

ITC INFORMATION SYSTEM: A WEB-BASED INFORMATION MANAGEMENT
FRAMEWORK FOR INTERNATIONAL TECHNOLOGY COMMONS

by

WENBO WANG

B.S., Anhui University of Technology, 2013

A REPORT

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Computer Science
College of Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2016

Approved by:

Major Professor
Dr. Daniel Andresen

Copyright

WENBO WANG

2016

Abstract

As a laboratory associated the English Language Program (ELP) at Kansas State University, the International Technology Commons (ITC) provides English instructions to students who are qualified to begin university work but do not meet the English proficiency standards for the university by using cutting-edge pedagogical technologies.

The ITC Information System is a centralized web-based framework that manages the policies, processes, and procedures to make sure that the ITC can fulfill all tasks required to archive its objectives, including checking in/out electronic devices and/or books to students and faculties, registering new students during the enrollment, keeping track of ITC properties and assets, etc. As a full-stack project, the ITC Information System has been designed and implemented by utilizing multiple modern programming languages, frameworks, and platforms.

Been serving the ITC since August 2015, the ITC Information System has significantly improved the efficiency of ITC electronic resources, and reduced the man-hours devoting to administrating undergraduate lab monitors. Leadership of the ELP appreciates the outcome and expresses expectation to broaden the scale of this project to serving more instructional divisions.

Table of Contents

List of Figures	v
List of Tables	vi
Acknowledgements	vii
Chapter 1 - Introduction.....	1
1.1 Project Description	1
1.2 Motivation.....	1
Chapter 2 - Related Work	4
2.1 The ITC “Old School”	4
2.2 Commercial Products.....	5
Chapter 3 - Requirement Analysis.....	7
3.1 Operational Requirements	7
3.2 Technical Specification.....	8
Chapter 4 - Implementation	12
4.1 MVC Architecture	12
4.2 User Interface and User Experience	21
4.3 Database.....	28
Chapter 5 - Testing.....	31
5.1 Compatibility	31
5.2 Performance	32
Chapter 6 - Future Work.....	34
Bibliography	35

List of Figures

Figure 1-1 Administrative Structure of ITC	2
Figure 2-1 Sample of ITC Staff Record Documents	4
Figure 2-2 Device Records in Excel	5
Figure 4-1 WildCat ID Card	13
Figure 4-2 Searchable EID.....	14
Figure 4-3 Privilege Levels in ITC Information System	15
Figure 4-4 Home Page	22
Figure 4-5 Dashboard Page.....	23
Figure 4-6 Enrollment Page.....	23
Figure 4-7 Enrollment Page Modal.....	24
Figure 4-8 Library Page.....	24
Figure 4-9 Library Page Visitor Information.....	25
Figure 4-10 Library Page Respond Modal.....	25
Figure 4-11 Staff Page	26
Figure 4-12 Staff Total Hours in Admin View.....	26
Figure 4-13 Staff Sign-on	27
Figure 4-14 Utilities Page	27
Figure 4-15 Table of People	28
Figure 4-16 Entity-Relation Diagram of ITC Database.....	29
Figure 4-17 Staff Record Trigger	30
Figure 5-1 Performance Analysis of Home Page	32
Figure 5-2 Performance Analysis of Dashboard Page.....	32
Figure 5-3 Performance Analysis of Enrollment Page	32
Figure 5-4 Performance Analysis of Library Page.....	32
Figure 5-5 Performance Analysis of Staff Page	33
Figure 5-6 Performance Analysis of Utilities Page	33

List of Tables

Table 5-1 Compatibility Test Result.....	31
--	----

Acknowledgements

This acknowledgement expresses my gratitude and respect toward all the people who have been guiding and inspiring me throughout my project.

I would like to thank Dr. Daniel Andresen for giving me timely advice, encouragement, and signing all those paperwork for me. Also, I would like to thank Dr. Torben Amtoft and Dr. Mitchell Neilsen for serving as my committee.

A special thanks to Ms. Jenell Williams, Director of the International Technology Commons, for her supervision and support all the way along.

As our collaborator, the Office of Mediate Education (OME) have provided us lots of resources and suggestions, which is truly appreciated.

A big thank-you to all my friends, your encouragement and good ideas enrich this project.

The most special thanks to my wife, Dr. Tracy Shi, for all the delicious food and everything else.

Chapter 1 - Introduction

1.1 Project Description

The International Technology Commons (ITC) Information System is a centralized framework that manages the policies, processes, and procedures make sure that the ITC can fulfill all tasks required to archive its objectives, including checking in/out electronic devices and/or books to students and faculties, registering new students during the enrollment, keeping track of ITC properties and assets, etc. Together with the ITC Database, it is a revolutionary step in the development of ELP toward the 2025 Plan of Kansas State University.

1.2 Motivation

The English Language Program (ELP) is an intensive language program associated with Office of International Programs of Kansas State University in Manhattan, Kansas (Figure 1-1). Used to be called *the ELP Lab*, the International Technology Commons (ITC) provides English instructions to students who are qualified to begin university work but do not meet the English proficiency standards for the university by using cutting-edge pedagogical technologies.

Figure 1-1 Administrative Structure of ITC



On a daily basis, hundreds of students and teachers come to ITC for various reasons: attending/instructing classes, joining/hosting events, working on homework, studying on projects, etc. In order to maximize the efficiency and effectiveness of the academic activities, the ITC provide visitors with many kinds of electronic resources and materials, such as laptops, tablets, and cameras. However, with the growing number of electronic devices comes in the difficulties of management.

Another kind of administrative problem results from the constant necessity of laboratory monitors, who are undergraduate student workers responsible for taking phone calls, answering enquiries, assisting teachers with lectures, and checking-in/out devices, etc. According to the polices of Human Capital Services, they need to use the eTime Entry page in HRIS to report their working hours as student employees, which will be approved by the ITC director biweekly. Ensuring the submitted working hours requests objectively reflect lab monitors' actual performance is one of the essential, albeit time-consuming, duties of the ITC director.

The ITC Information System has, for the first time in the history of ITC, solved these two most important problems of ITC by using only one centralized information management system. Furthermore, it has been contributing to the success of ITC services in many other ways. For instance, an individual ITC user database has been populated with thousands of user activity records through semesters, which provides brand-new possibilities of pedagogical analysis, e.g. the relations between students' behaviors and their academic performance.

Chapter 2 - Related Work

2.1 The ITC “Old School”

Due to the nature of its work, the ITC would never maintain high quality services without appropriate assistance of information management systems. In the old days of ITC, which used to be called the ELP Lab, pen and paper had been utilized as the only way to keeping records for device usage and lab monitor hours. Later joined Microsoft Excel, the spreadsheet guru which finally reduce the need of thousands of paperwork and convert them into structured data. Before the initiation of the ITC Information System in 2015, however, lab monitors were still relying on signing on paperwork to sign-in and sign-out (Figure 2-1). Therefore in the end of every K-State payroll, quite a few man hours had to be spend on collecting and cross-referencing different records from dozen of paper with handwritten names and timestamps.

Figure 2-1 Sample of ITC Staff Record Documents

Time	≥1/5	≥1/6	≥1/7	≥1/8	≥1/9	≥1/20
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
Luzhi		1:00-5:00 5:00-9:00	1:00-4:00		1:00-6:00	
Yunxia		1:00-6:00pm 7-8 PM	1-5 PM	3-6pm		
Sydney	8:15-10:15 11:30-1:00		8:00 AM- 10:15 AM 11:55 AM 1:50 PM		2-9 8:30 AM- 10:00 AM 11:30 AM-2 1:15 PM-2:55	
Yi	8:00am 11:00am	11:00am -1:00pm	8:00am 1:00pm	8:00am 11:00pm	8:00am 11:00pm	8:00am -11:00pm
Phong		1:00-4:00 PM	8:05 AM -12:05 PM	7:30 AM -8:55 PM	12:00 -6:00 PM	
Spencer	10:10 AM -1:10 PM		10:30 AM -1:50 PM 4:10-5:00 PM		6-8 PM	
Heidi		4:00pm 9:00pm	4:00pm 9:00pm	4:00pm 9:00pm	5:00pm 9:00pm	
Wenwen		6:00 PM -9:00 PM	1:00 PM -5:00 PM	5:00 PM -9:00 PM	1:00 PM- 3:00 PM	
Alex		5:30-9:00 6-9	11-4 6-9	5:30-9:00 11-5		
Chris			12:00 PM 2:00 PM		8:00 am- 10:00 pm 2:00 PM- 4:00 PM	
Youwei			7:45 AM -11:00 AM 4:00-8:45 pm		1:00pm-3:00pm	

Thursday	Log in time	Log off time	Signature	
Luzhi	8:03 am	11:00 am	<i>Luzhi</i>	
Yunxia	8:00 am	10:00 am	<i>Yunxia</i>	
Sydney	11:20	5:00	<i>Sydney</i>	
Phong	11:00 AM	5:00 PM	<i>Phong</i>	
Spencer				
Heidi	Akila R.	4:00pm	9:00pm	Akila R.
Alex	10:00 5:00	2:30 9:00	<i>Alex</i>	
Akila	8:00 am	11:00 am	Akila R.	

