Cruzcourt: A Software Productization Project from the Computer Science Students' Perspective

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Abstract

This paper presents an overview of the first full project completed by the Software Productization Center at Millersville University. The project, called Cruzcourt, is described from the perspective of the Computer Science students involved, including the development and communication processes employed, the technical problems tackled, and the overall experiences that they gained.

1. Introduction

The Software Productization Center (SPC) at Millersville University [1] was formed with a three-year PASSHE infrastructure grant that began in January of 2008. The SPC is a cross-disciplinary effort involving faculty and students from computer science, graphic design, business/marketing, and communication/public relations. The term "software productization" refers to the process of turning a rudimentary software concept or early prototype into a marketable product. Thus the efforts of the SPC are primarily focused on assisting local entrepreneurs with market research, the technical implementation of a working prototype of the software concept, the development of business and marketing plans for the launching of the product, and the branding and physical packaging of the product. Once the collaboration with the SPC is complete, the entrepreneur should be prepared to sell their product, either by attempting to raise additional funds (through business loans, angel investors, venture capitalists, etc.) or by directly selling to a customer base.

The model upon which the SPC is based leverages faculty expertise to guide and mentor students in working with the participating entrepreneurs. In fact, slightly over 40% of the grant amount is comprised of student salaries. The structure and focus of the SPC allows several important benefits to be achieved simultaneously: 1) the strengthening of the regional economy by assisting fledgling businesses (and hopefully the creation of local jobs), 2) the providing of valuable practical learning opportunities for Millersville students in multiple disciplines, and 3) the increasing of faculty awareness of the current issues facing regional businesses, thus facilitating the development of compelling and practical curriculum content.

In order to collaborate with the SPC, candidates must participate in the application process, which is publicly announced and consists of two stages. First, applicants must complete a Request for Qualifications. The Faculty Steering Committee and the SPC Community Advisory Board then selects the top candidates to complete the second stage of the process, the Request for Proposals. After reviewing the proposals, the Faculty Steering Committee and the SPC Community Advisory Board selects the top candidates to participate in the presentation/interview process, after which a candidate is chosen.

This paper presents an overview of the first full project completed by the SPC. In the subsequent sections, the Cruzcourt project is described from the perspective of the Computer Science students involved, including the development and communication processes employed, the technical problems tackled, and the overall experiences that they gained.

2. Project Overview

2.1 Cruzstar

Launched in 2007, Cruzstar LLC [2] is an internet service company that provides online meal ordering and management for professionals. The service offers a web-based system that allows organizations to consolidate expense and payment info, as well as reduce administrative overhead in routine meal ordering for business functions. In addition, Cruzstar also provides sales lead generation for more than 25 restaurant and catering partners around the Harrisburg, PA area. Cruzstar is currently located in the Harrisburg Chamber and CREDC's business incubator, the Murata Business Center, in Carlisle, PA. The company moved into the facility shortly after winning the Murata Great Business Challenge in April 2008 [3].

2.2 Cruzcourt

Cruzstar's collaboration with the SPC yielded their new subsidiary service, Cruzcourt. Cruzcourt is an online cafeteria system for small to mid-size businesses (of 75 - 300 employees). Instead of venturing out of the office and wasting time looking

for food, employees use the Cruzcourt system to order daily lunches (with eventual plans to offer breakfasts and dinners as well) from their desktop and have them delivered right to their office. In addition, corporations will have the ability to offer subsidized meals, meal plans, and a rewards program through Cruzcourt. The benefits of Cruzcourt are two-fold: 1) organizations can offer convenient in-house meals for their employees, while 2) simultaneously boosting workplace productivity and morale.

2.3 Team Organization

The SPC's effort on the Cruzcourt project involved the three members of the SPC Faculty Steering Committee: Center Director Dr. Stephanie Elzer (Computer Science), Ms. Nancy Mata (Art/Graphic Design), and Dr. Pat McCaskey (Business). The team also included six student members: Elyse Dougherty and Trevor Scheitrum (Computer Science); Chris Willet, Erin Kaufmann and Seth Eck (Art/Graphic Design); and Amy Duggan (Communications/Public Relations).

2.4 Communication/Scheduling

When we first began communicating with the owners of Cruzstar and determining the requirements for the Cruzcourt system, we chose to employ use cases as a means to simplify the complexities of development so that the client could more easily understand the system's functionality. Use cases allow the examination of a system from the user's perspective, walking through each action to ensure that both the client and the development team are on the same page in terms of functionality. They allow the flow of information through the system to be considered from the user's point of view, which improves ease of use in the end product.

