

## CHAPTER 5

### **HFBUIT: HUMAN FACTOR BASED USER INTERFACE DESIGNING TOOL**

#### **5.1 Introduction**

People of all ages, backgrounds, and abilities in a wide variety of job, school, and home settings are using computers, often in unanticipated ways. The computer industry is being pressed to meet the needs of these various users. Academic and professional interface design guides often stress the fact that designers must "know the user." However, in today's rapidly growing computer and internet market, understanding the users' needs and abilities is becoming an increasingly difficult task. A well-designed software application has a consistent user interface that is easy to learn, leads to few errors, and is one that users enjoy using that interface. As Tidwell J. described that to design systems which are useful for the users are very difficult and designers need effective tools that help them to design such systems [10].

*In the previous chapters basics of HCI, usability, human factors and user interface tools etc. have been explained. This chapter now outlines the proposed **HFBUIT** framework. In this chapter, firstly an overview of the whole **HFBUIT** framework is given. Findings from the empirical study are used to motivate design and implementation of **HFBUIT**. The practical implementation of one of the tool **Suggestion***

*summarized in the next section. Finally, validation of Suggestion tool with the help of empirical study is contained in the last section of this chapter.*

Although there have been significant progress in computer technology but focus on human factors are still lacking. This is one of the important reasons of user's frustration. Numerous user interface principles and guidelines have been identified in an attempt to enhance usability so that human performance is improved. Many of these principles and guidelines are encapsulated into the fundamental usability design technique of User Centered Design (UCD), which focuses on designing software interfaces that are consistent to the users' skills, knowledge, habits and tasks [56]. Designers should know about the user to design the interface for different categories of users. In general, a human factor influences functioning of technological systems as well as stability of human-environment. Human Factors focuses on how people interact with tasks, machines and the environment with the consideration that humans have limitations and capabilities. It is a general problem that a few important issues have been ignored in research. Designers of user interface mostly concentrate on design issues-accessible design features often go unnoticed.

We introduced **HFBUIT, Human Factor Based User Interface Design Tool** that addresses the shortcomings mentioned above. HFBUIT in short, is a fundamental approach to impart human factor knowledge for innovative user interfaces to the designers. The most important reason for concentrating on this issue is the lack of knowledge of the designers in the area of human factors. Our HFBUIT framework suggests a wider scope

for the designers by concentrating on human factors during the development of user interface.

Exploring user interface design and development problems is the core of current HCI research. As Mark Green described that desktop user interfaces inhabit a very predictable environment and traditional user interface tools have taken advantage of this predictability. For example, a desktop application can safely assume that a mouse and keyboard will be available for input and a high resolution color display for output [3].

The rapid progress in hardware technology provided such immense computing power that the research and development of so called ‘sci-fi’ style state-of-the-art interaction techniques became a reality. Speech synthesis and recognition, gesture recognition, and virtual reality are only a few examples of such techniques [5].

There is clearly a wide range of user groups who have some level of difficulty in using technologies because of their disability. These disabilities can be physical or cognitive disabilities. The research focus in the field of HCI for the disabled has been on physical disabilities. To date there has been much less research dealing with cognitive disability and appropriate Human Computer Interaction [10].As a result, developers rarely design interfaces to be accessible to people with cognitive disabilities.

## **5.2 Designing of User Interface with the help of Tools**

The affordances and philosophies of many user interface tools contrast with the nature of the process of designing a user interface. As it can be

expected, there are many methodologies, lifecycles, and processes that can be followed in order to design a user interface [8]. It's clear that the user interface design has to be embedded in the software development life-cycle. A large number of s/w tools and environment for the design and development of user interfaces has been produced by the human computer interaction community [7]. User interface designers have very few options in terms of s/w tools when working on their design projects. According to Puerta following four qualities are essential and it should be incorporated in User Interface tools:

**Process Orientation:** A UI tool should conform to the general process of developing software. Not purely in a methodological sense, but rather in an organizational or procedural sense. The functions, input and output of UI tools therefore should be designed to match the way organizations work and processes flow.

**Interoperability:** A UI tool should be envisioned to work with other UI tools in building a user interface. It should not be conceived as a tool that produces design artifacts all on its own.

**Localized Functionality:** A UI tool should focus its functionality on a specific aspect of the design process as opposed to focusing on supporting entire lifecycles.

**Designer Impact:** A UI tool should enhance the limited design skills of non-designers thereby enabling to design where before they could not [8].