Even though pen and paper outranks every other system by the incomparable availability and reliability, the drawbacks are obvious: records are hardly manageable or sortable. Microsoft Excel was indeed a leap toward the digital era, but it was not designed to handle constant user input as a database (Figure 2-2). Lacking of convenient input validation, absence of multi-user accessibility, inflexible data management, and complicated usage of calculation formulas implies, despite succeeding in many other fields, it is yet the most appropriate solution for the ITC scenario.

Figure 2-2 Device Records in Excel

WID	Name	Device type	Number	Check-out time	Check-in time	Date
4869	Alexandra Maria	dell	4345	2:39:00 PM	4:15:00 PM	5/1/15
4870	xin cheng	dell	4336	2:39:00 PM	4:16:00 PM	5/1/15
4871	ivonne	mac	4411	4:11:00 PM		5/1/15
4872						
4873	Maria Leticia Blanco Montorfano	Dell	4343	4:12:00 PM	5:24:00 PM	5/3/15
4874						
4875	Taif Bader B Alotaibi	dell	4924	8:30:00 AM	9:40:00 AM	5/4/15
4876		mac	4413	9:29:00 AM	10:58:00 AM	5/4/15
4877	Segundo Eriberto Casacumba Pila	dell	4917	9:34:00 AM	10:30:00 AM	5/4/15
4878	Marco Santiago Carrillo Yopez	dell	2924	9:42:00 AM	10:30:00 AM	5/4/15
4879	Yuxuan Yang	dell	4921	9:51:00 AM	11:26:00 AM	5/4/15
4880		dell	4925	10:32AM	11:59:00 AM	5/4/15
4881	Mohammed Salman A Al Shaikhali	dell	4924	11:02:00 AM	2:36:00 PM	5/4/15
4882	Omar Maddad M Almurairi	dell	4922	12:31:00 PM	12:34:00 PM	5/4/15
4883	thiago	mac	4413	1:17:00 AM	1:22:00 AM	5/4/15
4884		dell	4922	1:17:00 AM	2:32:00 AM	5/4/15
4885	dinh thi xuan phan	mac	4413	1:24:00 PM	2:32:00 PM	5/4/15
4886		dell	4921	2:35:00 PM	8:03:00 PM	5/4/15
4887	maria noceda	dell	4343	3:44:00 PM	4:32:00 PM	5/4/15
4888		mac	4431	6:08:00 PM	8:03:00 PM	5/4/15
4889	Yuxuan Yang	Dell	4921	9:44:00 AM	1j0:40 AM	5/6/15
4890		dell	4346	10:00:00 AM	10:40:00 AM	5/6/15
4891	Mohammed Salman A Al Shaikhali	dell	4921	10:30:00 AM	3:01:00 PM	5/6/15
4892		Mac	4423			5/6/15
4893	Yan Zhang	Dell	4346	11:27:00 AM	11:30 A.M	5/6/15
4894	Joon Seok Lee	Mac	4432	11:33:00 AM		5/6/15
4895	Maria Jose Bogarin Noceda	dell	4921	11:42:00 AM	1:07:00 PM	5/6/15
4896	Abdulrahman Sadoon	mac	5173	12:15:00 PM		5/6/15
4897	Tariq Hamed A Alahmedi	dell	4436	12:26:00 PM	1:03:00 PM	5/6/15
4898		mac	5175	1:16:00 PM		5/6/15
4899	henrique leitao	mac	4432	1:31:00 PM	2:20:00 PM	5/6/15
4900	lucas silva	mac	5173	1:31:00 PM	2:21:00 PM	5/6/15
4901	guilherme	mac	4349	1:33:00 PM	2:20:00 PM	5/6/15
4902	abdularahman altuwijri	dell	4414	1:34:00 PM		5/6/15
4903	david abreu	dell	4421	1:39:00 PM	2:21:00 PM	5/6/15
4904		mac	4428	1:41:00 PM		5/6/15
4905		mac	4416	1:41:00 PM		5/6/15

2.2 Commercial Products

Out in the industrial, many mature information management software products have proved their greatness over decades, e.g. QuickBooks, TradeGecko, and InFlow. Most of them offer functionalities such as asset tracking, employee hours monitoring, and inventory organizing.

Considering the scale and the budget devoted to this office, most of the commercial solutions have fallen into one or many of the following problems:

- Too expensive to apply.
- Failed to fulfill all operational requirements.
- Unable to customize or expand.
- Security issues.

Chapter 3 - Requirement Analysis

3.1 Operational Requirements

Generally, this system will implement the following functionalities:

- Displaying general information to visitors and staff;
- Recording staff sign-in/sign-out activities, monitoring working hours;
- Managing check-out/check-in process of electronic devices, books, etc;
- Providing local inventory service;
- Reporting historical data, analyzing statistics, and generating graphical reports;
- Useful tools and gadgets, as well as links to relevant resources;
- User-friendly interfaces and technical support;
- The following part introduces detailed requirements for each page:

3.1.1 Dashboard

- Display real-time statistical information of resources usage, e.g. Percentage of checked-out devices;
- List lab monitors in service;
- Reflect number of faulty devices;

3.1.2 Enrollment

- Provide Terms and Conditions of Studying in the ITC and the ELP Photo Release Form in multiple languages to students;
- Synchronize students' response among different languages;
- Record students' choices of releasing image for promotional use of ELP;
- Retrieve basic information of students from K-State ID Center, including WID, ISO, EID, first name, last name, and portrait;
- Save above information to local database for easy access;

3.1.3 Library

- Retrieve visitors information after swiping Wildcat ID Card;
- Check-out/check-in books, electronic devices, e.g. Computers, tablets, cameras;

- Retrieve requester's information and privilege from database to decide accessibility;
- Search ELP tag number or nickname to identify device;
- Change device status if it is reserved, broken, or not available;
- Offer recommendation based on device battery conditions(optional);
- Read QR code to identify device(optional);

3.1.4 Staff

- Retrieve staff information after swiping Wildcat ID Card;
- Sign-on or sign-out staff members;
- Report to staff hours of various date range;
- Switch to admin mode when needed;
- Calculate total staff hours for validating student employee time entry;

3.1.5 Utilities

- Decide to offer direct access to a user based on the privilege;
- View and export original database records;
- Use administrative privilege to overwrite records (insert, update, or delete);

3.2 Technical Specification

3.2.1 Languages

HTML 5

As the current version of HTML standard to structure and present content on World Wide Web, HTML5 is undoubtedly the most advanced markup language for modern interactive web pages. Simplified syntax but stronger features makes handling multimedia and graph contents easier than all the predecessors. Semantic content of document have been enriched by adding brand-new structure elements such as <header>, <nav>, <footer>, <figure>, etc. Refined and standardized attributes also contributes to precise performance of response of elements.

CSS 3

As the latest evolution of Cascading Style Sheets, CSS3 is split into several modules. Without sacrificing backward compatibility, new and extend features have also been added to models defined in CSS2. The modularization contributes a broader range of browser support because each module is being worked on individually.

During the development of ITC Information System, along with the help of Bootstrap 3 Framework, HTML5 and CSS3 have been used to construct and polish the Graphical User Interface. Some User Experience (UX) related animations are made possible by modifying attributes of HTML elements.

JavaScript

JavaScript is a lightweight, dynamic, and interrupted scripting language. Alongside with HTML5 and CSS3, it is one of the three most essential standardized components of web development. Widely employed but the majority of web-based applications, JavaScript is prototype-based with first-class functions. Despite its power in the World Wide Web, due to the fact that JavaScript is multi-paradigm — supporting object-oriented, imperative, and functional styles — it is also used in non-web-based environment.

