

Prototype Development Proposal Using the User-Centered Design Approach

Victor M. Chi Pech¹, Erika R. Llanes Castro², Carlos A. Miranda Palma³, Maximiliano Canché Euán⁴

Faculty of Mathematics, Autonomous University of Yucatán, Mérida, Yucatán, México¹⁻⁴

Abstract: Nowadays, the great boom that computer systems have had is largely due to the fact that these systems are designed with a greater knowledge about the users who will use them, resulting in that these systems help users to reduce, among others, the time to perform their activities, that is, currently for success in the use of the developed systems, the User-Centered Design must be considered. This document describes some prototypes developed under this design that will be of great help to students of the Undergraduate Degree in Software Engineering of the Autonomous University of Yucatán, México, by putting into practice their knowledge acquired in the Human Computer Interaction course, facilitating their learning in software development in real learning scenarios. Likewise, the process of an inspection technique specific to the discipline for interaction in user interfaces is described, making use of the CogTool tool.

Keywords: software, human-computer interaction, design thinking, user-centered design.

I. INTRODUCTION

The Faculty of Mathematics of the Autonomous University of Yucatan in the Tizimin Multidisciplinary Unit offers an Undergraduate Degree in Software Engineering, which has among its curriculum the core course called Human Computer Interaction taught in the sixth semester and its competence is "Develops software systems that provide adequate interactions for the user, considering methodologies and basic principles of interface design in interactive systems" [1]. The success of a software system is largely related to the ease and natural understanding of how it works. Much of this ease of use is provided through the interfaces with which the end user interacts. It is in this last point where the importance of the study of Human-Computer Interaction lies, since it contributes to the development of skills for the design of prototypes of interactive systems considering the fundamental aspects of usability.

In order to achieve the competence of this subject, the unit "User-Centered Design" is taught, in which the student implements interactive systems products, based on the basic principles of the design centered on the user.

Regarding the implementation of interactive systems products, and with the aim that students put into practice in real learning scenarios the knowledge acquired in Human-Computer Interaction, the professors who teach the course at the Tizimin Multidisciplinary Unit ask students to develop prototypes with user-centered design that provide a solution to a problem identified in their locality and in this way the university contributes by providing services to society.

The purpose of this work is to present the development of prototypes of some computer programs made in the course Human Computer Interaction, as well as the analysis of GOMS-KLM for some scenarios selected by the students in order to be used as facilitators of the learning process of the students of the sixth semester of the Undergraduate Degree in Software Engineering of the Faculty of Mathematics of the Autonomous University of Yucatan in the Tizimin Multidisciplinary Unit.

II. HUMAN-COMPUTER INTERACTION AND USER-CENTERED DESIGN

Human-Computer Interaction (HCI) is a new discipline concerned with the interactive component between computer applications and users, as well as the contextual considerations of this interaction. It is a multidisciplinary area that brings together specialists in the domain of the application being built, user interface specialists, cognitive psychologists, graphic designers, educators and the user, among others [2].

HCI is an area in permanent evolution given the technological changes that are continuously occurring. Expectations for development in the coming years are such that major advances in computing will focus on solving the problems of human-computer interaction [3].

Nowadays, new roles for computing have emerged; in particular the role of communication, which is supported by the revolution in information and communication technologies (ICT). The transcendental thing about networks is that behind the important fact of communication between computers is communication between people. This technology-mediated communication introduces the human-computer interface as a central medium. For this reason, this new role results in the growing importance of interfaces and, more generally, of Human-Computer Interaction (HCI) [3].

When it comes to the world of design and product development, two terms are referred to: design thinking and user-centered design.

Design Thinking has become a widely known term in different creative disciplines such as architecture, product design and advertising. However, thanks to the attention paid to it by professionals from other disciplines in project management and action research, among other subjects, the popularity of the term has increased in the last decade [4].

Design Thinking is a method for generating innovative ideas that focuses its effectiveness on understanding and providing solutions to the real needs of users. It comes from the way product designers work. It is an iterative process to address complex challenges composed of problems that are complex to define and solve.

