Usability engineering in the OnCakes case. What should be taken into account when designing software for a bakery and its customers?

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Abstract

Abstract text. In this work, a methodological process is proposed to design the interface of a software that is aimed at a niche of companies in the gastronomic sector in the southwest of Colombia, specialized in the production of custom cakes. For this reason, it is necessary to ask: What should be taken into account to ensure that good levels of user experience are met? To solve this question: First, a literature review is carried out, where the most relevant parameters and methods that must be taken into account from a cultural perspective and focused on users are identified and established, with the purpose of achieving a collaborative or participatory design, which optimizes the communication and understanding processes between the different productive units. Second, the culture-centered design method is applied, from a cognitive linguistic approach, mapping the contextual conditions and generating a user model. Third, for the creation of the interface, the user-centered design method is applied from the perspective of semiotic engineering to investigate, analyze, and address the communication problem identified in the commercial processes of the pastry shops. Fourth, a heuristic evaluation is performed to measure the user experience when interacting with the prototype.

Keywords

User Experience, Culture-Centered Design, Interface Design, Pastry Shops, Food Industry.

1. Introduction

In Colombia, culturally we love to celebrate the important dates of our loved ones. The central object of every celebration is the cake [1]. There are more than 28,000 bakeries / pastry shops in the country, with sales of more than 3 trillion pesos and generating close to 400,000 direct jobs [2]. 12.14% of the bakeries / pastry shops are located in the southwest of Colombia [3]. The personalized cake is an artifact [4], [5] that has an eminent symbolic value within the social order [6]. Considering its implications in affective, assertive and social relationships [7], the decoration of a personalized cake is designed to transmit [8] a message of high emotional value [9], [10] to the honored individual. The design of a personalized cake decoration involves a collaborative or co-design process [11] in which the customer of the bakery is included in the commercial processes, so that he/she can make decisions about the aesthetic and formal aspects of the product [12], supported by reference images, and under the guidance of a salesperson of the bakery. Communication with the customer in the commercial process is done through digital media such as: phone calls, video calls, email, chats (WhatsApp, Facebook, Instagram) or in person at the point of sale.

The customer's participation and the commercial process ends when the wishes, requirements and expectations are recorded in a paper format that serves as a formulary [13] of the order form. The paper form is filled out in calligraphy and must be read and interpreted by the pastry chef [14], in order to decorate the cake with the design requested by the customer. In this production process, when the pastry

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chef must read and interpret [8], [15] the paper format, problems of understanding arise due to errors: calligraphic, legibility and interpretation, which result in the creation of a customized product that does not meet the customer's expectations and, therefore, cause frustration and sadness in the customer [8]. For traditional bakeries, this situation manifests itself as a critical problem of communication and understanding between production units, since the main processes depend on paper formats [14]. For this reason, it is presumed that the design of such forms does not allow to generate a representation of an efficient user mental model [16], thus causing confusion, reprocessing and errors in repetitive tasks.

We propose the design of a software interface [17] that allows the correct mediation between the expectations and requirements that the customer has, compared to its purchasing power, and the production capabilities of the bakery. Mainly, it should allow the generation of a mental model of representation of the cake designed by the user that is efficient, understandable, and as realistic as possible to avoid or reduce the level of errors or confusions. The objective of this paper is to try to answer the question: What criteria or guidelines should be taken into account when designing a software interface for a bakery and its customers, to ensure good levels of user experience? [18] Under the hypothesis that, by replacing the paper format corresponding to the order form with an interactive digital web form, it is possible to communicate a more efficient mental model of the user, and to take advantage of the visual representations that can be generated by emerging technologies.

2. Related works

To perform a comprehensive literature review, the following process is followed [19]:



Figure 1: Systematic Mapping. General structure of the methodological model used for the research. Image: Own design.

