one of the ways of describing the analysis. Some of the requirements from the scenario are help in using appropriate search terms as the users may be unaware of them. Searches and request copies to the related material must be carried out by the users. [23, 24]

2.6.2 System prototyping

The development of prototype system helps in guiding the evolution of the interface. Prototyping process with early paper prototypes are used as the basis for automated prototypes. [5]

2.6.3 Interface evaluation

In interface evaluation we collect the users experience with the interface. Evaluation of interface design should be done to know its suitability. Full scale evaluation is not practical for the systems and is also very expensive. Generally interface is evaluated against the usability specification. Interface evaluation based on usability attributes evolution is conducted. Evaluation of user interface design in a systematic way can be an expensive process. This process involves graphics designers and cognitive scientists. Cheap way to evaluate an interface is by surveying users by questionnaire. Users should rate the questionnaire with their own experience and background. Observation-based evaluation involves users watching as they are using system. Specially equipped evaluation is required for complete video analysis. Analysis of recordings help the designers to find if the interface requires too much hand movement or unnatural eye movement will do. [5]

2.7 Evaluation of User Interfaces

In this section, we will be taking the examples of different User Interfaces and evaluating them on the basis of the quality measures discussed in the previous section.

2.7.1 Electronic Mail

Electronic mail (e-mail) systems are the most widely used interfaces of our time. Free as well as economically priced solutions to effective online communication are available. There is a wide range of E-mail Service Providers (ESPs). We will be studying a three of such ESPs and then evaluating the UIs presented in them.

> ➢ **Gmail Interface**

First of all we will be taking into account the Google Mail (Gmail) interface. We will move from one measure to another in order to determine whether it complies with the quality characteristics or not.

1. Gmail homepage has the constant display of the status of the byte increase in the storage space being provided to the users. This enables the user to view the system status graph for the constant improvements in the provided user space.
2. All the UIs of Gmail are designed under the same choice of consistent color schemes, font size, font style, etc. Hence, there are no surprises to the user.
3. During the operation of Gmail, there are many possible scenarios in which varied errors can occur. These errors include: delay in response, sign-in issues, server conflict etc. In such a scenario, Gmail provides fast and efficient error handling. For example, if we take one particular scenario, in which while there is a delay in getting response from the server for sending email due to the slow speed of the internet connection. The UI updates its status periodically. This is done by displaying *sending* first and then after a certain time, *still working....*This particular feature lets the user know that the system is actually working on the request, but, due to the slow transfer of data, is unable to cater to the request immediately.
4. Gmail interfaces are quickly loaded on browsers due to the fact that they are designed in such a way that they are not large in size. Therefore, they provide high speed in loading. Another attractive and unique feature that Gmail has is the provision of a much light weight Hypertext Mark-up Language (HTML) view. By utilizing this view, the users are able to view information even if they are using a very slow internet connection such as the conventional dial-up connections on 56K modems. The HTML view is much like the original view, and is much lighter and faster.
5. The Gmail interface displays simple menu options that are spread in the column conspicuously located at the left hand side of the inbox panel. Therefore, locating the required options on Gmail is very easy and simple for a user.
6. Gmail provides detailed help options for all its features. The help is a step by step guide for the solution of the problems that the user is likely to face.

7. The Gmail interface uses less of color and more of quality and speed. Although everything is not black and white, but colors are appropriately utilized in such a way that they are irritating for the eyes of a user.

8. A user is able to find the relevant and significant amount of information at relevant areas of Gmail UIs. The related information is spread across the concerned sections of pages which make it easy to track and extract.

9. Last but not least, the Gmail UIs represent user ease and comfort along with fast and simple access to the target utility.

Figure 2: A representation of Gmail interface

➢ **Yahoo! Mail Interface**

The next ESP being analyzed is Yahoo! Mail. This ESP is recognized of being one of the most widely used among people of varied backgrounds. In the subsequent points, the compliance of Yahoo! Mail with the good UI design measures is studied.