Software designers want help / tools which should be integrated in their design tool to design human factor based user interface. These tools should allow the designer to concentrate on the design process and on the

quality of the design result. Thus, we see there is a need of such type of tools. The implications from these facts are significant to the nature of the user interface tools we need to build.

### **5.3 HFBUIT Framework**

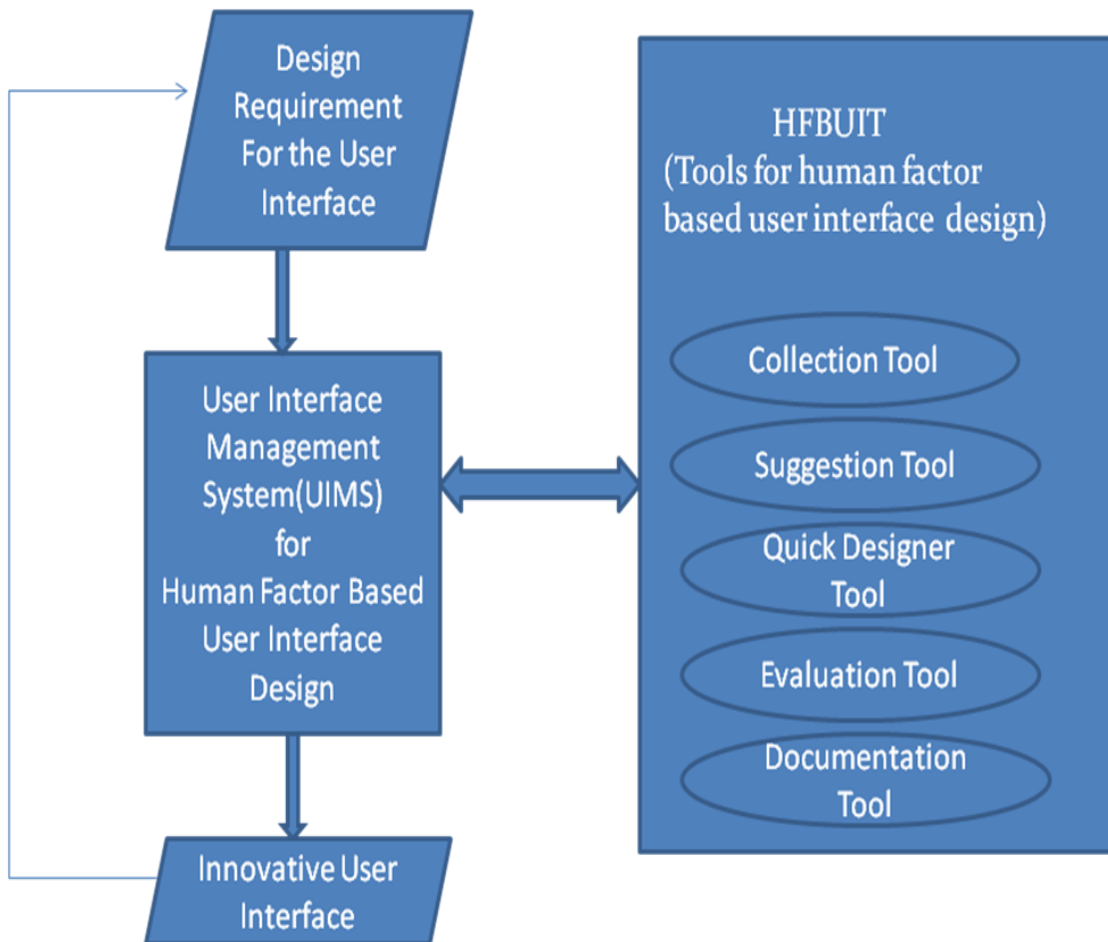
The science of understanding the properties of human capabilities includes cognitive ergonomics, usability and human computer interaction etc. Proposed solutions can be valuable for software developers, who can improve quality of user interfaces. As we know that designers have very limited knowledge about the target users. Therefore most of them are not able to apply standards, design principles and methodologies in design process. So the designed system makes end user confused and frustrated. Our HFBUIT framework helps the designers to concentrate on human factors during the development of user interface. This will be done with the help of tools. These tools offer a way to the user interface designers to design human factor based user interface.

HFBUIT a five phase framework of a tool that might help designers to design a Human Factors based user interface.