The methodology of interface design where the user is permanently taken into account is known as User-Centered Design, and allows us to find a visual and functional solution to various communicative and functional requirements in computer systems. This solution as a whole seeks to provide the end user with a good "user experience", whose reward for developers is to gain their acceptance and loyalty to the system and all that this entails: brand positioning, product sales and dissemination of information, among other benefits [5].

User-Centered Design is an approach to problem solving that focuses on the people for whom a product is designed. It starts by establishing who the user is and what their problem is, and ends by finding a solution that suits them. It is an approach to developing interactive systems that aims to design such systems so that they are useful and easy to use for users. This design takes into account the human factor as well as knowledge and methods related to usability.

User-Centered Design is a multidisciplinary approach to product development based on human needs, which seeks to better understand the target user and their activities, allowing to design, evaluate and improve design proposals, throughout the entire design process and with the purpose of creating more useful and usable products [6].

User-Centered Design consists of three stages: inspiration, ideation and implementation.

The inspiration stage focuses on learning from the people you are designing for in order to empathize with them and better understand their needs.

In the ideation stage, prototypes of solutions to the problems discovered in the inspiration stage are designed and created. Finally, the implementation stage builds the solution and takes it to market, confident that its human-centered nature means it will be a success.

The works presented here follow User-Centered Design in its inspiration and ideation stages.

The importance of making use of User-Centered Design is due to the following:

- Improved productivity: developers can use their resources in a more targeted way thanks to early feedback collection.
- Lower training costs: customer service and training expenses are reduced.
- High customer satisfaction: the process generates a very good user experience that few other methods can match.
- Less stress: constant and frequent feedback from users minimizes the economic risk so the work environment will be more relaxed, which favors the creativity of the team.

III. COGTOOL TOOL

Once the prototypes of the user interfaces of the different software proposed in this work were built, it was proceeded to use an inspection technique specific to the discipline for interaction in user interfaces, using the Cogtool tool.

An inspection technique is an evaluation method that: provides feedback on the design under development; evaluates whether the objectives have been achieved; and is applied in early stages of system development.

CogTool is a general-purpose, open source tool to create prototypes of user interfaces that uses a human performance model to automatically evaluate how efficiently a trained user can perform a task in a designed user interface. To use CogTool, you simply create a storyboard of the design idea with sketches, images, or on a canvas with CogTool widgets. You then demonstrate the tasks in that storyboard and then press a button to produce a valid cognitive model that predicts how long it will take an expert user to complete those tasks. CogTool is used to establish a baseline of the current interface, or compare the interfaces of the competitors and predict how much better the new designs will be [7].

IV. DESCRIPTION OF THE DEVELOPED PROTOTYPES

Online sales management software system for a coffee shop

This software is intended for the management of online sales of the food in the already established cafeteria of the Tizimin Multidisciplinary Unit, which does not have a specific software for its sales. The main purpose of the software is to reactivate the sale of food within the facilities, avoiding crowds and complying with sanitation protocols. In this way, it will be possible to maintain health safety for the customers of the cafeteria, which are the students, teachers, administrative staff, manual workers and managers of the University.

Among the advantages of having this software is that the cafeteria will offer an efficient service to its customers, since due to their class schedules and work activities, they have little time to rest and eat, and there are no other places near the university that offer food service.

The target audience for this software will be the students and all the staff working at the Tizimin Multidisciplinary Unit. In order to identify the necessary functionalities for a cafeteria management system, the system requirements were obtained through online surveys and interviews with the cafeteria manager and potential users of the software, all this in order to obtain the type of interface that provides a pleasant user experience.

Once the requirements gathering stage was completed, it was determined that the functionality of the software will have administrative functions and functions for customers. As part of the administrative functions, it is contemplated to register and deregister vendors, register, deregister and modify product information, as well as create the daily and weekly food menu that the cafeteria will offer. On the other hand, the functions that the software will have for customers include: user registration, visualization of available products, visualization of the food and beverage menu, placing and canceling orders, reservation and cancellation of tables, and visualization of the delivery time of the requested order.