1. Yahoo! Mail presents attractive outlook for the email services. This includes placement of text and graphics in such a manner that they are not irritating to the eyes of the user.
2. The Yahoo! Mail's new version, beta, is a heavier version, with more details added to it. Therefore, sometimes, it takes more time to load on slow internet connections.
3. The Yahoo! Mail interface has a complicated way of representing the required information. Nevertheless, the information that is required by the user is easy to find. This is due to the fact that the placement if information is in the form of sets. With each relevant piece of information placed appropriately in its respective set.
4. Yahoo! Mail provides multiple interfaces within the same page. Its chat interface is adaptable and easy to operate.
5. All the Yahoo! Mail interfaces for email utilities are linked to each other. They seem related to each other as they follow the same theme. The UI opens the new option in a tab rather than a new window, therefore, it becomes easy to select and manage options. But at the same time, the draw back of loading pages gets difficult to manage when the user selects a large number of options to be opened in the window.
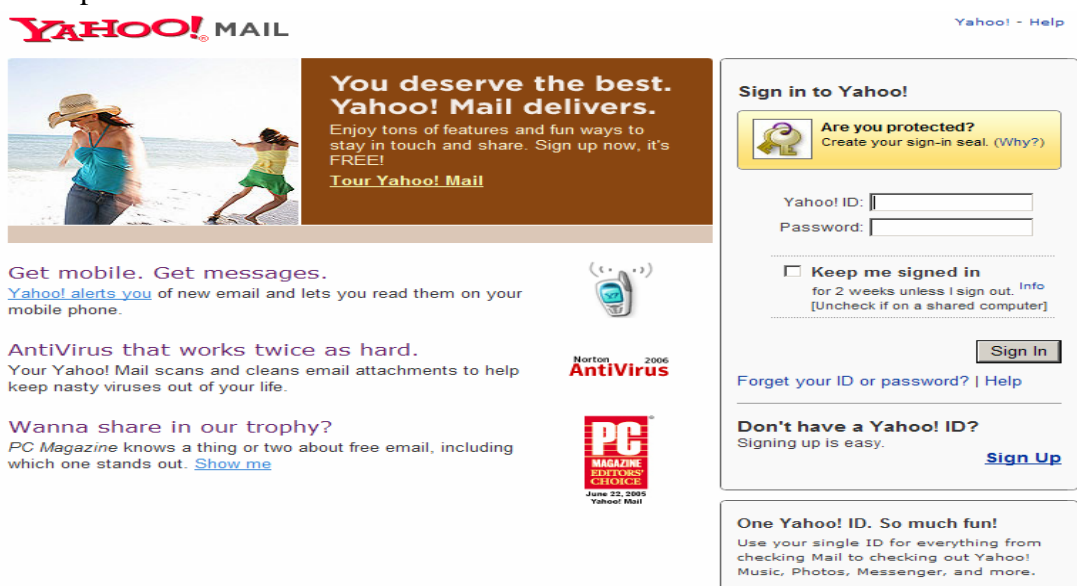

Figure 3: A Representation of Yahoo mail interface

➢ **Hotmail Interface**

1. The new version of Hotmail called *Live* presented many changes in the conventional hotmail design. The hotmail UIs were designed to be much simpler and easier to understand as compared to its earlier versions.

2. There were many graphical features added to the UIs of hotmail, with large advertisements being the most prominent. However, with the increase in the graphical features, it becomes more and more difficult for a user to access the required information on slow speed internet.

3. The UI presented simple and easy to access design of menus and options for emailing utility. It was more or less like the design of earlier email applications built by Microsoft, namely *Outlook Express* & *Microsoft Outlook.*

4. The Hotmail UIs are designed in such a way that they all seem to the part of the same system running behind them. Therefore, a user knows what he is going to find even if he clicks or selects to use multiple options.

5. Hotmail has an effective feedback system. Even while the new version was still in the testing phase, vigorous actions were taken against the user feedbacks. Individual importance was given to the comments and suggestions that were given by the user. So that there is a constant involvement of the user in designing of an ESP that the users are looking for.

6. The Hotmail UIs have a range of colors that are soft combinations that have soothing effect on the eyes. The UIs are not created by using high contrasts so that the user feels comfort in utilizing the offered services.

