Incorporating UCD Into the Software Development Process: a Case Study

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Abstract
This case study addresses how we applied user centered design (UCD) to the software development lifecycle for the new City of Austin Utilities Online Customer Care website. The case study focuses on the use of personas, prototypes, and user testing, discusses what worked well, and provides lessons learned.

Keywords
User experience, personas, prototypes, simulations, usability

ACM Classification Keywords
H.5.2 [INFORMATION INTERFACES AND PRESENTATION]: User Interfaces—User-centered design, Prototyping, Screen design; H.1.2 [MODELS AND PRINCIPLES]: User/Machine Systems--Human Factors

Introduction
The City of Austin Utilities Online Customer Care (OCC) portal launched in early October 2011. City of Austin utility customers use the OCC portal to pay their bills online, sign up for additional services, start, stop, and transfer their utilities, review billing, payment, and usage history, and “contact us.” The OCC project is part
of a larger city-wide project to update our customer information system and migrate the utility records for more than 400,000 customers. Although not our first experience with enterprise-level portal technologies, it was our largest and most complex engagement to date and included portal, content management, identity management, integration and security technologies. Approximately 100,000 customers used the previous vendor-hosted website.

There were several factors that contributed to the challenging nature of the OCC Portal project. One factor was that OCC Portal needed to interact with multiple electronic systems. The system that OCC Portal needed to interact with the most was Oracle Customer Care and Billing (CC&B), the backend customer information system. OCC Portal would get customer information from CC&B such as contact info, energy usage history, and payment history. Authentication would be handled by an enterprise authentication tool. CC&B and the enterprise authentication tool were being configured simultaneously to the design of OCC Portal. In addition, OCC Portal needed to interact with two payment providers. One of the payment providers handled bill payment services for savings and checking account payments. The other payment provider handled bill payment services for credit and debit card payments. These two payment services were completely independent of each other. Finally, we planned on using an enterprise content management system for OCC Portal content management.

Another factor that added to the challenge of the OCC Project was the composition of the project team. The project team consisted of a mixture of in-house staff and IBM consultants. IBM consultants included a technical lead, a business system analyst, onsite developers, as well as two offshore development teams. One offshore team was in India, and the other was in the Philippines.

The in-house staff included a user experience team, system administrators, and project managers. The user experience team consisted of a portal architect, a portlet developer, an information architect with an interaction design focus, an information architect with a content management focus, a content writer, and a user interface designer.

A third factor that contributed to the difficulty of the OCC Project was the large group of stakeholders. This was an important project for the City of Austin and involved representatives from many city departments. One group of stakeholders consisted of customer care managers. Customer care managers supervise the call center staff who handle customer questions, concerns and complaints. Another group of stakeholders was the marketing teams from across the city. The marketing teams were interested in using OCC Portal to market their group’s services and initiatives to customers. The last group of stakeholders consisted of managers and executives from each utility including Austin Energy, Austin Water, Austin Resource Recovery, and Watershed Protection.

This case study addresses how we applied user centered design (UCD) to the software development lifecycle in this challenging environment of multiple and conflicting stakeholder visions and priorities, changing requirements and business processes, and technological learning curves. We focus on how we integrated personas, prototypes, and user testing into
the software development lifecycle. We discuss what worked well and what could have worked better.

UCD is a design methodology that “structures the development process around users and their practices.” [6], p. 404. UCD emphasizes the needs of the users of a system and how they will use that system. The goal of UCD is to achieve usability. “ISO defines usability as ‘The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use’” [10].

Incorporating user centered design in the software development lifecycle has proven problematic. In practice, UCD is frequently a separate activity within the software development lifecycle. “Techniques are often added on to the software-development process as single activities” [3], p.113. Many times, UCD techniques are employed late in the project lifecycle when it is difficult to implement UCD recommendations. Rather than shaping the initial design decisions, late stage recommendations must confirm to the design decisions to date. The recommendations may be perceived as being prohibitively expensive in terms of time and resources. They may be ignored or deferred so as not to jeopardize the project schedule.

A proposed solution to these problems is to integrate UCD with the software development lifecycle, rather than isolating UCD as a separate activity. “Integrating usability into software development requires a process perspective and that the usability professional is involved throughout the entire development process” [3], p.113.

Goransson et al write:

“In order for the [UCD] process to work, the organization or project must be very explicit about using it and integrating it into their software development process. This includes adapting, or tailoring all parts of the overall development process to make sure that it supports a user-centered approach where usability is not just the concern of usability professionals but the concern of everyone involved in the process” [3], p.127-128.