Figure 1 shows the interface where users can see the menu of the day, as well as the weekly menu offered. If they wish, they can place an order by clicking on the buy button.



Fig. 1 Interface to purchase a food item from the menu.

Figure 2 shows the interface for the cafeteria manager, in which the manager will be able to add or delete the products he/she sells, as well as to create the cafeteria menu. To access these functionalities, all the cafeteria manager has to do is click on the icon with the three horizontal bars located at the top left of the interface.



Fig. 2 Interface with the options for the cafeteria manager.

Once the prototypes were completed, a design analysis was carried out using the CogTool tool. For this purpose, the necessary scenarios for this type of tests were determined.

Figure 3 and Figure 4 show the results of one of the scenarios of this prototype, which consisted of the purchase of a product from the cafeteria.

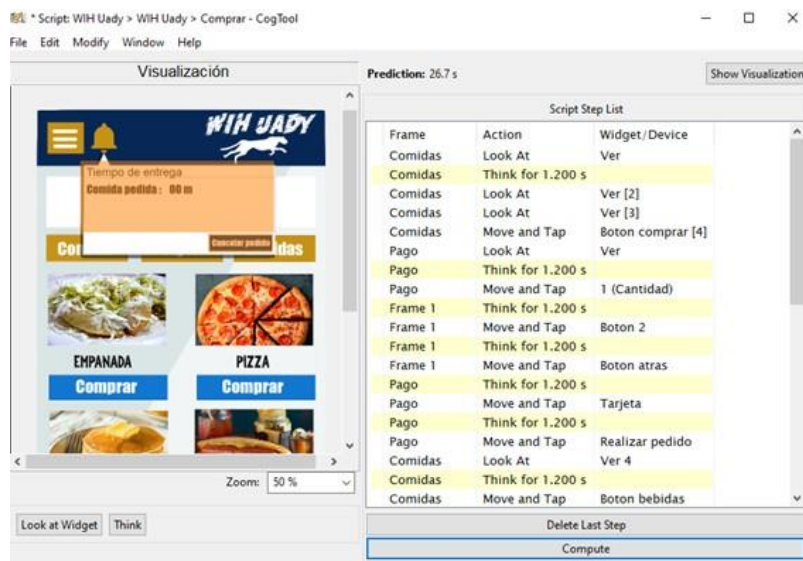
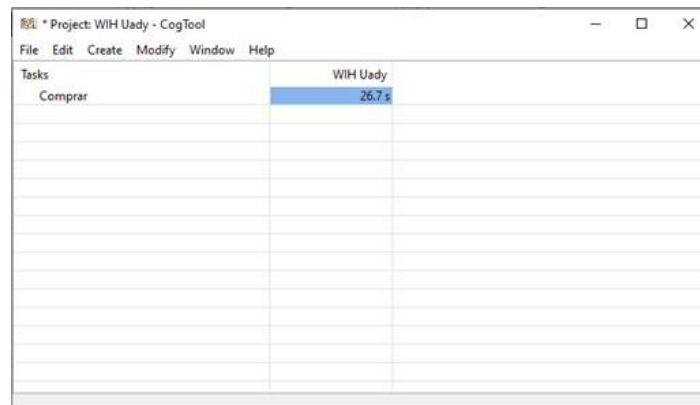


Fig. 3 Process of performing a product purchase



Tasks	WIH Uady
Comprar	26.7 s

Fig. 4 Response time for the process of performing a product purchase.

Publicivo

This software is a website created to offer advertising services to companies in the hotel and food sector in the city of Tizimín, Yucatán and its surroundings, as well as various functions so that users can access these ads and learn about the services they offer, their promotions, location, contact, among others.

The objective of this software is to help the economic reactivation of the businesses of Tizimín and its surroundings, offering the advertising services of the SMEs through the creation of a website where the owners of the hotel and food sector can advertise their services, in a fast and efficient way, in which their users will be able to choose among the products or services that best suit their needs.

This website will be implemented on devices such as computers, cell phones, laptops and tablets so that any user can access it quickly, securely and easily from wherever they are.