As will be mentioned in the next chapter, JavaScript not only handles dynamic components of Views and coordinates page animations, but occasionally conducts tasks as the View Controller to ameliorate performance and reduce responding time of user interactions.

PHP

Having some functionalities in common with JavaScript, PHP is a server-side language designed for web development, it is also a widely-used open source general-purpose scripting language. However, PHP is distinguished from JavaScript in the way that the code is executed on

the server, but the generated code will be send to the client, maybe for further processing by JavaScript, e.g. AJAX load() function.

PHP is responsible for implementing logic protocol in the back-end, returning to AJAX calls via populating placeholder div elements, and backing up database regularly from the primary server to the backup MySQL server. PHP works closely with HTML and JavaScript in this project to form consistent data flow and smooth user interactions.

Python

Similar to PHP, Python is a high-level, general-purpose, interpreted, dynamic programming language. As the one of the most elegant languages in this world, Python was designed to fulfill the pursuit of readability and efficiency. Comparing to traditional structured languages like C or general object-oriented language like Java, Python would result in more concise implementation without sacrificing any functionality.

Due to its special characteristics, Python works mostly as utility tools and helping scripts to initialize the database, check status of the Restful Service provided by Office of Mediated Education, regain or replace missing or corrupted portraits, etc. However, decreasing and then eliminating the need of running Python scripts from Terminal is expected in the next version to dispose the constant requirement of professional maintenance.

3.2.2 Frameworks

Bootstrap 3

Although not applied into the ITC Information System in the first version, Bootstrap is the most popular HTML, CSS and JS framework for developing responsive, mobile first projects on the web, containing hundreds of templates for typography, forms, navigation and many other common interface components.

Originally developed by and used for Twitter as a framework to encourage consistency across internal tools, Bootstrap later became an open-source project on GitHub with more than 40,000 forks by its contributors.

jQuery

jQuery is a fast, small, and feature-rich DOM (Document Object Model) manipulation library. With a combination of versatility and extensibility, jQuery provides a paradigm for event handling which is more sophisticated than DOM element selection and manipulation. Assigning events and event callback function definitions are split among multiple small parts of the code. Cooperating with JavaScript, jQuery allows developers to express functions with less concern about complicated syntax.

AJAX

AJAX stands for Asynchronous JavaScript and XML; it is a bundle of web development methodology and technology to implement asynchronous web-based applications. It communicates with the server-side scripts, such as PHP by using XMLHttpRequest objects. Without reloading the page, Ajax can send request to the server (in the background). It is also capable of sending and receiving data in a variety of formats, such as JSON and XML.

Chapter 4 - Implementation

4.1 MVC Architecture

Model-View-Controller (MVC) is a commonly used, if not most popular, architecture pattern for web development, which divides a web application into three interconnected camps, so as to separate internal representations of information from the ways that information is presented to or accepted from the user.

During the implementation of the ITC Information System, the concept of MVC has been broadly applied to multiple sub-systems. In this section, emphasis will be focused on Models and Controllers.

4.1.1 Models

Models mostly consist of PHP logic and functional modules, which a) defines the properties and methods of People, Staff, Visitors, Devices, etc., in the Object-Oriented fashion; b) establishes connections to MySQL database; c) organizes all SQL queries and execute certain ones when asked by other logic modules; d) applies the policies and procedures of the ITC library protocols and staff protocols, and e) returns to Controllers the structured data to display with status of execution. Several essential models are as follows:

People.php

This PHP module defines the *People* class, with properties and methods that describes the attributes and behaviors of people who will access this system. Among many, several properties and methods are crucial to the functionality of ITC Information System as listed and explained:

WID

WID is the WildCat ID consisting of nine digital characters, that uniquely identifies every student, teacher, or staff of Kansas State University. Due to its nature, this value has also been used as the primary key of the information entry of every K-Stater in most databases across campus. Identifying a K-Stater by using WID is recommended by K-State ID Center and Office of Mediated Education (OME).

ISO

ISO is a serial number of a WildCat ID Card (Figure 4-1) which is associated with only one physical card. Every WildCat ID Card carries this segment of information in the magnetic strip. Mapping between WID and ISO will thus be withdrawn when a card gets stolen or lost. Consequentially renewing or replacing a WildCat card will generate a new record in the database of K-State ID Center. In addition, since ISO offers access to Cat Cash, a prepaid, declining balance debit account to use for purchases on the K-State campus, it is considered as sensitive information for K-Staters.

Figure 4-1 WildCat ID Card

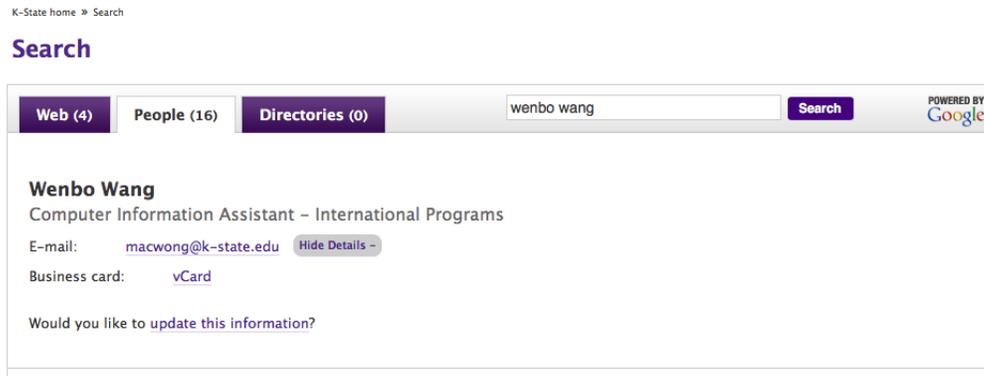


EID

All K-State employees, students and those needing access to university computing systems are required to have an eID. EID is the K-State user name and becomes part of the K-State email, which is used to enroll in classes, access K-State Online, view online paychecks, etc. Due to the

fact that EID is searchable on K-State search engine, the function of identifying a K-Stater by EID was deprecated in the second version of ITC Information System.

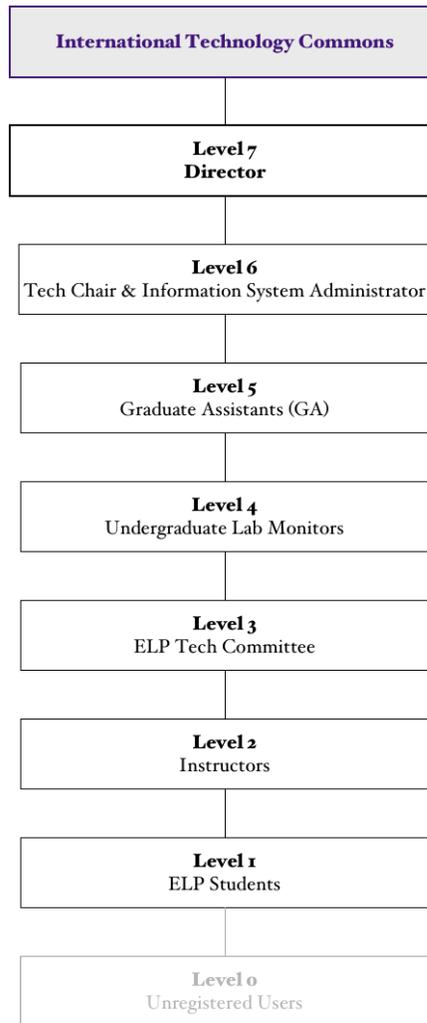
Figure 4-2 Searchable EID



Privilege

Different from the above privileges, which are defined by K-State, *Privilege* is a value uses only in ELP/ITC (Figure 4-3). When a visitor wants to check-out a device or book, he or she needs to provide an adequate privilege. Some pages of the ITC Information System will provide different options for visitors or staff with higher privileges.

