Designing Database Interfaces using a Human Computer Interaction Approach

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Abstract *— In 1960, Charles W. Bachman designed the Integrated Database System. IBM company, not wanting to be left out, created a database system of their own, known as Information Management System. In the late 1970's Human Computer Interaction emerged in the computer science field, the Association for Computing Machinery defines Human Computer Interaction as "A discipline concerned with the design, evaluation and implementation of* interactive computing systems *for human use and with the study of major phenomena surrounding them." This article shows Human Computer Interaction techniques can be applied to improve the Graphical User Interface design and testing process of a database.*

Key Terms *— Cognitive Engineering, Database Management System, Database Systems, Graphical User Interface, Human Computer Interaction, Human Interaction Database (HIDB), User First Design.*

INTRODUCTION

From the creation of a database system, which main purpose is to store an organized collection of data, to Human Computer Interaction (HCI), which develop usable, safe and functional systems, how can we merge both disciplines and "make it work"? Charles W. Bachman designed the Integrated Database System, the "first" Database Management System (DBMS). IBM company, not wanting to be left out, created a database system of their own, known as Information Management System (IMS) [1]. The DBMS [2] is a general-purpose software system that facilitates the processes of defining, constructing, manipulating, and sharing databases among various users and programmers, practically is a collection of programs that enables users to create and maintain a database.

Part of a DBMS consists of the following three elements:

- The **physical database**: The collection of files that contain the data
- The **database engine**: The software that makes it possible to access and modify the contents of the database
- The **database scheme**: The specification of the logical structure of the data stored in the database [1].

Figure 1 shows the basic knowledge on the structure of a Database System (DBs) and DBMS.

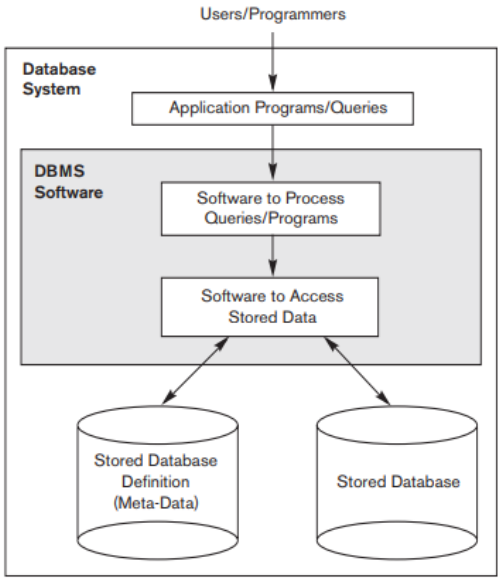

Figure 1
Structure of DBs and DBMS

This article shows a process that includes Human Computer Interaction techniques and how

they can be applied to improve the Graphical User Interface (GUI) design and testing process of a database to simplify user's interactions, because after all, the users are the ones that work on them daily.

LITERATURE REVIEW

Human Computer Interaction, also known as **cognitive engineering** is a socio-technological discipline whose goal is to bring the power of computers and communications systems to people in ways and forms that are both accessible and useful in our working, learning, communicating, and recreational lives. Toward this end, technologies such as the graphical user interface, virtual environments, speech recognition, gesture and handwriting recognition, multimedia presentation, and cognitive models of human learning and understanding are developed and applied as part of HCI research agendas. HCI has what is called the User First Design approach, which is used to ensure system design is based on an explicit understanding of users, their tasks and the environments in which they are using systems. This iterative system design and development process is driven and refined by User-centered evaluation and addresses the whole User Experience. Figure 2 shows an User First Design development cycle, also an HCI approach [3].

Figure 2
User First Design Process

As the times evolve, humans do too, maybe the things that are needed now are not going to matter in a few years or maybe new things would emerge later on. One thing is for sure, humans are in a constant change, the same happened with requirements. A database could be designed for a specific need in a specific time and function as expected, but later the need to add new fields of information may arise.

