

**MAKAHIKI: AN EXTENSIBLE OPEN-SOURCE PLATFORM FOR CREATING  
ENERGY COMPETITIONS**

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**By**  
**George Lee**

**Thesis Committee:**

**Philip M. Johnson, Chairperson**  
**Daniel Suthers**  
**Martha Crosby**

We certify that we have read this thesis and that, in our opinion, it is satisfactory in scope and quality as a thesis for the degree of Master of Science in Information and Computer Sciences.

THESIS COMMITTEE

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Chairperson

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by

George Lee

To the friends I have made during my time at the University of Hawaii at Manoa. Thank you for an amazing ride. I have no regrets.

# Acknowledgments

This process was arduous and sometimes intimidating. I would like to thank the following people who have made this entire process a little easier.

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Finally, this could not have been done without the support of my parents. This would be all but impossible to achieve without their continued love and support. I am truly blessed.

# Abstract

Due to rising costs and the questionable future of our non-renewable energy reserves, individuals need to become aware of their energy usage. In order to instill these habits earlier, organizations have held energy competitions to promote the reduction of energy. This also has the side effect of reducing the energy cost to the organization holding the competition. Typically, these competitions are held in colleges and universities and there are companies that can provide hardware and software to support them. However, since such solutions can be expensive, we would like a free, open source solution that can be used by any organization.

We created Makahiki to be an open source framework for sustainability competitions. We also designed it to be a platform for researchers to investigate user behaviors during an energy competition. However, in order to validate our design, we need to evaluate and test our design. During the course of development, we had three evaluation phases. In the mockup phase, we validated our design before doing any implementation. In the onboarding phase, we investigated how individuals will interact with the system when they visit it for the first time. Finally, in the beta phase, we simulated the competition on a much smaller scale in order to observe how Makahiki might be used in an actual competition. Following these evaluations, Makahiki was used to support the 2011 Kukui Cup, which was held in mid-October.

In summary, we claim the following contributions:

1. An open source system for creating serious games for energy competitions.
2. A research platform on which researchers can observe user behavior during energy competitions.
3. A methodology for evaluating and testing serious games that involve competitions over a period of time.

# Table of Contents

Acknowledgments . . . . .	v
Abstract . . . . .	vi
List of Tables . . . . .	x
List of Figures . . . . .	xi
1 Introduction . . . . .	1
1.1 The Problem . . . . .	1
1.2 Goals for Makahiki . . . . .	3
1.3 Evaluation . . . . .	4
1.4 Research Questions . . . . .	5
1.5 Thesis Structure . . . . .	5
2 Related Work . . . . .	6
2.1 Energy Competitions . . . . .	6
2.1.1 Duke University's Eco-Olympics . . . . .	6
2.1.2 Oberlin College's Ecolympics . . . . .	7
2.1.3 Competition Evaluation . . . . .	8
2.2 Serious Games . . . . .	11
2.3 Usability Evaluations . . . . .	13
3 System Design . . . . .	16
3.1 Architecture . . . . .	16
3.2 Supporting Components . . . . .	17
3.2.1 Rounds . . . . .	17
3.2.2 First Login Wizard . . . . .	18
3.2.3 Quests . . . . .	19
3.2.4 Social and Referral Bonuses . . . . .	19
3.2.5 Badges . . . . .	21
3.2.6 Logging . . . . .	22
3.3 Pages . . . . .	23
3.3.1 Get Nutz . . . . .	23
3.3.1.1 Activities . . . . .	24
3.3.1.2 Events/Excursions . . . . .	26
3.3.1.3 Commitments . . . . .	27
3.3.2 Go Low . . . . .	28
3.3.2.1 WattDepot Integration . . . . .	28
3.3.2.2 Current Power and Energy . . . . .	29
3.3.2.3 Daily Energy Goal Game . . . . .	29

3.3.3	Prizes . . . . .	30
3.3.3.1	Competition Prizes . . . . .	30
3.3.3.2	Raffle Game . . . . .	31
3.3.4	News . . . . .	32
3.3.5	Profile . . . . .	33
3.3.6	Help . . . . .	33
3.3.7	Canopy . . . . .	34
4	Experimental Design . . . . .	36
4.1	Mockup Evaluation . . . . .	36
4.2	Onboarding Evaluations . . . . .	38
4.3	Beta Evaluation . . . . .	40
4.4	Production Deployment . . . . .	41
4.5	Summary . . . . .	42
5	Results and Discussion . . . . .	43
5.1	Mockup Evaluations . . . . .	43
5.2	Onboarding Evaluations . . . . .	43
5.2.1	April Evaluation . . . . .	43
5.2.1.1	First Login Wizard . . . . .	44
5.2.1.2	Quests . . . . .	45
5.2.1.3	Home Page . . . . .	46
5.2.1.4	Go Low . . . . .	47
5.2.1.5	Get Nutz . . . . .	48
5.2.1.6	Prizes Page . . . . .	50
5.2.1.7	Discussion . . . . .	50
5.2.1.8	Focus Group . . . . .	51
5.2.2	July Evaluation . . . . .	51
5.2.2.1	Changes . . . . .	51
5.2.2.2	First Login Wizard . . . . .	52
5.2.2.3	Quests . . . . .	53
5.2.2.4	Smart Grid Game/Actions . . . . .	54
5.2.2.5	Onboarding Evaluation Summary . . . . .	55
5.2.3	Beta Evaluation . . . . .	56
5.2.3.1	Changes . . . . .	56
5.2.3.2	Results . . . . .	56
5.2.3.3	Issues . . . . .	56
5.2.3.4	Post Beta Survey . . . . .	58
5.3	Production Results . . . . .	58
5.3.1	Issues . . . . .	58
5.3.2	Results . . . . .	59
6	Conclusion . . . . .	61
6.1	Future Work . . . . .	62
6.2	Contributions . . . . .	62
A	Onboarding Evaluation Script . . . . .	64
A.0.1	Pre-Test . . . . .	64
A.0.2	Post-Test . . . . .	65

B Post-Beta Survey Results . . . . .	66
Bibliography . . . . .	71

# List of Tables

<u>Table</u>	<u>Page</u>
1.1 Features of Makahiki compared to other dorm energy competitions . . . . .	4
2.1 University dorm energy competition implementations . . . . .	9
2.2 Laws of Learning linked to Game Design Techniques. Used with permission from Curtiss Murphy.	14
3.1 Quest predicates used in Makahiki . . . . .	20
3.2 Activity predicates used in Makahiki . . . . .	24
5.1 Summary of results in April onboarding evaluation . . . . .	44
5.2 Quests performed by users in the April evaluation . . . . .	46
5.3 Activity items completed during the April evaluation . . . . .	48
5.4 Summary of results in July onboarding evaluation . . . . .	52
5.5 Quests completed by subjects in the July evaluation . . . . .	53
5.6 Activity items completed during the July evaluation . . . . .	54
5.7 Average results of the April and July evaluations. . . . .	55
5.8 Summary of results in the beta evaluation. . . . .	57
5.9 Hours spent on the website during the 2011 Kukui Cup. . . . .	59
5.10 Statements evaluated on a likert scale during the 2011 Kukui Cup. . . . .	60

# List of Figures

<u>Figure</u>	<u>Page</u>
2.1 Duke Eco-Olympics . . . . .	7
2.2 Oberlin College Campus Resource Monitoring System . . . . .	8
2.3 Dorm energy web sites as they appear on an iPhone. . . . .	11
3.1 Architecture of Makahiki . . . . .	16
3.2 Sitemap of the pages in Makahiki . . . . .	17
3.3 Terms and conditions step in the first login wizard. . . . .	18
3.4 The final version of the quest bar. . . . .	19
3.5 Social bonus for making a commitment. . . . .	21
3.6 Referral bonus step of the first login wizard. . . . .	21
3.7 List of available badges in Makahiki. . . . .	21
3.8 The Get Nutz page. . . . .	24
3.9 A activity in the Smart Grid Game. . . . .	25
3.10 A excursion in the Smart Grid Game. . . . .	26
3.11 A commitment in the Smart Grid Game. . . . .	27
3.12 Daily Energy Goal Game visualization . . . . .	29
3.13 Competition prizes displayed on the prizes page. . . . .	30
3.14 The raffle game at the end of the overall round. . . . .	31
3.15 The news page. . . . .	32
3.16 The profile page. . . . .	33
3.17 The help page. . . . .	33
3.18 Canopy Missions and Visualizations . . . . .	34
4.1 Mockup of the landing page. . . . .	36
5.1 First Login Wizard profile setup . . . . .	45
5.2 The Quest Bar on an Activity's page . . . . .	45
5.3 Layout of the six top level pages on the home page . . . . .	47
5.4 The Go Low Page . . . . .	47
5.5 Upload a Screenshot Instructions . . . . .	49

# Chapter 1

## Introduction

Because of the questionable future of our current energy sources, it has become increasingly important to educate people about their energy usage. To ensure that current energy sources are still available for future generations, organizations from non-profits [1] to utility providers [2] have advocated energy conservation. Some organizations have targeted children in order to instill these habits early [3].

One approach to educating the younger generation is to hold college residence hall energy competitions. The goal of these competitions is to have the residents of the dorm reduce their energy usage. Typically, the dorm that reduces their energy use the most at the end of the competition is declared the winner. Other smaller prizes can be awarded for accomplishing certain goals, like reducing energy usage by 10 percent in a week. The overall energy reduction is determined either by having someone read the meters or using “smart meters” that are connected to the internet and can send out data. Universities such as Duke (Eco-Olympics) and the University of Wisconsin (Energy Apocalypse) have run competitions relating to energy conservation and awareness.

### 1.1 The Problem

To aid in running the competition, many of these universities used web sites to display the dormitory’s current usage. While it is easy to create a content management system to display mostly static data (i.e. one that is only updated when someone reads the meter), dormitory residents are more motivated by real-time feedback [4]. However, the development of such a system can be a complicated and/or expensive process. Providing real-time feedback not only requires special meters that can communicate with other devices, but also requires software that can process the data and display the relevant information to the user. Because of this, many organizations have turned to

companies like Lucid Design Group that can provide this software and hardware at a cost. Peterson et al estimated that the cost for their experiment was about \$5,000 for each of the two dorms, though they suggest a conservative estimate of \$10,000 for each dorm [4].

However, Lucid Design Group's software only involves the visualization of energy data for the building or dorm as a whole. Because of this, the software is unable to immediately provide user-related information. For example, if a dorm resident wants to view their floor's energy usage, they must interact with the visualization to get the information that they need. In the ideal case, the user would log in using their university credentials and then be able to immediately view their current standings.

If another organization is handling the development and maintenance of the software and hardware, who owns the data related to the competition? While some organizations may feel the benefits of the competition will outweigh the loss of control of the data, it can be used to make improvements to the overall design of the competition in the real world. Data of interest to an organization include a more granular look at the energy readings and the web server logs. For example, organizations can see how effective marketing and real-world events are by seeing how they drive traffic to the website.

Another issue is that many of the web sites for these dorm energy competitions have not kept up with the latest trends in technology. Two trends in particular are social networks and mobile phone interfaces. Social networks, like Facebook, are extremely popular especially among college students. A few colleges/universities have energy competition pages or groups on Facebook. These two things provide a place for students to discuss what is going on in the competition. However, providing the ability to share user activity within Makahiki can help spread the word and encourage other potential users to sign in.

The rise of mobile computing devices such as Android devices, iPhones, and iPod Touches have web developers designing interfaces for smaller screens. While a normal website is viewable on an iPhone, users will have to zoom in to read sections of the site, which can be a little cumbersome. Also, these devices may not support browser-based plugins like Adobe's Flash. If the website only uses Flash for a few elements, then everything else will load except for those elements. If the website uses Flash for their entire interface, the page may not load at all.

Finally, energy competitions that only involve energy reduction may result in the energy use going back up after the competition is over. Promoting energy *literacy* in addition to the energy reduction competition can provide the necessary context for individuals to drive sustained energy reduction past the end of the competition. Many energy competitions involve events that help people

be more aware of their energy usage. However, participation in these events is typically tracked manually and is updated periodically. Furthermore, many systems do not have such a component built in. Our goal is to provide a system that also promotes energy literacy and makes it as easy as possible to manage.

## 1.2 Goals for Makahiki

The goal of Makahiki is to provide a complete software package for organizations that want to hold their own dorm energy competitions that addresses the problems described above. It has the following features:

1. Near-real time energy data by integrating with WattDepot.
2. Personalized user information.
3. The ability to create and track participation in activities, commitments, and goals.
4. Integration with social networks such as Facebook and Twitter for displaying progress and standings.
5. Free and open source project.
6. Support for an energy literacy points competition with content created by administrators.

WattDepot [5] is an open source web service in development at the University of Hawaii at Manoa. Its purpose is to collect power data from sources and to store it. By combining Makahiki with WattDepot, competition organizers have an automated way of tracking the energy usage for buildings. While compatible meters still need to be purchased, the software comes at no additional cost. WattDepot also provides data at near-real time intervals, meaning that dorm residents can immediately see the results of their actions.

While WattDepot is able to collect all of the power data, the data still needs to be processed and presented to users in a visually appealing way. Through the use Google Visualizations, electricity data can be presented in a way that is easy to understand and dynamic. Users will be able to see their past and current electricity usage and be able to compare it to other floors. Competition standings and goal status can also be displayed to users.

While a competition is active, competition participants will want to see personalized information about how well their floor is doing in the dorm. To accomplish this, Makahiki will have

the ability to create user accounts for participants. There, they can view personalized energy data as well as view and participate in activities, events, and/or commitments. Users also have a public profile that they can customize, including the ability to upload a profile picture.

In order to promote energy literacy, Makahiki will also have support for creating actions, commitments, and daily energy goals. Actions can range from replacing light bulbs in a desk lamp to attending meetings by sustainability organizations. Commitments are typically small “pledges” that dorm residents can accept, like committing to turning off the lights in the lounge. Goals are actions that entire dorm floors participate in. Daily energy goals involve floor members voting on how much they plan on reducing their floor’s energy and then attempting to accomplish the goal. Competition participants can participate in these items in order to gain points.

Finally, Makahiki will be open source. This means that competition organizers can design the visual look of the application to fit their organization. Also, advanced users can add or tweak modules in the application to fit their needs. **Table 1.1** outlines our desired features and compares Makahiki with other dorm energy competition implementations.