**HFBUIT framework consists of five tools/phases:**

- 1. Collection Tool**
- 2. Suggestion Tool**
- 3. Quick Designer Tool**
- 4. Evaluation Tool**
- 5. Documentation Tool**

**Figure 5.1: HFBUIT Framework: Collection Tool, Suggestion Tool, Quick Designer Tool, Evaluation Tool, and Documentation Tool**



### ***5.3.1 Collection Tool***

The collection tool supports the process of designing the user interface and is based on previous work. With the help of this tool the interface designers could search for information and use it as a part of the user interface. On the basis of this information the designers will be able to build the final interface which will be easily accessible by the end user.

The main reason behind development of this tool is that there is a real need for libraries of previous work that have been developed and tested. This would lead to increased productivity by reusing the software and by providing necessary information to the designers to develop a useful user interface.

### **5.3.2 *Suggestion Tool***

The problem that we designers face with most user interface tools produced so far is that they do not support the idea of providing advice or suggestion to design interfaces according to the users. Any movement in the direction of providing those types of support could be very helpful to user interface design.

This tool presents the designers information about human factors. Suggestion tool will provide this help to the designers and it will improve the performance and quality of the system. Usually designers refer to written manuals to get guidelines to design system according to the needs of the user. With the help of suggestion tool these guidelines will be available online to the designers. These suggestions would definitely help the designers to improve the user interface.

### **5.3.3 *Quick Designer Tool***

In most projects, it is extremely useful to create a prototype of a user interface. The prototype serves as a user interface specification and it is an ideal vehicle for evaluation and refinements to the UI. A prototype is also optimal when transferring the UI design to engineering. Prototyping is now recognized as a keystone of the successful

construction of the user interface. This prototyping tool will help the designers to develop a prototype. Before proceeding to the development phase this prototype can be tested with users and user can check whether the system is upto the mark or no. if not, then again changes can be made.

Early user involvement can be very beneficial. The end user can describe the problems associated with the system to perform their task. The use of prototyping feature will help to detect problems with the UI itself and architecture before programming starts.

#### **5.3.4 Evaluation Tool**

Each prototype will be evaluated by Evaluation Tool. The result of this evaluation will be some comments that show the defects in the system and give some suggestions to the designers to rectify those defects. This tool will help designers to point out undesirable features among user interface units. This tool will check whether newly designed interface is upto the mark.

#### **5.3.5 Documentation Tool**

Writing documents is a significant part of software development. Such documents include the results of requirement analysis and various levels of specifications of the software. Writing the document on Application Programming Interface (API) is essential. The document on the API, which we call the API documentation, is mainly read by programmers who want to develop their applications on top of that framework or library. They read the API documentation to know how



to write a program using that framework or library; the API documentation is its users' manual. Note that the API documentation is not comments or remarks for helping programmers understand the internal implementation of the framework or library. The Documentation Tool will generate the API documentation of a framework [6].

#### **5.4 Applying the Framework to Tool Development**

There are some fundamental reasons why many proposed tools do not prosper in practice. In particular, we see the following problem:

- Presently, the tools do not provide the knowledge about human factors that could be used during design of the user interface.

One of the tools, Suggestion Tool of this framework (HFBUIT) has been developed (partial code attached in Appendix II) to validate the project. Suggestion tool enables its designers to guide them to design user interface according to the collected information about the target user. A rule-based approach is used while designing the tool as Suggestion Tool discusses the problem and solution using IF/ THEN type statements. Conventional problem-solving computer programs make use of well-structured algorithms, data structures, and crisp reasoning strategies to find solutions. Conventional rule-based expert systems use human expert knowledge to solve real-world problems that normally would require human intelligence. Expert knowledge is often represented in the form of rules or as data within the computer. Depending upon the problem requirement, these rules and data can be recalled to solve problems. Rule-

based expert systems have played an important role in modern intelligent systems and their applications in strategic goal setting, planning, design, scheduling, fault monitoring, diagnosis and so on[11]. In a rule based approach the rules begin with some basic building blocks.