Database General Design Process

Using the Access support website [4], was possible to find the general design process steps:

- **Determine the purpose of your database:** This helps prepare you for the remaining steps.
- **Find and organize the information required:** Gather all types of information you might want to record in the database, such as product name and order number.
- **Divide the information into tables:** If you divide your information items into major entities or subjects, such as Products or Orders, then each subject becomes a table.
- **Turn information items into columns:** Decide what information you want to store in each table. Each item becomes a field and is displayed as a column in the table. For example, an Employees table might include fields such as Last Name.
- **Specify primary keys:** Choose each table's primary key. The primary key is a column that is used to uniquely identify each row. An example might be Product ID.
- **Set up the table relationship:** Add fields to tables or create new tables to clarify the relationships, as necessary.
- **Normalize your design:** Analyze your design for errors. Create the tables and add a few records of sample data. See if you can get the results you want from your tables. Make adjustments to the design, as needed.
- **Apply the normalization rules:** Apply the data normalization rules to see if your tables are structured correctly. Adjust the tables, as needed.

METHODOLOGY

Due to software availability and prototyping purposes, the database system was developed under Microsoft Access environment for the DBMS (Figure 3). The GUI was created using the form designer available in MS Access also, integrated with Visual Basic for Applications. The purpose of this system is being able to gather and track information, but also do it in a usable, safe and functional way.

To demonstrate the HCI technique implementation, this project is focused in the Project Table from the DB tables relations showed in Figure 3.

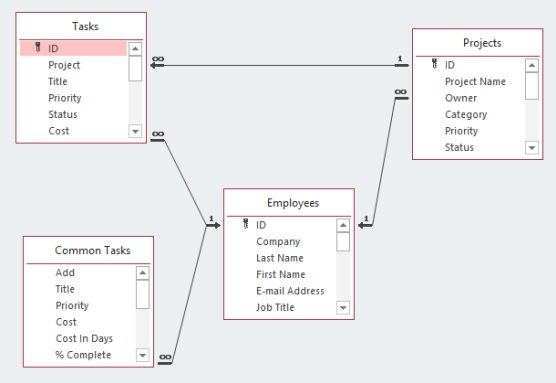

Figure 3
Project Table Relations

Database Development Lifecycle

Figure 4 shows the Database Development Life Cycle [5]. This regular database process is going to be merge with the User First Design.

Once the user requirements were analyzed along with the project requirements, then the Design Phase implement the Project Scope along with the User Scope, which includes the implementation of paper prototyping and Fitt's law to have an overview of the GUI. The Evaluation and Selection come along when both parts, User and Project representation, give the "Go ahead". The Logical and Physical Design are the next steps, then it comes the Implementation, and of course, there must be a complete GUI prototype in order to be successful. The Data gets load and after that the Testing and Performance come along including the system usability scale test to see the user's inputs on the new system. Figure 5 shows the Lifecycle Process created for this project.

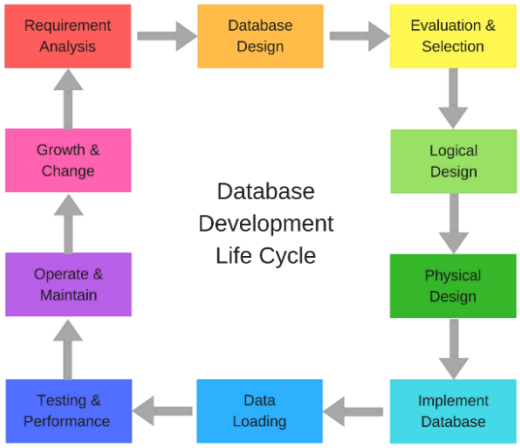

Figure 4
Database Development Life Cycle

Integration of the User First Design to Database Development Life Cycle

To implement the integration between the Database Development Life Cycle and the User First Design, a process merging both different cycles must be designed. To do this it was used the software Draw.io [6]. In the process of merging both cycles it was also integrated three **HCI** techniques, since the project is trying to show how HCI techniques can be applied to improve the GUI designing process of a database.

HCI Techniques on the GUI Design Phase

These two concepts are HCI techniques that helps to develop and test GUI's in a more efficient way.

1. **Paper Prototyping Technique:** Practically paper prototyping is to create a sketch of how the GUI would look. As simple it might be, it helps to communicate ideas and have a visualization of how GUI would turn out to be. Also is pretty cheap since the customer don't have to hire no one to code, at least not until the design was evaluated and moved to the Implementation Process. Fitt's Law can be applied on this technique also.