Feature	Makahiki	Lucid	Duke	Harvard	Indiana	Stanford
Near-real time energy data	Yes	Yes	No	No	No	No
Information personalization	Yes	No	No	No	No	No
Activity competition management	Yes	No	No	No	No	No
Social network support	Yes	No	No	No	No	No
Mobile device support	Yes	No	No	No	No	No
Development cost	Free	High	Low	Low	Low	Low

Table 1.1. Features of Makahiki compared to other dorm energy competitions

### 1.3 Evaluation

In order to evaluate the design of the system, we needed to bring in subjects to interact with the system. We also had multiple evaluation phases. First, we designed mockups and had subjects “interact” with them as if they were the real system. Based on their feedback, we implemented the system and then recruited subjects to evaluate the web site in our lab. We did two rounds of these evaluations. After this, we held a beta evaluation where we ran a small-scale version of the actual energy competition. Subjects in the beta evaluation interacted with the system during their

own time. We used the contents of the database, logs, and surveys to gain insight into how subjects interacted with the system.

The final step in evaluating the Makahiki system was to use it in our own dorm energy competition. We held a dorm energy competition here at the University of Hawaii at Manoa in October 2010 using both Makahiki and WattDepot. Much like the beta evaluation, we used the contents of the system and surveys to gain insight into how these users interacted with Makahiki.

## 1.4 Research Questions

The evaluation of Makahiki is intended to address two primary research goals.

1. How can we provide a system that supports researchers interested in users participating in an energy competition?
2. How can we effectively test the website and the overall design of the competition?

## 1.5 Thesis Structure

Chapter 2 will discuss related works, which includes other dorm energy competitions. Chapter 3 will describe the overall design of Makahiki. Chapter 4 describes our evaluation procedure. Chapter 5 will present results and discussion and Chapter 6 presents contributions and future directions of the research.

# Chapter 2

## Related Work

The primary goal of Makahiki is to support energy competitions. [Section 2.1](#) will look at the current state of energy competitions in the United States and how we can improve upon them. [Section 2.2](#) will look at the growing field of *serious games* and how we can use game design techniques to engage players while increasing their energy awareness. Finally, [Section 2.3](#) will look at usability evaluations and how we can collect metrics in order to assess the usability of our system.

### 2.1 Energy Competitions

Ever since Harvard hosted the first Green Cup in 1990 [6], universities all over the nation have started holding dorm energy competitions. [Section 2.1.1](#) will look into Duke University's Eco-Olympics. [Section 2.1.2](#) will look into Oberlin College's Ecolympics, which is the first energy competition based on Lucid Design Group's Energy Dashboard. Finally, [Section 2.1.3](#) will do a brief comparison and evaluation of a few other dorm energy competitions and how they compare to each other.

#### 2.1.1 Duke University's Eco-Olympics

Duke held their first Eco-Olympics [7] in 2002. The Eco-Olympics not only involves energy conservation, but water conservation and waste reduction as well. However, energy reduction plays a significant part in the competition as it is one of the largest components of the Eco-Olympics in terms of possible points. Each week, the organizers get meter readings from the dorms and compare the readings with the dorm's respective baseline reading in order to calculate a per-capita reading. This baseline reading is obtained in September, so it reflects usage when students are living in the dorm. The key thing to note is that dorms are not directly competing against each

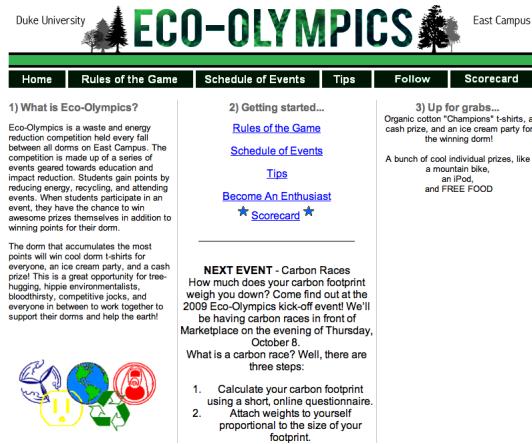


Figure 2.1. Duke Eco-Olympics

other, as dorms vary in size and have differing energy requirements. Also, the weekly readings are to provide feedback on how residents of each dorm are doing. Points are only awarded at the end of the competition and the dorm with the lowest per-capita reading receives the full number of points.

The other major component of the Eco-Olympics is participation in events. Dorms are awarded points based on the percent of residents who attend each event. The number of points for each event may vary, but the total points is comparable to the possible number of points for energy conservation. These events can also involve conservation-related games. The individuals participating in these games can also win prizes, providing additional incentive for dorm residents to participate.

The web page for the Duke Eco-Olympics is very basic. The interface is similar to most content management systems in that there is a row of tabs at the top and the content listed below. However, there is no place for user generated content, very little energy conservation related content, and, outside of a Google calendar, very little “Web 2.0” design to it. The lack of these three things give users little reason to visit the page other than to see the weekly current standings and upcoming events.

### 2.1.2 Oberlin College’s Ecolympics

Oberlin College in Ohio also runs dorm energy competitions. Instead of going with manual meter readings, Oberlin has partnered with Lucid Design Group to create their Campus Resource Monitoring System [8]. The Campus Resource Monitoring System is active year-round and retrieves

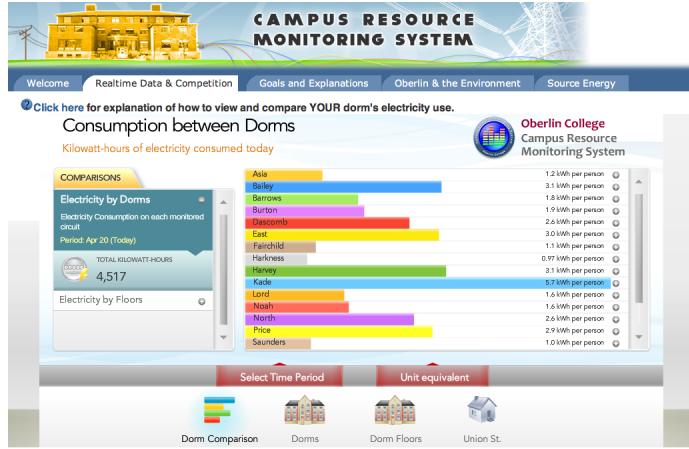


Figure 2.2. Oberlin College Campus Resource Monitoring System

real time electricity and water usage from 26 buildings [9] on campus. The system provides graphs and statistics and are presented to users in a clean and interactive way.

The first competition that used the Campus Resource Monitoring System proved to be a success. A study conducted during the 2005 dorm energy competition found that dorms with real time feedback reduced their energy consumption by 55 percent while dorms with “medium resolution” feedback only reduced their energy usage by 32 percent [10]. In total, the competition saved 68,000 kWh which translated to a savings of \$5,100.

While Oberlin held yearly dorm energy competitions for some time, they had their first sustainability competition, called the Ecolympics, in March of 2008 [11]. The Ecolympics at Oberlin are run at about the same time as the dorm energy competition, but the two competitions are separate. Dorms earn points for participation in events like attending environmentally themed lectures and film screenings [12]. Depending on the event, participants can also win individual prizes. However, participation in these events are tracked separately from the campus resource monitoring system.

### 2.1.3 Competition Evaluation

Dorm Energy competitions are becoming increasingly prevalent across the United States. Chelsea Hodge found that 163 universities and colleges held or planned to hold an energy competition during the 2010-2011 academic year [13]. Furthermore, 40% of these organizations are holding a competition for the first time. Hodge also found that these competitions are successful, with the top 25% of universities reducing energy usage within a building by 12% on average.

Organization	Energy Input	Participation Competition	Mobile Viewable	Facebook page
Duke University	Manual	Yes	Yes	No
Oberlin College	Real-Time	Yes	No	Yes
Brandeis University [14]	Manual	No	Yes	No
Bowdoin College [15]	Real-Time	No	No	No
Harvard University	Manual	Yes	Yes	No
Indiana University [16]	Manual	No	Partial	Yes
Northeastern University [17]	Manual	No	Yes	No
Northwestern University [18]	Manual	No	Yes	Yes
Ohio University [19]	Manual	No	Yes	Yes
Rice University [20]	Manual	No	Yes	No
Stanford University [21]	Manual	No	Yes	No
Tufts University [22]	Manual	No	Yes	No
University of North Carolina - Asheville [23]	Manual	No	Yes	No
University of North Carolina - Chapel Hill [24]	Manual	Yes	Yes	Yes
University of Iowa [25]	Manual	Yes	Yes	No
University of Rhode Island [26]	Manual	No	Yes	No
University of Virginia [27]	Manual	No	Yes	No
Wellesley College [28]	Manual	No	Yes	No
Wesleyan University [29]	Manual	No	Yes	No
Yale University [30]	Manual	No	Yes	No
Williams College [31]	Manual	No	Yes	No
Western Washington University [32]	Manual	No	Yes	No

Table 2.1. University dorm energy competition implementations

**Table 2.1** outlines a few college and university energy competitions and the features they have.

Duke University and Oberlin College both hold dorm energy competitions, but the way these two colleges implemented the competition are very different. While Lucid Design Group's building dashboard is very clean and interactive, some competition organizers use a static site like Duke's. This is understandable, since using hardware and software provided by Lucid Design Group is relatively expensive. Thus, organizers that want to run an energy competition with little to no funds are relegated to manually reading the meter and updating the standings and web site accordingly. The web interface of these competitions is fairly sparse, with a simple, static layout of tabs and content.

Also, the goal of most university sustainability organizations is to improve energy awareness. To accomplish this, many organizations have competitions where dorms earn points by participating in energy awareness events. Usually, these competitions are held as another component of an overall competition. In Harvard's Green Cup [6], energy reduction is a mere 10 percent of the overall competition. The other 90 percent includes recycling and waste reduction, participation in the Harvard Sustainability Pledge, and developing ecological projects.

However, the implementations of these dorm energy competitions have not kept up with the advances of technology and the web. First, none of the dorm energy competitions surveyed seem to have a mobile device (iPhone, iPad, Android) interface. Simple energy competition websites like Duke's, Stanford's, and Yale's load the full version of their web site on the iPhone. Because mobile devices have small screens, this means that a user would have to zoom in to read the content and click on links. Furthermore, because the iPhone and iPad do not support Adobe Flash at this time, competition websites that use Flash may not load. In a few pages, like Indiana University's Energy Challenge, most of the page still loads. However, pages that use Flash extensively do not load on these devices at all. [Figure 2.3](#) shows screen shots of Oberlin College's Campus Resource Monitoring System, Indiana University's Energy Challenge, and Duke's Eco-Olympics as seen on an iPhone.

Another advancement in technology that these competitions do not involve is the use of social networks like Facebook. Since most college students already have an account on one or many social networks, having a presence there provides opportunities for them to share their activities. To spread the word of their dorm energy competition, Virginia Tech has a page on Facebook for their 2010 Eco Olympics [33]. Duke University also has yearly Facebook group pages for their Eco-Olympics [34]. However, Facebook users like to share what they are doing and what they find interesting, and this cannot be accomplished with pages and groups alone.

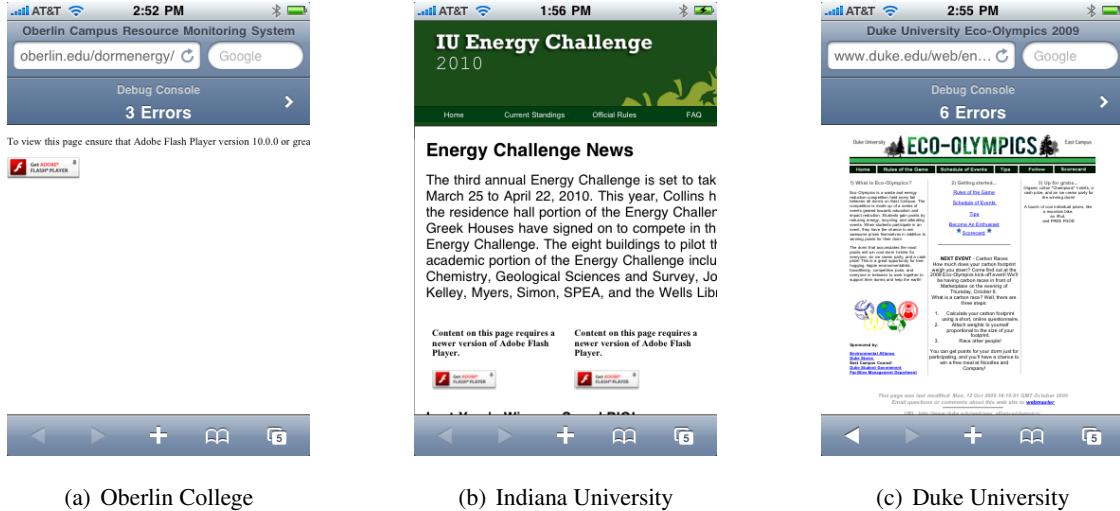


Figure 2.3. Dorm energy web sites as they appear on an iPhone.

Despite these shortcomings, Lucid Design Group's Building Dashboard has become a very popular option. Lucid's latest project is the Campus Conservation Nationals [35], a sustainability competition involving multiple colleges and universities across the United States and Canada. Their pilot competition had over 40 participants and was held in November 2010. They succeeded in reducing energy usage by 508,000 kilowatt-hours and water usage by 730,000 gallons. Their next competition will be in 2012, where they have over 170 colleges and universities signed up.

## 2.2 Serious Games

Michael Zyda defines serious games by building up the definition from games and video games [36]. Zyda defines a serious game as “a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.” While integrating games with real-world tasks is not a novel idea, advances in technology allowed Zyda and serious game makers to look at simulations of real-world activity. The key turning point was the development of the game “America’s Army”, a third-person military shooting game developed initially as a recruiting tool for the U.S. Army. While there was initial skepticism that the game would improve real-world skills, they found that soldiers who played the game generally performed well in real-world tests.

Not all serious games need to involve virtual simulations of the environment. EVOKE (<http://www.urgentevolve.com>) is a serious game developed by the World Bank Institute and is a

game where people learn to find ways to change the real world. Instead of having players control a virtual avatar in a simulated world, players log in to the EVOKE website where they are given a set of quests and missions. Quests take place on the EVOKE website and involve the player answering questions in order to create a story. Missions are things that players do in the real world. These missions require “evidence” (either a blog post, a video, or a photo), which need to be submitted and approved in order to get credit.