**Rules are of the form**

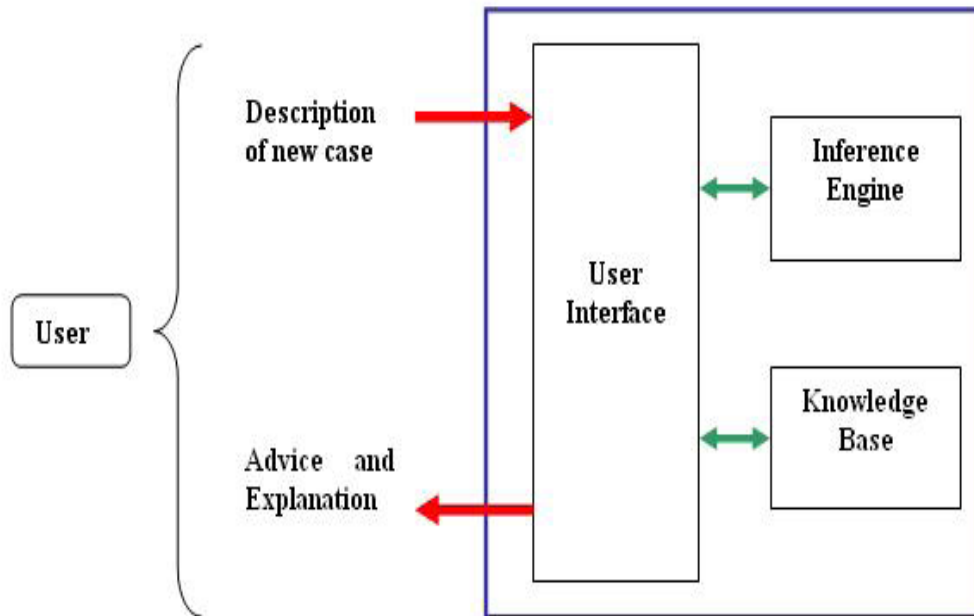
*IF condition THEN fact*

*Or*

*IF condition THEN action*

The condition is a logical expression or rule. The combination of the knowledge base and inference system developed the rule-based system. A set of these rules develops the knowledge base while the inference system utilizes rules and observations to think of conclusions for a state within a particular job or area of expertise [9].