To manage the various tasks and deadlines, especially while Cruzcourt was still in the planning/design stages, we used Basecamp project management software [4]. Once development was underway, it was necessary for all of the collaborators on the project to test the ongoing results and to log any issues they may encounter. We chose Mantis bug tracking software, a free PHP/MySQL-based bug tracking client that allowed issue recording, task assignment, deadline management and other project responsibilities [5].

3. Project Details

3.1 Technical Specifications

Cruzcourt was built on a PHP/MySQL backend. We used PHP 5 and took as much advantage as possible of its newly-implemented object-oriented abilities. MySQL 5.0 allowed us to use stored procedures for our database interaction; this topic is covered in-depth later in this paper. We used a PHP framework, CakePHP [6], to expedite and organize development. CakePHP utilizes a Model/View/Controller design pattern approach; this topic is also covered in more detail later in this paper. Our integrated development environment (IDE) of choice was Eclipse, platform 3.4, Ganymede release.

3.2 User Roles

Cruzcourt required four distinct user roles, each of which needed its own interface and functionality.

The first and most widely used role is an employee. Once a corporation becomes a client of Cruzcourt, the system is available for all employees within their company; all that is necessary is a valid email address, valid office location, and the approval of a corporate manager to confirm that the employee is associated with their company. The primary action performed by an employee using Cruzcourt is to place an order, which walks the user through a series of steps to choose delivery date, delivery time, menu items, customizable options for a subset of those items, and a payment method. Menu items can be filtered by the meal and the category into which they have been assigned, as well as by preset employee favorites or through a keyword search. Before placing an order, employees review their selections on a confirmation screen, which also enables them to charge the order to a credit card already saved in the system or to add a new one.

The second role, which serves as a parent to the employee role, is a corporation. As a client of Cruzcourt, corporations receive an account that allows them to oversee the activity of their employees. If corporations would like to add multiple employees at once (as opposed to requiring each employee to register individually on their own), they are able to download and populate a Comma Separated Value (CSV) template with all of the employee information, then upload it to the Cruzcourt system. Each employee that they add is automatically approved and will receive an email with a temporary password allowing them to log in to their new Cruzcourt employee account. Corporations can also use their accounts to place orders for small luncheons or business meetings, following a process similar to the one an employee uses to place an individual order.

The third role is a kitchen or caterer, which is used by companies contracted by Cruzcourt to prepare and

deliver placed orders to the appropriate corporations and employees. Kitchens are able to view all incoming orders, which can then be filtered by delivery time and/or the corporation from which they were placed. A running count of how many of each menu item is included in all of the current orders is also displayed to aid the kitchen's preparations. The page that displays all of the current orders refreshes every two minutes in order to keep the information as current as possible. Kitchens can also mark menu items unavailable for one day or a range of days, if their inventory is not sufficient to prepare those items at that time. Unavailable items do not display as options for employees and corporations trying to place orders. If an order containing an item has been placed for a day where that item is unavailable, the item is automatically removed from the order and an email is sent to the employee or corporation who placed the order, explaining the circumstance and offering them the opportunity to select another item or items. Since their credit card is not charged until the order is delivered, there is no need to factor refunds in this situation.

The fourth and final user role is a Cruzcourt administrator. This role allows the owners or moderators of Cruzcourt to oversee all activity within the system at any given time. Administrators are able to view all current orders, edit and cancel any of these orders, and place orders on behalf of an employee or corporation. They are also able to manage refunds and credit card charges when discrepancies occur. Administrators are the only ones able to add corporation and kitchen accounts, and they have the ability to add employees as well. They are also responsible for adding menu items and managing the menu hierarchy, including meals, categories, preset menus, customized corporate menus and allergies to which all menu items can be assigned. This menu hierarchy determines how employees and corporations navigate through the menu system while placing orders, so its ability to be customized was a substantial part of our system design.

3.3 Security Scheme
Because we chose to store users' credit card and other payment information, the security scheme was a significant point of research for us. In order to comply with the PCI Security Standard Council's Data Security Standards (DSS) set forth to ensure PCI compliance, we were only able to store the card number, expiration date, service code and cardholder name. The card number, also referred to as the Primary Account Number (PAN), must always be transmitted securely and stored in the database under an encryption scheme. In addition, the DSS specifically prohibits the storage of any magnetic stripe data, card validation codes or values (CVV, CAV2, CID, CIV2 or CW2) or PIN block data. [7] We were very thorough in ensuring that the Cruzcourt system not only achieved PCI compliance, but that it was also easy to continue maintaining the compliance and security measures to prevent the compromise of any customer information.