Jane McGonigal, the creator of EVOKE, is no stranger to the idea of using games for more than just entertainment. In her book “Reality is Broken”, she states that gamers seek escape in games because reality needs fixing [37]. She then describes these fixes to reality and bases them on techniques used in games to engage players and keep them interested. While she starts with traditional computer and video games, she moves on to *alternate reality games* games that involve people in the real world playing together. Finally, she describes large scale alternate reality games that encourages players around the world to work together to figure out solutions to hypothetical global issues. She describes a game called “A World Without Oil”, where players are thrust into a hypothetical peak-oil situation where demand outstrips supply. Players are then challenged to brainstorm ways to live their lives without dependence on oil and share their ideas with other players. While player ideas are initially very simple, they get developed further as a result of feedback from other players in the game.

Serious games can engage people and help them become more productive and engaged. Byron Reeves observed that many adults are playing online games like World of Warcraft. These adults find themselves to be more engaged in their online quests than their real life jobs. If concepts from these online games can be incorporated in a compelling way toward real-life tasks, employees would be far more productive. In his book “Total Engagement” [38], Reeves studied how games transform the way people work and provides guidelines to creating games that increase real world productivity in the workplace. Components of games that can be applied to the workplace include:

- Self-representation with avatars
- Three-dimensional virtual environments
- Narrative context
- Feedback
- Reputations, ranks, and levels

- Marketplaces and economies
- Rules that are explicit and enforced
- Teams
- Communication system that can be reconfigured by participants
- Time pressure

How do games motivate us and keep us engaged? McGonigal describes in her book a state called “fiero”, which describes a feeling that people get when they feel their hard work has paid off. An example of this is when an athlete wins a gold medal or a sports team wins the championship. Typically, you will see people experiencing “fiero” with their hands in the air, with an expression of both happiness and relief. However, such a feeling is very difficult to attain in the real world. Games, especially ones that involve other players, can be designed to be competitive and rewarding. In that sense, McGonigal sees multiplayer games as being the “ultimate happiness engine”.

The motivation and sense of accomplishment in games can be tied to learning. In researching the Navy’s Damage Control Trainer, Curtiss Murphy examined the basic tenets that improve learning and compared them to the basic tenets of game design [39]. He describes 6 laws of learning and ties each law directly to a game design technique. The links are summarized in [Table 2.2](#)

## 2.3 Usability Evaluations

Evaluating the usability of a website can be very costly. They can involve specialized tools such as eye-tracking devices and include many users. In 1994, Jakob Nielsen showed how organizations can cut the cost of these evaluations using what he calls “discount usability engineering” [40]. Discount usability engineering is based on three techniques; scenarios, simplified thinking aloud, and heuristic evaluation. Scenarios involve very specific tasks and do not necessarily require full functionality. Simplified thinking aloud reduces the number of subjects and involves taking notes rather than capturing video. Finally, heuristic evaluation simplifies a list of rules to follow to ten “rules of thumb”.

Steve Krug further builds upon these heuristics in his book “Don’t Make Me Think” [41]. His main point is that new users do not look at a website in the way you want them to. In many cases, the designers of a website want users to read all of the provided content in order to make

Law of Learning	Idea	Game Design Techniques
Motivation	Motivated students learn more	Flow: The fundamental attraction of games. Games are fun and require moment to moment choices. These lead to motivating experiences.
	Feedback is how learners correlate actions with outcomes	Feedback loops in games help the learner correlate actions to outcomes.
	Practice is necessary for learning and mastery	Games use practice to encourage mastery.
	Learning is increased when associated with positive feelings	Games that are <i>fun</i> create positive feelings and encourage the user to continue playing.
	Intense experiences increase learning, interest, and retention	A person experiencing <i>flow</i> is immersed and engaged with the activity.
	Involvement and decision making can increase motivation, intensity, and positive feelings	Playing a game means making a series of interesting and meaningful decisions. Players are learning through their experience in the game.

Table 2.2. Laws of Learning linked to Game Design Techniques. Used with permission from Curtiss Murphy.

decisions. However, Krug has found through eye tracking studies that users skim the content and try to find something that matches what they are looking for. Krug also develops a usability test procedure based on Nielsen's techniques and walks through an example usability test with another user.

One important assumption in the example websites used in Krug's usability test walk-through is that the user knows what they wish to accomplish in the website. This is very different from our system, where it is likely that the user will not know what they can do within our website; only that it involves some kind of competition. Krug's usability scenarios are based on basic tasks that users should be able to accomplish, so how can our subjects accomplish these scenarios if they do not know what they can do?

One approach is to provide time for the user to navigate around the site and figure out what they are able to do. In the book “Interaction Design”, the authors describe a collaborative project between the Fred Hutchinson Cancer Research Center and Microsoft called “Hutchworld” [42] [43]. Hutchworld is a three dimensional virtual world designed for patients within the cancer research center. Within the virtual world, patients can access information about the center, interact with family members who are also logged in to Hutchworld, and participate in diversionary activities. As part of developing the system, Microsoft conducted usability tests on Hutchworld. Before getting to the usability test’s scenarios, however, subjects were given five minutes to explore the virtual interface. Subjects were given a chance to figure out how to move within the virtual interface and also find what content is available to them within Hutchworld.

How do we measure the usability of our system? Tullis and Albert provide various examples of usability metrics in their book “Measuring the User Experience” [44]. Since our usability procedure involves completing transactions, Tullis and Albert suggest measuring task success, user efficiency, issues-based metrics, self-reported metrics, and live website metrics. Task success is a fairly simple metric: given a task, does the user complete it or not? User efficiency is a measurement of the effort required for the user to complete the task. For example, we can measure this by the number of clicks or the amount of time spent to complete the task. Issues-based metrics involve measuring the number of times usability issues are encountered. These issues may manifest themselves as both verbal and non-verbal expressions of confusion or indecision. Self-reported metrics are based on user responses to questions. Finally, live website metrics involve the usage of the logs created by the website to evaluate the user.

# Chapter 3

## System Design

This chapter covers the design of the system. First, we will discuss the overall architecture of Makahiki. Then, we will describe the supporting components of the system. Finally, we will go into the top-level pages of the system.

### 3.1 Architecture

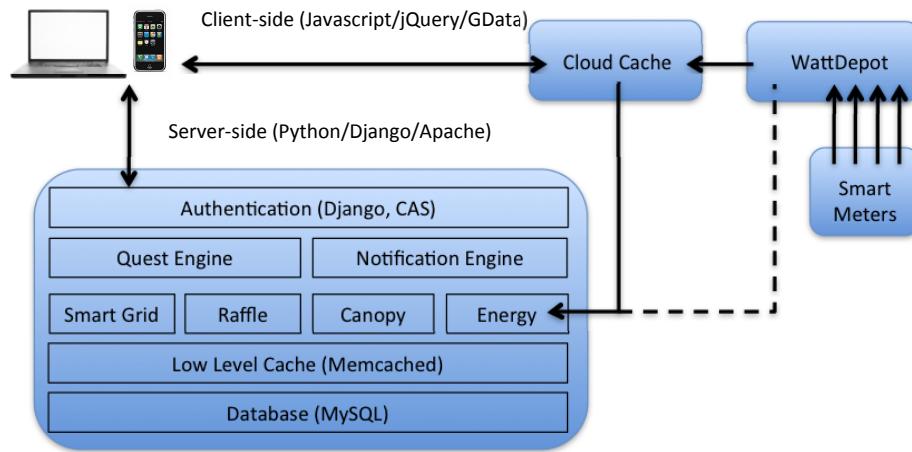


Figure 3.1. Architecture of Makahiki

Figure 3.1 provides an overview of the different components of Makahiki and how they interoperate. The web application component of Makahiki is implemented using the Django web framework in the Python programming language. In addition to the modules we created, we used other third party libraries including “django\_cas” (an authentication plugin that allows players to authenticate using a Common Authentication Service server), “brabeion” (a Django module for

badges), “minidetector” (detects if a client is a mobile phone), and “restclient” (a library for interacting with RESTful web services). To handle server loads more efficiently, we used memcached (an in-memory caching system) to cache parts of the website for quicker access. Figure 3.2 shows how the pages are laid out in the system.

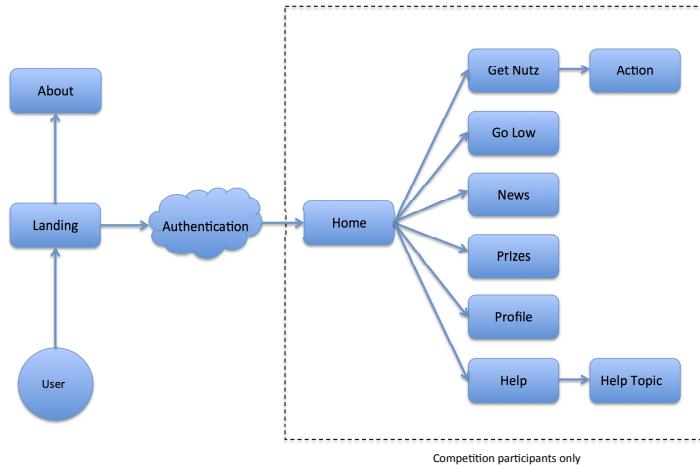


Figure 3.2. Sitemap of the pages in Makahiki

The energy data is handled by another system called WattDepot. More details will be provided in Section 3.3.2.1.

## 3.2 Supporting Components

Before we discuss the top level pages, there are several supporting components in Makahiki. Some of these components have a UI component, while others operate behind the scenes.

### 3.2.1 Rounds

As part of the configuration for Makahiki, a competition period can be split up into rounds. The energy usage and points during a round are tracked separately but still contribute to the overall totals. If there is no round configured during the competition period, then the overall score is tracked. As an example, the 2011 Kukui Cup was three weeks and had two week long rounds (Round 3 was the overall round). This configuration had the interesting side effect of putting the top players in Round 1 at a disadvantage during Round 2, since they have completed most of the content that is available to them. Players who were new to the competition in Round 2 could also complete tasks

that were available in Round 1, although they did miss out on any real world events and excursions that happened during that time.

### 3.2.2 First Login Wizard

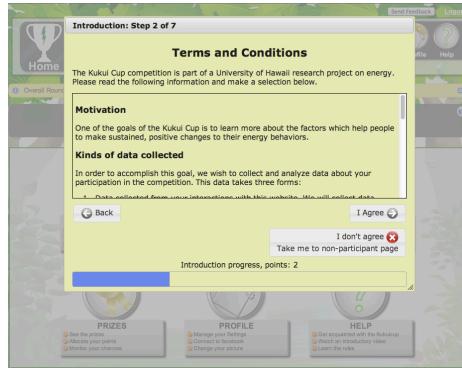


Figure 3.3. Terms and conditions step in the first login wizard.

When a player logs in to the site for the first time, they are taken to the First Login Wizard. Inspired by the setup processes for other websites, the First Login Wizard guides the player through setting up their profile and getting them acclimated to the competition. [Figure 3.3](#) shows the terms and conditions step of the first login wizard. The First Login Wizard is split up in to 7 steps.

1. Welcome: This also shows the player their configured name and floor. If this is not correct, they are asked to email the competition organizers.
2. Terms and Conditions: This is where organizers will place their terms and conditions. Players are given the option to not agree, in which case they will be logged out of the system.
3. Referral Bonus: Detailed in [Section 3.2.4](#).
4. Profile Setup: Here, the player can customize their user avatar and their profile name. Players can either upload a picture or use their picture from Facebook. After completing this step, the player is automatically awarded five points.
5. Intro Video: Competition organizers can provide a video for players to view when they come to the website for the first time. This video is often linked to a task in the Smart Grid Game.
6. Question: Organizers can provide a multiple choice question for new players to answer related to the video they just viewed. Players that answer the question correctly are awarded points

corresponding to the value of the related task and the task is marked as completed. Players that do not answer correctly can complete the task later on.

7. Success: Tells the player that the wizard is complete. This step also provides some information about the quest system, which will be discussed in [Section 3.2.3](#).

### 3.2.3 Quests

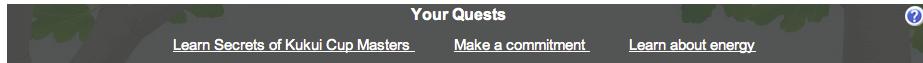


Figure 3.4. The final version of the quest bar.

One of the main challenges in Makahiki is providing guidance to new players. When new players come to the Makahiki website, they are thrust into an unfamiliar system and have to figure out where to start or what to do next. Most games these days contain some sort of “tutorial” system that help players get accustomed to the controls and the different things they have access to. While the control system of Makahiki is straightforward (point and click), we do want to guide players to the different sections of the site so that they can become experienced players of the system.

Quests are our solution to the tutorial/help problem. Quests are “meta-level” activities in that they are tasks designed to show the player the different components of the system and how they work. Examples of quests include “Make a commitment” or “Sign up for an event”. Users are not awarded points for these tasks, but the quests they complete are tracked and shown on their profile page. Quests also have “levels”, so players have to complete low level quests before moving to higher level ones. Quests use a subset of Python in order to determine when quests are available and completed. We implemented a set of predicates that can be used in the unlock and completion conditions. These conditions are checked as the user navigates around the site. A list of the possible quest predicates are listed in [Table 3.1](#).

### 3.2.4 Social and Referral Bonuses

In an effort to get more people to participate in the competition, we implemented two types of bonuses; social and referral. These bonuses were designed to tie into the law of intensity and is intended to get people playing with their friends. The social bonus is an administrator option when a task is created in the Smart Grid Game. It awards extra points if the player has done the task with someone else. Examples of actions with social bonus include attending an event, recording a

Predicate	Description
has_action	Takes an action's name as a parameter or an action's type. If the name of the action is provided, then this predicate is true if the user has submitted anything for that action. If the type is provided, then the predicate is true if the user has submitted an action with that type. Actions are described in <a href="#">Section 3.3.1</a> .
completed_action	Also takes an action's name or an action's type as a parameter. If the name of the action is provided, then this predicate is true if the user has completed the action. If the type is provided, then the predicate is true if the user has completed an action with the given type.
num_actions_completed	Takes a number of actions and optional category name and type parameters. The predicate is true if the user has completed at least the number of actions. If the category name parameter is provided, then the predicate will look for actions in the provided category. If the type parameter is provided, then the predicate will look for actions of the given type.
has_points	Takes a point value and an optional round name parameter. This predicate is true if the user has at least the number of points in their score. If the optional round name is provided, then this predicate only considers their score within that round.
allocated_ticket	Takes no parameters and is true if the user has allocated any tickets in the Raffle Game (discussed in <a href="#">Section 3.3.3.2</a> ).
badge_awarded	Takes a badge name as a parameter. The predicate is true if the user has the badge.
posted_to_wall	Takes no parameters and is true if the user has ever posted on their floor's wall.
set_profile_pic	Takes no parameters and is true if the user has uploaded a profile picture or used their picture from Facebook.