7. Hotmail displays a range of help topics that are given to the user for guidance in case of an ambiguity. The information is easy to use and properly focused on the required field.
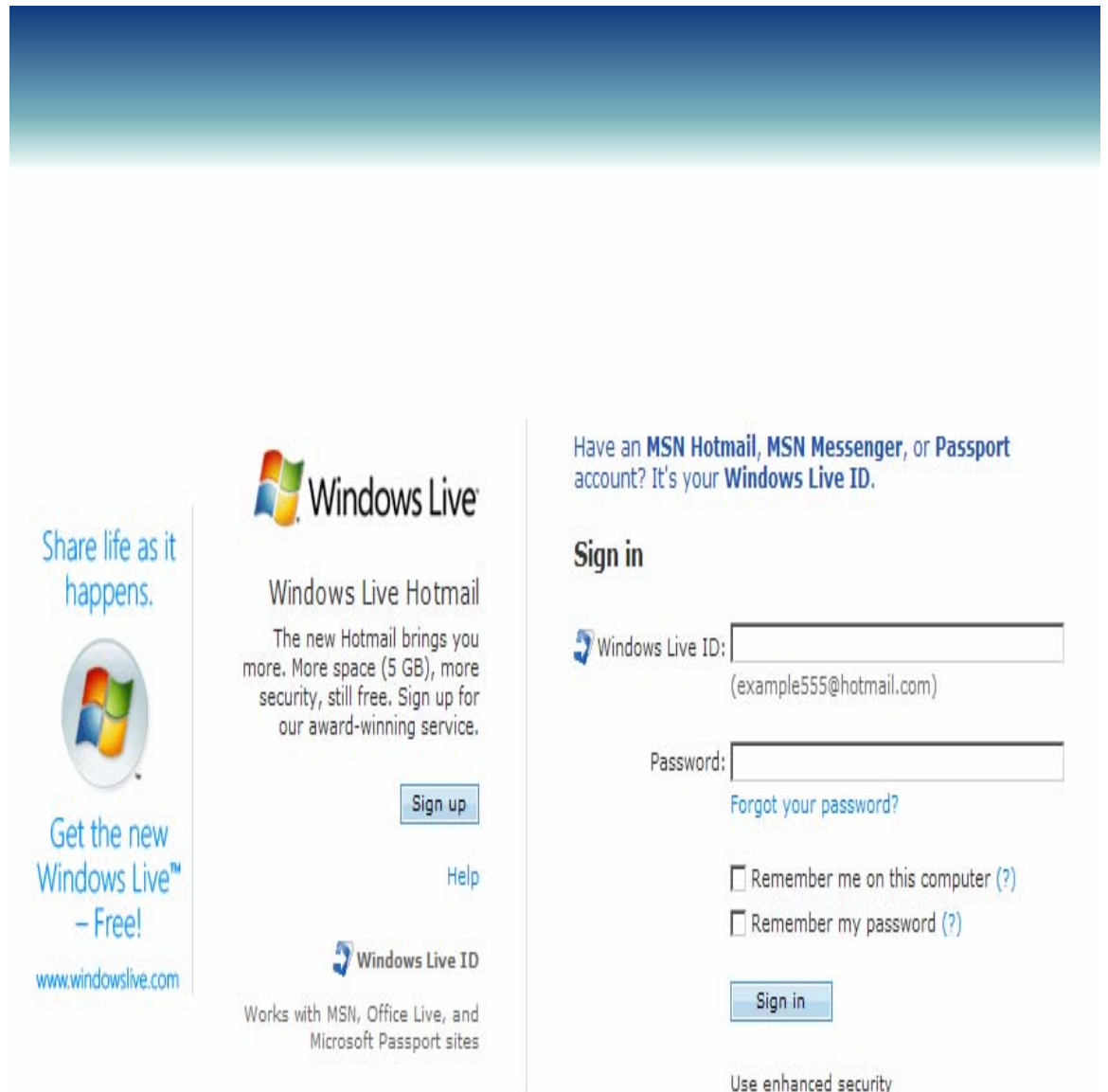
Figure 4: A Representation of Hotmail interface

A table was drawn with the list of 'Golden' rules and each website discussed was compared to check whether the rules are satisfied or not and results can be inferred from Table 2.

Rule	Golden Rule	Gmail	Yahoo	Hotmail
Rule-1	Consistency of the software	Yes	Yes	Yes
Rule-2	Shortcuts for the convenience of frequent users	Yes	Yes	Yes
Rule-3	Feedback information	Yes	Yes	Yes
Rule-4	Designing dialog boxes to show the status	No	No	No
Rule-5	Recoverability to minimize errors	Yes	Yes	Yes
Rule-6	Action reversal- undo	Yes	Yes	Yes
Rule-7	Design in a way that the user is in control of the software	Yes	Yes	Yes
Rule-8	Minimize instructions and information to make it easy for the user to remember things.	Yes	Yes	Yes

Table 2: represents the list of 'Golden' rules and each website discussed. All the three websites were compared to check whether they satisfy the golden rules.