The main reason why this prototype was developed is due to the fact that as a result of the COVID-19 pandemic, SMEs have had a difficult growth, so most of them were forced to close their businesses temporarily, permanently and others in a change of line of business. Therefore, many businesses were left without economic resources to continue, which has been frustrating for entrepreneurs as they have lost customers and their sales have decreased considerably, in addition to their net income has not been favorable. For these reasons it is difficult for some SMEs to make an expenditure in the area of advertising, either by electronic media or radio.

Among the benefits that this software will provide, we can mention: providing hotel and food businessmen with a web page so that they can advertise their business in a fast, simple and effective way; attracting customers; increasing the income of hotel and food business owners; making it easier for users in general to search for hotels or food according to their economy and that best suits them; foreign users (tourists) will find it easier to search for available hotels or food businesses near them.

In order to obtain the requirements, the following users were considered: the merchants who offer their various services and the customers who are looking for the best option for the purpose they need. The required information was obtained through surveys to visualize the impact of the site.

Regarding functionality, for the type of users such as hotel and food business owners, the following were considered: registering on the website; registering, deleting and modifying content; notification tray and card association. On the other hand, for the type of users such as people who enter to search for hotel and food options, the following were considered: register on the website, search, service request, create review, view map, associate card, view shopping cart and purchase history.

Once the requirements were collected and analyzed, we proceeded to build the corresponding prototypes. The purpose of creating this prototyping is to avoid ambiguities regarding the design of the interfaces for the user and the administrator, so that the latter has a detailed idea of how the design will look and how it will work. It is of great importance to know the opinion and degree of satisfaction of the users before coding the website for its success, and also to verify if the requirements requested by the users are being fulfilled as they were described.

The preview of the system design prevents future problems, especially errors in the interpretation of the requirements, which lead to great economic losses, time investment and loss of customers due to dissatisfaction with the system. On the other hand, prototyping is a tool that allows the user to interact previously with the system interfaces, helping to know their experience with the system and if there is any modification that needs to be made before the coding stage.

Figure 5 shows the unregistered user view. This interface of the website is for consumer users who are not registered within the system, who will be able to search for registered food or hotels within the website. The restrictions for registered users will be that every time they wish to review their purchase history or view their shopping cart they will be sent to the login page, as well as when they wish to make a food purchase and/or hotel reservation.

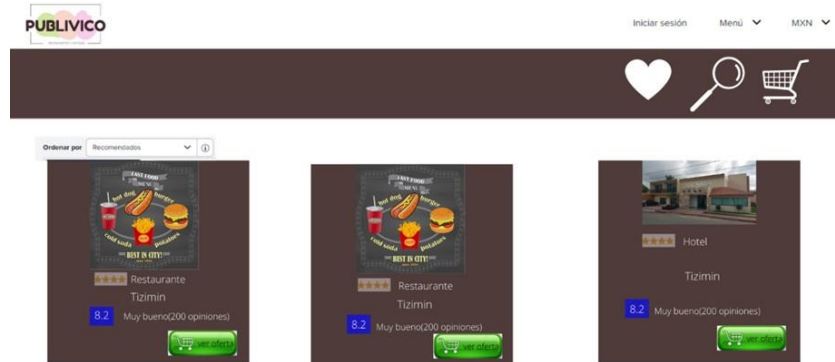


Fig. 5 Interface for unregistered user view

For administrators, it will be mandatory to register in the system in order to publish their food or hotel advertisements in the website and thus have all the functionalities corresponding to administrators. Once registered they will have access to the administrators view, as shown in figure 6, in which the administrator will be able to make publications, modify and delete them, as well as insert the location of their business.