2.1. Second level heading

Systematic mapping proposes a research protocol that consists of: First, identify the thematic cores related to the situation to be investigated. In this case study it corresponds to Computer Science, Communication & Design and Business Administration. Second, an analysis is made of each thematic core in order to identify the intersections and define a central thematic axis. In this case it corresponds to the area of cake design, supported by emerging technologies such as artificial intelligence, evaluated and validated through usability heuristics. Third, the keywords are categorized for each thematic core and ordered according to the number of publications in the Scopus meta-search engine. A selection is made of the most relevant words for the central thematic axis. Fourth, quality, inclusion and exclusion criteria are established to define the keywords that will make up the search string. Fifth, the final search string is constructed [17]:

((("Convolution Neural Networks" AND "Natural Language Processing" AND "Attention Mechanism") OR (("natural language supervision" OR ("Generative adversarial Networks" AND "Text-to-image generation")) OR (("Computer Vision" AND "Generative Models" AND "Attention Mechanism") OR ("Computer Vision" AND ("Data Forms" OR "Paper Forms")))) OR (("Semiotic Engineering" AND "Usability") OR ("User Experience" AND "Web Design" AND "User Interfaces"

AND "User Centered Design") OR ("Semiotic Engineering" AND "co design")) OR (("Cake design" OR ("Gastronomy" AND "Supply Chain") OR ("Process Control" AND "paper forms") OR ("Automation Process" AND "Food Industry")) ANDNOT ("health" OR "Farming" OR "farm" OR "Agriculture" OR "Chemical" OR "tourism" OR "Video" OR "Medical" OR "chemistry" OR "Healthcare" OR "School" OR "Medical images" OR "fruits")).

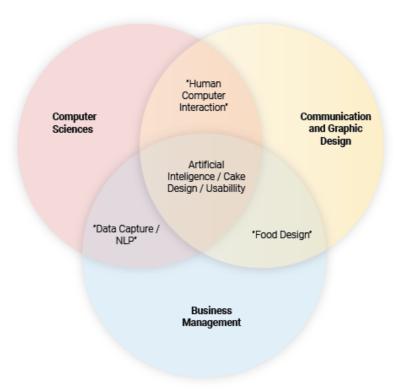


Figure 2: Thematic cores and their intersections of general and central interest in the study of systematic mapping. Image: Own design.

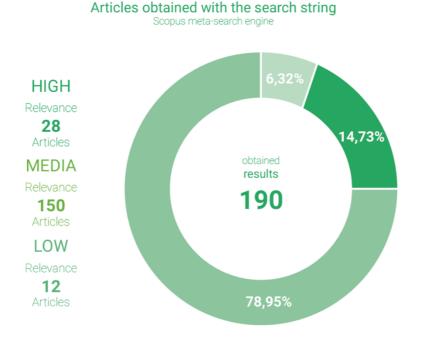


Figure 3: Results obtained with the search string. 28 documents (14.73%) were categorized as high

contribution to the project. Image: Own design.

One of the predominant research areas in the results obtained are 3D food printing technologies [12]. For the particular case of study, in addition to the articles found, different commercial software have been identified such as Baking IT (UK) [20], BakeSmart (US) [21], CakeNote (AU) [22], BakeryDiary (IE) [23], Flexcatering (US) [24], JotForm (US) [25], RiseHQ (IN) [26], CakeBoss (US) [27], Cake Stacker (UK) [28], Calculated Cakes (US) [29] or, bakeries that allow to customize cakes from a web application such as Ferguson Plarre (AU) [30] or, local cases such as CupCake Factory (COL) [31] that use digital forms for the customization process.

Cases such as CakeVR [32], a virtual reality application that allows the customer to co-design cakes through realistic 3D visualizations in real time, is a perfect reference for the research, and ratifies the relevance of the digital transformation processes of bakeries in closing technological gaps. Regarding the three design strategies proposed by CakeVR [32]: (1) Adapt from references, (2) combine elements from different reference images, (3) create a new cake from scratch [30]. For these three design strategies, technologies such as: Photorealistic Tex-to-Image Diffusion Models with Deep Language Understanding [33] BERT: Realistic image generation from text [34], Palette: image to image Diffusion Models, Dall-e (Hierarchical Text-Conditional Image Generation with CLIP Latents) [35], AffectGAN: Affect-Based Generative Art Driven by Semantics [36] DR. GAN: Distribution Regularization for Text-Image Generation [37], VQGAN-CLIP Open Domain Image Generation and Editing with Natural Language Guidance [38], CLIP: Learning Transferable Visual Model From Natural Language Supervision [39], to optimize the process of phase 2, and free up the time spent by the pastry chef in helping clients turn inspirations into tangible cake designs.