Table 3.1. Quest predicates used in Makahiki

song related to energy, or measuring a shower water flow rate. When a player submits a response for a task with a social bonus, the player can provide the email address of the person who jointly completed the task. Once the other player completes the task, the social bonus is awarded. Social



Figure 3.5. Social bonus for making a commitment.

bonuses are not bi-directional; if the second player doesn't provide the first player's email address, only the first player will get the social bonus. [Figure 3.5](#) is what a user would see when completing a commitment with a social bonus.

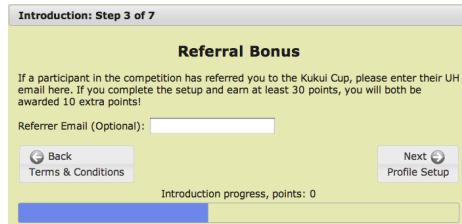


Figure 3.6. Referral bonus step of the first login wizard.

Players are led through a setup process when logging into Makahiki for the first time. One of the steps in this process is the referral bonus. If a player was referred by another player in the system, they can use this step to input their email address. Once the new player earns 30 points in the competition, both players are awarded a referral bonus of 10 points. Typically, going through the setup process gives the player fewer than 30 points, so we wanted to encourage the new player to complete at least one additional task in order to get the referral bonus. [Figure 3.6](#) shows the referral bonus step of the first login wizard.

### 3.2.5 Badges



Figure 3.7. List of available badges in Makahiki.

Web sites that incorporate concepts from gamification typically involve “badges”, which are given to the user when they perform certain tasks within the web site. For example, the location-based social networking site “Foursquare” gives players badges as they visit places in their area. An example of a badge in Foursquare is the “Gym Rat” badge, which is given to players who visit a gym 10 times in a month. Badges can be used to provide players with additional incentive to try out new things.

We implemented badges in Makahiki with the help of “brabeion”, an open-source badges plugin for Django. On the player’s profile page, they can view their current badges and also view the list of available badges. Additionally, in the floor’s player directory, every player has their badges shown next to their name. We implemented three badges:

- Daily Visitor: Awarded to a player when they visit the site three days in a row.
- Fully Committed: Awarded to a player when the commit to the maximum number of commitments.
- Bug Hunter: Awarded to a player when they report a bug in the software.

**Figure 3.7** is what a user sees when looking at the list of badges. The Daily Visitor badge and the Fully Committed badges are awarded automatically by Makahiki. The system checks the conditions for unlocking the badge as they perform the actions required to have them awarded. The Bug Hunter badge is awarded by a competition administrator. If an admin feels that a player deserves this badge, they can run a command on the server to give the player the badge.

### 3.2.6 Logging

Because Makahiki is developed primarily for research, we need to log user interactions with the system in order to evaluate the game design and gain insight into the players. In a production environment, the web server will log the actions of individuals when they visit the site. However, the amount of information provided by the web server is insufficient for our needs. First, the web server can only identify the player through the use of an IP address. Since first year students are likely to use more than one computer or device to access Makahiki, we need to detect those users as well. Also, when a player submits a form via a POST request, the web server does not display the contents of the submission. The information the player submitted may be lost unless we can capture their submission. Finally, many interactions in Makahiki happen through the use of

Javascript. Because these actions may not trigger a request to the server (unless they use AJAX to get and retrieve data), these interactions also would not be logged.

We implemented a logging component in Makahiki to capture more complete data about the player’s interaction with the website. Similar to the log format used by web applications, Makahiki’s logging component captures the date and time of the request, the player’s username, the type of request they made (POST, GET, etc.), the url they requested, and any POST parameters they may have submitted. To support the logging of Javascript actions in the website, the client-side Javascript can send a request to the server through a log url. This log url contains the type and id of the object they are manipulating (for example, the quest they are viewing) as well as an action. Below is an example entry in the logs.

```
INFO 2011-10-17 00:28:17 12.223.124.27 gelee GET /home/setup/profile/ 200
```

In addition to the request-level logging framework, the system also tracks transactions involving points in the competition. There is the potential for bugs to affect the scores of individuals in the competition. Using the log of points transactions, we can verify that the point values for individuals are correct. These actions are also helpful for players who may want more information about the things they completed. These points transactions are also displayed on the player’s profile page for them to see.

Note that Makahiki’s logging is provided in addition to the logging already done by the web server. Web servers can provide additional information that may be of interest to researchers looking at the data, like what browser the player used and what HTTP response code was sent back by the server. Using these logs, researchers have a complete record of the competition.

### 3.3 Pages

#### 3.3.1 Get Nutz

The “Get Nutz” page is where users come to complete *actions* in order to earn points. The main component of the page is the “Smart Grid Game” (SGG). Each individual action is either locked or unlocked. This means that some actions in the SGG are not immediately accessible by the user; they have to complete other actions in order to access them. The SGG organizes these actions into *categories*. Each category represents a column in the grid. To support this, we implemented a set of predicates that can be used to determine if a task is available or not. Examples of predicates

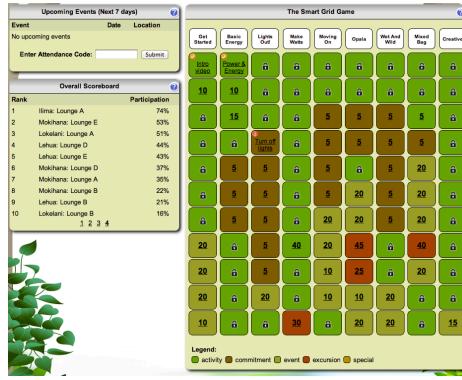


Figure 3.8. The Get Nutz page.

Predicate	Description
completed_all_of	Takes a category name as a parameter and is true if the user has completed all of the actions in the category.
completed_some_of	Takes a number and a category name as parameters. This predicate is true if the user has completed the number of actions in the category.
completed	Takes a task name and is true if the user has completed the task.
after_published	Takes no parameters and is true if the action's publish date has passed.

Table 3.2. Activity predicates used in Makahiki

include completing certain actions, completing actions within a category, and time-based unlocking (task is available after a certain date).

These predicates are implemented using a limited subset of Python and can be changed within the Django admin interface. Competition designers can use logical operators to combine predicates in order to organize the player's path through the Smart Grid Game. A list of predicates is shown in [Table 3.2](#).

There are three different types of actions in the Smart Grid Game: activities, events/excursions, and commitments. The following subsections will go into those in more detail.

### 3.3.1.1 Activities

Activities are actions that require a competition participant to perform a specific action in order to earn points. Examples of activities include attending presentations, watching energy conservation related videos, or joining campus sustainability groups. These activities are designed



Figure 3.9. A activity in the Smart Grid Game.

to make participants more knowledgeable and get them involved with the sustainability community.

**Figure 3.9** shows a video in the SGG that helps people learn how to play the game.

Users who participate in activities usually require administrator approval before they can earn the points in the activity. Administrators can either approve or reject these requests for points. Makahiki supports four different confirmation types: question and answer, confirmation code, image upload, and free response.

In the question and answer, the activity creator needs to come up with at least one question to ask participants. The admin also specifies an answer to each question, which is merely used to tell administrators what the expected answer is. When a participant requests to receive points for a question and answer activity, a random question is picked from the list of questions for that activity. Once a participant submits their answer, it is then available for admins to review. Activities that require participants to watch a video might require them to answer a question. Questions can be as simple as “What is the unit of measurement for household energy?”

A confirmation code is typically used for activities that require attendance of an event. This will be covered more in depth in [Section 3.3.1.2](#).

The image upload confirmation type requires participants to upload a picture in order to verify that they have performed the activity. When the admin creates the activity, they also specify what the content of the image should be. After the participant performs the activity, they are asked to upload the image. Admins can then review the image. An activity that might require an image upload would be “Replace an incandescent bulb with a CFL”. The participant could then be required to take a picture of themselves holding both the CFL and the incandescent bulb.

The free response confirmation type presents a simple prompt similar to that of the question and answer. Unlike a question and answer, however, there may be no “correct” answer to the

prompt. For example, a free response activity may ask the user to perform an energy audit and provide their results.

### 3.3.1.2 Events/Excursions

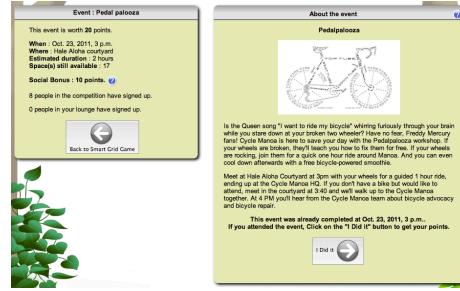


Figure 3.10. A excursion in the Smart Grid Game.

Events require players to attend a presentation or workshop in order to earn points. Excursions are similar to events, but they may require more time and are held off-campus. Each event and excursion specify a event location and time as well as how long the excursion is expected to take. Before an event or excursion, players have the option to sign up for it beforehand. Players who do this will receive a 2 points as a “signup bonus”. These points are removed if the player later decides they are not interested in the event or excursion. Not only does this encourage players to sign up for things they are interested in, but it can also be used by administrators to gauge interest in events and make the appropriate preparations. We also implemented a reminder system for excursions and events, so users can receive emails and/or text messages before the event takes place. [Figure 3.10](#) shows the PedalPalooza excursion after the excursion has occurred.

Events and Excursions are typically used with the confirmation code confirmation type. When creating the event or excursion, the admin needs to specify the number of confirmation codes to generate. Once the admin creates the event/excursion, they can view the list of codes generated for this activity in a printable format. When the event occurs, competition organizers can then hand out the confirmation codes to attendees of the event who are also participating in the competition. When a participant requests points for this activity, they are required to enter a confirmation code. If the code is valid, it is immediately approved. Codes cannot be used more than once and a user can only use one code per activity.

Since Events and Excursions occur at a specified date and time, players may want to be reminded when it will occur. Players can set up a reminder before the Event/Excursion occurs

by providing a email address and/or a cell phone number and carrier (for text messages). These reminders can be sent up to 5 hours before the Event/Excursion takes place. A periodic script is run to send any reminders that need to be sent out at a given time.

### 3.3.1.3 Commitments

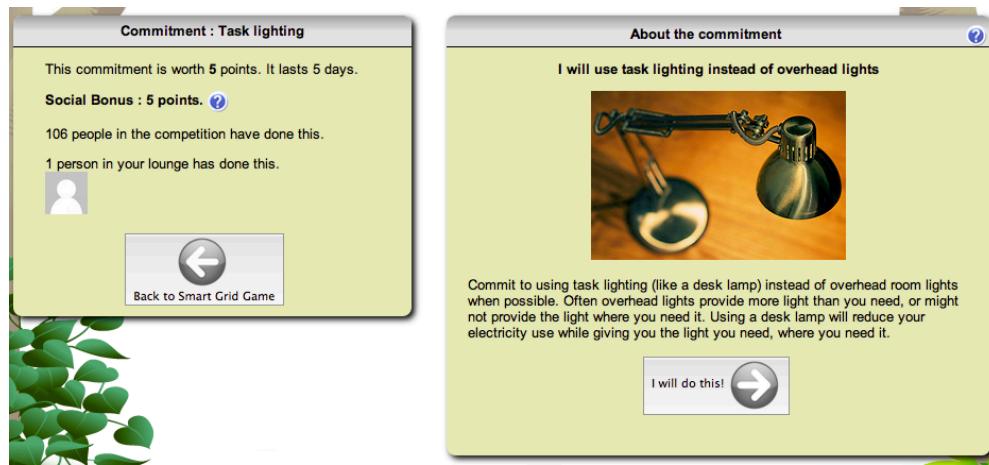


Figure 3.11. A commitment in the Smart Grid Game.

Unlike activities, where a task is completed for points, commitments are more of a “pledge” to perform a task over a longer period of time. Examples of commitments include “Turn off the lights in the bathroom when no one is using it” or “Make sure the lounge television is off when no one is there”. Commitments provide an incentive for users to change their energy usage habits. [Figure 3.11](#) is an example of a commitment in the SGG.

Also, unlike activities, commitments do not require administrator approval. Because of this, there are additional constraints on commitments. First, commitments are typically worth fewer points than activities. Second, a user can only participate in up to five commitments, which prevents users from committing to every possible commitment. Third, users who participate in commitments are public and displayed to fellow dorm floor residents, competition billboards, and on the web site. Finally, participation in a commitment lasts for five days. After this point, users can either participate in the same commitments or change to different commitments. Commitments also have signup bonuses similar to events and excursions. Players will receive 2 points for signing up for a commitment and will have those points removed if they cancel their commitment later on.

### 3.3.2 Go Low

The “Go Low” page is where users view their power and energy information. Here, they can also see their progress towards a daily energy goal. These visualizations are supported by WattDepot, a system developed here at the University of Hawaii at Manoa.

#### 3.3.2.1 WattDepot Integration

WattDepot is an open source web service that collects and stores energy usage data from meters. The system is currently under development in the Collaborative Software Development Laboratory at the University of Hawaii at Manoa. While instances of the service are hosted in the laboratory, organizations can choose to host their own instances.

There are several reasons why we want to support integration with WattDepot. First, the data in WattDepot is accessible via a REST API [45], meaning that external services can easily request and retrieve data from the system. Also, WattDepot supports near-real time (sub-minute) update intervals, which is one of the reasons why competitions that use Lucid Design Group’s Building Dashboard are so successful. With these updates, we can immediately present users with their current energy usage. Users can then run “experiments”, like seeing what happens when someone turns off their lights. Other freely available solutions like Google PowerMeter [46] do not have this level of feedback.

Because WattDepot stores all of this data, Makahiki can retrieve current and historical data in order to provide visualizations. Thus, competition participants can see how their usage has changed over time. Administrators can also use this data to see if residents are completing energy reduction goals like reducing a floor’s usage by 10 percent over a week.

However, calculations that use historical data can be computationally expensive. For example, in order to calculate a floor’s energy usage during a round, WattDepot must sum up power information for the floor over a period of time. Given that we may have hundreds of users accessing the site at any given time, having to calculate this information repeatedly will put a burden on WattDepot. In order to mitigate this issue, we created a cache for WattDepot data in Google Spreadsheets [47]. The spreadsheets are periodically updated by updaters running alongside WattDepot. Then, instead of going to WattDepot directly, Makahiki will use a Google Spreadsheet URL to access the cached data.