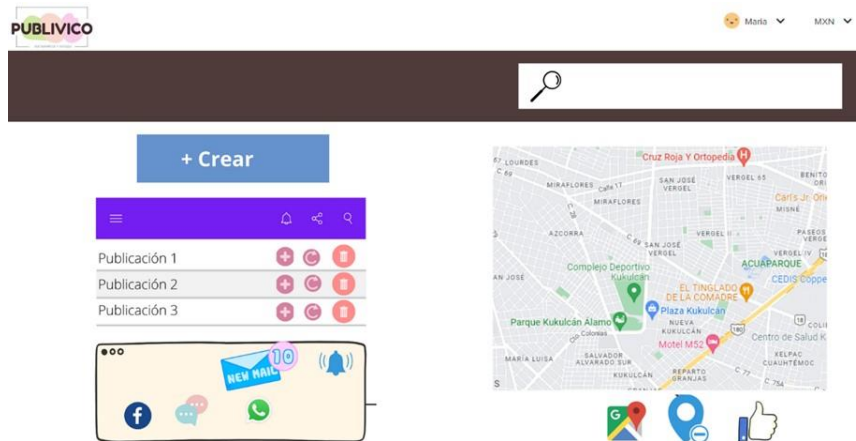


Fig. 6 Interface for the administrator user view.

As mentioned in the previous software description, once the prototypes were completed, a design analysis was carried out using the CogTool tool. For this purpose, the necessary scenarios for this type of tests were determined. Figure 7 shows the results of one of the scenarios of this prototype, which consisted of content creation. To do this, the user first has to "log in", which is shown in the figure.

Inicio de Sesión	Think for 1.200 s	
Inicio de Sesión	Move Mouse	Widget 6
Inicio de Sesión	Left Click	Widget 6
Inicio de Sesión	Home Keyboard	
Inicio de Sesión	Type 'contrasena'	Widget 6
Inicio de Sesión	Type 'usuario'	Widget 6
Inicio de Sesión	Think for 1.200 s	
Inicio de Sesión	Home Mouse	
Inicio de Sesión	Move Mouse	Widget 7
Inicio de Sesión	Left Click	Widget 7
Elegir seccion		

Fig. 7 Logging scenario for content creation.

Ruta: Tool to determine the best route for public transportation in Tizimin

The purpose of this software is to provide users with a tool that allows them to avoid all the possible inconveniences they might encounter when using public transportation. Its main function is to trace the path that represents the best option when taking public transportation, all this considering approximate departure times and possible stops that could be made. It will have a community similar to a social network but focused on the solidarity support of other users, which will generate a feeling not only of belonging but also of support when using the application. Ruta will be used by any user who meets the requirements of having a smart device with internet connection and using public transport, being these very varied, as we can refer to users such as students to workers or office workers.

Regarding the functionalities that Ruta will have, there are: the creation of user accounts with their passwords; login; the creation of routes; displaying transport times and routes; receiving reports and notification of mishaps; community; listening to a voice navigation system; obtaining real-time locations; displaying a point system; displaying support information; and finally, releasing premium functions.

In order to obtain the requirements, surveys will be conducted and users must comply with the following: use the public transportation service; have a smart device with internet connection, and be over 15 years old.

Once the requirements were obtained, it was started with the creation of the prototype for Ruta. The Ruta application has many functionalities designed to help the user reach his destination. This work presents the scenario for creating a route. This function is in charge of tracing the route that the user must follow to get to his destination. Also, at the moment of tracing the route, information about transportation schedules, total cost, total time and distance will be shown so that the user has control over his transportation times. As an example of this scenario, the following was considered: A user needs to get to his destination, however, he needs to find an option that allows him to get there in a short time and at the same time is cheap. The user will start the application and will tap on the screen to continue to the loading screen, then he will have to fill the user space with a username and password. Once the information has been entered, the user will press the "Login" button to enter the main menu. In the main menu he must choose his current location and the destination location, with this data the application will calculate and display the information corresponding to the route for the user. Figure 8, 9, 10 and 11 show the start of this scenario using CogTool.