2.1.1. A literary and methodological approach to the user experience concept.

To answer the research question, what criteria or guidelines should be taken into account when designing software for a bakery and its customers, so that it meets good levels of usability? First, a protocol should be generated to address the cultural context of the users involved, including a detailed analysis of the business culture of the bakeries. Second, a methodology must be generated to involve the users and make them participate in the process of co-designing the software. Third, it is necessary to study from a semiotic perspective the communication processes present in all the interaction processes of the users with the software. Fourth, evaluation parameters [40], [41] heuristics [41] should be generated to validate and measure the impact that the introduction of emerging technologies [40] to optimize the processes [17] of co-creation of personalized cakes would have on the traditional commercialization processes of pastry shops in southwestern Colombia [42]. It is necessary to develop a methodological framework based on three thematic cores:

2.1.2. A Culture-Centered Design [43] & User-Centered Design [44].

When designing an artifact [45], it is necessary to understand the cultural context [46] in which it will be introduced, and, above all, to accept, understand, and empathize with the particular characteristics of the different people who will use it [44]. To address this cultural approach, cognitive linguistics [18] should be analyzed in order to understand how universal concepts exist in language [47], [48], which are appropriated and used differently by each culture [49], [50]. Even within the same culture, where there are socially agreed patterns, the individual, depending on his or her cultural [51] and linguistic [52] capital, can access, interpret, appropriate, use, or re-signify a concept. These relationships of knowledge, meaning and understanding allow us to interact with the contextual conditions of a specific culture.

2.1.3. Emotional Evaluation of Usability [53], Interaction [54] and Accessibility.

How to evaluate an emotional experience generated by an interactive system? [55] There are challenges in the evaluation of user experience and usability, one of them, initially, is to achieve an approximation to the definition of these two particular concepts. Literature analysis shows that usability, along with accessibility, playability, plasticity, among other contextual elements [56] influence good levels of user experience. The main contribution to answer the research question of this study are the Heuristics of usability for virtual worlds: clarity, simplicity, feedback, consistency, low memory usage, flexibility and efficiency of use, orientation and navigation, camera control, visualization, avatar customization, interaction in the virtual world, laws of physics (reality metaphor), communication, error prevention, helping users to recover from the error, help and documentation [18].

2.1.4. Semiotic Engineering [57], Communicability [57], [58] and understanding [15].

Graphical interfaces are communication objects [59], so the result of their interaction is an emotion [18]. To ensure that the emotion is positive for the user, it is necessary to meet certain design requirements to make the message as effective as possible. The Interface must have the ability to communicate in a simple manner [5] information related to the use of the software functions [60]. If the information related to the use of the interface is incorrect, conflicting, or incomplete [57] communication problems arise for the users.

In the graphic design of the interface [49] must have the ability to mean through the geometric position of the object, as well as its shape, as analyzed in the theory of Gestalt, it must give meaning through color, line, point, plane [61], in short, to the visual composition, to generate pleasant aesthetic effects and to communicate in a simple and effective way, depending on the culture where the meanings are represented.

3. Design Approach

The creation of OnCakes software is proposed, with the purpose of optimizing communication between business processes and production processes. For the design of the Oncakes software interface, a cultural analysis of the context is made, where a cognitive linguistic approach is made, to understand the barriers or gaps in the communication processes. A mapping of the contextual conditions is constructed to identify the spaces and circumstances faced by users when performing their tasks. A user model is generated to identify the levels of interaction with the software, processes are mapped, and system requirements are defined.

A usability analysis is proposed to evaluate the levels of user experience, with the objective of measuring the emotional experience in the current process, and to define a baseline that allows contrasting the effects of the technological implementation based on an interface prototype, to which heuristic evaluations are applied. To ensure correct understanding, an analysis of communicability is carried out through semiotic inspection methods.

4. Implementation: Cultural context analysis.

4.1. Linguistic-cognitive approach.

The limitations that the client has from his cultural capital [62] to make use of oral language with the objective of describing the imagined cake, implies that the client uses reference images as support. Even when using reference images, the customer's requirements must be written in calligraphy on the order form, we move from oral language to written language. Written language is susceptible to calligraphic errors, spelling mistakes, legibility problems, just as in oral language, making an accurate description of the imagined cake will be limited by the skills and mastery of written language. For example, the mental model of the size of the cake is oriented towards the number of guests or portions, while the mental model of the baker relates the size to the number of pounds and the dimensions of the baking

pan. From a linguistic approach, concepts such as the size of the cake can cause problems of understanding in the communication process.