Figure 3.12. Daily Energy Goal Game visualization

### 3.3.2.2 Current Power and Energy

The left side of the “Go Low” page contains a power meter and the energy scoreboard. The power meter shows the user their current power usage in their floor and is updated every 15 seconds. The energy scoreboard shows the floor’s energy usage during each round and is updated hourly. While the energy scoreboard is not updated as frequently as the power meter, it is able to calculate historical data by using a spreadsheet that contains the energy data over the last thirty days.

### 3.3.2.3 Daily Energy Goal Game

Competition administrators can create daily energy goals that take place over the course of the competition by creating another Google Spreadsheet. This spreadsheet should contain a “goal” energy usage for the floor to attain. The spreadsheet is then updated periodically with the floor’s current energy information. This spreadsheet is used to provide a daily energy goal widget in the “Go Low” page. The stoplight in the middle of the the widget is green if the user’s floor is on track toward meeting their goal, red if they are not on track, and yellow if they are close to being off track. Note that red and yellow do not necessarily mean that the user’s floor cannot meet their daily energy goal. Informing users whether or not they are on track gives them the opportunity to adjust their energy consumption habits as necessary to meet the goal. If the light were to turn red when they went over the goal, the members of that floor would not be able to do anything about it.

Makahiki can be configured by a daemon process (like launchd or cron) to check if floors have met their energy goal during the day. This is accomplished using the Python GData Library provided by Google [48]. This process goes out to the spreadsheet and compares each floor’s energy usage to their goal usage. If a floor meets their energy goal, each member of the floor that is participating in the game will receive 20 points. The Daily Energy Goal Game provides the link between the energy literacy (points) competition and the energy competition.

Figure 3.12 shows what a player would see when they go to the energy page. The Daily Energy Goal display shows both their current progress and their goal so far for two reasons. First, everyone will be under their actual energy goal for most of the day, so this display would not be very useful. Second, we have noticed that the students in the residence halls use more energy at night rather than during the day. Thus, it is easy to be under for most of the day and then jump over the goal at the very end. Displaying their goal so far provides a pace for players to follow.

### 3.3.3 Prizes

The prizes page is where players can go to see the things they can win in the competition. The prizes serve as additional motivation for the Law of Readiness and encourage players to play more. There are two sub-sections of the prizes page; the competition prizes and the raffle game.

#### 3.3.3.1 Competition Prizes

Prizes and Prize Winners	
Round 1 Prizes	
Prize	Criteria
 <a href="#">Ice Cream Party</a>	Mochi Ice Cream Party by Bubbles for lounge that consumes the least amount of energy usage during the week of Round 1. Winner: Lokelani-B
 <a href="#">Cupcake Extravaganza</a>	Cupcakes by Hokulani Bakery for the lounge that earns the most points during the week of Round 1. Winner: Lehua: Lounge E
 <a href="#">Bubbles Certificate</a>	\$5 Bubbles Gift Certificate for the individual who earns the most points in each lounge during the week of Round 1. Current leader:
 <a href="#">Bookstore Certificate</a>	\$25 UH Bookstore Gift Certificate for the individual with the highest number of points at the end of Round 1. Winner: [REDACTED]

Figure 3.13. Competition prizes displayed on the prizes page.

In an energy competition, there are typically prizes for the winners. For the two competitions (points and energy reduction), we can award prizes to the floor that wins each competition. We can also award prizes to the top individuals in a floor or overall in the points competition. Finally, prizes may be given out for the winners of a round in the competition as well as the overall competition. [Figure 3.13](#) shows the list of prizes on the prizes page.

Makahiki supports these competition prizes through the use of the Django admin interface. A competition organizer needs to provide a title, description, value, the round for the prize, who the prize should be awarded to (for example, overall floor winner or individual points winner in a floor), and the competition type (either points or energy). This information is used in the prizes page, where players can view the current prizes as well as who is in the lead for those prizes. Players can also view past prizes, and the winners of those prizes are displayed as well.

### 3.3.3.2 Raffle Game

Overall Raffle Game						
Your total raffle tickets: 92 Allocated right now: 91 Available: 1						
Prize	Value	Your Tickets	Total Tickets	Current Odds	Change	Ticket Allocation
Guitar	\$250.00	68	839	8.1%	+1 -1	
Navigation Print	\$52.00	2	71	2.8%	+1 -1	
Energy Meter (1)	\$30.00	4	15	26.7%	+1 -1	
Energy Meter (2)	\$30.00	3	19	15.8%	+1 -1	
Energy Meter (3)	\$30.00	1	12	8.3%	+1 -1	
Resta Shirt	\$25.00	2	8	25.0%	+1 -1	
JJ tshirt (XL)	\$20.00	2	22	9.1%	+1 -1	
JJ tshirt (L)	\$20.00	2	12	16.7%	+1 -1	

Figure 3.14. The raffle game at the end of the overall round.

Our initial concept of Makahiki involved awarding prizes to the top individual points getter, top lounge points getter, and the lounge that used the least energy during each round. Players who enter the game in the middle of a round may be discouraged by the top players in that round because they will have a head start. Since an individual prize is only awarded to the top points getter, they may feel unable to catch up and decide not to play.

To alleviate this, we came up with the Raffle. Every 25 points a player earns in the game gets them one raffle ticket. These raffle tickets can be used toward the prize of their choice. Each

round will have its own set of prizes and unused tickets carry over from round to round. Winners of each prize are chosen at the end of the round. The Makahiki website shows the player the number of tickets they allocated as well as the total number of tickets allocated for each prize. It also shows the odds of the player winning the prize so that they can decide whether or not they want to allocate a prize or not. [Figure 3.14](#) shows the raffle game at the very end of the 2011 Kukui Cup.

At first glance, this does not solve the issue of top players dominating the game. Since these players have a lot of points, they will have a lot of raffle tickets to allocate. However, these players will have to decide how to divvy up their tickets. Because we show the number of tickets allocated for each prize, other players can find prizes that they have a better chance of winning. Also, unlike the overall prizes, these raffle prizes do not have to be appealing to everyone since players can choose the prize(s) that interest them the most. On the other hand, the onus falls upon the competition organizers to get a wide selection of raffle prizes for the competition. If there are only a few prizes for each round, then players with lots of points can dominate the raffle with their large amount of tickets.

### 3.3.4 News



Figure 3.15. The news page.

In the context of a residence hall energy competition, players may want a place to communicate with each other. The news page provides a “wall” similar to the ones used by social networking websites that allow players within a floor to communicate with each other. In addition to player-provided posts, automatic posts are created as players add and/or complete actions within the competition. For example, when a player adds a commitment, an automated post is made to the floor’s wall that says the player has added the commitment.

The News page also provides a “floor directory”, where players can see what others in their floor are doing. There, the avatar, profile name, points, rank, badges, and public commitments are displayed for each member of the floor.

### 3.3.5 Profile



Figure 3.16. The profile page.

Each player has a “profile” that allows the player to provide an online identity within the system. Players can provide their own profile name and an avatar image. Players who want to use their picture from Facebook can link their Makahiki profile to their Facebook profile through the use of the Facebook API. Players can also set their default reminder settings (for Events and Excursions) so they do not have to enter that information every time they want to create a reminder. All of these things can be changed at any time by the player during the competition.

### 3.3.6 Help



Figure 3.17. The help page.

The Help page is where players can go if they have questions. Competition organizers provide help topics for the Help page through the Django admin interface. In addition to the content provided by competition organizers, a form is available for players to ask the competition administrators a question. This form, when submitted, will send an email to a pre-configured email address on behalf of the player. The email will also contain the email address of the player, so a competition organizer can reply to them directly.

### 3.3.7 Canopy

We designed the Canopy to be a place for the top players to go and view more advanced energy visualizations and actions. Elite players could “level up” and reinforce the laws of intensity and effect for learning. The current visual design of main game has a forest background with trees, bushes, and grass. The background of the Canopy, however, is different from the rest of the system, with tree tops on the bottom and blue skies on top to symbolize that the Canopy and its players are above the “Forest” level. Players need to be invited to the Canopy. A competition administrator can run a command on the server that adds the top players to the Canopy.

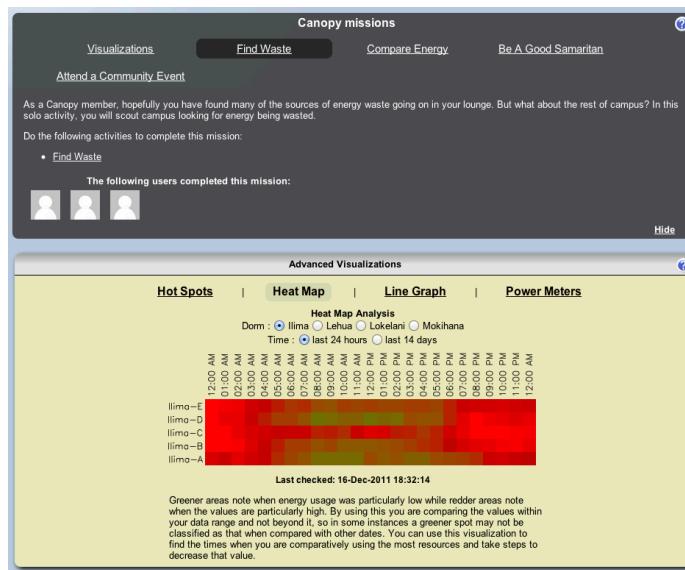


Figure 3.18. Canopy Missions and Visualizations

In addition to the new background, the Canopy page includes new components. First, there is a Canopy wall that members can use to communicate with other Canopy members as well as administrators (who can always access the Canopy). Second, there are Canopy missions that replace the quest interface. Unlike quests, missions do not use predicates in order to determine when they are completed. Instead, missions are completed when their related Canopy actions are completed. These Canopy actions are based on the actions in the Smart Grid game, but they do not appear in the Smart Grid. Also, some Canopy actions may require collaboration with others to complete. Finally, the Canopy includes advanced energy visualizations, which give members additional insight into how the other lounges are doing in the energy competition. Unlike the energy data displayed on

other pages, these advanced energy visualizations access WattDepot’s API directly. Figure 3.18 shows an example of a mission and an advanced energy visualization.

When we designed the Canopy, we initially thought we would provide points for completing Canopy actions. Since only elite players were invited to the Canopy, earning points would allow the top players to earn points not available to the rest of the players, allowing them to obtain an insurmountable advantage. Thus, instead of points, Canopy actions award “Canopy Karma”. A scoreboard is shown on the Canopy page and the top Canopy player earns a prize.

# Chapter 4

## Experimental Design

The overall goals of the evaluation are:

1. How can we provide a system that supports researchers interested in users participating in an energy competition?
2. How can we effectively test the website and the overall design of the competition?

Since December of 2010, we held four user evaluations: one mockup evaluation, two onboarding evaluations, and a beta evaluation. We also have survey results from the inaugural Kukui Cup.

### 4.1 Mockup Evaluation



Figure 4.1. Mockup of the landing page.

Before we started implementing the beta version of Makahiki, we created mockups of the system in order to plan out what the new beta interface would look like. To create the mockups, we used a program called Balsamiq Mockups[49]. The mockups created by Balsamiq are visually simplistic by design; it conveys the idea that the mockups are not final and are subject to change. At the same time, Balsamiq allows us to link together mockups, thus creating a mockup representation of the actual system's navigation. [Figure 4.1](#) is a mockup of the landing page, which is the first page users see when they visit the website.

After we finished creating our initial set of mockups, we held a user evaluation in December, 2010 of our “mockup” system. The evaluation involved three scenarios. The first scenario involved the user coming to the system for the first time, setting up their profile, making a commitment, and signing up for an event. The second scenario was then having the user redeem a confirmation code for the event they said they would attend in the previous scenario and visit the “Go Low” page for the first time. The final scenario involves viewing the list of prize winners and also seeing if they had earned any badges.

We invited colleagues, family, and friends to come in and go through the mockups. When they came in, we gave them a brief overview of the competition (being careful to not provide too much information) and asked them to sign a consent form. We then guided these subjects through the mockups instead of having them navigate through the system on their own. While Balsamiq lets us link together mockups, it would be difficult to enumerate all possible paths through the mockups. This is especially difficult because the state of many pages change after the user has done something (like participate in an event, for example). Instead, in situations where there are several places that the user could go, we asked the user where they would like to go. While the user may not always go where we want them to go, the hope is that most users will follow our scenarios.

During the evaluation, we asked the users to use a “think out loud” protocol. We asked them to tell us what they are thinking, what they see, and what they want to do. By doing this, we obtained additional insight into situations where users might get stuck. We recorded both the audio and the computer screen of the guided tour using an application called “ScreenFlow”. As part of the consent form, we let the users know that their voice was being recorded and that only people working on the project will have access to this data.

## 4.2 Onboarding Evaluations

After we finished the mockup evaluations, we started implementing the beta version of Makahiki using the mockups and user feedback. We worked with a graphic designer at Windward Designs, who helped us develop our graphical design for the 2011 Kukui Cup. By April of 2011, we were ready to have our first onboarding evaluation. After we received feedback from the April evaluation, we held a second onboarding evaluation in July of 2011.

We use the term *onboarding* to refer to the process that beginning and novice users go through early on in the game. During this phase, we need to show the user the rules of the game and how it works. Users coming to the Makahiki system for the first time may not know exactly what they have to do during the competition and will have little intuition for what they can do with the interface. Within the Makahiki system, we have to provide sufficient guidance for these users in order to get users familiar with the interface.

Unlike the mockup evaluations, we did not create any scenarios for the user. Instead, we relied on the content of the quests and activities to get users acquainted with the interface. While traditional usability evaluations use scenarios to evaluate how people complete tasks, using the content of the system provided a way for us to “playtest” our game. We also want to see how people interact with the system when someone is not guiding them through. These evaluations evaluate our ability to make a game as much as it evaluates our system’s usability. Also, since the quests and activities are types of “transactions”, we can measure the user’s ability to complete them.

Each user that attended the evaluation was compensated in cash. However, we also wanted to emulate the competitive environment, albeit on a smaller, individual scale. Thus, we provided additional incentives that were available to the user during the evaluation. First, we created dummy users and simulated their participation in the website. If a user was able to get to first place against these sample users (the highest dummy user had 60 points), they earned additional cash. Also, if the user allocated a raffle ticket in the raffle game to a gift certificate, we gave them the gift certificate. In the beginning of each evaluation, we informed the users that they could earn these additional incentives. However, we did not tell them how or where they would be able to earn it. The incentives were displayed to the user as quests and they appeared as the user progressed in the game.