**Figure 5.2:** shows use of knowledge base and inference system to give suggestions [4].

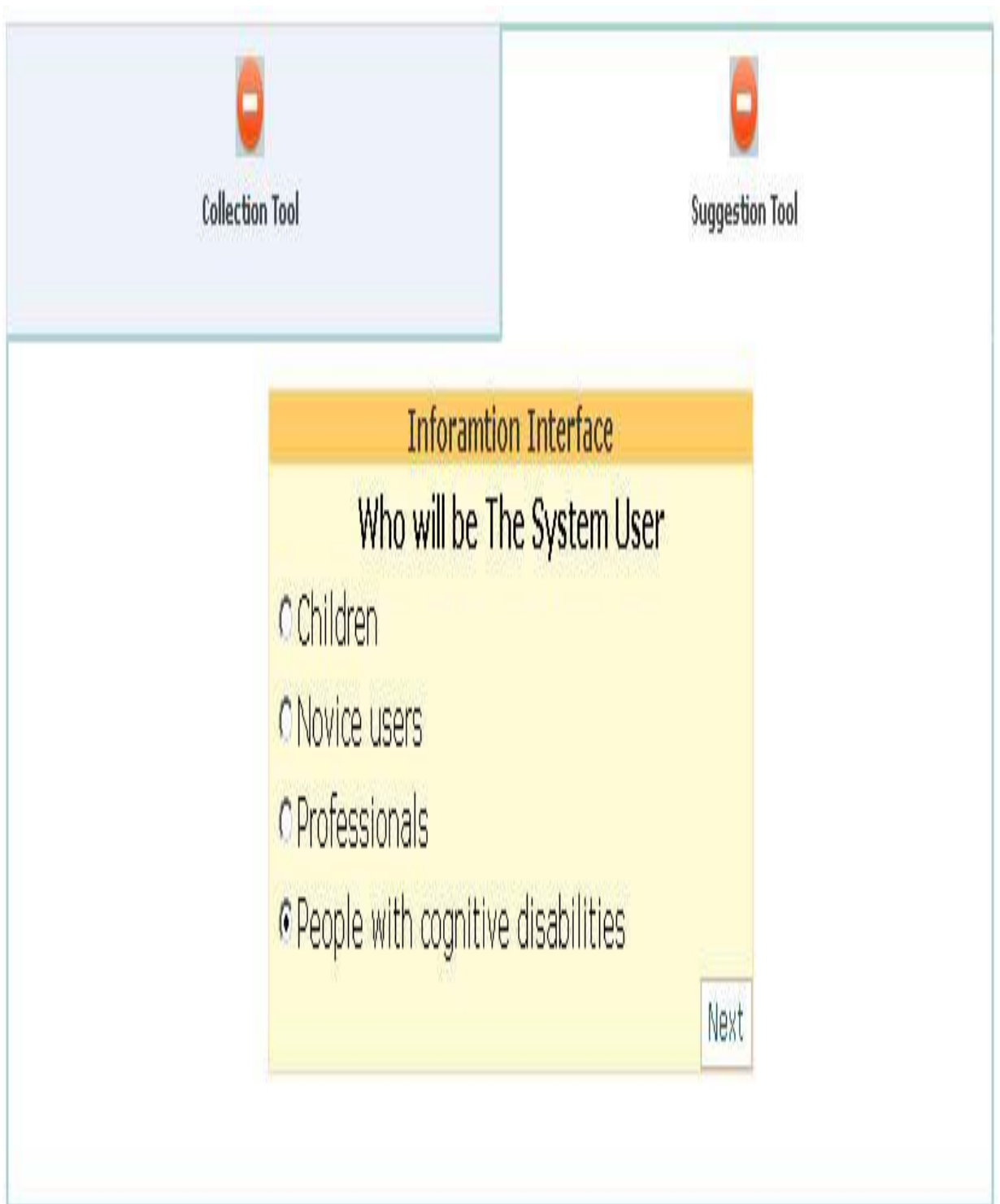


### 5.5 Front –End Components of Suggestion Tool

Suggestion Tool uses screen to ask questions, provides explanation on the system’s reasoning and display results. The front-end components of HFBUIT can be briefly described as follows:

Figure 5.3 shows the screenshots of the Suggestion Tool to collect the information about the type of users such as Novice, Professional etc. Figure 5.4 shows the screenshot to collect the detailed information about the type of users selected in figure 5.3.

**Figure 5.3: Screenshots of Suggestion Tool to select type of users**



**Figure 5.4: Screenshots of Suggestion Tool to input details about the users**

The image displays two overlapping windows from a software application. The top-left window is titled "Collection Tool" and has a red circular icon with a white square inside. The top-right window is titled "Suggestion Tool" and also has the same red circular icon. The "Suggestion Tool" window is active and shows a yellow "Information Interface" with the heading "Basic Information about user". Below the heading are four dropdown menus for user selection criteria: "over all Type of web site" (set to "Informational"), "User group :Typical Age" (set to "25-35"), "User Group: Literacy" (set to "Adult,normal education"), and "User Group:Computer Skills" (set to "Basic"). At the bottom right of the interface are two buttons labeled "Previous" and "Next".

**Figure 5.5: Recommendation based on user's need [5]. Recommendation can be generated in two ways; one is HTML document and second is in report form**