Figure 4-3 Privilege Levels in ITC Information System



Staff.php

Similar to the *Visitor* module, the *Staff* module defines a subclass inherited from *People* with particular staff properties such as *is_in_service*, *last_record*. However, in addition to the inherited constructor, the *Staff* constructor validates the privilege of an instance to make sure the user is indeed a staff member of the ITC. Otherwise a null instance will be returned. Two methods of *Staff* are of great importance to the rest of this system as explained here:

getStaffRecordsBetweenDates(from_date, to_date)

After being instantiated, a *Staff* object can use this method to respond to a request for records of a staff, which will usually be displayed on Staff page. This function returns all the sign-in and sign-out records between the specified date range in a JSON format. It does not take the staff WID as parameter because this property will be retrieved from referencing that property in the current instance.

getHoursBetweenDates(from_date, to_date)

This methods calculates the accumulated number of hours between the specified date range. Because of the complexity of converting MySQL timestamp to PHP timestamp and the absence of native duration type in PHP, calculation is conducted by MySQL. It will firstly convert all HH:MM:SS representation of durations to number of seconds; and then sum up to get the total duration expressed in seconds; finally reformat and return the result in a human-readable way.

Device.php

An instance of *Device* class consists of basic information of an electronic device of ITC, including *tag*, *nickname*, *brand*, *model*, *category*, *condition*, etc., and methods to return device status and a list of records indicating every previous usage for inventory and/or analytic purposes.

ELP tag (tag)

As the primary key of the ELP inventory database, a four-digit tag number will be assigned to every asset of ELP. This tag number provides feasibility of tracking fixed assets without managing thousands of serial numbers possibly in different formats.

In the database ITC Information System, *tag* uniquely identifies every electronic device, book, and peripheral equipment. Thanks to the fixed length and type of *tag*, validating the input of a *tag* is relatively easier the handling a visitor or staff login input.

Required_privilege

Checking-out protocols of the ITC resources was once so complicated that new lab monitors could not work independently without supervision or help from experienced colleges, because neither paperwork nor Excel spreadsheet could suggest whether a visitor has been approved to use a certain category of library resources. The ITC Information Systems proposed, implemented, and succeeded in a simplified approach: people will be assigned a privilege upon registration, administrative level users may modify privileges of other users. Accordingly, required privileges will be appended to device information, therefore a privilege comparison will result in approval or denial of a check-out request given a pair of *WID* and *tag*.

getDeviceRecords()

As an important analytic parameter, check-in and check-out records will be returned by invoking this function. Also, this function converts the device records from PHP array format to JSON object to be loaded to a *<table>* element, which will be initialized by Bootstrap Table.

sql.php

This module aggregates all the SQL queries used in the ITC Information System, so that they are not scattered throughout multiple files. It also responsible for establishing connections to MySQL server, executing queries, and return to the callback function appropriately formatted results.

In the first version of ITC Information System, this module did not participate in processing data. Additional PHP models thus needed to assisting processing and/or reformatting data, e.g. subtracting rows from mixed types of MySQL results. Currently, this models serves not only as a portal to the ITC Information Database, but as a pre-processor for data-handling so that the traffic and resource consumption is better balanced, which improves the overall performance.

executeQuery(is_multiple, queries)

This function takes two arguments, the first indicates whether there are multiple queries included in the second argument. After establishing the connection to MySQL, queries will be executed in the functional approach. Upon execution, queries are capsuled in a transaction. If multiple queries are supplied, this function will return an array consisting of results for each execution.

ksu_id_info.php

This module consumes the RESTful API provided by Office of Mediated Education (OME) by invoking *libcurl*, a client URL library allowing a PHP program to connect and communicate to different types of protocols.

OME tested and launched two *KSU_TechCommons* RESTful services as requested in October 2014 and May 2015, and registered them under K-State webMethods Integration Services for serving ITC. The first service converts singular or grouped WID into ISO and vice versa. The second service, which ITC constantly relies on, returns a student's basis information in a JSON format, including WID, ISO, EID, first name, last name, and portrait, given one of three *ID mentioned above.

Upon receiving a request with *login_input*, a curl session is initiated with options to add manually specified HTTP headers carrying encrypted authorization information. After execution of this curl session, the module decodes the JSON response and fills the result into an object as return value.

4.1.2 Controllers

In the first generation of ITC Information System, controllers were implemented only by PHP. Javascript handles interactions with users by invoking Ajax *load* function. Upgraded this

semester, the current version has re-balanced the controlling tasks between processing locally via Javascript and involving PHP engine. Thus technically speaking, the controller layer is implemented by both Javascript and PHP. Several essential controllers are as follows:

library.js

Similar to many other JavaScript files accompanying other HTML pages, this script helps simplifying user interactions during checking-in or checking-out books or electronic devices.

Upon getting the fourth digit from user input, the *tag* form validates the input and detect whether this tag is associated with a book or device. Then this script sends an Ajax request to the PHP controller to fetch book or device information accordingly, and updates the device/book information area based on the return value.

The same methodology applies to updating visitor information. In addition, this script also checks the privilege of the visitor, and when encountering an admin level visitor, a *Reserve* button and a *Release* button are added to the possible library actions.

Part of checking-in and checking-out is implemented within this script: when the Check-out button is pressed, comparison between the text of *privilege_required* for a device and *privilege_provide* by the visitor results in either permission for submitting a check-out request, or denial due to insufficient privilege.

Some utility functions have also been implemented to improve user experience, e.g. instead of clicking the text input field, hovering across a form triggers focusing on the text area.

staff.js

The Staff page not only provides access for ITC lab monitors to sign-on or sign-out, but also offers a portal for both ITC administrators and lab monitors themselves to check their working records.

Once someone swipes his WildCat card, this script validates the identity of the card holder by asynchronously sending the information to another PHP view controller, which tries to initialize an object given the POST value from AJAX as the parameter of constructor. If successfully instantiated, the object is populated and returned to the page to fill in the staff information area, otherwise an empty object is sent back and an error message appears accordingly indicating insufficient privilege.

Clicking the Sign-out or Sign-in button triggers a pre-processing function to reduce the unnecessary AJAX request: by analyzing the current status of a staff and the request he tries to submit this script denies sign-out or sign-in request without communicating to controllers or models when encountered obvious logic error, e.g. when a monitor clicks sign-in button while he is in-service. In the other case, this script submits an AJAX request to the corresponding controller and then model to execute a monitor sign-in/out sequence.

Upon successful sign-on, this scripts displays the start timestamp of this shift, and a successfully sign-out message comes with a duration of the last shift for the monitor's reference.

When the scripts identifies the card holder as of the admin level, instead of the Staff Records panel, the Admin Panel displays list all the accumulated working hours for every monitor of the ITC in the specified date range. Selecting a row further displays all records in details.

enrollment_modal.php

Every semester begins with the a two-day enrollment for ELP, during which dozens of requirements need to be checked and fulfilled by every student. The responsibility of ITC station is to ask students to read and agree to the Term and Conditions of Studying In The ITC and choose to give or not give the ELP permission to take their photo/video/audio for promotional use.

The enrollment is also an opportunity for the ITC Database to retrieve student information from K-State ID Center, so that the ITC Information System does not have to interact with OME RESTful service and wait for response when a student asks to check out a book or device.

In case of encountering a returning student, the card swipe results in a match from the ITC Database, and thus triggers displaying a warning message.

admin_staff_records.php

This module formats and displays the staff records by using the Bootstrap Table. Similar to the several other PHP files, this module consists PHP, HTML, and JavaScript.

The PHP controller invokes the corresponding model as requested by the AJAX call from the Staff page, which lists all staff in an array. With the supplied date range, this module loops through the list of staff, accumulates their working hours, and appends the value to the element.

Since the Bootstrap Table is a JavaScript framework, to minimize the resource consumption of AJAX, this module utilized the simple PHP *echo* function to pass a JSON-encoded string in place as the data source for Bootstrap Table initializer, similarly to UNIX/Linux Piping.

4.1.3 Views

As the most essential front-end components, views are structured by applying HTML5, CSS3, and Javascript to build visual objects for the users, which will be discussed in the next section.