In order to prevent the sort of security compromises regarding passwords and credit card information that are a common concern for most users, we chose a new approach. When a user enters a new credit card, the PAN is encrypted with the user's plaintext password as the key, using a built-in PHP security function, cipher(). This encrypted value is stored in the database, along with the cardholder name and expiration date entered by the user. As a result of doing so, the only time any user's credit card information becomes available for decryption is when they are actively logged in and their plaintext password is therefore accessible.

Because a user's credit card number uses their plaintext password as the encryption key, we needed to devise an alternate way to store the user's password in the database to check against for login authentication purposes. Therefore, when a user registers, a one-way hash function is applied to the password that they select, and that hash value is stored in the database in the user's password field. On subsequent visits when the user logs in, the password they enter has the same one-way hash function applied, and that hash value is compared to the value stored in the database. If the two match, the user is logged in successfully. Using this security scheme, even if an unauthorized user gained access to the database, they would have no way of decrypting even one credit card number within it.

Since users can only place orders when they are logged in, their credit card information can only be decrypted when they confirm and submit an order. Users are required to enter their Card Verification Value (CVV) because it is a Card-Not-Present transaction, and then all the information necessary to charge the user's credit card - card number, CVV, cardholder name, and expiration date - has been obtained. The user's shipping and billing information are retrieved from the database, as well as the details of this particular order, including an item inventory and order total. All of this information is compiled into an array, which is then submitted as an "Authorization Only" transaction to the client's payment gateway. This type of transaction does not

charge the credit card at the time of submission, but does send the payment gateway all of the information necessary to validate the credit card and the ability to complete a charge. The gateway returns a Transaction ID, which can be used to identify all of this information in their system at a later date when the user should be charged for their order.

Users are charged for their orders on the day each order is delivered. The order's Transaction ID is retrieved from the database and is passed into the payment gateway, which will use all of the previously passed billing, shipping and order information to actually charge the credit card for the total amount of the order.

Because a user's password is stored in the database as the product of a one-way hash function, it can never be decrypted or retrieved in plaintext form. Therefore, creating "forgot password" functionality that would email a user their password if they misplace it would not be possible. In place of this option, we implemented a "reset password" functionality, which randomly generates a new password, stores a one-way hash of it in the database, and emails it to the user. The function that generates this random password returns a string of customizable length (with a default of 9 characters) and strength. As the strength (on a scale of 0 to 4) increases as follows:

- Strength 0: random characters are drawn from all lowercase consonants and vowels
- Strength 1: random characters are drawn from Strength 0 plus uppercase consonants
- Strength 2: random characters are drawn from Strength 1 plus uppercase vowels
- Strength 3: random characters are drawn from Strength 2 plus integers from two through nine
- Strength 4: random characters are drawn from Strength 4 plus symbols @, #, $ and %.

The user can then log into the Cruzcourt system with the randomly generated password and change the password to something more familiar. Because there exists the possibility that an attempt to reset a user's password could indicate a compromise of the account's security, all credit cards that the user has stored will be deleted upon the password reset. This will ensure that no credit card information is accessible by anyone for whom it should not be.

3.4 Model/View/Controller Design Pattern

To structure the Cruzcourt system in the most programmatically efficient way possible, we employed a Model-View-Controller (MVC) design pattern. Our implementation of the MVC pattern followed a fairly traditional approach. Each section of the system - employees, kitchens, items, etc. - had its own controller, own model, and own set of views. Every model contained all business logic and database interaction for the section, including the calling and execution of stored procedures. Every view contained what is actually displayed to the user, including forms. The views were composed of HTML markup, CSS styling, AJAX or jQuery elements, and other components used to display what appears on the user's screen. Every controller handles the interaction between the views and the models, specifically the passage of data from one to the other. For example, the ability to edit employee information would begin as a form where the user would make their desired modifications to the existing values. The submission of that form would pass the new values of the fields to the controller, which would then pass the required values to the model. The model would make any necessary changes to the values (e.g., putting a date into the format that the database is expecting) and then call the appropriate stored procedure to update the employee's information in the database.

In order to accomplish smooth interaction, controllers and models have common function names, which match up with the filename of the related view, in accordance with CakePHP's standards. In this case, the employee controller and model would each have a function perhaps called "edit", and the set of employee views would include a view called "edit" as well.

3.5 Use of Stored Procedures

The Cruzcourt system involved a fairly intricate structure of relationships between sections. As a result, we concluded that actions performed on the database would be best served by stored procedures. This allowed us to prevent against SQL injections and to improve the efficiency and quantity of the database interactions. For example, registering a new employee required adding not only a new employee to the system, but also a new basic user. Without stored procedures, this would require two SQL insert statements, in addition to a statement that returns the ID of the first insert statement in order to use it in the second insert statement. With stored procedures, both insert statements and the return of the inserted ID can be accomplished in one procedure call. The parameters only have to be passed into the procedure one time, and the logic can be condensed into a more legible statement (e.g., "addEmployee"). With as many insert, update and delete statements as the Cruzcourt system required, stored procedures significantly improved the efficiency and complication within the models.