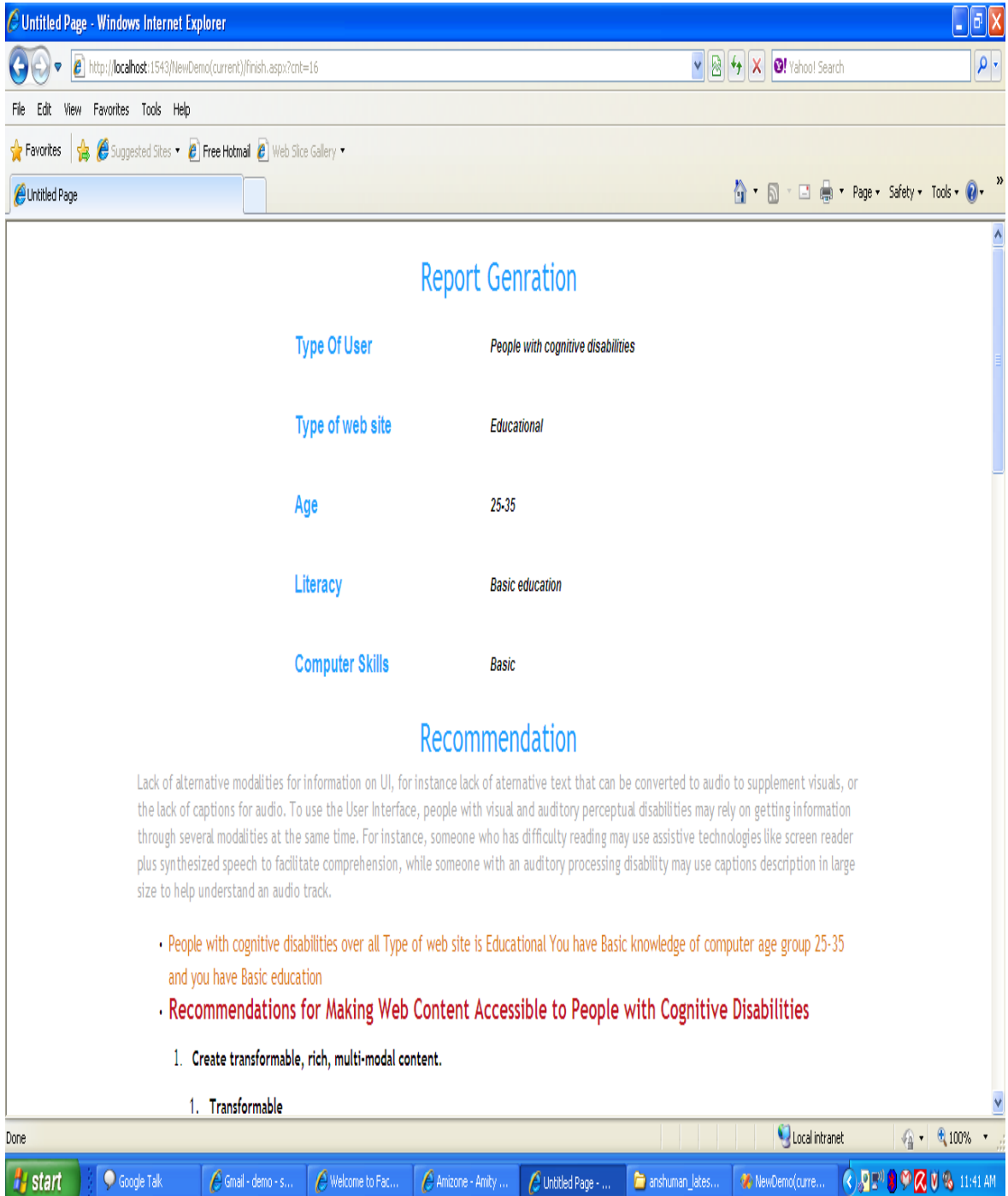


Figure 5.5 shows the screenshot of the Suggestion Tool that displays the suggestions based on the input from figure 5.3 and figure 5.4 and information stored in the knowledge base.

These inferences will definitely help the designers to design human factor based user interface and most importantly it would increase the usability of the system. Suggestion tool can be implemented in different levels of complexity, using a variety of techniques. The simplest case is where the designer has enough information about the users of the system.

## **5.6 Back End Component of Suggestion Tool**

**As the backend of the suggestion tool we have used the knowledge base which contains details about human factors of the target users.**

### **5.6.1 Knowledge Base**

This knowledge base contains user's details that allow designers to conduct analysis and design .These results are added to the knowledge base, which can later be used to make informative decisions. It can be incorporated at design time.

This will help the designer to create interface according to the needs of users. The most important aspect of modern interactive computer systems is the level of support they provide for the underlying human activity. This level of support is encompassed in the user interface (UI) with which the user interacts with the system.

**Figure 5.6: Knowledge Base containing details about the user**

The screenshot displays the Microsoft Access application window. The title bar reads "Database : Database (Access 2002 - 2003 file format) - Microsoft Access". The ribbon is set to "Table Tools" and shows various options like Home, Create, External Data, Database Tools, Add-Ins, and Datasheet. The task pane on the left lists tables: insert\_Sugg, QuestionResult, and recommendation. The main area shows a Datasheet View of the 'insert\_Sugg' table with 16 records. The status bar at the bottom indicates "Record: 1 of 15" and "No Filter".

ID	q1	q2	q3	q4	q5
1	Professionals	Informational	45-55	Higher education	Basic
2	Professionals	Informational	35-45	Higher education	Medium
3	Professionals	Educational	35-45	Basic education	Medium
4	Professionals	Informational	35-45	Basic education	Medium
5	Novice Users	Educational	35-45	Basic education	Medium
6	Novice Users	Educational	25-35	Basic education	Basic
7	Novice Users	Educational	25-35	Basic education	Basic
8	Children	Educational	10-15	Basic education	Basic
10	Novice Users	Educational	25-35	Higher education	Advance
11	Novice Users	Informational	35-45	Higher education	Medium
12	Novice Users	Educational	25-35	Higher education	Basic
13	Novice Users	Educational	35-45	Basic education	Basic
14	Children	Educational	10-15	Higher education	Medium
15	People with cognitive disabilities	Educational	25-35	Basic education	Basic
16	People with cognitive disabilities	Educational	25-35	Basic education	Basic
*	0				



