Guidelines for the Design and Creation of a Web Form to Facilitate the Registration of First Time Tax Payers: An HCI Approach

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Abstract

Research has been conducted both in the field of Human-Computer Interaction and in the field of design and creation. Very little research has been conducted in the area of tax registration systems. No research was carried out in the overlapping area of these three fields. By combining insights from literature in these fields the paper aims to provide insight into Human-Computer Interaction's implications and influences on the design and creation of a web form to facilitate the registration of first time tax payers in South Africa. Each aspect of human-computer interaction is broken down into individual themes. For each aspect, the factors that played a direct role in design and creation are discussed. For example, the human component may include factors such as senses, memory, emotion and individual differences. The computer component may include components such as input and output devices, system requirements and physical and logical setup. Norman's execution-evaluation cycle will be applied to the case study to explain the interaction process. The result of this study indicates that the influences of these factors are used as guidelines for the design and creation of a web form to ease the registration of first time tax payers.

Keywords

Human-computer interaction (HCI), design and creation, web forms, tax payer registrations

Introduction

Research has been conducted both in the field of Human-Computer Interaction and in the field of design and creation. Very little research has been conducted in the area of tax registration systems. No research was carried out in the overlapping area of these three fields. This proposes a gap in the academic literature which is illustrated in figure 1. The paper discusses the implication and influence that Human-Computer Interaction (HCI) has on the design and creation of a web form for first time tax payer registrations in South Africa by means of a literature review.

The concept of design and creation is defined as the development of new innovative information technology services by Oates (2006). For the development of any software product it is important to implement some form of design and creation strategy. The reason for this being that the design and creation of applications should be built on the principles that systems development is based on (Oates, 2006). This paper will look at the design and creation strategy in designing web forms with a Human-Computer Interaction approach. In this research, three key areas of Human-Computer Interaction are studied: (1) The human or user who will be using a particular system or device; (2) The computer or a system that the user will be making use of; (3) The process of 'making use of the system', which is defined as the interaction that takes place between the human and computer or the user and system. Each of the individual aspects, i.e. human, computer and interaction, will have an influence on the design and creation strategy.

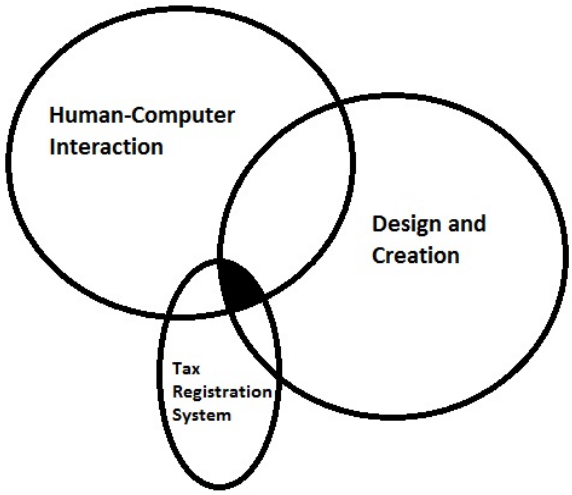

Fig 1. The Research Gap.

According to Dix et al. (2004), the main goal of design is to 'understand your materials'. The obvious materials in this case are the user and the system. Therefore, it is important to know and understand the user and to know and understand what type of system is needed and the requirements the system needs to meet. In the case of the user, the paper discusses the influential aspects, i.e. human senses, human memory, the manner in which humans think and reason, mental models, emotions, and individual differences. In the case of the system, the paper argues the influential aspects, i.e. physical setup, input and output devices required, the extent of the interface display, limitations on interactive performance, and network implications. Lastly, another aspect that needs to be taken into consideration would be 'interaction', i.e. level of interaction, and requirements of interactivity. For the purpose of interaction analysis, Norman's execution-evaluation cycle will be used. This model of interaction is a seven step execution-evaluation cycle. The other aspects that will be discussed regarding interaction is the impact of ergonomics; what type of interaction style is needed and the elements used for the specified style; the context of the interaction; how to design experience.