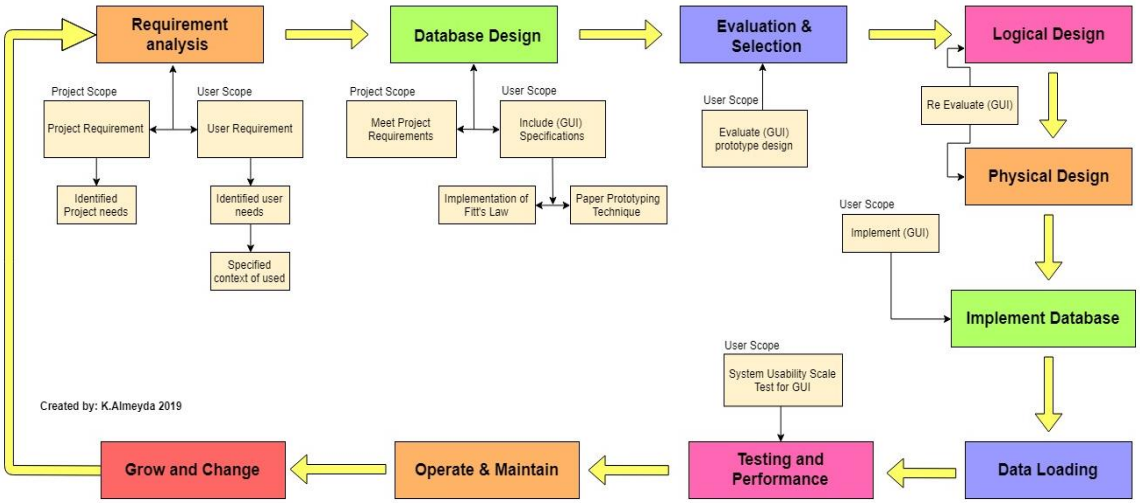

Figure 5
HIDB Lifecycle Proces

2. **Fitt's Law:** When a size of an object is bigger the selection time is less, because the distance between the user standing point and the object is less. Figure 6 shows three different buttons. Target A is the more appealing to the eyes because the bigger the button, less the selection time easier to the user. This law was applied on the project's GUI, first on the paper prototyping technique.

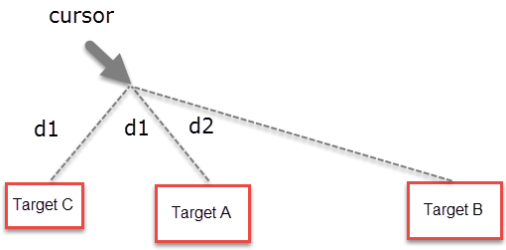

Figure 6
Fitt's Law

HCI Technique on the Testing Phase

This concept main purpose is to measure the usability of the GUI.

System Usability Scale (SUS) – This technique was created by John Brooke in 1986. It consists of 10 questions you must ask to a sample (people) with one of five responses that range from Strongly Agree to Strongly Disagree. For each question are converted to a new number, added together and then multiplied by 2.5 to convert the original scores of 0-40 to 0-100. Though the scores are 0-100, these are not percentages and should be considered only in terms of their percentile ranking. Based on research, a SUS score above 68 would be considered above average and anything below 68 is below average. However, the best way to interpret your results involves "normalizing" the scores to produce a percentile ranking.

Implementing Paper Prototyping & Fitt's Law

Paper prototyping and Fitt's law were implemented in the GUI from the project table of the database (Figure 7) to show an example on how it should be done.

Field Name	Data Type
ID	AutoNumber
Project Name	Short Text
Owner	Number
Category	Short Text
Priority	Short Text
Status	Short Text
Start Date	Date/Time
End Date	Date/Time
Budget in Days	Number
Budget	Currency
Notes	Long Text
Attachments	Attachment

General | Lookup

Field Size	Long Integer
New Values	Increment
Format	
Caption	
Indexed	No
Text Align	General

Figure 7
Project Table of the Database

P**aper prototyping** doesn't have to be in paper, it can be on a dry erase board, sticky note, or other media. Figure 8 shows how the implementation of **paper prototyping** was done, it was on the early stages of the GUI design process. Also the **Fitt's Law technique was** implemented on the **submit button.**