## **5.7 Evaluation of Suggestion Tool**

We have conducted an empirical study to validate this tool. Study 2 was a follow-up study that attempted to find out usability problems encountered by user in study 1. The study took place in Think Computers. Think Computers is an interdisciplinary, professional consulting firm, which has its primary purpose the application of Managerial, Information system and Engineering skills to the solution of a wide number of problems in various commercial environments. The firm has in the past provided Software solutions government training in size from small private organizations to Major Corporation. Think Computers has a large number of developers with experience in development tools. Participants were informed that the tasks that they would be asked to do was not a test of their intelligence. All participants began by filling out a general information questionnaire concerning their personal characteristics like age and education (Illustrated in Appendix I). Researcher used library interface of Think Computers for this study. Participants were asked to perform the given tasks. Task duration and task success scores were collected. The task time started after the participant read the task aloud and ended in one of two ways:

1. The participants finish the task. A predetermined “correct” answer for each task was used to calculate task success measures.
2. The participant gave up.

New participants were given the same tasks as in study1 but worked with redesigned version of the system. Suggestion Tool was used by Software Designers of Think computer which enabled them to redesign User Interface according to the needs of target users.

### **5.7.1 Participants**

These participants were balanced by age, literacy level and general computer experience. Participants were divided into two groups; 1- having age less than or equal to 40, 2- having age above 40. Literacy level was measured using a 3 –pt scale: users with different literacy levels namely 1=literate, 2=semi literate and 3=illiterate. Computer experience was measured using a 5-pt scale: 1= novice, 2=beginner, 3=intermediate, 4=advanced and 5=expert.

### **5.7.2 Scenario:**

Participants have to find out “Yashwant Kanetkar’s book “Let Us ‘C’, from the library: (1) Find the above mentioned book (2) Find multiple edition of the book (3) Find the recent version (4) What is the unique id( Id. No.) of the book (5) Take print out of the details so you can refer to it later.

On the completion of the tasks, the participants were asked to complete questionnaire (feedback) on their experience. Finally the participants were thanked and asked if they had any questions.

### **5.7.3 Results**

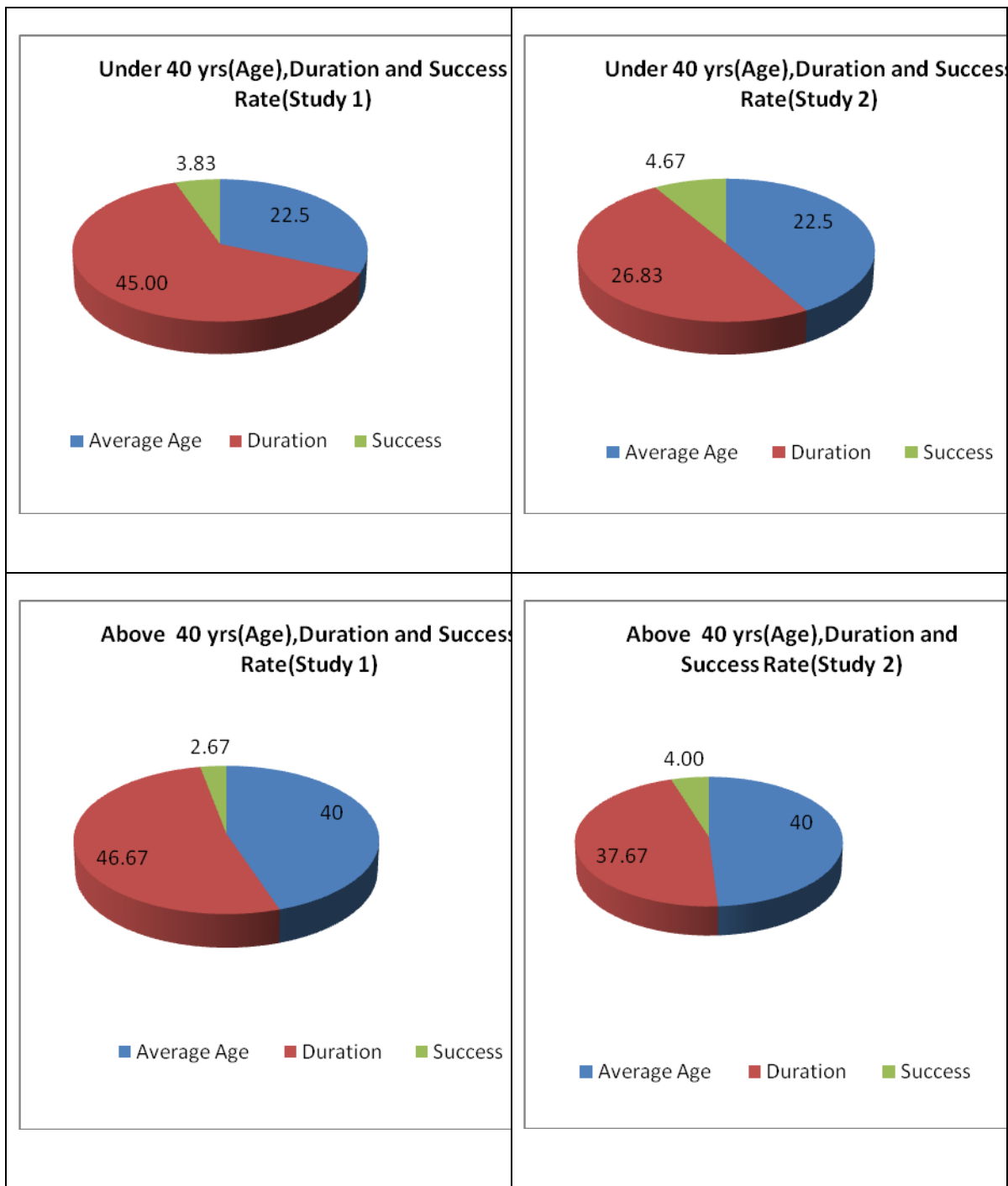
Participants found redesigned system “Easy to use”; ”Easy to learn”; etc. in less than an hour participants managed to complete the assigned task with the minimal help and without any prior knowledge of the system.