Case Study

The research is based on a case study to indicate how each aspect of the HCI applies to a specific problem. By using this approach it is easier to identify HCI in everyday situations by applying the same type of approach to different situations.

At present, South Africa has no online registration system for first time tax payers. If individuals want to register for tax for the first time they need to fill out a paper-based form and submit it at the applicable SARS (South African Revenue Services) branch. SARS, however, identifies noncompliance as an issue and have joined forces with the Customs National Stakeholders Forum to identify problematic areas (Cruikshank, 2010). The researcher argues that an online web form, designed and created from an HCI perspective, may aid in compliance towards tax registrations.

From the case study the following information can be extracted:

- There is a user, a system and interaction that will take place.
- The user of the system is the individual registering for tax for the first time.
- The system is the problem of translating the paper-based method into a web form.

- The interaction is defined as the transfer of data and information between the individual that will register for tax for the first time and the system that responds to the user via interaction through the web form.

Even though this breakdown of components may seem simple there are a number of factors that affect each aspect of the HCI analysis. When people hear the term Human-Computer Interaction for the first time, their initial impression is that it concerns the interaction that takes place between a human and a computer. This is true; however, the underlying meaning of the concept runs much deeper than that. There are many factors that influence each aspect of Human-Computer Interaction. The following section will discuss these factors and the implication each factor could have on design and creation.

The Human (User)

As mentioned before the user in this case study is the individual that will be registering for tax for the first time. When developing any type of system, it is important that the design and creation is business-specific, i.e. related to the organization that will be making use of it. Most important, the design and creation should be user-specific, as the user is the key generator of businesses. Therefore, it is important to understand the user that will be making use of the system. 'Understanding the user' could mean that factors such as human senses, human memory, the manner in which humans think and reason, mental models, emotions and individual differences should be taken into account when designing and creating the system.

Human Senses

It is common knowledge that the human senses consist of sight, touch, hearing, taste and smell. The senses that are most applicable to Human-Computer Interaction are sight, touch and audio. Sight or vision is the most important sense as visual stimuli tend to capture our attention the best. Touch or "haptic perception" is defined as a secondary source of information. Haptic perception is the extent to which we can identify objects through touch alone (Henriques and Soechting, 2003). Hearing or the audio system's capability to receive information is also underestimated many times.

With regard to design and creation, human senses may play a role in the following way:

i. When visual perception is taken into account it is noteworthy that the concept of optical illusions is a great way of explaining the way in which humans perceive objects. That is why most interfaces are designed around the optical centre of the screen. The optical centre is the point on the screen where the human mind perceives the centre to be. It is however not the actual centre. If screen measurements were to be taken, the result would indicate that the actual centre of the screen appears to be lower than a human's perceived idea of where the centre is. Research has shown that top and bottom margins in the ratio 1:1.5 gives the illusion that the interface design is well-centered. This is known as the optical centre (Venter and Von Bellow, 2010).
ii. From a young age we are taught to read from left to right (except in cases where the reading direction is different in other languages). It is important to arrange objects in such a way that the actions that need to be executed first are read or seen first, i.e. it is ideally more beneficial to arrange objects from left to right, in order of execution. When placing objects it is also important that the distance between objects is short and that objects and their functions are clearly visible.
iii. Haptic perception is an important source for information regarding the surroundings and the environment. For example, pressing the keys on the keyboard and feeling it moves under the weight of one's fingers gives the impression that an action needs to occur on the other side of the system. Scrolling with the thumbwheel on the mouse gives the impression of 'continuance', meaning that the process (e.g. registering for tax on the web form) is moving forward.

iv. Sound in systems is a component that could be better utilized in general. Even though our attention is mainly distracted by what we see, it is also true that sound warnings or indications could focus our attention to important matters.

Human Memory

Human memory can be categorized into three sections: sensory, short-term and long-term memory (Maccarelli, 2006). Sensory memory includes all memories that are based on reception from our senses. Short-term memory (the "RAM" of the human brain) is the memory that has the fastest access but deteriorates at a fast pace. Long-term memory (the "hard drive" in the human brain) has slow access but is 'imprinted' to human recollection.