We also asked participants to use the “think out loud” protocol. We informed them that while they can ask questions, we may not be able to answer right away. This is because we want to observe the subject when they do not have someone guiding them through. We provided little

guidance to the subject once they started playing the game. We kept our interactions with the subject to a minimum. We stopped them after the first login sequence to get their feedback on the process. We also asked the subjects for feedback whenever they watched a video to provide some feedback to the administrators who created the content. We used “ScreenFlow” again to capture the subject’s voice and onscreen actions.

When the subjects came in, we had them sit in front of a Macbook Pro equipped with the latest versions of Firefox, Safari, and Google Chrome. We then provided the subject with the guidelines of the evaluation and informed them that we are recording their voice and on screen actions. They were then asked to sign a consent form. After the consent form was signed, we provided a little context about the system and the possible additional incentives. We then let the subject interact with the system unassisted for 30-40 minutes. After that period, we answered any questions that may have come up, asked a few post-test questions of our own, and gave the subjects their compensation. The script we used for the procedure can be found in Appendix A. We also made sure to dump the database after each subject for analysis before resetting the system to a pre-evaluation state.

Because these subjects were interacting with the system, we needed to have at least two people at each evaluation; one to observe the subject as they navigate through the system and ask questions and one to act as an administrator. The person playing the administrator does not interact with the subject during the evaluation. Their task is simply to review the submissions for tasks in the smart grid and choose to either approve or deny the subject’s submission. Because we are simulating the game on a small scale, the administrator needed to provide realistic feedback and encourage the subject to keep trying.

After the individual’s time with the system was up, we asked them a few questions about their experience. These questions were based on questions in Krug’s Don’t Make Me Think [41]. The questions were:

- What did you think about the website?
- What did you think about the background? Was it too cartoony?
- Is this something you think you and your friends would participate in? Why?
- What issues did you have while using the site?
- What can we do to improve the site?

For both of these evaluations, we recruited current residents of the Hale Lehua residence hall here at the University of Hawaii at Manoa, which was one of the residence halls participating in the 2011 Kukui Cup. This residence hall was chosen because at the time of the first evaluation, it was the only residence hall in which we could get near-real time energy usage. Since the residence halls in the competition are for first year students, these first-year students in 2010 would not be able to participate in the upcoming 2011 competition.

Once we had the screen recordings and the database dumps, we analyzed them to get a sense of how usable our system is. First, we looked at how long it takes a subject to complete workflows. Examples of workflows include the first login sequence, completing an activity, or completing a quest. The only workflow that is required of every subject is the first login sequence, so some subjects completed tasks that others have not. We also examined at the raw numbers from the database, including the number of points, number of quests completed, and the number of actions completed. We compared the evaluations with each other to see if there was improvement between iterations of the system. Of course, since a new subject is interacting with the system, we also took note of potential usability issues that each of the subjects have encountered.

### 4.3 Beta Evaluation

Before deploying the website in production, we held a closed beta evaluation. Unlike the in-lab evaluations, this was more of a field test where subjects interacted with the website on their own time. Instead of using subjects from the towers, we recruited friends, family, and local organizations. This posed an issue: the energy and power information used in the Go Low page is directly tied to the energy in the Hale Aloha towers. We got around this by basing the energy use of the floors in the competition on the activity of the individuals in the floor. The number of points, the amount of wall activity, and the number of quests completed all contributed to this mocked energy data. However, the daily energy goal game was functional and awarded points to individuals of the team if their mocked energy consumption fell below the goal.

The duration of this evaluation was 6 days. The competition was divided into two rounds, with round two being an “overall” round. We purchased a few prizes for the winners as well as a few prizes to put in the Raffle Game.

After the beta test ended, we sent out a survey to the participants. This was a short 5 question survey that was used to get feedback for the system and the 2011 Kukui Cup. The questions were:

- What aspects did you like most about the Kukui Cup beta test?
- What did you like least about the Kukui Cup beta experience?
- What suggestions (big or small) do you have for improving the Kukui Cup for our October launch at UH?
- What did you find to be your primary motivators and de-motivators for participating in the beta test?
- Any other comments you'd like to share with us?

This is an important component of our evaluation. Aspects of the website involve the passage of time (rounds, commitments, events, submission approval process) or interacting with others (social bonus, tickets in the raffle game, news page). The energy competition is also less about individuals and more about the group or floor as a whole. This was also an opportunity to test our mobile implementation and get a sense of how difficult the administration of the system might be.

Once again, we looked at the database to gather metrics on the performance of the evaluation participants. While we did not have screen recordings, we used our logging system to estimate how much time subjects spent in the system. This served as an early test of our logging component, which was used heavily to gather metrics from our production deployment. We also sent out a short survey to all of the beta evaluation participants for them to provide feedback on their experience using the system.

## 4.4 Production Deployment

In October 2011, we held the inaugural “Quest for the Kukui Cup”, a residence hall energy competition here at the University of Hawaii at Manoa. The competition involved 1000 first-year students and resident advisors residing in the Hale Aloha Towers. This competition served as the first public deployment of Makahiki. In addition to the logs generated by Makahiki and the web server, we added a survey in the form of an activity to the Smart Grid Game in the last round of the competition. This survey included a few questions about the subject’s experience with the website and what they felt we could improve.

## 4.5 Summary

These various evaluations contributed to our evaluation goals in different ways. Each type of evaluation satisfies a subset of our goals we outlined at the beginning of this chapter. Together, they provided us with a complete look at how individuals in the actual competition might have interacted with our site.

First, our mockup evaluation gave us insight into our design interface and whether or not it was intuitive. The benefit of the mockup evaluation was that we did could evaluate our interface before writing a line of code. This was critical because we did not want to waste time creating an interface that would be thrown away later. The downside of the mockup evaluation was that individuals did not directly interact with the mockups. Thus, we could not evaluate how these subjects interacted with the components. In addition, the lack of incentives made it impossible to evaluate our game design. Finally, the contents of the system was not developed at the time of the mockup evaluation, so we could not gain any insight into the content of the system.

The onboarding evaluation also gave us insight into our interface, but we also observed subjects interacting with the user interface components directly. Subjects were also interacting with the content of the system, so we also gained useful feedback that was forwarded to the content creators for the system. We also “gamified” the evaluation by providing incentives to do well in the system. This provided subjects with additional incentive to do well in order to get the full value out of the evaluation, but the way they were awarded was not an accurate representation of how the incentives would be awarded in an actual competition. Thus, while we gained some insight into our ability to make a compelling game, we needed to run a competition with multiple subjects over a period of time to fully evaluate our game design.

The beta evaluation was a more accurate representation of how the competition would be. Having multiple subjects interact with the site and compete against each other allowed us to more accurately evaluate the design of the actual competition. We also had more individuals interact with content, meaning that we could get even more feedback on the content of the web site. However, since individuals were interacting with the web site away from our lab, we could not directly observe their interactions with the web site.

# **Chapter 5**

## **Results and Discussion**

### **5.1 Mockup Evaluations**

In total, we had seven subjects come in to evaluate the mockups. We noticed several usability issues with certain features, many of which were subsequently removed. For example, we initially thought we would allow the participants of the competition to vote on their energy goal. The voting interface was a dialog box that was displayed after the user had completed the first login wizard. This confused the subjects in our mockup evaluation, so it was subsequently dropped. Overall, we generated nearly 40 tweaks that needed to be made to the mockups. Many of these tweaks made it in to the final system.

### **5.2 Onboarding Evaluations**

We held two in-lab evaluations; one in April 2011 and one in July 2011.

#### **5.2.1 April Evaluation**

We recruited 5 students from the Hale Lehua residence hall at the University of Hawaii at Manoa. Of these students, four were first-year students while one was a senior resident advisor. Of the 5 subjects, only 4 were able to attend both the focus group and the onboarding evaluation. One subject only attended the onboarding evaluation. A summary of results is shown in [Table 5.1](#).

All five subjects allocated a ticket to the Bubbles gift certificate raffle prize and thus received the prize. Three of the subjects also earned the \$10 bonus for getting to first place on the points scoreboard (60 points or higher).

Subjects	A	B	C	D	E
Points	51	74	45	74	99
Time taken	41:39	29:49	39:15	34:24	36:11
First login time taken	5:26	5:06	7:08	5:40	3:01
Tasks attempted	12	7	11	15	14
Approved activities	2	5	3	6	7
Excursions, events, and commitments	8	2	5	8	7
Rejected activities	2	0	3	1	0
Allocated raffle ticket(s)?	Yes	Yes	Yes	Yes	Yes
Quests attempted	5	1	8	1	4
Quests completed	2	1	7	1	3

Table 5.1. Summary of results in April onboarding evaluation

The following sections will present results related to various components and pages in the site.

### 5.2.1.1 First Login Wizard

Each of the subjects were able to complete the first login wizard and earn the full 25 points. After each of the subjects completed the first login wizard, we asked them if there were any issues completing it. All of them said that it was very straightforward. However, we observed some minor issues in the process.

Four of the subjects spent a little additional time thinking about what to put in their profile. [Figure 5.1](#) shows the profile setup phase of the First Login Wizard. The main issue was the “about” field. Some subjects wondered out loud if they could type in anything into that field. The about field’s label confused one subject, who thought it was a yes or no question.

This version of the system also had an explicit Facebook setup step in the First Login Wizard before the profile step. This was because we wished to asynchronously post news and events to the walls of players. All five of the subjects had a Facebook account, but only three signed up as part of the First Login Wizard. One player connected their Facebook account later and mentioned that they were unsure as to what their Facebook information would be used for. After they watched the introduction video, they understood why they might want to connect with Facebook. The fifth



Figure 5.1. First Login Wizard profile setup

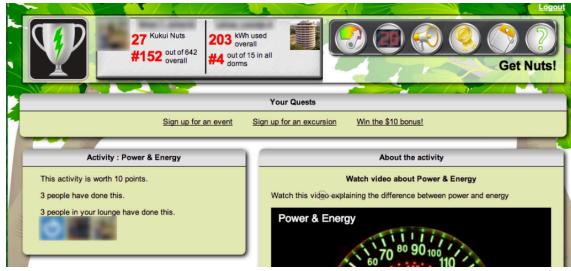


Figure 5.2. The Quest Bar on an Activity's page

player wanted to complete the Facebook activity in the Smart Grid Game, but could not remember their password.

### 5.2.1.2 Quests

Only two out of the five subjects saw the quest bar right away. One subject did not see the quest bar until about 12 minutes into the evaluation. The last two subjects did not see the quest bar until about 20 minutes into the evaluation. These two subjects saw the “Win the \$10 bonus” and the Bubbies Gift Certificate quests, so the possibility of winning something caught their eye. A possible reason why subjects may have missed the quest bar is because it looks identical in style to the other boxes in the page. As Krug points out, many designers want users to read everything on a page, but it turns out that users skim content and skip sections until something gets their attention [41]. An example of the quest bar is shown in Figure 5.2.

Quest	A	B	C	D	E
Get the Fully Committed Badge	Incomplete				Incomplete
Win the \$10 Bonus	Incomplete	6:53	Incomplete		8:44
Learn About Energy		9:15		13:14	
Make a Commitment		0:50		9:35	
Win a Bubbles Gift Certificate	0:16		0:13	2:56	
Get a Grip on Energy Use			1:17		
Get Social	Incomplete		4:42		
Sign Up For An Excursion	6:53		0:39		
Sign Up For An Event			2:04		

Table 5.2. Quests performed by users in the April evaluation

**Table 5.2** is a table of the quests each subject attempted and how long they took to complete the task. Most of the subjects accepted a quest and then got distracted by other things. The main exception was subject C, who read the quest descriptions, accepted the quest, and carried out its instructions immediately. Subject B also completed their lone quest relatively quickly (they watched a 4 minute long video), but the “Win the \$10 bonus” quest is more open ended than the others.

While the visibility of the quest bar is a significant issue, we also have the issue of users failing to carry out the quest once completed. Subject C mentioned that putting the important parts of the quest description in bold would make it easier to complete quests. Another possibility would be to use images in the description to illustrate what users are supposed to see and/or click on. Other issues with quests were that one subject almost canceled a quest they were reading about and that most of the quests involve the “Get Nutz” section of the website.

### 5.2.1.3 Home Page

**Figure 5.3** shows the home page of the website. Two of the subjects went to the “Go Low” page first after completing the first login wizard. The icon for this page was in the top left corner of the home page content and these users both reported that it was the first page they saw. Subject C went to the profile page first with the intent of making changes to their profile after watching the introduction video. One subject accepted the “Make a commitment” quest on the home page, but they then went to the prizes page because they were interested in what they could win. The last

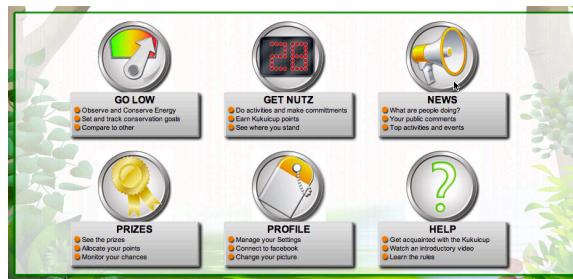


Figure 5.3. Layout of the six top level pages on the home page

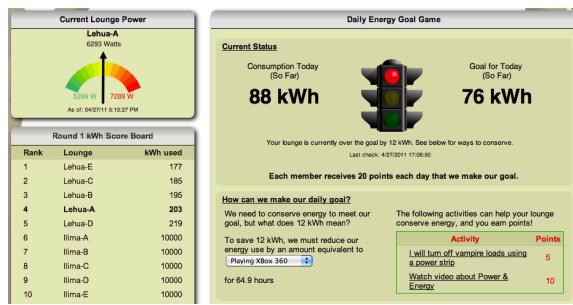


Figure 5.4. The Go Low Page

subject went to the “Get Nutz” page first because they were specifically looking for the Smart Grid Game and thought that is where it would be.

#### 5.2.1.4 Go Low

Figure 5.4 shows the “Go Low” page of the website as it was in April 2011. Because it was the first page listed in the home page, two users came here with little information about what is going on in the page. Subjects that came here before completing the “Power and Energy” and “Energy Intuition” tasks were confused as to what is going on in this section. One of these subjects asked about the energy goals and who sets them while another became confused by the energy calculator. The calculator was designed to calculate how many hours you need to *not* do something in order to reduce your energy usage. A subject using the energy calculator compared the amount of time one needs to not play Xbox versus the amount of time one needs to not play Wii and came to the conclusion that the Wii uses more power because the number was higher. This is not the case; since the Wii uses less power, you must reduce your playing for a longer period of time. Those subjects that came here first eventually left the page by selecting an activity in the “How can we meet our energy goal” list of activities.