4. Project Deliverables and Results

4.1 Cruzcourt Premiere Launch Event
On October 15, 2009, the Software Productization Center and Cruzstar jointly hosted the Cruzcourt Premiere, an event designed to introduce the new Cruzcourt product to the community and to celebrate the success of the collaboration. The event was held at the Murata Business Center in Carlisle, PA, home of Cruzstar and Cruzcourt. Demonstrations of the Cruzcourt software were set up, and attendees were able to use the system to place customized orders that were prepared for them at the event by an on-site caterer. This simulation of Cruzcourt's process was very well-received by the event's attendees, and the functionality of the Cruzcourt system was very successful.

4.2 Time and Money Savings to the Client
Working with the SPC allowed Cruzstar to significantly advance the release of Cruzcourt. Originally, the company was not planning to even begin development on the product until 2010. Between the increased rate of development and the savings on developer and designer wages, Cruzstar/Cruzcourt President Adrian Fang estimates that collaborating with the SPC saved Cruzstar at least $100,000.00 [8]. "When we started up, we didn't have the financial resources to develop a prototype and go into R&D," he says, adding that "Millersville was very dedicated and we built a pretty strong relationship with them" [9].

5. Student Experiences

From a student perspective, our experience with the Software Productization Center was the most defining experience of our undergraduate career. Students involved with the SPC are given the opportunity to take on levels of responsibility that they would not be able to obtain in the classroom. Creating products that will be used by clients in the marketplace gives students a chance to apply what they learn in the classroom in a practical way, with the knowledge that what they create will be seen, used, and sold in a real-world context. The work done no longer becomes about achieving a certain grade, but rather about satisfying the client and ensuring a quality end result.

In addition to the real-world implications of the software, the leadership roles that the SPC allows students to take on are a very valuable asset. Many decisions, from minor choices about the logic of a function to major choices like the design of a database, are left entirely to the students. Therefore, the outcome of a project becomes very closely tied to the students' ability to exercise good decision-making. Students are also expected to plan the project schedules and adhere to the deadlines set therein. Because their work with the SPC occurs in parallel with classes, this requires a lot of discipline and self-motivation, which even traditional internships do not foster.

The collaborative aspect of the SPC offers another learning opportunity for students. It allows students from one field to better understand the intricacies of other fields, with focus on those that could become the most useful in the future. A computer science student could very easily end up in a position where graphic design theories or business principles are involved, and an experience like the SPC would be very helpful in that case. Our close work with the graphic design students on Cruzcourt helped us to understand the process through which a site is designed from scratch, especially when the user experience is a point of focus.

Along with the exposure to other disciplines, students involved with the SPC also gain beneficial teamwork experience across the board. Students learn to assess the strengths and weaknesses of the other members of their team, and they are able to tailor tasks and scheduling accordingly. The ability to work well in a team environment is perhaps one of the most valuable skills a student can gain during their college career, and the SPC provides a more practical way to develop these skills than a classroom setting can provide.

6. Conclusion
This paper has described the Cruzcourt project, which was the first full project to be completed by the Software Productization Center at Millersville University. Note, however, that only one perspective -- that of the Computer Science students involved, has been presented. The richness of the SPC collaboration means that there are other worthwhile stories resulting from this same project: those of the graphic design students, the communication/PR student, the faculty involved, and most certainly the client! And this is only the first project. The next project is already well underway, and the collaboration with MRG Power Laboratories is a very different technically, but still very rewarding in many of the same ways.

The conclusion to be drawn is that the SPC model is of irrefutable benefit to the faculty, students, and

clients involved. Faculty members gain practical knowledge that can be disseminated in the classroom while having meaningful mentoring experiences, students gain technical and leadership experience that can be invaluable after graduation, and clients gain quality products that have been developed using the most current technology.

7. Acknowledgments

Though this paper is presented from the Computer Science perspective, the project was truly cross-disciplinary and could not have been successfully completed without our team members, including Ms. Nancy Mata (Art/Graphic Design), Dr. Pat McCaskey (Business), Chris Willet, Erin Kaufmann and Seth Eck (Art/Graphic Design), and Amy Duggan (Communications/Public Relations).

This project would not have been as rewarding if the clients had not been so organized and responsive. The entire SPC team wishes Cruzcourt (aka Adrian and Aaron Fang) much future success.

8. References:

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