With regard to design and creation, human memory may play a role in the following way:

i. Sensory memory – Memories that are based on reception from human senses. There are 3 main types of sensory memories which are iconic, echoic and haptic memory. An example of iconic memory is a picture of a cross (x) that gives the impression of being incorrect or ending a process because this is what the icon represents in human memory. An example of echoic memory could be hearing an eerie sound that recalls the sense of misbehavior or ominous results if proceeding with an action. This is because the pitch and frequency of the sound could be similar to a sound in human echoic memory that represented a threatening situation. An example of haptic memory could be the touch of a rough surface that indicates the grip of a rugby ball or a smooth surface that indicates the softness of silk material.
ii. Short-term memory – An HCI principle such as *learnability* would typically fall under this category. Learnability is the ability of the system to allow the user to understand and use the system when encountering it for the first time (Sharp et al., 2007:20). This only requires short-term memory as the user may only interact with the system in that instance and needs to understand what to do in that given moment.
iii. Long-term memory – An HCI principle that would be categorized under long-term memory is *memorability*. Memorability is the ability of the system to allow the user to recall how to use the system in the future (Sharp et al, 2007). This relies on information that was stored in long-term memory.

Thinking and Reasoning

The way in which humans think determines the way in which humans reason, which in turn determines the way in which humans solve problems. Reasoning can be divided into three categories: deductive, inductive and abductive (Kovács and Spens, 2005).

With regard to design and creation, reasoning may play a role in the following way:

i. Deductive reasoning – A logical conclusion is derived from a group of statements. For example, if the design of a system is simple and the design of the system is elegant and professional we can conclude that the user will be satisfied with the result.
ii. Inductive reasoning – A conclusion is reached by applying current knowledge to unknown situations. For example, one can conclude that all the functions for all word processors will work in the same way as Microsoft Word. This could be proven false by showing that one function differs in another word processor like Open Office.
iii. Abductive reasoning – This approach is reasoning in reverse. The individual reasons from the conclusion backwards to the event that could have resulted in it. For example, if a system repeatedly shuts down when a certain button is pressed, the user will reason that pressing the button caused the system to shut down. This could, however, be incorrect as there could possibly have been power failures every time the button happened to be pressed.

Mental Models

Humans have the capability to absorb, interpret, manipulate and represent information. Humans build mental models according to their experiences and prior knowledge. The problem is that humans are prone to err. Incorrect mental models are then built and this influences the way in which humans interpret situations and manipulate data. For example, if the help file of a system explains that "the green button" will save the document you are busy with, the user might assume that any green button will do the same. Incorrect mental models can in this way be disastrous.

Emotions

The way humans feel (emotional state) affects human performance. Stress can make even the easiest task seem tedious. Whereas a positive attitude could possibly aid problem solving more than a negative attitude would. It is therefore important in design and creation to promote positive responses, which can be done by designing interfaces that are aesthetically pleasing or rewarding (Venter and Von Bellow, 2010).

Individual Differences

Every person is different and unique. Aspects that should be considered can include gender, age, physical capabilities and mental capabilities. For example, for a preschool system you would use large images and bright colours. A professional organization will not be pleased if you present them with the same type of system for their business purposes. In design and creation it is important to take every decision regarding design into account as it could adversely affect the user. It is advised that system design and creation should not push users to their cognitive limits (Venter and Von Bellow, 2010).

The Computer System

The system in this case study is the problem of translating the paper-based system into an interactive web form to aid the registration of first time tax payers. This translation would, however, be subject to the redesign of some components to suit the electronic system. The current process is paper-based and the staff at the SARS branch does the data-capturing into their system. The implementation of a web form not only promises for a possibility of compliance but also eliminates manual data-capture which could lead to human error. However, the system is not limited to the interface design but also includes the physical components of the computer setup and the necessary software. It is crucial to understand the system, its requirements and the constraints that could have an influence on efficient interaction.