4.2 User Interface and User Experience

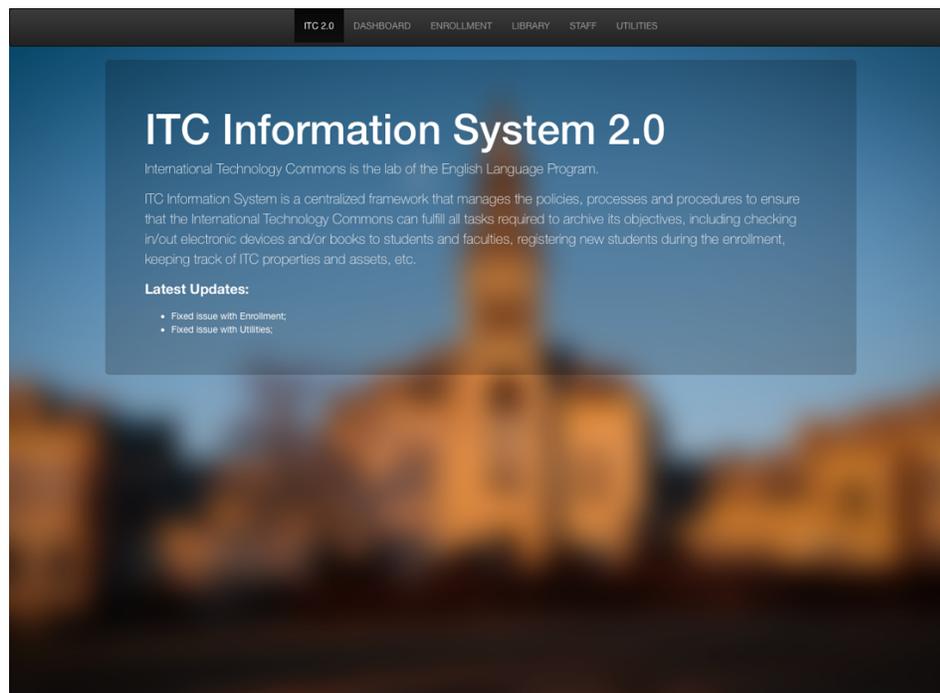
(Graphical) User Interface and User Experience design offers clients the first impression of the entire system, it therefore requires dedication to not only the art of piling HTML webpage elements, but assuming every kind of problems that a user could encounter. During the preliminary UI & UX design phase of the ITC Information System, the goal had already been set as exposing

the least about of complexity to a user. Consequentially, no tutorial has ever needed to send to ITC lab monitor for any update or release, since most operations are intuitive for them as university students.

On the other hand, the ITC Information System handles errors and offers prompt messages in a light-weight user-friendly approach: errors or expected actions are stated in straight-forward English. Animations such as color change or flashing elements helps users quickly pinpoint the location and reason of problems. Essential pages are listed as following:

4.2.1 Home

Figure 4-4 Home Page



4.2.2 Dashboard

Figure 4-5 Dashboard Page

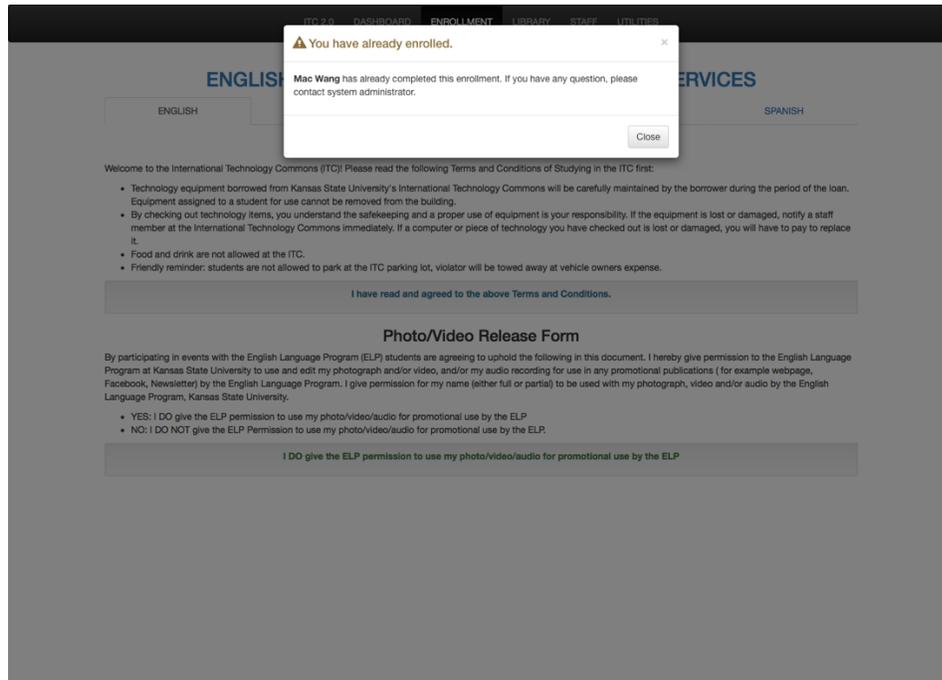
The screenshot shows the 'ENROLLMENT' section of the dashboard. At the top, there is a navigation bar with links for 'ITC 2.0', 'DASHBOARD', 'ENROLLMENT', 'LIBRARY', 'STAFF', and 'UTILITIES'. Below this is a header for 'ENGLISH LANGUAGE PROGRAM ENROLLMENT SERVICES' with tabs for 'ENGLISH', 'CHINESE', 'ARABIC', 'PORTUGUESE', and 'SPANISH'. The main content area is titled 'Terms and Conditions of Studying in the ITC'. It includes a welcome message and a list of terms: technology equipment is borrowed and must be maintained; equipment cannot be removed from the building; users are responsible for safekeeping and proper use; food and drink are not allowed; and students are not allowed to park in the ITC parking lot. Below the terms is a button that says 'I have read and agreed to the above Terms and Conditions.' The next section is 'Photo/Video Release Form', which explains that users are giving permission for their photos and videos to be used in promotional materials. It includes two radio button options: 'YES: I DO give the ELP permission to use my photo/video/audio for promotional use by the ELP' and 'NO: I DO NOT give the ELP Permission to use my photo/video/audio for promotional use by the ELP'. At the bottom, there are two buttons labeled 'YES' and 'NO'.

4.2.3 Enrollment

Figure 4-6 Enrollment Page

The screenshot shows the 'ENROLLMENT' section of the dashboard. At the top, there is a navigation bar with links for 'ITC 2.0', 'DASHBOARD', 'ENROLLMENT', 'LIBRARY', 'STAFF', and 'UTILITIES'. Below this is a header for 'ENGLISH LANGUAGE PROGRAM ENROLLMENT SERVICES' with tabs for 'ENGLISH', 'CHINESE', 'ARABIC', 'PORTUGUESE', and 'SPANISH'. The main content area is titled 'Terms and Conditions of Studying in the ITC'. It includes a welcome message and a list of terms: technology equipment is borrowed and must be maintained; equipment cannot be removed from the building; users are responsible for safekeeping and proper use; food and drink are not allowed; and students are not allowed to park in the ITC parking lot. Below the terms is a button that says 'I have read and agreed to the above Terms and Conditions.' The next section is 'Photo/Video Release Form', which explains that users are giving permission for their photos and videos to be used in promotional materials. It includes two radio button options: 'YES: I DO give the ELP permission to use my photo/video/audio for promotional use by the ELP' and 'NO: I DO NOT give the ELP Permission to use my photo/video/audio for promotional use by the ELP'. Below these options is a button that says 'I DO give the ELP permission to use my photo/video/audio for promotional use by the ELP'. At the bottom, there is a text input field with a password strength indicator on the right.