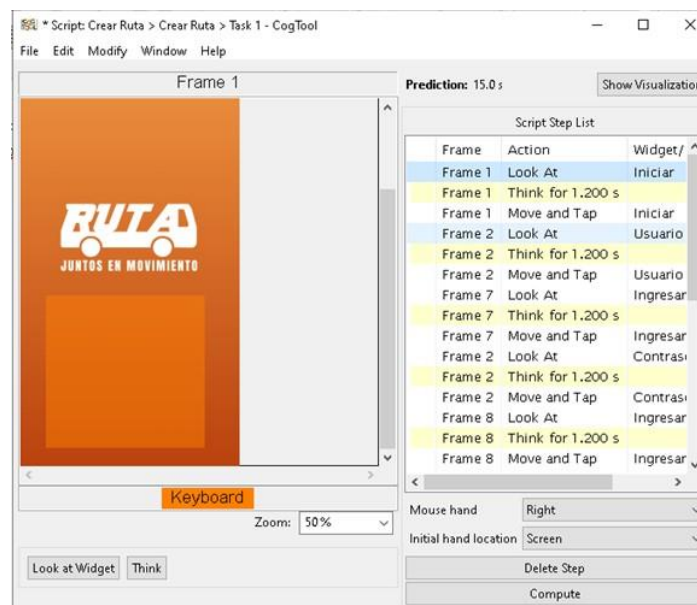


Fig. 8 First part of the scenario for the creation of a route.

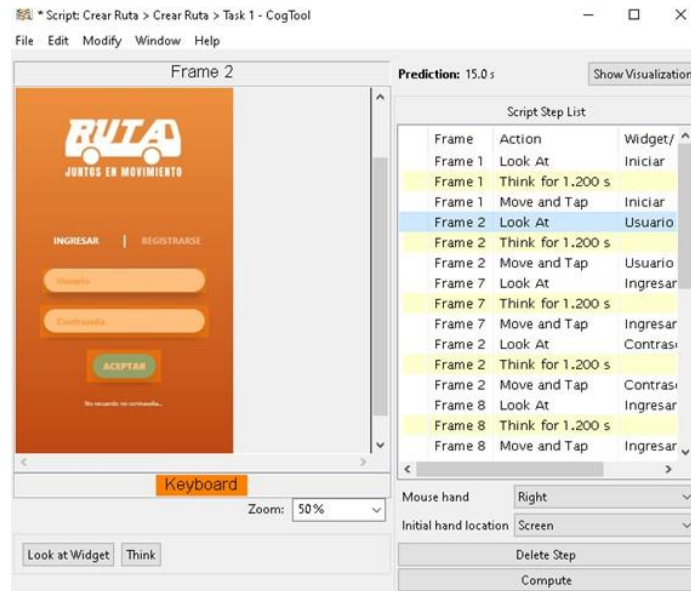


Fig. 9 Second part of the scenario for the creation of a route.

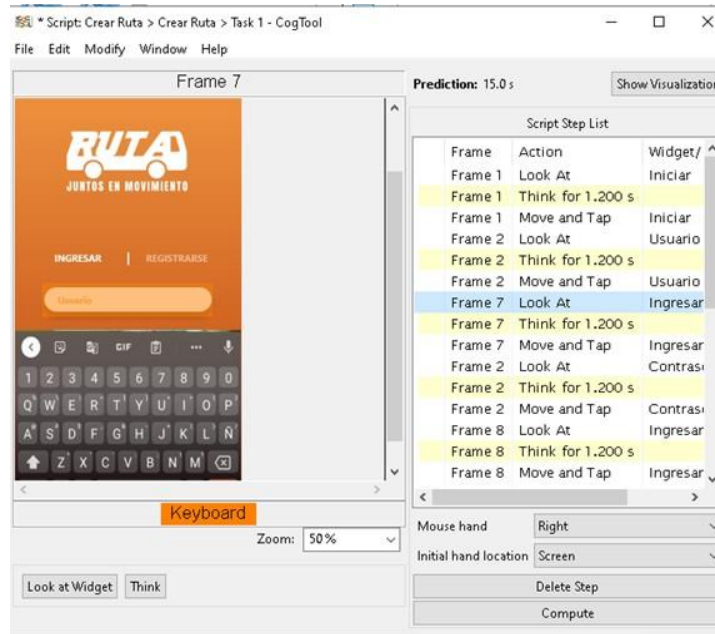


Fig. 10 Third part of the scenario for the creation of a route.