Physical Setup

The physical computer setup plays a role in the design and creation strategy. There are different types of computer setups ranging from the standard stand-alone personal computer to laptops to personal digital assistants (PDA). Mobile computing is also becoming increasingly popular (Godwin-Jones, 2008). When designing an application it is important to take into consideration for which computer setup the interface will be used. For example, the same interface will display differently on a personal computer than on a mobile phone or PDA. This in turn affects the placing of objects and resolution settings, which determines the design and creation approach.

Input and Output Devices

If the assumption is that the web form will mainly be displayed on the standard computer, the next step is to determine which input and output devices are required. The main components of the standard computer are the box,

screen, mouse and keyboard. The mouse and keyboard are the standard input devices used mainly for navigation and text-entry. The screen is the main output device. If the web form includes audio output, speakers will also be necessary as an output device. If the user wants to have proof of registration or documentation of the process, a printer could also be added as output device. Another form of input device could be the use of touch screens for navigation purposes. Input and output devices play an important role because they need to be accounted for during the design and creation process. For example, options for audio and printing should be visible on the interface display and the layout of the interface display should be adaptable to the screen display.

Limitations on Interactive Performance

Processor speed could also affect the interface display. There are a number of factors that can influence the processor speed such as graphic limitations, storage capacity and network related problems (Venter and Von Bellow, 2010). If the design includes high definition graphic displays and the system doesn't have an efficient graphical user interface card it could alter the level of interaction between user and system. Storage capacity refers to the amount of memory that is available for fast access. Users will discontinue the use of a system if there are long delays in interaction. As this web form needs to be accessible on the World Wide Web, which is a network, the web form also suffers under the problems that can be experienced by network limitations. The next section will discuss this in more detail.

Network Implications

The assumption is that an individual will typically use their computer at home or the work's computer to register for tax for the first time, depending on where there is an Internet connection available. The Internet is a worldwide network of information. Many organizations promote their businesses on the Internet by means of online marketing and online shopping. Since the web form should be available online for easy access, SARS's first time tax payer registrations should then become an electronic business solution (Bentley and Whitten, 2007). As this form of interaction increasingly becomes popular, it is acceptable to assume that a percentage of the population may prefer to do online registration for tax payments. As the web form would operate on a network spanned over a large distance, we could infer that data transfer could take time and this could affect the response time of the system, which in turn affects the level of interaction.

The Interaction

The interaction in this case study is the communication that takes place between the individual registering for tax and the system, which interacts with the user through the web form. In this section, Norman's execution-evaluation cycle will be used to demonstrate how interaction typically takes place between the user and the system. It is important to understand interaction and interactivity so that the level of communication between user and system can be optimized.

Norman's Execution-Evaluation Cycle

The implication of the facts of the case study indicates that an interactive web form needs to be developed where individuals can register for their tax payments for the first time. The interaction between user and system can be explained by using Norman's execution-evaluation cycle. Norman introduces this model to show why interfaces confuse users. He discusses it in terms of two 'gulfs', execution and evaluation (Norman, 2002).

Execution involves the first four steps of the model, establishing the goals, forming the intention, specifying the action sequence and the execution thereof. In these four steps the user defines the execution process of a certain

activity according to his or her own perception. This, however, does not necessarily correlate to how the actual execution of the activity will take place. Execution is defined as the difference between users' perception of what an action should be able to do and which actions the system eventually allows for. If the actions allowed by the system coincide narrowly with the perception of the user of what the actions should be able to do, the interaction should be effective.

Evaluation includes the remaining three steps of the model, perceiving the system state, interpreting the system state and evaluating the results against the goal and initial intention. These three steps determine how effective the user's initial perception corresponded to the actual system state by determining possible problems experienced with the specified execution plan, solutions to these problems and an evaluation of whether the goal was reached, regardless of the problems experienced. Evaluation is the correspondence between the expectation of the user and the physical representation of the system. The narrower the correspondence, the more efficient the interaction will be. Dix et al. (2004) stated that the model is defective in the sense that it focuses mainly on the user's perception of interaction with the interface and does not include the system's interaction through the interface.

Norman's execution-evaluation cycle can be applied to the case study as follow:

1. Establish the goal

The goal is to develop an interactive web form for first time tax payer registrations. The design and creation for this web form should promote compliance amongst the users.