Figure 4-7 Enrollment Page Modal



4.2.4 Library

Figure 4-8 Library Page

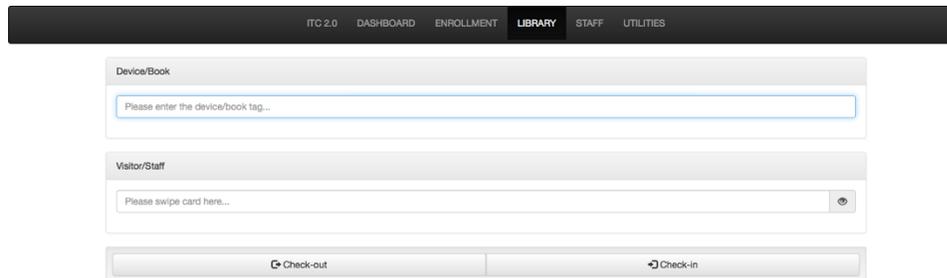


Figure 4-9 Library Page Visitor Information

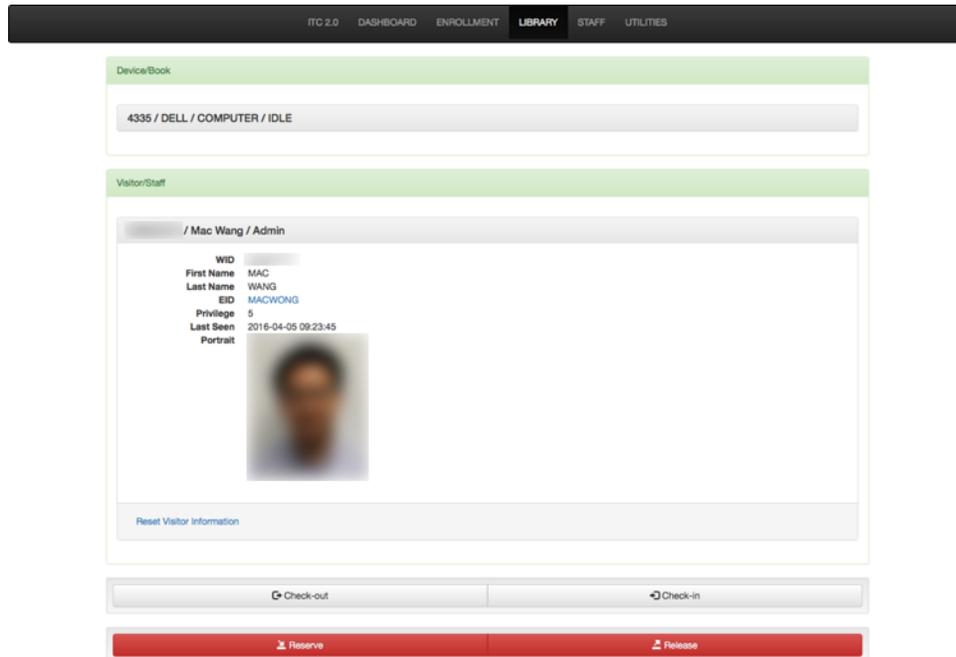
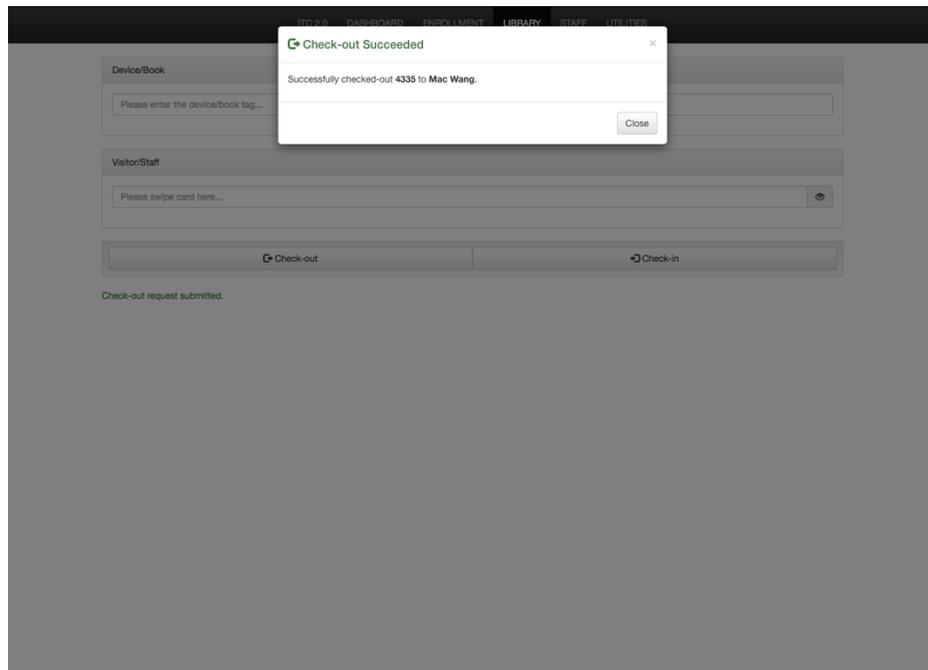


Figure 4-10 Library Page Respond Modal



4.2.5 Staff

Figure 4-11 Staff Page

The screenshot shows the top navigation bar with the following items: ITC 2.0, DASHBOARD, ENROLLMENT, LIBRARY, **STAFF**, and UTILITIES. Below the navigation bar is the "Staff Login" section, which includes a text input field with the placeholder "Please swipe card here...", a "Sign-out" button, and a "Sign-in" button. Below the login section is the "Staff Records" section, which contains a date range input field set to "04/05/2016 - 04/06/2016".

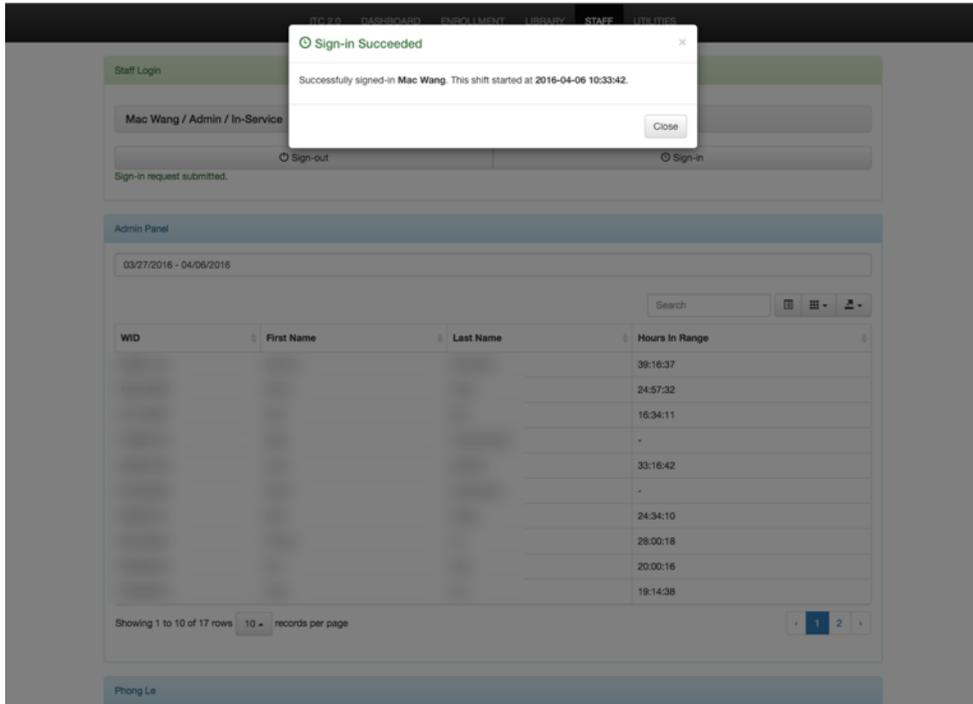
Figure 4-12 Staff Total Hours in Admin View

The screenshot shows the top navigation bar with the following items: ITC 2.0, DASHBOARD, ENROLLMENT, LIBRARY, **STAFF**, and UTILITIES. Below the navigation bar is the "Staff Login" section, which includes a text input field with the placeholder "Mac Wang / Admin / Not In-Service", a "Sign-out" button, and a "Sign-in" button. Below the login section is the "Admin Panel" section, which contains a date range input field set to "03/27/2016 - 04/06/2016", a search bar, and a table of staff hours. The table has columns for "WID", "First Name", "Last Name", and "Hours In Range". The table is currently displaying 10 records out of 17. The "Hours In Range" column shows values such as "39:16:37", "24:57:32", "16:34:11", "-", "33:16:42", "-", "24:34:35", "28:00:18", "20:00:16", and "19:14:38".