Our Process
We initiated the OCC Portal project by holding a series of meetings with representatives from the various City of Austin utilities to define almost 200 business requirements. Working with the business systems analyst and technical lead from IBM, we identified 40 use cases. After getting signoff from the project stakeholders, we began the work of translating the requirements and use cases to a user experience by considering the following questions:

- Who will use this system and how do we think they will use it?
- How will users accomplish their tasks?
- Will our customers be able to use the system?

Who will use this system and how do we think they will use it?
We used personas to describe our users and how we thought they would use the system. Personas have been shown to “strengthen the focus on the end user,
Figure 1: We sketched ideas for the information architecture and the interaction design using wireframes and site maps. Their tasks, goals and motivation" [6], p. 7. They help to prevent self-referential design and challenge assumptions that the project team may have about the system users [8], p.427.

We had hundreds of pages of focus group transcripts and reports from our internal market research group, as well as hours of customer interviews. Personas helped us to understand this research. They embodied our research in a way that was memorable to both the cross-disciplinary project team and the stakeholders. Each persona included a short narrative describing how tasks would be performed within the system. The narratives were a “textual prototype” that communicated our plans for fulfilling the requirements.

Figure 2: We created storyboards for high priority functionality. This example shows Cailey, one of the personas, ordering new service.

After completing a draft of the personas and narratives, we reviewed them with stakeholders which helped us gain consensus for our design direction early in the process. The personas reinforced the design direction described in the narratives.
How will users accomplish their tasks?
We used interactive prototypes to visualize the requirements and interaction flows. Prototypes help “interaction designers to define user interfaces, and evaluate usability issues in early stages of design” [12], p. 1.

We started by flowcharting the user experience for each use case. We then sketched ideas for the information architecture, and interaction design. (See figure 1) We created storyboards for high priority functionality such as ordering new service. (See figure 2)

After sketching, we were ready to build our interactive prototype. At first, we built a low fidelity prototype. (See figure 3) In order to validate the design direction, information architecture, and interactions, we conducted an informal usability test. We recruited test participants by sending an email with a link to a screener to City employees. We used the screener to identify participants who were similar to Sandy Smith, our primary persona. We performed four informal usability tests and modified the low fidelity prototype based on the results. Over several iterations we continued to add functionality, content, and visual design until we had a high fidelity prototype. (See figure 4)

The interactive prototype was used as a reference for development by both the onsite and the offshore developers. We reviewed the prototype in depth with the IBM technical lead. The technical lead then shared the prototype with both of the offshore development teams. Although most of our communication with the development teams was mediated through the technical lead, we held occasional conference calls with
the offshore development teams to answer questions and review portions of the prototype. When we made changes to the interactive prototype in response to the developer’s questions, we also updated a log in the prototype that listed each change and included a link to the location of the change within the prototype.

As well as being used by the development teams, the interactive prototype was also used by the testers. Testers used the simulation for reference when creating and running test scripts. When we were ready to begin testing, we presented the interactive prototype to the testing team and answered any questions that they had.

During testing, we reviewed defects with the testing lead and the technical lead. We not only assessed the priority of defects in the reviews, but also identified unforeseen use cases, and modified the interactive prototype to address what we had uncovered. We distributed new versions of the prototype to the testing team as changes were made.

**Will our customers be able to use the system?**

We conducted multiple streams of testing to validate the usability of the system. One stream consisted of a series of user acceptance sessions where 48 City employees performed 22 tasks. After completing a task, each participant filled out a short survey where they identified defects and rated the ease of use. We analyzed the results and identified the easy and problematic tasks. Survey comments provided insight as to why a task was difficult.

We also conducted remote usability testing where 27 remote participants completed eight tasks. We posted participant invitations both to Twitter and our website. Audio and video of each session were recorded using GoToMeeting [4]. After completing the usability test, participants filled out an online survey. We tagged the recordings for usability problems which were then prioritized based on frequency, severity, and business importance.

Another stream of testing was an accessibility heuristic review conducted by Knowbility [5]. Five users with various disabilities followed test scripts to perform eight tasks. Knowbility identified problems between the portal technology and assistive devices such as screen readers.

Finally, we conducted two residential and two commercial focus groups. During the focus group sessions, participants used OCC Portal to register and pay their bill. They then discussed what they did and did not like about the process.

**Discussion**

The user experience team was successful in integrating UCD into the software development process for the OCC Portal project. We were involved early enough in the process that we could participate in planning the project schedule and in defining the project tasks. Along with participating in the project planning process, the user experience team remained involved with the project throughout the development process. Rather than handing our deliverables off to the developers and testers, we continued to actively engage in the project by continually refining the interactive prototype. The prototype was always available for project team...
Personas were used throughout the software development process. Early in development, personas helped to define scope and to communicate the design direction to more than 50 stakeholders, each with their own perspective. Personas and narratives had several other uses besides communicating the goals and direction of the user experience to City of Austin staff. For example, we used personas to screen participants for user testing and focus groups, and as a basis for the interactive prototype.