Activity	A	B	C	D	E
Power and Energy	3:13	3:02	<b>3:16</b>	3:01	2:21
Energy Intuition	<b>3:53</b>	3:52	<b>4:25</b>	<b>4:12</b>	3:34
Like Kukui Cup on Facebook		1:03	2:33	2:41	
Share Kukui Cup on Facebook			1:16	1:10	
Examine Your Lounge's Energy Use			1:11	1:09	
Configure Computer to Sleep After Inactivity		1:04			
Trash is Treasure		5:29			<b>4:21*</b>
Climate Change					4:17
Wind Energy					2:43
Solar Energy				3:35	

Table 5.3. Activity items completed during the April evaluation

The “Learn about your energy use” activity brought subjects back to this page later on. This activity asked users to check if they are over or under their energy goal, by how much, and what they can do to reduce their energy usage. One subject fully understood what was going on and completed the task efficiently. Another subject (who went to the “Go Low” page early on) came back to do the activity and also completed it. The activity included an image of the power gauge that users were supposed to look at on the “Go Low” page. This caused one subject to use the information from that static image to complete the activity.

After the evaluation, the subjects did mention that they had a better understanding of what was going on in this page after playing the Smart Grid game for a while.

#### 5.2.1.5 Get Nutz

Three out of the five subjects that came here clicked on the “Intro video” item in the grid even though they had already completed it as part of the first login sequence. These users went through the video for a little bit to make sure that it was the same video that they already saw.

All of the subjects that viewed the grid expressed some initial confusion as to what is going on in the Smart Grid Game. One subject mentioned that the introduction video did not explain how to play the game at all. A few subjects clicked on the question marks hoping that there would be some response. At this point, the question marks did nothing, which left the subjects even more confused. However, once they clicked on a number (which is an unlocked task and represents



Figure 5.5. Upload a Screenshot Instructions

the amount of points the task is worth), the subjects began to understand how the Smart Grid Game works. One subject even mentioned that the numbers turn to the name of the task as they complete them.

When completing tasks that involve videos, only two of the subjects went back to watch the video when they did not know the answer. The other three tried to guess the answers to the questions without going back to the videos. The two subjects who went back to watch the videos to answer the question correctly were the two highest point getters in this evaluation.

For the most part, subjects had few issues with actually completing tasks. As part of submitting the task, we included an “additional comments” section that was to be used to provide feedback about the task from the user to the administrators of the competition. Three of the subjects took the time to input text into the box for every single task. While this section is optional, the text does not explicitly say so. Another interesting outcome was that one user declined to sign up for events or excursions that they were unable to make in real life. The event/excursion dates were based around the time of the evaluation. This probably is not an issue, but it was interesting given that signing up for events and excursions award points and the events and excursions were not actually going to occur.

Three of the activities (Share Kukui Cup Link on Facebook, Like Kukui Cup on Facebook, and Configure Computer to Sleep After Inactivity) required subjects to take a screenshot and upload it. Instructions were displayed as part of the activity description like in [Figure 5.5](#). Some subjects were able to take the screenshot quickly without looking at the instructions. However, subjects who were more used to Windows PCs had difficulty figuring out how to take the picture. There was not

much we could do in terms of changing the evaluation due to limitations in our available hardware, but we decided to use screenshots sparingly and only when needed. For example, liking the Kukui Cup on Facebook can be verified simply by asking subjects for their Facebook name.

What happens after submitting responses for a task was another major issue. At the time of the evaluation, we displayed a red box near the top of the page whenever a submission is rejected by administrators. However, the red box only shows up once before disappearing. Out of the five subjects, only one of them caught the box even once and did something about it. Another subject eventually found out that one of their tasks was rejected from their profile page. The subject clicked on the “rejected” link and saw that the administrators left a response for them. This subject mentioned that it was good that the administrators provided feedback and that they could read it. However, they did not go back and try to complete the task, even though a button was provided for the subject to click on and try again.

Subjects also had a difficult time interpreting the rotating scoreboards on the “Get Nutz” page. One subject, who was trying to get the number one score, saw that they were number one on a scoreboard, but later checked and found themselves lower. The scoreboards do change automatically, so the user likely found themselves at the top of their floor but not at the top overall. Another subject noted that the scoreboard rotated too quickly.

There was a bug in our evaluation where subjects could not access certain activities in the website. This occurred because the system failed to select a question for certain activities. This bug affected the subjects depending on what their database id was, so some subjects were able to access activities that others were not. Subject B in particular encountered the error more than once. The solar energy video was also not intended to be shown, but subject D found it and completed it.

#### **5.2.1.6 Prizes Page**

Other than the one subject who came here to see what they could win, the subjects primarily came here as part of the Bubbles gift certificate quest. The subjects understood how the raffle works and how tickets can be allocated. The only issue was that one subject was concerned that adding or removing tickets would decrease their point total.

#### **5.2.1.7 Discussion**

Overall, the sessions were a success. The subjects uncovered several usability issues, many of which we would not have thought of on our own. The primary issues that came out of the

evaluation were the missed rejection notifications, the quest bar, and having the Go Low page listed first on the home page. As a result of these evaluations, we created a notification component that made the rejected notifications more “sticky”, changed the color of the quest bar, and changed the order of the pages on the home page so that the Get Nutz page is first.

We were provided with positive feedback regarding the game. When asked if individuals would recommend it to their friends, all of the subjects said that they think their friends would be in to it. Some found the points aspect “addicting” while others thought the near-real time power meter and energy displays were “cool”. Some of the subjects were disappointed that they would not be able to participate in the actual competition (because it will be held for the first-year students in the following year).

#### **5.2.1.8 Focus Group**

Four participants were able to make it to the focus group. Subjects were asked about their attitudes to energy conservation and about their experience with the system. They also provided valuable suggestions that can be applied to the design of content for Makahiki and ways we can market the events and excursions.

### **5.2.2 July Evaluation**

We recruited five different participants from the Hale Lehua residence hall who were available over the summer. Again, four of the participants were first year students and one was a resident advisor. Four subjects were able to make it to both the onboarding evaluation and the focus group, while the fifth could not make it to the focus group. [Table 5.4](#) is a summary of the results in the July evaluation.

#### **5.2.2.1 Changes**

We made several changes going into the July evaluation. The first login wizard used to contain a Facebook Connect step that informed users we would be posting to their wall. We decided to scrap the idea and instead incorporated the Facebook Connect button into the profile step. The “about” field in the profile step was also removed, since that information was not displayed elsewhere in the system.

We changed the color of the quest bar. Previously, the quest bar looked very similar to other “widgets” in the system, which may have caused users to ignore it. The color of the quest

	A	B	C	D	E
Points	113	83	101	74	72
Time taken	39:35	41:05	36:57	37:35	49:04
First login time taken	3:10	3:59	3:40	4:00	3:34
Tasks attempted	13	10	16	7	14
Approved activities	9	6	8	3	4
Excursions, events, and commitments	4	4	7	4	7
Rejected activities	0	0	0	0	3
Allocated raffle ticket(s)?	No	Yes	Yes	Yes	No
Quests attempted	3	7	8	6	1
Quests completed	3	3	8	3	1

Table 5.4. Summary of results in July onboarding evaluation

bar was changed to a black background with white text, so it is now unique compared to other user interface elements in the system.

We knew we needed to improve the video/answer question workflow in the SGG. First, we added an explicit cancel button and text that tells the user they can close the window and review the video if they need to. Second, when a submitted answer is rejected, we display a message to the user just below the quest bar that is persisted as the user navigates around the site. In addition, answers that are rejected also appear as a modal dialog box that has to be closed before the subject can continue using the site. These boxes can contain multiple notifications, so users do not see more than one at a time.

We also added a video to the SGG called “Secrets of the Kukui Cup Masters”. This video provides “strategies” that can be used to win the game. These strategies provide a little explanation to some of the components of the game. In addition to the video, a new quest was added that guides the user to this video. The videos on solar energy and wind energy were removed. Liking the Kukui Cup on Facebook was changed to ask for a Facebook name instead of a screenshot.

### 5.2.2.2 First Login Wizard

Everyone got through the first login wizard in 4 minutes or less. It seems that the profile step did hang people up in the previous evaluation. We can say that the first login wizard takes about 5 minutes in the introduction. Also, the subjects did not customize their profile and stuck to the

	A	B	C	D	E
Secrets of the Kukui Cup Masters	9:13	Opt-out	0:00	0:00	
Make a Commitment	0:30		13:05	Incomplete	22:37
Win the \$10 bonus	2:49	0:00	0:00	9:15	
Sign Up For An Event		5:55	0:55		
Sign Up For An Excursion		Incomplete	0:21	0:37	
Win a Bubbles Gift Certificate		0:07	1:13		
Get Social		Opt-out		Incomplete	
Get the Fully Committed Badge		Incomplete	13:30		

Table 5.5. Quests completed by subjects in the July evaluation

default profile name and profile image. None of the subjects used their picture from Facebook, even though some of them logged into Facebook later on in the evaluation. During the actual competition, 48 users signed in to Facebook to use their image. All of these users linked to Facebook in the first login wizard.

### 5.2.2.3 Quests

**Table 5.5** is a summary of the quests attempted and completed by the subjects. Subjects in this evaluation saw the quest bar within 5 minutes of finishing the first login wizard, so changing the color of it was very successful. There were still a few instances where someone did not know they needed to accept the quest. It might be good to have a simple introductory quest that shows a user how to add a quest. That quest would be completed as soon as they add it. We would need a predicate for this quest to check if the user has ever completed a quest before.

We had an issue with the way the quests were set up. For a few of the quests, the unlock condition for the quest was true even if the subject already completed the steps required for the quest. The quests in particular were the Secrets of the Kukui Cup Master's quest and the Win the \$10 Bonus quest. A few subjects saw the quest complete as soon as they added it. Subject B was reading about the Secrets quest and realized they had already done it, so they were confused. We instructed them to opt out of the quest because they had already completed it.

Other issues were that subject E was a little confused when they looked at their achievements in their profile. The subject knew that they completed the quest, but was confused as to why

Activity	A	B	C	D	E
Power and Energy	3:05	3:13	2:45	4:38	<b>3:37</b>
Secrets of the Kukui Cup Masters	5:26	5:48	<b>4:34*</b>	5:05	5:43
Energy Intuition	4:13	4:13			<b>3:42</b>
Like Kukui Cup on Facebook	1:10		0:57		1:28
Share Kukui Cup on Facebook	2:19		2:05		
Examine Your Lounge's Energy Use	3:07	3:36	1:40		6:28
Configure Computer to Sleep After Inactivity	3:27				<b>3:52</b>
Trash is Treasure		5:00	3:00		
Take a survey	3:29			4:41	

Table 5.6. Activity items completed during the July evaluation

they weren't awarded points for it. After subject B opted out of the Secrets quest, they opted out of the Get Social quest since they did not use Facebook.

#### 5.2.2.4 Smart Grid Game/Actions

**Table 5.6** is a summary of the activities attempted by users. The times recorded represent the first time they attempted the activity. Bolded items were rejected. Starred items were rejected but later resubmitted and approved.

Overall, our success rate with these activities were very high compared to the previous evaluation. The issue that came up during subject E's evaluation was that they received a notification for being rejected for one activity right after they submitted a response for another one. The subject thought the rejection notice was for the one they just did (Energy Intuition) when the rejection notice was referring to the "Power and Energy" activity they did previously. As for the "Configure Computer to Sleep" activity, the screenshot did not have the necessary information and the subject declined to resubmit.

Subjects were also a lot more likely to close the question window if they didn't remember the answer to a question in the video. During the previous evaluation, the subjects tried to guess and got it wrong. Having the cancel button and the text that says they can close the window and review the material was a major addition and got subjects to correctly answer questions. The addition of a modal dialog when activities are rejected also worked very well for subject C, who was able to resubmit their response when they got the answer to a question wrong.

	April	July
Points	68.6	88.6
Time taken	36:16	40:51
First login time taken	5:16	3:40
Actions attempted	11.8	12
Approved activities	4.6	6
Excursions, events, and commitments	6	5.2
Rejected activities	1.2	0.6
Allocated raffle ticket(s)?	5/5	3/5
Quests attempted	3.8	5
Quests completed	2.8	3.6

Table 5.7. Average results of the April and July evaluations.

We were also able to implement surveys for the first time. Subjects were able to complete the surveys without much issue. However, we were not satisfied with the implementation of the survey type and decided to remove the feature from the system. Instead, surveys in the beta evaluation and production system were handled using SurveyGizmo, a third party service for creating surveys. Users in the actual competition provided their name in the survey so that we could determine who to award points to.

#### 5.2.2.5 Onboarding Evaluation Summary

**Table 5.7** compares the average results of the April evaluation to the July evaluation.

Although we gave the subjects in the second evaluation a little more time, their point total went up by 20 points. This is 0.0424 points per minute in the April evaluation and 0.0534 points per minute in the July evaluation, so subjects in the July evaluation were more productive than the subjects in the April evaluation. Subjects in the evaluation also took less time to complete the first login wizard, possibly due in part to the removal of the optional “about” text field in the profile setup. Subjects also attempted and completed more quests in the July evaluation, meaning the change in color for the quest bar made it more visible to subjects.

The number of actions attempted by the subjects were about equal despite the increased time taken and reduced first login wizard time. However, in terms of activities, subjects in the July evaluation had more of their activities approved and half the number of rejections. In fact, all of the

rejections in the July evaluation were from one subject, while three subject had submissions rejected in the April evaluation.

### **5.2.3 Beta Evaluation**

The beta evaluation started on August 11th, 2011 to August 17th, 2011. We had 4 teams take part in the test, each with 5 members. Three of the four teams were fielded by local companies and organizations, while the fourth involved friends and family.

#### **5.2.3.1 Changes**

Because of the increased length of this evaluation, we needed a lot more content in the system. In addition to new videos, we created advanced actions that were more involved. Advanced actions included creating a poem related to sustainability, making a video, or writing a song. We also wanted suggestions on how we could improve the competition, so an action in the Smart Grid Game was created to suggest ways to promote the competition. We also had prizes to give away to participants, so that content was added to the prizes page.

#### **5.2.3.2 Results**

**Table 5.8** is a summary of the results of the beta evaluation. Of the 20 users entered into the system, 18 logged in to the system at least once. On average, the users that logged in averaged 915.28 points and they each completed 1.8 quests, 4 commitments, and 16.2 activities.