2.7.2 E- Commerce Websites

In addition to the kind of websites discussed above, there are other websites that are used for online shopping, banking, transactions, etc. In such websites, the UI plays a vital role in the success and further progress. In general, there are two types of such websites:

1. The websites that are actually representing a business are already present in the real market offline, with the online business serving as an extension to the business.

2. The websites that are representing the business which is only present offline, with only the shipping and delivery system etc. present office.

In the latter, the appropriate UIs are the most crucial part of the business. They serve as the main object for attracting customers and increasing business. In the subsequent sections, we will be discussing about the e-commerce websites.

➢ **ebay Interface**

1. ebay offers a wide variety of goods for purchase. All the data is properly sorted and arranged. Hence, it becomes extremely easy for the user to locate the desired good for purchase.
2. In addition to the proper placement of the goods in different categories, it also displays different searching options. So that the user is able to select the required good easily.
3. The color scheme that is used in creating the ebay UIs is light with the main emphasis on the product rather then the design of the UI itself. The website itself remains in the background whereas the products are displayed at the front.
4. Although there is much information displayed on the website, but all the information is strictly precise, so that the user doesn't get fed-up with the nitty gritty details that he is not interested in.
5. Different promotion options are updated quickly and the system displays the status of the promotion and updates it while the user is going through different product details. In this way the user is able to know when a certain feature on the promotion will ending.
6. As it is an interactive website, therefore the users place their request very rapidly. In such a scenario, ebay present a highly efficient error handling and loading system. The system is not only secure for online transactions but also is highly efficient in terms of responding to a request placed by the user.
7. The objective of ebay website is to provide the users an interface which is easily manageable in terms of access as well as retrieval of information about a product. In this way the users are able to decide which product they want to purchase. The UIs are designed in such a way that they users are able to utilize this online shopping facility easily.
8. ebay provides an efficient feedback system. In order to help the customers the guidance is provided through phone, email and online chatting sessions. This is a unique but extremely productive and innovative method for solving the user problems right when they arise.

Figure 5: A Representation of ebay interface

➢ **Amazon Interface**

The UIs of Amazon are designed in such a way that the customers are encouraged to purchase goods and feel comfortable with the available interface design and utilities.

1. There are different categories of items available at Amazon for purchase. These items are placed at appropriate places in different sets so that it is easy for the user to locate and purchase them.
2. Searching techniques for quick item retrieval are presented, on the top of the homepage UI. In this way the user sees that the main emphasis is given on the searching of the item. A user accessing the information on an item for purchase using this utility.
3. The entire website uses the same look and template for displaying relevant information. In this way nothing seems to be out of context in terms of the out look.
4. The main emphasis is given to the products. Therefore, the websites is very easy to load and fast in the processing that is required.
5. The fast query response time enables the user to indicate and cater a query for purchase in no time.
6. The website is designed by keeping view that the presentation of the UI should not be irritating to the user. Hence, no sharp contrasts are used, but plain and simple background is used instead so that the primary focus remains on the product.

Figure 6: A Representation of Amazon interface.

The findings were also tabulated, to check the usage and satisfaction of the 'Golden Rules' by the E-Commerce websites. Most of the rules were satisfied and this can be inferred from Table 3.

Rule	Golden Rule	E-Bay	Amazon
Rule-1	Consistency of the software	Yes	Yes
Rule-2	Shortcuts for the convenience of frequent users	Yes	Yes
Rule-3	Feedback information	Yes (user rating and review)	Yes (seller and buyer ratings)
Rule-4	Designing dialog boxes to show the status	No	No
Rule-5	Recoverability to minimize errors	Yes	Yes
Rule-6	Action reversal- undo	Yes (add or remove to shopping cart)	Yes (delete item from the list)
Rule-7	Design in a way that the user is in control of the software	Yes (provides much options to users to change the feel of the website)	Yes
Rule-8	Minimize instructions and information to make it easy for the user to remember things.	Yes	Yes

Table 3: represents the usage and satisfaction of the 'Golden Rules' by the E-Commerce websites

3 Method

The present thesis work consists of Academic and industrial aspects in user interface development. In order to write this thesis work I used materials like research papers, journals, tutorials, books, market news, web browsing and literature survey. Subject related to the literature work was collected from university library, material available on the internet, research papers published by the people, workshops and books. The literature study also included the material from the conferences which were held at different places. The search engines like citeseer.ist.psu.edu, google.com, yahoo.com, springerlinks.com, ACM portal and IEEE Xplore were utilized.