4.2. Contextual conditions mapping.

In the gastronomic sector, the niche of bakeries and pastry shops is characterized by very traditional production models, which depend mainly on the use of paper formats. Three main types of processes can be characterized: Commercial Processes. These are the processes of promotion and sale of the products of the bakeries and pastry shops. Productive Processes: Processes involved in the elaboration of bakery/pastry products. Administrative Processes: These are the financial, support, support and control processes of all the activities carried out in the business.

4.3. User model.

Table 1. Actors and interactions. Table: Own design.

Actor	Process	Activity	Priority	Papers Forms Interaction
Customer	Commercial	Needs a custom cake.	Very High	Order Form
Salesperson	Commercial	Capture of customer requirements.	High	Order Form
Pastry Chef	Productive	Control and assign work, organize orders, ensure supply of raw materials and supplies.	High	Order Form. Order routing. Work assignment. Raw materials and inventory.
Pastry cook / decorator	Productive	Materialize product requirements	High	Order Form. Raw materials and inventory.
Accountant	Management	Register of financial movements	Media	Purchase order Daily balance sheet
Manager	Management	Decision Making	Media	Balance Sheet

4.4 Process mapping.

A mapping of the different processes is made through the papers forms [16], [62] that go through the different production units of the bakeries: sales form, order form, production order form, raw material form, order route form, dispatch form, standard recipe form, good manufacturing practices form, invoice form. For this particular case, we will focus our studies on the order form, since it participates in all the processes and interacts with 5 of the 6 identified actors.

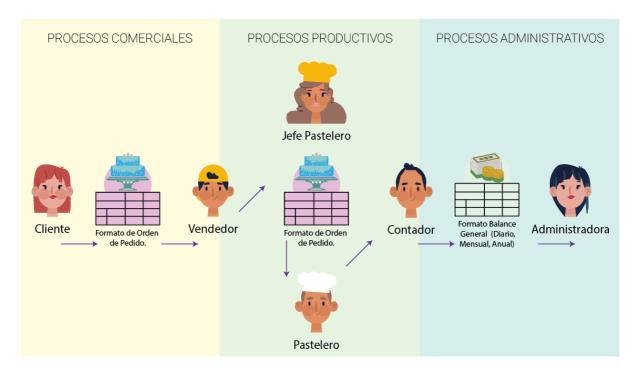


Figure 4. Paper form Roadmap: Order Form. In the commercial process, the customer communicates his requirements to the salesperson, who records them on an order form. In the production process, the form is sent to the pastry chef, who assigns a pastry chef to make the cake. Based on the requirements written on the form, the pastry chef materializes the cake. The decorated product goes with the order form to the storage area. In the administrative processes, the order form is passed to the accountant, who records it in an accounting software, and generates the corresponding reports for the bakery manager. Image: Own design.

4.5 System Requirements.

It was decided to intervene in the commercial processes in the first place because it is in this process where the design of the cake is made, and it is the process that presents the most problems of interpretation and communication.

Three user models are involved in this process: the customer, the seller and the paste-lero. It is necessary to optimize the communication between these three users, and it has been identified that the problem lies in the limitations that people have in the use of natural language to describe the desires and expectations regarding the product, and the difficulties that arise at the time of expressing them in the order form. The first requirement is to design an interactive order form, which is able to process natural language, and allows to visualize with 3D graphics the product that is being co-created. The second requirement is to generate a virtual decoration set based on the tools, utensils, techniques and molds used by bakeries to decorate custom cakes. The third requirement is to create a virtual space that allows to generate a metaphor based on the cognitive linguistic approach, and to generate a participatory experience that allows to use the virtual tools and utensils to decorate the cake. The fourth requirement is related to the clarity and visibility of important information for the client, particularly that related to the costs associated with the amount of decoration elements used, size, cake flavors, packaging and shipping. The fifth requirement is related to interface design parameters that ensure a good user experience.