WID	First Name	Last Name	Hours In Range
			39:16:37
			24:57:32
			16:34:11
			-
			33:16:42
			-
			24:34:35
			28:00:18
			20:00:16
			19:14:38

Showing 1 to 10 of 17 rows | 10 records per page | 1 2

Figure 4-13 Staff Sign-on



4.2.6 Utilities

Figure 4-14 Utilities Page

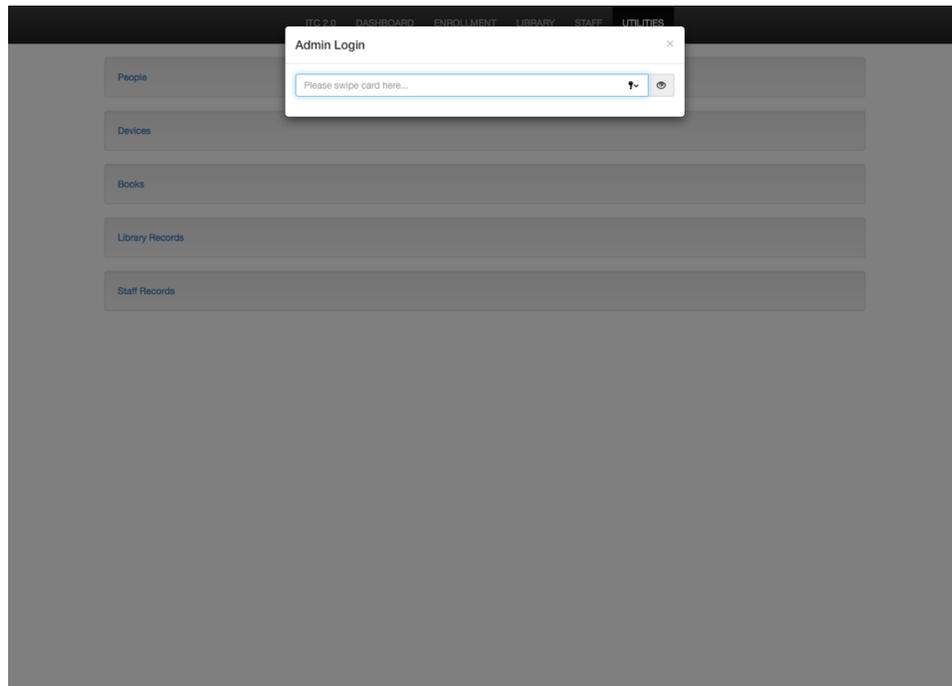


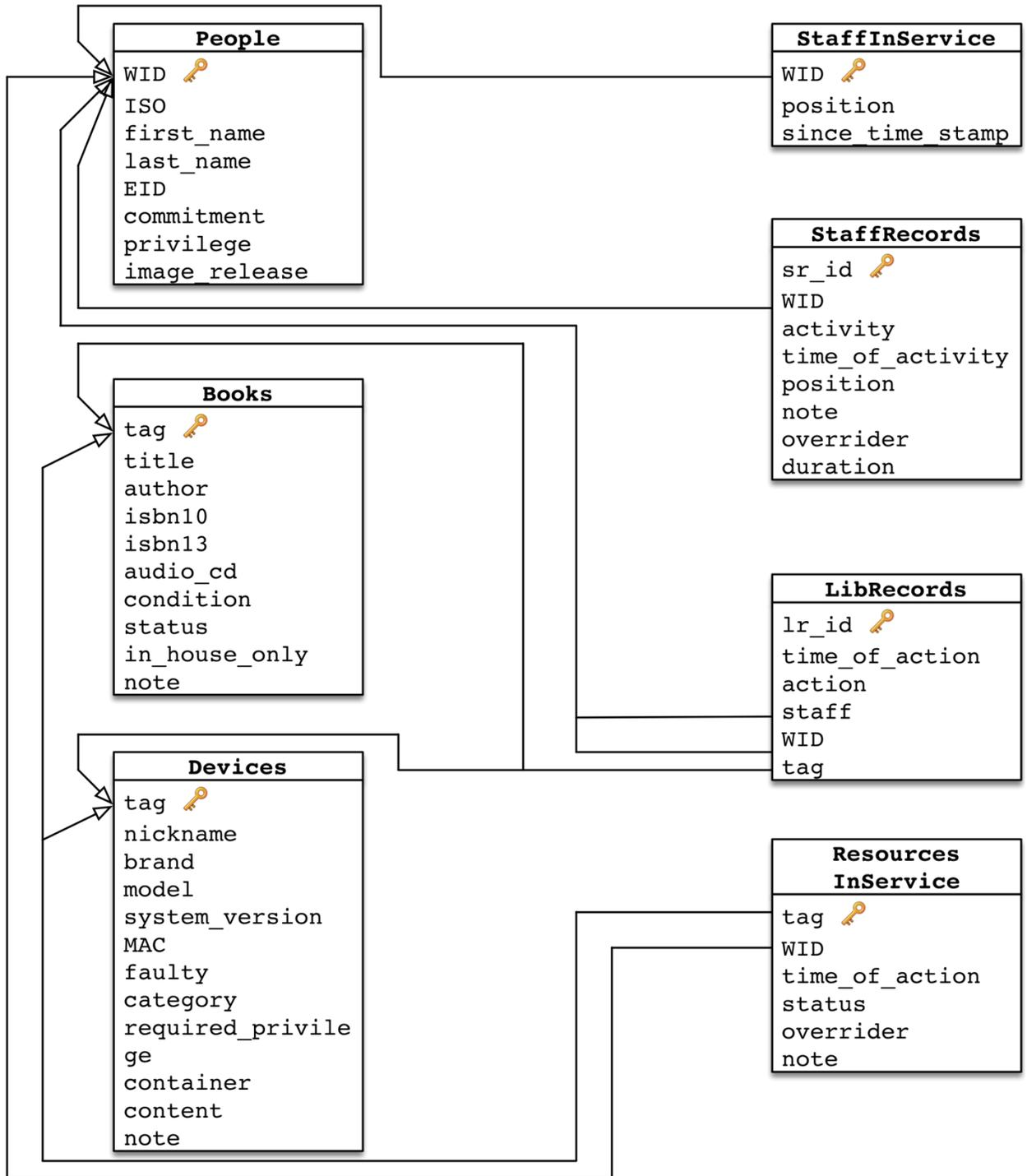
Figure 4-15 Table of People

WID	EID	First Name	Last Name	Privilege	Photo R
				1	NO
				1	NO
				1	NO
				1	YES
				1	NO
				4	NO
				1	NO
				1	NO
				1	NO
				1	NO

4.3 Database

Implemented by utilizing the MySQL database engine, The ITC Information Database is not only an essential component of the ITC Information System, but also an individual data service. Figure 4-16 demonstrates the the structure and content of this database.

Figure 4-16 Entity-Relation Diagram of ITC Database



To improve the performance and reduce unnecessary traffic of the ITC Information System, timestamps are appended natively by MySQL server. Therefore durations of staff shift are calculated by a trigger using MySQL *timediff()* function (Figure 4-17).

Figure 4-17 Staff Record Trigger

```
1 CREATE DEFINER='itcadmin'@'%' TRIGGER `ITCInfoSys`.`StaffRecords_BEFORE_INSERT`  
2 BEFORE INSERT ON `StaffRecords`  
3 FOR EACH ROW BEGIN  
4     IF NEW.duration IS NULL AND NEW.activity = 'sign-out' THEN  
5         SET NEW.duration = timediff(NEW.time_of_activity, (SELECT time_of_activity FROM StaffRecords SR WHERE SR.  
6             wid=NEW.wid ORDER BY time_of_activity DESC LIMIT 1));  
7         END IF;  
8     END
```

Chapter 5 - Testing

5.1 Compatibility

Compatibility tests have been conducted with multiple mainstream desktop and mobile browsers. The status of network resources, such as HTML files, CSS files, and JavaScript files, are monitored to reflect the availability of the system. If the status of all resource files in a page are either *200 OK* or *304 NOT MODIFIED*, the test is flagged as successful, otherwise the status is indicated in the test log. Any error or warning generated by the browser console is also captured for analyzing and debugging. The test results (Table 5-1) suggest that the ITC Information System is compatible with all tested desktop and mobile browsers.

Table 5-1 Compatibility Test Result

	Home	Dashboard	Enrollment	Library	Staff	Utilities
Firefox	OK	OK	OK	OK	OK	OK
Firefox iOS	OK	OK	OK	OK	OK	OK
Safari	OK	OK	OK	OK	OK	OK
Safari iOS	OK	OK	OK	OK	OK	OK
Chrome	OK	OK	OK	OK	OK	OK
Chrome iOS	OK	OK	OK	OK	OK	OK
IE	OK	OK	OK	OK	OK	OK
Edge	OK	OK	OK	OK	OK	OK

5.2 Performance

To test and evaluate the performance of the ITC Information System, the built-in developer tools with Mozilla Firefox are utilized to record the loading time of elements and efficiency of caching.