Personas and narratives were built into the prototype. The prototype included a screen that displayed a summary of the personas. This screen included a photo, a short two or three sentence narrative for each persona, and a link to a full description of each persona. (See figure 5 and figure 6) The persona summary screen also included a link to a section of the prototype where the persona’s information could be used to complete a representative task. For example, Sandy Smith’s representative task was to pay her bill online for the first time. When meeting with stakeholders and team members we would use Sandy Smith’s username and password to log in to the prototype and demonstrate the process of paying a utility bill. (See figure 7)
Figure 7: When logged in as a persona, the prototype displayed that persona’s information. Here is an example of logging in to the prototype as Sandy Smith.
they pointed out problems with the way requirements or business rules were implemented.

We also used the interactive prototype to achieve stakeholder consensus for our proposed design. We presented demos to groups of stakeholders including the cross-departmental project team, and customer care managers, supervisors, and executives. Demos began with a discussion of the personas. This was followed by using particular personas to run through the demo. For example, Cailey Johnson’s persona was used to demonstrate how a new customer would sign up for service. (See figure 8) We also presented the prototypes at a series of educational expos for City of Austin employees. Although the expos were for the CC&B project as a whole, they included demos of the prototype of OCC Portal. We gathered detailed feedback during both the stakeholder demos and the educational expos. We tagged elements in the prototype with the comments that we received during the demos and expos. (See figure 9) After analyzing these comments, we used what we had learned to improve the prototype.

The prototype was used to facilitate communication between the user experience team, the developers, and the testers. Because the developers and testers were using our simulation for reference, they contacted us with questions that came up during their work. Developers proactively contacted us to discuss changes they were considering making, because they knew that the testers would be referring to the simulation, and would mark variances from the prototype as defects. The developers made sure that we updated the interactive prototype to match any discussed changes.

For example, there was a change to the requirements around the display of a customer’s utility accounts. Many customers have both active and inactive utility accounts. Where active accounts are utility accounts with current services, inactive accounts are utility accounts that are no longer being used. The business required that inactive accounts be displayed to customers in order to encourage them to pay outstanding balances owed on those accounts. We needed to have a way for customers to differentiate between active and inactive accounts. Our design decision was to add a control to allow customers to filter for either active accounts or inactive accounts. The developers had questions around detailed aspects of how this control would work and how it would
Figure 9: We tagged elements in the prototype with the comments that we received during the demos and expos.

display. There can be a great deal of variation around the details of even this simple of an interaction. What displays in the default state? What displays when one filter is selected? How does the control look both in the default state and when a filter is selected? The prototype answered these questions efficiently and effectively. (See figure 10)

We conducted multiple types of user testing for the OCC Portal project. User testing included remote
usability testing, user acceptance sessions, accessibility

Figure 10: Screen from the prototype displaying a control to allow customers to filter for either active accounts or inactive accounts.

Figure 11: The Edit mailing address link was not active in the prototype. We did not build a set of screens to demonstrate editing a mailing address.

Lessons Learned

There were several lessons learned from the OCC Portal project. One thing that we learned concerns the interactive prototype. How do you decide which interactions to model in the prototype, and which interactions to leave out? We modeled tasks that were high priority, or that we thought would be difficult to communicate to the developers.

We prioritized tasks based on business goals. For example, an important goal of the OCC Portal was to make it easy for customers to pay their utility bills. Consequently, bill payment interactions were detailed to a great extent in the interactive prototype. However, tasks that we defined as lower priority, tasks that were...
similar to another task that was already modeled, and tasks that were seen as edge cases that impacted very few users were not modeled. Editing the mailing address is an example of a task that we did not model in the prototype. The prototype displayed the mailing address along with a control to edit the mailing address. The control was not active, however, and we did not build a set of screens into the prototype that demonstrated editing the mailing address. (See figure 11)

In some cases, when confronted with an interaction that was absent from the prototype, the developers were unsure how the interaction should work and discussed their questions with us. We would then extend the functionality of the prototype to address their questions. In other cases, the developers extrapolated their code from what was already in the prototype and did not engage us to answer questions. Sometimes this resulted in a usable interface. However, in some cases, the resulting interaction was not very usable, or did not match the style of similar interactions. For our next project, we plan to better define the development process for functionality that is not included in the interactive prototype. Perhaps we could define patterns and annotate the interactive prototype to indicate where those patterns should be used.