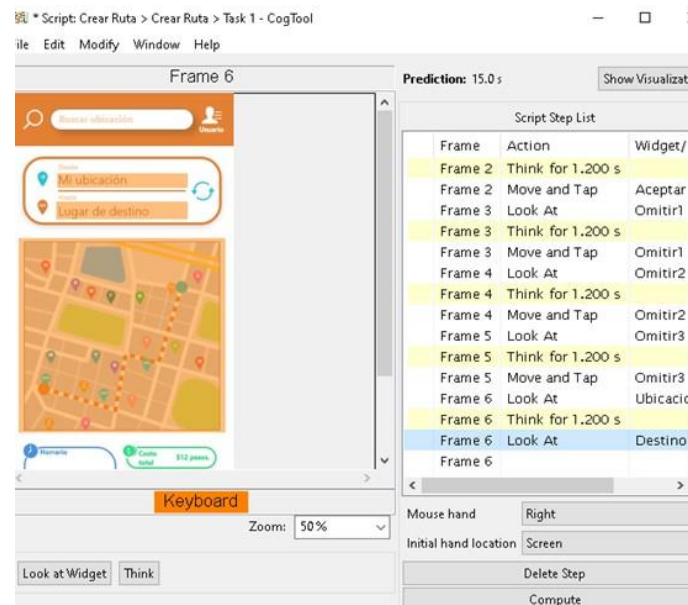


Fig. 11 Seventh part of the scenario for route creation.

V. CONCLUSIONS

The software described in this work and its prototypes developed in the Human-Computer Interaction course facilitate the teaching-learning process, since through the development of these prototypes, the undergraduate students put into practice not only the process of obtaining requirements, but also the advantages of building a prototype with a User-Centered Design, which allowed them to exercise the contents of the course. The prototypes presented here were developed considering that the interfaces were simple and easy to understand even for those people who commonly have problems with technology.

As future work, these prototypes will be presented to the students of the semester in which the course is taught in order to receive feedback on the design of the prototypes to improve them, since this will help to identify significant improvements, failures to be solved or possible deficiencies. On the other hand, this feedback will allow the exploration of new proposals and behaviors, since the use of prototypes encourages these types of attitudes within a work team. Likewise, it is intended to design the corresponding scenarios to perform the corresponding usability tests with the end users for whom the applications are intended.

ACKNOWLEDGEMENTS

We thank the students of the sixth semester of the Bachelor of Software Engineering of the Tizimin Multidisciplinary Unit who took the Human-Computer Interaction course for designing the images presented here.

REFERENCES

- [1] Cambranes Martínez, E.; Menéndez Domínguez, V. Planeación didáctica de la asignatura Interacción Humano Computadora. UADY, 2021.
- [2] Borchers J. 2000. Breaking the interdisciplinary limits of computer-human interaction design: A pattern approach. SIGCHI. Vol 32 1.
- [3] Acosta, A., & Zambrano, N. (2006). Importancia, problemas y soluciones en el diseño de la interfaz de usuario. SABER. Revista Multidisciplinaria del Consejo de Investigación de la Universidad de Oriente, 18(2), 174-182.
- [4] Córdoba, A., Arteaga, J. & Bonilla, H. (julio-diciembre, 2015). Fundamentos del pensamiento del Diseño. Investigium IRE: Ciencias Sociales y Humanas, VII (2), 38-50. Doi: <http://dx.doi.org/10.15658/CESMAG15.05060204>
- [5] Galeano, Roylan (2008). Diseño Centrado en el Usuario. Revista Q, 2 (4), 12, enero-junio. Disponible en: <http://revistaq.upb.edu.co>.



- [6] Trujillo Suárez, Manuel; Aguilar, José; Neira, Claudia. Los métodos más característicos del diseño centrado en el usuario -DCU-, adaptados para el desarrollo de productos materiales. Revista ICONOFACTO VOL. 12 N° 19 / Páginas 215 – 236. DOI: <http://dx.doi.org/10.18566/iconofact.v12.n19.a09>.
- [7] Guía de usuario de CogTool. Disponible en <http://cogtool.hcii.cs.cmu.edu/CogToolUserGuide.pdf>.