2. Forming the intention

The intention is to translate the current paper-based system into an effective interactive web form. It is, however, not limited to translation alone and also includes additional improvements to aid in design and creation.

3. Specify the action sequence

In this step, the plan for design and creation carefully needs to be laid out step by step. The sequence of actions for this specific case study could include the following activities: analyze the paper-based form and determine which data is really needed, take these requirements and translate them into a web form prototype, revise the layout by determining which HCI principles should be considered to improve the design and creation process, implement and test the result.

4. Execute the action sequence

In this step, the execution of the action sequence takes place. It is important that every action occurs in order and that every action is completed before the next action can take place, except in cases where two individual actions can occur simultaneously.

5. Perceive the system state

During the execution of the action sequence it is possible that some actions may not be executable due to unforeseen problems. In this step analysis should be done to determine problems that could occur. For example, if one of the steps in the action sequence has a time constraint it is possible that unforeseen events can occur that may push that step beyond its time constraint.

6. Interpret the system state

In this step, provision of possible solutions to the problems identified in the previous step is necessary. An example could be adding a 'forgiving-week' to the time constraint problem mentioned in step five.

7. Evaluate the system state

After the initial action sequence has completed, inclusive of the unforeseen problems and possible solutions, it is necessary to determine the status of the project by weighing the result against the goal and intention. If the problem was successfully completed, this step could possibly read as follow: The interaction was successful with minor complications. Some of the actions had to be revised as there were unplanned interruptions during the design and creation phase. After the solutions were implemented, execution of the action sequence continued and was successfully completed.

Impact of Ergonomics

Ergonomics can be defined as the research done on the physical components that influence interaction, some of which could be positioning, the use of colour and health issues (Chaffin, 2005).

In the case of design and creation, ergonomics could have the following impact:

i. Positioning of displays need to be sequential, i.e. placed in order of use or operation.
ii. Colour displays need to be distinguishable and relate to prior knowledge. For example, a red display should be used to indicate danger.
iii. Health issues may include constraints such as the time spent in front of the system. It is unhealthy to remain seated in front of a computer for long periods of time. Therefore, the design and creation of the web form should take into account the length of the web form.

Interaction Style and Elements

As most computers make use of some form of Windows operating system, it is safe to say that the best interaction style for the web form will be the use of WIMP. WIMP is an acronym for windows, icons, menus and pointers (Sharp et al., 2007). Typical elements of the WIMP interaction style are buttons, toolbars, menus and icons. These are some of the elements that could be used in the design and creation of the web form.

Context of Interaction

The context of the interaction refers to the people, environment and motivation behind the interaction (Venter and Von Bellow, 2010). The people involved will be the individuals registering for tax, the environment will typically be that of a working individual and the motivation for the interaction will be fear and gain. Fear because of the complications one could experience by avoiding the legal system. Gain because of the benefits that an individual could receive by claiming tax back in cases where it was wrongfully deducted. These are all factors that should be considered when planning the design and creation of the web form.

Designing Experience

Designing experience is a key issue in interaction. This is the process of taking the real world situation and translating it into the virtual world representation (Dix et al., 2004), i.e. the successful design of a prototype that represents the 'real thing'. For this case study designing experience is the efficient translation of the paper-based form into an interactive web form. Refer to table 1 as explanation.

Other factors to consider when designing experience are legal issues, safety precautions, economic effects and aesthetic characteristics.

Table 1: Designing Experience Comparison between Real-world Example and Web Form Prototype

	Paper-based form	Web form
Design	Ordinary and easy to complete	Simplistic and allows for help if user doesn't know what to do
Layout	IT77 form	Similar to paper-based form but only includes relevant information
Cost	Cheap – each user prints their own form	Cheap – user has no need for printouts but bandwidth costs increases
Access	Downloadable on SARS website	Accessible on SARS website

The Impact of these Factors on the Design and Creation of the Web Form

According to the case study's requirements, the following is needed: An interactive system needs to be designed and created by translating the information that is currently on the paper-based registration form into a web form that can be accessed on the Internet. The purpose of the web form is to accommodate individuals who want to register for tax payments for the first time to do it over the Internet. The web form is suggested on the idea that it might aid towards compliance of individuals to register for tax. The paper has discussed the impact that Human-Computer Interaction may have on the design and creation strategy. The findings can be summarized as follow:

The Human

i. Human senses may play a role in the design and creation of the web form as the visual display of the interface needs to be aesthetically pleasing, any audio features need to be provided for and haptic senses need to be encouraged for the completion of the form.
ii. With regard to human memory, the initial registration process requires only short-term memory as the user is only required to register for tax once. Therefore, the *learnability* of the web form needs to be well designed. If this web form is designed to resemble the tax-filing web forms then long-term memory will be of greater assistance and thus the *memorability* of the web form should be emphasized.
iii. Humans think and reason in different manners and it is therefore important that the web form design allows for individual approaches to problem solving. By doing this, the web form will also in turn cater for different mental models that users build whilst using it.
iv. Humans are emotional creatures and therefore feelings and emotions affects a human's every decision. An aesthetically pleasing interface could promote satisfaction in the user which could aid in compliance.
v. All humans are different; every system design is different and developed according to the needs of the user. For the web form it is important to consider aspects such as age and computer literacy. The web form should not push the user to his or her cognitive limit. Therefore it is important that the design is simple but professional.

The Computer

i. The assumption according to the requirements of this case study is that the user will interact with a standard computer system setup when doing his or her tax registration.

ii. The input devices required for the web form to be effective are a mouse and a keyboard, respectively used for navigation and text-entry. The leading output device is the monitor so that the user can see and visualize the process as he or she interacts with it. It could also be useful to allow for printing options and audio output in case pop-up warnings for incorrect input need to be emphasized.
iii. Where computers are involved, processing speed is of cardinal importance. Users do not want to struggle with a system that is too slow. A slow processor could cause users to believe that an action which they already performed on the website was never executed. Users then repeatedly redo this action until they receive some sort of feedback from the system. The problem is that the system keeps track of every action a user performs and this could then lead to the system overshooting (when the system tries to perform too many processes simultaneously, this usually causes a system to "hang") and having adverse affects on the registration system. Feedback in the design and creation phase is an extremely important issue.
iv. As the web form will be accessible on the Internet it is important to take network implications into consideration also.

The Interaction

i. Norman's execution-evaluation cycle was used to illustrate typical interaction between the user and the system.
ii. According to Norman, the narrower the relation between a human's perception of a system and the functionality of the system itself is, the more effective the interaction will be.
iii. The impact of ergonomics also directly affects the manner in which the user will interact with the web form and this should be accounted for in the design and creation process.
iv. The most applicable interaction style interface for the web form will be the WIMP interface and the corresponding elements contained therein.
v. A key aspect for the context of interaction is the motivation that drives the user to interact with the web form. In this case study, fear of the legal system and the satisfaction of claims would be key motivators for users to comply with the system.
vi. Designing experience is the main goal in the translation of the real-world paper-based registration system into the virtual-world web form registration system. This is the main focus for interaction during the design and creation phase.

Conclusion and Contribution to the Field of IT

Web forms are an easy and cost effective way to reach larger populations in a shorter amount of time (Barak and English, 2002). It is beneficial that the paper-based form be translated into an online interactive web form where a greater percentage of the population can have access to it. This, in turn, might aid in compliance of such a system because ease of access to the system and the elimination of data redundancy may promote positive responses in the user. The main goal of the research is to illustrate the relation and impact that Human-Computer Interaction fundamentals have on the design and creation strategy. From the study it is clearly seen that each aspect of Human-Computer Interaction may play a role in the approach to design and creation methods.

The research addressed the lack of academic research that covers the intersection of the fields of Human-Computer Interaction, design and creation and tax registration systems. In doing this, a small contribution was made to the field of Information Technology. This paper suggested possible guidelines to take into account when designing and creating a web registration form for first time tax payers. The study is, however, limited as it is not applied and tested by empirical work that includes the physical design and implementation of the web form. This constitutes future work, where researchers can design and implement a web form prototype by taking into account the suggestions made in this study and by including SARS in the process.

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