Another lesson from this project concerns the relationship between OCC Portal and the parallel work of designing and configuring CC&B, the backend customer information system. CC&B provided web services that were used by OCC Portal to view and modify customer information. The OCC Portal team had to understand the structure of the customer data in CC&B as well as how CC&B was configured in order to develop OCC Portal. The CC&B team was not aware of which configuration changes would impact OCC Portal, and so did not know when to alert us that a change had been made.

For example, the way that CC&B handled charitable contributions changed midway through OCC Portal development. Utility customers can make charitable contributions into two different funds. One fund offers customer assistance for paying utility bills. The other fund is used to finance tree planting throughout the city of Austin. Customers can either make a one-time contribution to a fund, or they can sign up to make a recurring monthly contribution. During the early CC&B design sessions, the project team decided that both one-time and recurring contributions would be treated in the same way as utility services. Contributions would be listed on a customer’s bill as a service in the same way that electricity and water would display on the bill as services. Based on these business decisions, we designed a portlet where customers could apply for a one-time or recurring charitable contribution which would show up on their next bill. (See figure 12)

During the process of configuring CC&B, the way that one-time charitable contributions would be dealt with changed. Rather than being treated as a service that would show up on the customer’s next bill, one-time charitable contributions would now be treated as a one-time payment. One-time contributions would no longer display on the customer’s next bill.

By the time we identified this change, the portlets for charitable contributions had already been designed and
Figure 12: The original design for making a charitable contribution to the Customer Assistance Program (CAP).

Figure 13: The revised design for making a charitable contribution to the Customer Assistance Program (CAP).

built. We needed to quickly analyze the impact of this change on OCC Portal, determine the effect on the user interface, and conduct the necessary development rework. We modified the portlet so that users could no longer make a one-time charitable contribution. They could only sign up for a recurring contribution. (See figure 13) We moved the one-time contribution into the bill payment interaction. The redesign was much more difficult than the original design because we had already made design decisions which limited our options. If we are once again involved in a project where different pieces are being developed simultaneously, we plan to focus more on communication between the project teams, so that there is a better flow of information between the teams.

Perhaps the most important lesson learned from the OCC Portal project is that UCD is not a panacea. Even though we successfully integrated UCD into the software development process, the resulting usability of the system was far from perfect. OCC Portal as implemented satisfies some of the users’ needs, but not others. It is easy for some people to use, but not others. Some customers are delighted with the new system, while other customers do not see much of an improvement from the old system.

This may be due to several factors. Perhaps our user research and resulting personas did not uncover enough of the users’ needs and context of use. Perhaps user needs changed since we conducted our research. The research used to construct the personas came from many sources, some of which were several years old. Another factor may simply be that people are resistant to change. Many of the comments received from an ongoing anonymous survey state things like: “the old site worked fine”; “what you had wasn’t broken. No need to fix it.”; “I NEVER, NEVER had any problems with the old site! If something is not broke, then DON’T try and fix it.”

Some of the factors that influence the usability of OCC Portal are external to the design of the user interface. One such factor is the response time and reliability of the system. When the system is unavailable, or is slow to display information, then the user experience suffers.
Another factor that influences the usability of the new system pertains to data migration from the old database to the new one. The structure of the new database is so different than the structure of the old database, that when we migrated our data it was necessary to create duplicate records for some customers. These duplicate records need to be fixed manually. We did not have the resources available to conduct this manual work before launch. However, we could identify the subset of customers who wanted to access their accounts online and fix those first.

When users with duplicate accounts try to access their accounts, they receive a message that customer care will need to work with them to set up their online accounts. OCC Portal then creates a ticket in the backend system alerting customer care to make the manual data fix. The need to manually fix duplicate accounts has created a backlog of requests to customer care.

**Conclusion**

The OCC project was challenging due to the multiple technologies, multiple stakeholders, a geographically dispersed development team, as well as several streams of simultaneous development, including an enterprise portal, a backend customer information system, and integration with third-party payment systems. There was a steep technology learning curve that led to emerging technical constraints and evolving business decisions that led to emerging requirements.

We navigated this complexity and uncertainty through regular check points with our stakeholders. At each checkpoint we incorporated their feedback into our design. We used personas and narratives to define who would use the system and how they would use it. Personas and narratives helped to solidify the stakeholder’s vision of the project. We modeled the interactions in a prototype which also served as a reference throughout development and testing and kept our team engaged throughout the process. Finally, we validated the user experience through multiple methods of testing with users and stakeholders.

OCC Portal is an ongoing project. Since customers have begun to use the system, we have been collecting data to evaluate and improve it. We are collecting data both through an anonymous survey and from customer feedback via the customer service representatives. We plan to conduct further remote usability testing to continue to evaluate and improve OCC Portal.

**References**