4.6 Design of software interface prototype.

The user-centered design methodology used for the creation of the interface prototype was developed in four phases [63]: First, Discover. In this phase, the brief or design brief map, the study of the environment, interviews with stakeholders, and observation of the processes are carried out. Second, Interpret. In this phase the information obtained is analyzed, and the following tools are used: map of actors, journey map, journey of emotions, experience of a service. Third, Delimit. In this phase, an analysis of causes and consequences, and of needs, benefits and opportunities is carried out. Fourth, Propose. In this last phase, different prototyping and validation processes are carried out, from the paper prototype to the high-fidelity digital prototype.

5 Validation of proposed model.

5.1 Prototype interface evaluation model.

The cultural approach model for the design of the graphic interface was evaluated in two bakeries, one in the city of Cali (PastelPan) and the other in the city of Popayán (Miski). To identify the communication problems, in addition to direct observation of the processes and their photographic record, a tool known as whiteboard selling [64] was used, which allowed the administrators (2), pastry chefs (3), and salespersons (2) to draw on the provided worksheet how they understood the commercial processes of their respective pastry shops from their perspective.

In PastelPan (Cali) it was possible to validate through two networked computers, one in the sales area and the other in the decoration area, the level of participation and interaction of the client at the moment of designing the cake, modifying a reference image with texts indicating the changes to the baker. Miski Pastelería (Popayán) is evaluating the design of an interactive form for taking orders for custom cakes.



Figure 5. Low fidelity prototype. Touch screen computer in the sales area, which allows searching for images of referrers through the internet. Image: Own design.

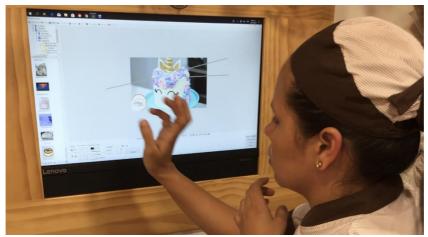


Figure 6. Design process. The salesperson is modifying an image, noting through text the modifications, and directions for the pastry chef. Image: Own design.



Figure 7. Computer in the decoration area. It allows the pastry chef to visualize the image of the cake and the modifications made by the customer. Image: Own design.

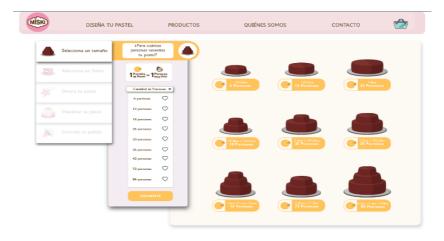


Figure 8. Graphic interface prototype. Image: Own design.

6 Conclusions and future work.

6.1 Results of the research and design process.

When applying the Usability Heuristics for the virtual worlds, the following results were obtained: 10 people used the prototype: 2 administrators, 3 pastry chef, 2 salespeople, and 3 customers. 1 is the lowest score, and 5 the highest value.

Clarity: (4 points) users found clarity in the information provided. Simplicity (4.6 points) the minimalistic interface allows for easy and simple use, Feedback (4.2 points) interactions with interface objects have an efficient response. Consistency (4.6 points) users found congruence and consistency in the steps to decorate a cake. Low memory usage (4 points) the five steps to design a cake have good recall. Flexibility and efficiency of use (3.6 points) users found it difficult to change the themes of the cake. Orientation and navigation (4.8 points) navigation directions are clear and efficient. Camera control (4.3 points) being able to manipulate the rotation of the product in 3D allows to obtain different perspectives of the product. Visualization (4.4 points) important information is visible and accessible. Personalization of the avatar (not applicable), interaction in the virtual world (4.2 points) the objects allow the "drag and drop" function, Laws of physics (metaphor of reality) (4.8 points) the decoration elements that were digitized in 3D, allow the user to feel that he is using the utensils of the bakery. Communication (4 points) The relevant information is provided to carry out the task. Error prevention (2 points) Error prevention methods and tools are needed. Help to users to recover from errors (1) there are not enough aids for error recovery. Help and documentation (1) there is no help and documentation. In conclusion, the prototype interface had a Promethean evaluation heuristic score of 3.7 out of a possible 5 points, which means that although it is above average, there is still much room for improvement.

It is very important to recognize that each bakery has its particularities, but it is also very important to know what are the general aspects that are shared with other bakeries, in order to generate models that are scalable and can be applied to other companies in the niche market of bakeries and pastry shops. This work can be applied in the future to other companies in the gastronomic sector that are dedicated to food customization, such as pizzas, hamburgers, sandwiches, among others.

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