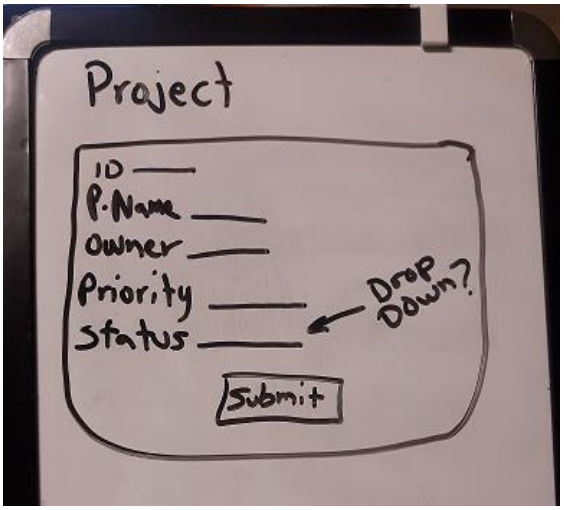

Figure 8
Paper Prototype

The bigger the button, less distance range, therefore less time; the placement of the button also matter. A too big button was avoided, since the design should be simple and user friendly.

GUI Project Table

Figure 9 shows the outcome; it wasn't exactly the same on the paper prototype but at least it gave an idea of what was needed in order to meet the Project Requirements along with the User Needs.

Wizard in Microsoft Access helps to make decisions about certain aspects of a form's design and produces a form based on the developer instructions [7].

CONCLUSION

There's a lot to cover and develop in the integration of Humans and Computers. Sometimes systems are made to reach a goal but in doing so, the programmer/designer forgets that some of them, if not most of them, are going to be used and manage by humans. The goal in this project was to show that there are different types of approaches when it comes to developing a database, application or a system in general. Developers can't forget the user's point of view, because what looks simple for them, might not be for the users, since they are not familiar with it.

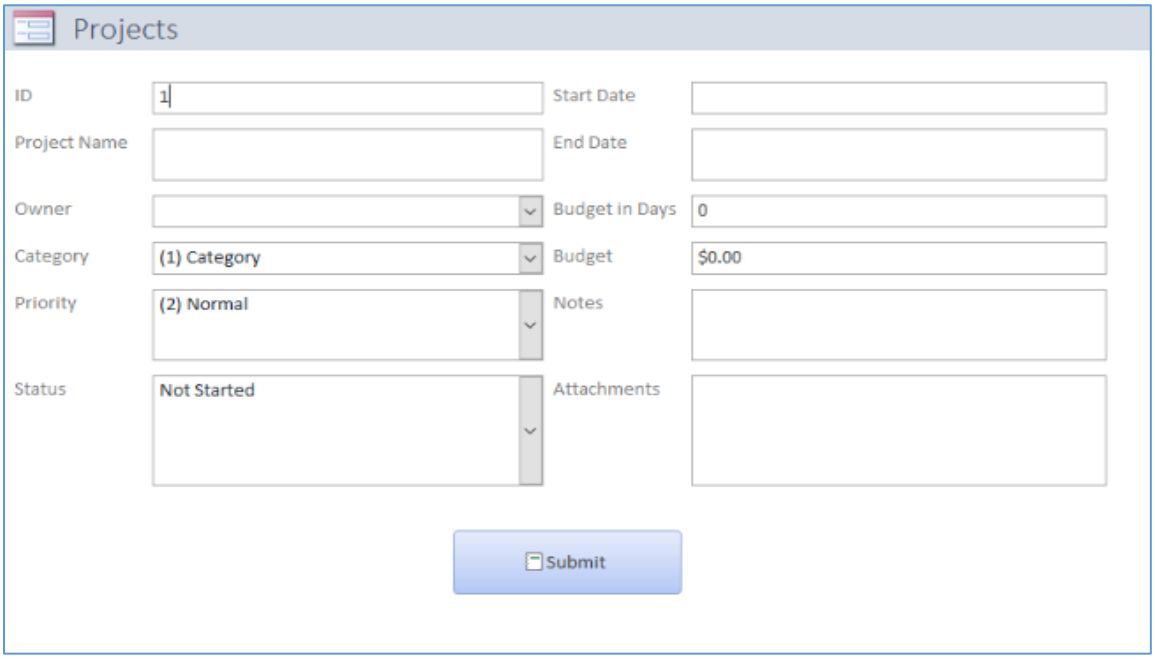

Figure 9
GUI Project Table

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