*Overall usability improved significantly for all users independent of age, computer experience and their literacy level. Overall usability improved significantly for all users from Study1 to Study2. If we take one parameter age as an example Table 5.1 shows the comparison of results of study1 and study2.*

**Table 5.1: Comparison of results of Study 1 and Study 2**

	<b>Study 1</b>		<b>Study 2</b>	
	<b>Under 40</b>	<b>Above 40</b>	<b>Under 40</b>	<b>Above 40</b>
<b>Tasks Duration</b>	45.00	46.67	26.83	37.67
<b>Tasks Success</b>	3.83	2.67	4.67	4.00

**Figure 5.7: shows effects of age on the completion of tasks**



For Study 2 also, users of old age had significantly lower task success rates than younger users. The results of the performance of older age users have improved in study2. From this study, it was concluded that however age is a moderating factor and it influence the performance of the user but a better user interface helps in improving their performance. Hence at design time this factor should be considered.

***This demonstrates that significant differences existed between age groups in both studies and significant improvement in task success and task duration were experienced by both age group in study 2.***

It was concluded that the more experienced people were more successful in study 2 also. The user's literacy is a fundamental factor in interface development, allowing designers to take advantage of target users' information seeking behavior. Low literacy users read everything on the screen trying to make sense of the information they read, while high literacy users glance through headings and paragraphs until they find relevant or interesting information. Study1 indicated that low literacy users performed significantly worse than high literacy users. Results of study 2 show that the performance of low literacy users has improved.

***Evaluation and validation of the results of study2 conducted on the interface designed with the help of Suggestion Tool shows increased efficiency and reduced error rate. Study 2 was conducted for human factors like***

*age, experience and literacy level. Similiar approach can be used for other factors also.*

## **5.8 Conclusion**

At a concrete level, we have introduced HFBUIT (Human Factor Based User Interface Tool) that helps the designers to design Human Factor Based User Interface. HFBUIT caters to all the needs of designers at a single place; it includes Collection, Suggestion, Quick designer, Evaluation and Documentation Tool. All these features combined are important from designers' perspective. Out of these tools Suggestion Tool has been implemented. We have demonstrated how Suggestion Tool will help the designers to design user interface according to the needs of target users. The tool has a feature of inserting users' details that can help the interface designers to try out different scenarios for different categories of users. The primary focus of Suggestion Tool is not to support the design process but to give the designers some suggestions for the user interface. The design of the final product in an iterative manner makes the user an active part of the process and results in a higher level of the system usability and user satisfaction, since designers are continually working according to their needs. Evaluation results shows that the use Suggestion Tool has helped the designers to design an effective user interface, use of which has shown improvement in the performance of users of different categories .We believe that our tool will help the designers to concentrate on human factors during the design of user interface in order to tackle usability issues of modern systems.

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