4 Discussion

The systems that are successful today have given primary importance to the UI design and development.

In order to enhance ones business for possible benefits, it is important that UIs are designed in such a way that the user feels easy and comfortable in using the software. The right choice of colors and background is extremely important in the UIs. They are used to emphasize on the target products. In the websites that are used for e-commerce and trading, the UIs play a very important role. They have the dual role of serving as the identifier of the main content of the website as well as the advertisement for future work. A good UI would be extremely beneficial for the system, in this way.

Feedback system in any system has proved itself to be a useful modern day technique for betterment of the product. Even in the case of user interfaces, if there is an effective feedback strategy upon which there are certain demanded actions taken. Then the users will always be inclined towards the actual product and they will use the system more frequently. [43, 52]

When a user accesses a system for any useful purpose, he expects to see what the software system claims to bring to him. In this scenario, if proper message is not conveyed to the user in terms of a good user interface design, he will never be able to receive the intended message and therefore, never utilize the software to its intended purpose. The system, in his scenario, is unable to depict its reliability feature and therefore, could not be used by the user.

Similarity and consistency between all user interfaces is an extremely important feature. A standard should be maintained between the interfaces across all sections, so that the user gets the true picture of the relationship between different sets of pages across a software system. [34, 48]

A well written and well designed User interface will always be appreciated because of its ease of interpretability. In a UI design, it is often noticed that when it is tested on one platform and it is opened using another software/platform where it has not been tested before, the UI will not remain in its present shape. This is a very important feature that has to be kept in mind. As for the online systems, the users can belong to any region of the world; hence, the similarity of the platform can not be assured. Even if the users come from the same geographical area, still the designer cannot assure which software they will be using to view the UIs of the system. In this case the UI has to be designed in a flexible way. As we have seen a few examples in the sections above about some of the successful user involving systems, that are frequently used and are very popular, that no matter in which browser you open them, they will give the exactly similar look. This

shows that they have been designed in such a way that they are able to adapt to the changing software and varying platforms.

With the fast pacing changes that appear in the user requirements as well as the software versions, a very important feature that the system should provide is backward compatibility. The UIs should be designed in such a way that they are compatible with the earlier versions of the software. In addition to this, they should also be updated periodically for the latest software.

If we look closely, then all the features of software quality assurance are very closely knit with the measures of a good UI design. In order to ensure good error handling, the software quality features of consistency, conciseness, and understandability come into play. In order to apply effective error handling techniques, it is important for the coder to know the exact orientation of the code and implementation details, so that he can make error free code. In addition to this, for any new error scenarios, an understandable code can be altered and maintained by the user. [52, 57]

In addition to the above, the portability feature is determined by testing the software across varied backgrounds so that a user is not troubled with different outlook each time he tries to access the same system through a different browser.

The availability of documents and manuals that show the details of the theme and the implementation design of the UIs plays its part in the maintainability feature of software quality. It might not be the case that the designer is called in each time there is a case of upgrading the UIs for changing requirements, if proper documentation is available, then even the maintenance team can take care of this on their own. Sometimes, the initial resources who are responsible for the design as well as the construction are not the ones who perform the maintenance tasks.

In each of the above, the understandability is the key feature. Understandability in terms of the documents and manuals, in terms of the consistent set of symbols and notations used across all UIs and in terms of orientation of the data on the actual UI. It is important to note that there is no use of a software system if it is not represented in a way which is easy for the user to understand and interpret. [11, 46]

The size of the UIs is also an important consideration that should be kept in mind because they directly influence the time of loading of the pages. As discussed above, the websites that are frequently being used by people are very light weight so that they can respond quickly to the user's requests.