Figure 5-1 Performance Analysis of Home Page

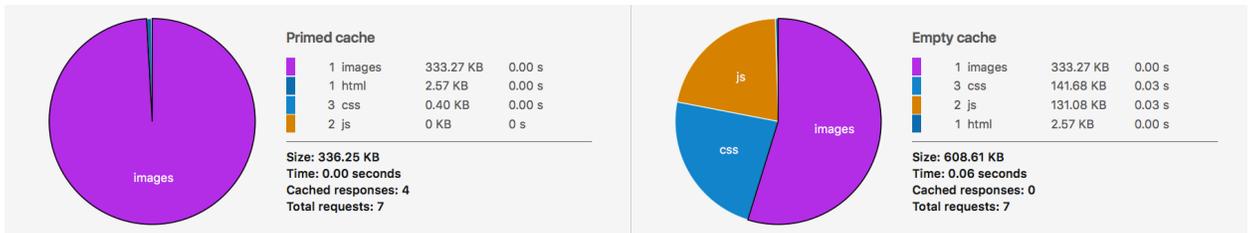


Figure 5-2 Performance Analysis of Dashboard Page

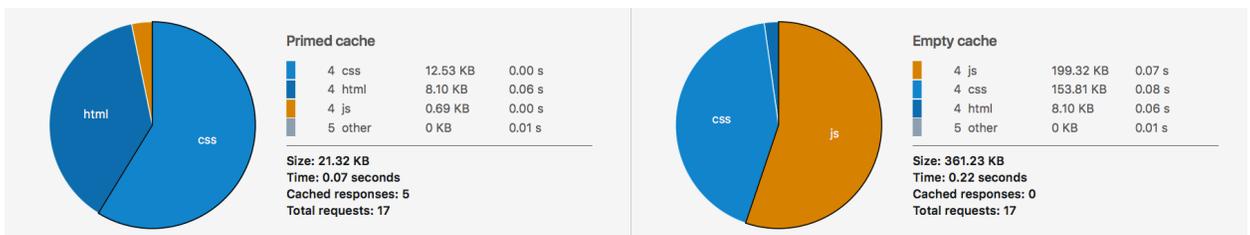


Figure 5-3 Performance Analysis of Enrollment Page

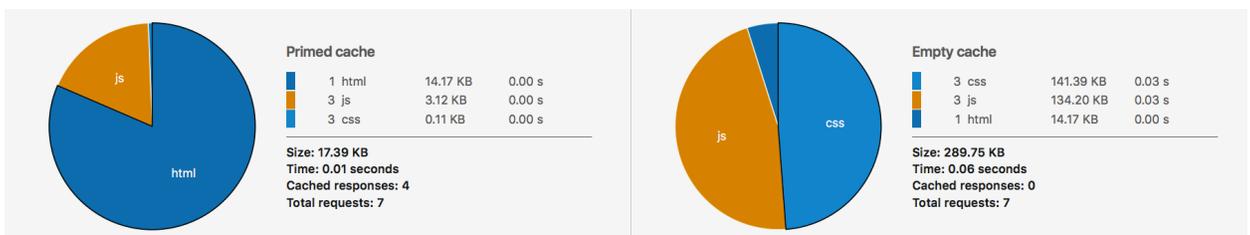


Figure 5-4 Performance Analysis of Library Page

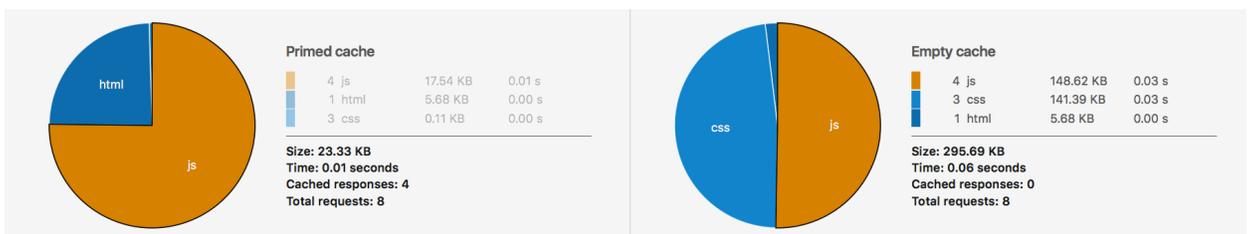


Figure 5-5 Performance Analysis of Staff Page

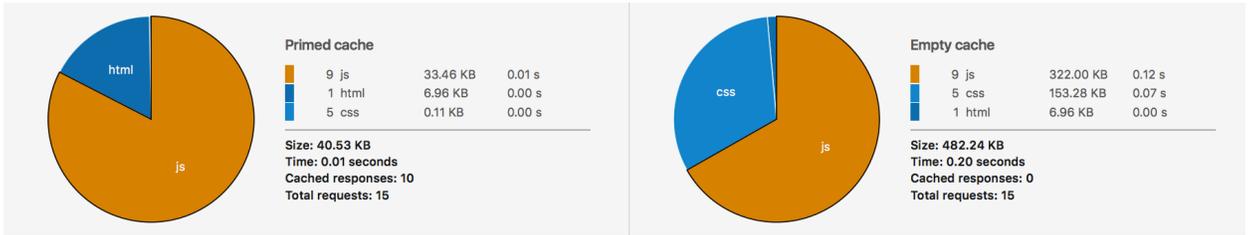
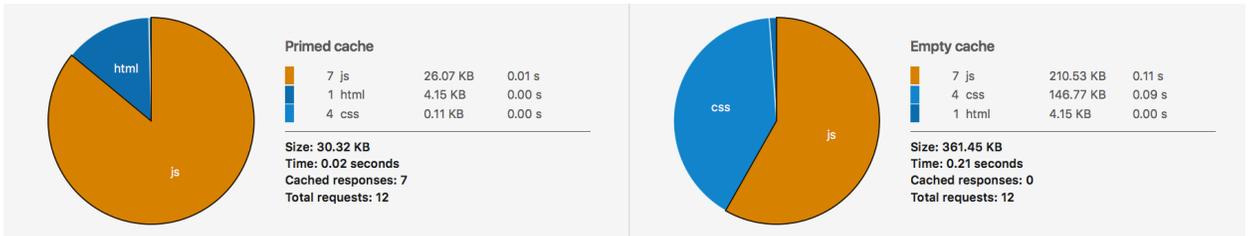


Figure 5-6 Performance Analysis of Utilities Page



Chapter 6 - Future Work

As a full-stack project implemented by myself alone, the ITC Information System has been contributing to simplifying the administration and management of ITC and improving the efficiency of service procedures. It has been demonstrated to the leadership of ELP with promising feedbacks. However, as an agile project, the development status of the ITC Information System remains active. There has been dozens of development versions and releases during the last two semesters. Two branches are currently in developing status and a couple tasks have been listed for the next major version change. The undergoing updates are as following:

- Adding functions to report device battery status (implemented and testing).
 - A universal python script will be added the Start Up Programs (Windows) or Boot Up Items (Macintosh) on every device, which will analyze and report the battery status of every device in every certain minute, and report the status to the ITC Database. The library protocol will consider the battery status of a device during checking-out and make suggestions to lab monitors, in case of service interruption in classes.
- Adding functions to calculate class or event attendees.
 - Attendance is an essential requirement of most ELP classes, and takes significant consideration on evaluating the academic performance of ELP students. The current approach still relies on pen and paper, lacking efficiency and wasting human resources. As requested by the ELP leadership, a class/event attendance page will be integrated in the ITC Information System, so that by asking students to swipe their WildCat ID Cards, the system will record their activities and generate attendance reports as needed.

Bibliography

Lutz, M. (n.d.). *Learning Python*.

Nixon, R. (2015). *"Learning PHP, MySQL, and JavaScript: With jQuery, CSS & HTML5"*

Duckett, J. (2014). *JavaScript & JQuery: Interactive Front-End Web Development*. John Wiley & Sons.

PHP: Hypertext Preprocessor. (n.d.). Retrieved April 11, 2016, from <http://php.net/>

jQuery. (n.d.). Retrieved April 11, 2016, from <https://jquery.com/>

Bootstrap · The world's most popular mobile-first and responsive front-end framework. (n.d.). Retrieved April 11, 2016, from <http://getbootstrap.com/>

Bootstrap Table. (n.d.). Retrieved April 11, 2016, from <http://bootstrap-table.wenzhixin.net.cn/>

Charts | Google Developers. (n.d.). Retrieved April 11, 2016, from <https://developers.google.com/chart/>

Kansas State University. (n.d.). Retrieved April 11, 2016, from <http://www.k-state.edu/oip/>

Kansas State University. (n.d.). Retrieved April 11, 2016, from <http://www.k-state.edu/elp/>