There are many aspects that should be kept in mind while designing a UI and all these ensure how successful a software system is going to be. For a good UI design, we can not ignore any of the above mentioned. No matter at what stage a business is, or how the planning is done, a representation of

a concept is of primary importance while dealing with a system that will be used for communication between a user and a system.

There are many software systems which are currently available in the market that shows excellent product features and compatibility, but they are not successful. This is due to the fact that not only the properties of a product are important, but how it is presented to the end-user. On the other hand, there are other systems that do not show very highly technical features and flashy outlook but still are widely accepted by the users belonging to every part of the world. These are the systems that have high preference towards the user perspective of the system at hand.

A very crucial aspect in this scenario is the acceptance from the users of the system. Many a systems that are developed in a highly technical way are rejected by the users only because the users are not comfortable with using the services. Now, all the effort that was put in during the design and the development of a *close to perfect* system are wasted only because the system failed to depict its real quality to the end user.

During the design and development of the UIs it is also an important consideration to keep the *type* of users who will be using the system. A close and clear analysis should be made in this respect so that there are no ambiguities about the nature of the users. Evaluating this would include the calculation and estimate of the user's need, objectives and experience. All three aspects have their own significance in a certain manner. [52, 55]

The users need to know the explanation about the system, so that he has the knowledge about the system at hand and he knows how to use it appropriately.

Simplicity is one of the key principles that should be kept in mind for designing UIs. The simpler to interpret the design, the more inclined the users will be to use it. [40]

A UI should be made by keeping in mind the fact that the users are new to the system and they will try out different options in order to achieve what they desire. In doing so, they can make a lot of mistakes, hey can enter wrong data or go to a wrong page. In this scenario, a system should be able to cater to all the needs and errors that a new user can possible make, so that they are not lost when using the actual UI. UI is therefore, very critical in this region. If the user is involved in the process of making the design, then the possible mistakes can also be pointed out, and hence, proper guidance can be placed for the user to perform the action that he actually intended to do.

The UIs should also be interpretable, the designs of the systems that are widely used all over the world have the quality of being simple and easily interpretable. Users always prefer a system that they are able to use intuitively. [16, 43]

5 Conclusion

If a software system is able to design a good set of UIs that are created under the golden principles of software quality, then it is likely that the software system will be widely appreciated and used by the intended audience. Among those principles are efficiency, conciseness, portability, consistency and reliability, but in reality there is a never ending list of the rules and principles that can generate an even better set of UIs. For achieving the high goals of progress and effective communication of the software system's perspective, the UIs should be designed under close and calculated supervision of the stake holders, and the end users should be involved in the process of construction and design. Requirements gathering, although, are separate dimensions, but it plays a vital role in designing the UIs. It can be seen that the systems that are successful today comply with the software quality standards and they also involve users in the process of UI development. This is of primary importance that the user knows what system they are seeing versus their expectations and the UI designer knows what the user is expecting from them. This all is possible, only if the software quality standards are kept under consideration and the constant feedback is taken from the user.

6 Future work

There are many possible ways in which the compliance of UI design and software quality can be checked. An intelligent software system can be developed in this regard. The system should be able to review the UIs for any errors. It should have the knowledge of the type of the software that is at hand. In this scenario, given the case that the software is aware of the type of system that the UI is going to represent, it can check for any features that are too odd for the system.

In addition to this, the system should be able to see how the designer is making the choice of colors, whether they are too sharp or irritating to the eyes of the user. The designer should also take care that good user interaction styles are followed to create a good user friendly interface.

It can also check the UI set for notation consistency. In order to perform all the above actions, the system should be given a clear set of data of the systems that are successfully running and maintaining the UIs.

This system will be able to add more ease at the designers end for designing error free UIs that comply with the software quality measures and the user preferences.

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A. First appendix

1. Figure 1: shows the usable design.
2. Figure 2: A representation of Gmail interface.
3. Figure 3: A Representation of Yahoo mail interface.
4. Figure 4: A Representation of Hotmail interface.
5. Figure 5: A Representation of ebay interface.
6. Figure 6: A Representation of Amazon interface.

B. Second appendix

1. Table 1: Represents 'Golden' rules to be followed in creating an effective interface design.

2. Table 2: represents the list of 'Golden' rules and each website discussed was compared to check whether the rules are satisfied or not.

3. Table 3: represents the usage and satisfaction of the 'Golden' Rules by the E-Commerce websites