#### **5.2.3.3 Issues**

One major issue that came up in the beta evaluation was that the website did not perform well on Internet Explorer. In particular, the buttons on the landing page were rendered in a way that made them inaccessible in earlier versions of IE. These participants were using laptops provided to them by their workplace, so they were unable to install browsers on their computers. For the purposes of the evaluation, this was solved using Google Chrome Frame [50], which allows early versions of IE to use Google Chrome as a rendering engine. This also did not require administrator permission to install, so these users could use it and be able to navigate around the site.

While the above issue is unlikely to occur in the residence halls, we do need to make sure the front page works for the most popular browsers and also be able to detect if a user is using an outdated version of that browser. We fixed the rendering issue on the landing page and implemented

Subject	Points	First Login	Quests		Commitments		Activities	
			completed	attempted	completed	attempted	completed	attempted
A	1103	3:45	3	3	5	10	24	25
B	1078	4:55	3	3	5	10	25	25
C	1062	4:43	0	0	10	15	20	21
D	1054	8:38	2	2	15	17	22	22
E	1053	3:29	5	5	15	20	21	21
F	993	3:23	1	1	4	9	24	24
G	953	6:25	3	3	0	5	21	21
H	943	3:45	1	1	0	5	21	21
I	930	6:40	4	4	5	10	19	19
J	925	5:48	4	5	5	9	18	18
K	903	6:09	1	2	4	9	16	16
L	878	5:29	2	2	0	5	16	16
M	858	8:40	3	3	0	5	15	16
N	855	6:12	1	1	0	5	14	14
O	773	9:02	0	0	4	9	5	10
P	760	5:00	0	0	0	5	7	8
Q	689	5:24	0	0	0	2	3	3
R	665	2:57	0	0	0	0	0	0

Table 5.8. Summary of results in the beta evaluation.

a browser check that checks the user's browser on the landing page. If they are using an outdated browser, they will be notified that the system does not support it.

We also encountered a bug with commitments where individuals were losing points when they added a commitment. This bug was fixed and points were added back in, but this also caused us to think of a way to detect this in the future. We later implemented a points transaction log that gets created whenever a user adds or removes points. We can use this log to detect anomalies in the point values of individuals and fix them when needed.

Finally, a subject was confused when they already had points going into the first login wizard. This occurred because the individual started the evaluation a day late and daily energy goal

game already awarded points. While this was not a bug, we decided to only award daily energy goal game points to individuals who were already logged in to the system.

#### **5.2.3.4 Post Beta Survey**

At the end of the beta evaluation period, we sent out the post-beta survey. A summary of their responses are in [Appendix B](#). The first question was about what aspects they liked about the beta test. Many liked the gamification and learning aspects of the system. When asked what aspects they liked least, some reported the lack of content and the lack of reminders. We also asked the participants what their primary motivators and de-motivators were. Some again reported the lack of content (some blew through the content in the first month) and the lack of real energy data as de-motivators, but many found the points and prizes to be a great motivator.

We also asked them for suggestions for improving the competition. We got some feedback about the canopy. The participants in this test were not motivated to participate in the canopy because there were no points to be awarded. We also received suggestions for a few tweaks to the interface as well as tips on getting people motivated to participate in the competition. Finally, we asked for additional comments.

### **5.3 Production Results**

The inaugural Quest for the Kukui Cup was held at the University of Hawaii at Manoa from October 17th, 2011 to November 6th, 2011. The competition involved the four Hale Aloha residence halls, housing 1,013 first year students and their resident advisors. Of these 1,013 students, 418 of them logged in to the website at least once.

During round one of the competition, we came up with the referral bonus, which is another way we tried to get more people to log in to the site. This was added to the first login wizard as an additional step. In order to get the referral bonus, the user had to enter the email address of a participant in the system. Then, the user had to earn 30 points before the user and the participant that referred them got 20 points each. This was developed and deployed to the live site in 4 days. Within minutes of the update, a new user went through the process and added a referring user.

#### **5.3.1 Issues**

While the referral bonus was tested and pushed out relatively quickly, it was also the source of a major bug that resulted in awarding thousands of points to two individuals. In compar-

Page	Total time	Average Time	Percent of total
Home	84.43	0.20	9.82%
Activities	550.24	1.33	64.03%
Energy	87.52	0.21	10.18%
Prizes	73.50	0.18	8.55%
Canopy	7.46	0.18*	0.87%
Help	8.62	0.021	1.01%

Table 5.9. Hours spent on the website during the 2011 Kukui Cup.

ison, the highest score was about 1,000 at that point in time. The bug in the code was fixed and pushed out a few hours after the incident occurred. We also encountered an issue where some people could “double submit” a form, meaning that they could send an additional request to the server when they should only have been able to send one. It mainly caused issues in events and commitments, where a signup bonus may be assessed multiple times. This was difficult to track down and fix. We periodically inspected the points transaction logs and the commitment/event signups and corrected the user’s points value when needed.

### 5.3.2 Results

**Table 5.9** outlines the results of the competition. While the average time was calculated based on the total number of participants, note that the canopy was based on the 42 individuals that were admitted to the canopy in round 3. Overall, 850 hours were spent on the web site. As expected, most of the time was spent on the activities, energy, and prizes page. During the prior evaluations, these were the pages we focused on. However, the canopy was not widely used even among the individuals who were admitted. We believe the canopy is a great idea, but we need to invest more time designing it and presenting it to users in evaluations. Out of the evaluations we performed, it was clearly the least tested component as we had it available only for a few days during the beta evaluation.

A survey to gather the opinions of participants was added during the third round. 42 of the participants completed the survey. When asked “What did you like about the website?” in a free response question, 25 of them said “ease of use”. When asked what they found confusing, 13 of them said “nothing”. 11 of them again said “nothing” when asked what they would change about the website. While the participants that made it to the third round are invested in the competition, it

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
It was easy to find what I was looking for on the website	4.7	2.3	4.7	32.6	55.8
The website was responsive	4.7	2.3	2.3	44.2	46.5
The website provided adequate help in teaching me how to play	2.3	2.3	2.3	37.2	55.8
I understood how to play	2.3	2.3	0	27.9	67.4

Table 5.10. Statements evaluated on a likert scale during the 2011 Kukui Cup.

is nonetheless encouraging that users found the system easy to use. Of course, the feedback of the other individuals will be investigated as we further evolve the system.

We also had a few statements for users that were evaluated using a likert scale. Those results are shown in [Table 5.10](#) as percentages of respondents who marked each statement. Overall, the system performed very well during the 2011 Kukui Cup.

# Chapter 6

## Conclusion

Makahiki is an open source platform for energy competitions. We started with concepts from other energy competitions and provided a more personalized view for users when they log in. We incorporated a serious game around energy conservation in order to help individuals become more aware of their energy usage. Furthermore, we implemented logging of users as they navigated through the system. This allows researchers to gain insight into the behaviors of participants in an energy competition.

To prepare for our first deployment of Makahiki in the 2011 Kukui Cup, we needed to evaluate the design of the system. We started with a mockup evaluation to validate our design. We then held individual onboarding evaluations when the system had most of its basic features implemented. In these evaluations, we observed the subject to gain insight into how an individual might interact with the system by themselves. Finally, we held a beta evaluation that involved subjects interacting with the system outside of a laboratory setting. This allowed us to observe how the time-dependent aspects of the system (rounds, events, etc.) may work in an actual competition. The beta evaluation also provided insight into social interactions that may take place in the system.

During the 2011 Kukui Cup, Makahiki performed very well with 413 individuals logging into the site during the competition period. Based on our logging, we found that individuals spent a lot of time on the smart grid and energy usage pages, which were tested in each of our evaluations. However, our Canopy page, which was barely tested in any of the evaluations, turned out to be our most significant failure of the system. Based on the feedback from a survey of users during the competition, they were very satisfied with the system overall.

## 6.1 Future Work

One of our original goals was to create a system that would more customizable for use by other energy competitions. For example, some organizations may not be able to install smart meters and support near-real time power and energy displays. Others may choose to omit the Smart Grid Game because they do not have the time to develop the content. We need to make it more configurable to support other organizations that may want to use our software. We also want the front-end graphical interface to be more customizable for other organizations.

Makahiki is also a research platform that was used in 2011 to support tracking of user behaviors within the system. This was accomplished through low level logging that tracked every action that users took within the system. In the future, we want to provide higher level analytics of user interactions that can be viewed in real time during the competition. We also want the system to support A/B testing, a usability technique that allows a researcher to create multiple interfaces to a component. Certain participants within the system will see one interface others will see another one. This allows researchers to observe how users interact with different interfaces and to evaluate which ones are more successful.

For the 2011 Kukui Cup, our research lab used its own web server. Competition organizers may not be tech-savvy enough to be able to set up Makahiki on their web server. Furthermore, many organizers may not have direct access to a web server at all. With the advent of cloud computing and platforms as a service (PaaS), organizers no longer need to have a web server of their own. We want to make it as easy as possible for organizers to deploy an instance of Makahiki to the cloud, configure it, and then run their competition.

Our initial design of Makahiki focused on energy. However, we can support additional reduction competitions. Meters that track water usage are currently available. Trash and recycling can be tracked manually by organizers as well. We are considering making components within Makahiki to support these competitions. However, since Makahiki is open source, we would also like to make it easier for other developers to create modules for the system.

## 6.2 Contributions

We claim the following contributions:

1. An open source system for creating serious games for energy competitions.

2. A research platform on which researchers can observe user behavior during energy competitions.
3. A methodology for evaluating and testing serious games that involve competitions over a period of time.

Over the course of this thesis, we developed an open source system for creating serious games for energy competitions. Development still continues and the system will evolve to support other sustainability-related competitions. Furthermore, the availability of detailed logging allows researchers to investigate the behavior of participants in a competition as they participate. Finally, in order to properly evaluate the usability of the system, we developed a procedure for evaluating our system using a series of evaluations involving separate sets of users.

## Appendix A

# Onboarding Evaluation Script

(Before they come in, we need their UH username and their name)

### A.0.1 Pre-Test

(Web browser should be open to Google or something “neutral”)

My name is <name> and I’m here to guide you through this session.

We asked you to come here to try using a web site that we are working on so that it works as intended. This session should take about an hour.

The first thing I want to make clear right away is that we are testing the web site, not you. You can’t do anything wrong here. In fact, this is probably the one place today where you don’t have to worry about making mistakes.

Because of that, I want to ask you to be as honest as possible. We are doing this to find ways to improve the site, so we need to hear your reactions, no matter how brutally honest they may be.

As you go through the site, I’m going to ask you as much as possible to think out loud. Say exactly what’s going through your mind, what you’re trying to do, and what you see.

If you have any questions as we go along, just ask them. I may not be able to answer right away because we’re interested in what people do when they don’t have someone to guide them through. When the session is done, I will try to answer any questions that may have come up. If you need to take a break at any time, please let me know.

The computer you are using has a screen and voice recording program. With your permission, we’re going to record your actions on the screen and our conversation. These recordings will only be used to help us figure out how to improve the site, and it won’t be seen by anyone except

the people working on this project. Don't worry about the camera on the computer. We are not videotaping our session.

(Introduce other observers, if there are any)

If you're okay with this, I'm going to ask you to sign a permission form. It just says that we have your permission to record your voice and actions and that it will only be seen by people working on the project. We can provide you with a copy of this form if you'd like.

(Give permission form and pen) (Start ScreenFlow)

Do you have any questions?

Great! Before we look at the site, I want to provide you with a little context. In October, we plan on having a competition in the Hale Aloha dorms called the Kukui Cup. We plan to get the word out by having events in the dorms and by putting up posters. The URL for the website you are about to use will be displayed around campus. That's all I'll tell you for now.

(If the user is not a freshman in the dorms, we want them to pretend that they are)

Okay, now we are going to look at the web site. Starting from the landing page, I want you to do as much as possible on the site for a few minutes. Please remember to talk out loud and say what's on your mind. I'll be here to give you a few reminders.

(click bookmark for the landing page)

### A.0.2 Post-Test

Good. Before you go, I'd like to ask you a few questions about your background and the website.

What do you think about social games on Facebook? Do you play them? Why or why not?

How many of your friends (online and off) play games online? What kind of games do they play?

What did you think about the Kukui Cup website? What about the background? Did you find it childish or cartoony?

Is this something you think you or your friends would like to participate in? Why?

What issues did you have while using the web site?

What can we do to improve the web site?

(Ask for questions from observers)

Do you have any questions for me?

## **Appendix B**

# **Post-Beta Survey Results**

Q1: What aspects did you like most about the Kukui Cup beta test?

- Repeating the Kukui Cup experience in other locations (such as public schools).
- Competitive aspect
- Points, being in competition with other teams and exhorting teammates to try harder if they were lagging behind.
- Liked videos, game stuff, trying for the prizes, and the competition part was fun, especially the real-time feedback and standings.
- Educational aspect
- Learning about energy
- Enjoyed learning about energy and conserving energy
- Always new content
- Quests and unlocking new levels
- Liked site interactivity
- Opportunity to see what is going on at UH
- Kukui Cup will be helpful to students
- Intensity (time period and level of engagement required)
- Smart Grid board

- Gamification worked well
- Video length of 2-3 minutes was good.

Q2: What did you like least about the Kukui Cup beta experience?

- Problems accessing visualizations in the canopy
- Worry that college students may not find our activities sufficiently stimulating compared to other things available to them, but competition could help that
- Information might be too advanced for average incoming freshman not interested in sustainability (based on showing some stuff to a friend)
- Mobile interface, should be more like desktop website
- commitments. Too easy to cheat (and user reports signing up just to get the points)
- Having to wait for commitments to end to collect points
- Not enough questions to answer, could do all of it in one sitting, but shied away from the activities that would take too long so perhaps they weren't worth enough points?
- More transparency on points awarded for advanced activities
- Did not care for some of the survey questions, particularly CNS (note: these are a set of pre-survey questions that were given out for another thesis).
- Beta test seemed to short
- Initially thought having 1st round mostly during weekend was bad, but ended up having more free time during weekend than during the week.
- Went through most activities in round 1. Might be hard to maintain their interest unless there is new info and challenges as time goes on.
- Worried about amount of manual work required by administrators, might want to switch to automated scheme.
- Page navigation took getting used to.
- Would have liked reminders: allocate raffle tickets, end of rounds, event.

Q3: What suggestions (big or small) do you have for improving the Kukui Cup for our October launch at UH?

- Additional ways for players to get more points, and possibly increasing the point value of activities in later rounds so late starters could catch up.
- Perform a 1 week trial run to generate buzz. Give out prizes, but then reset scores to zero.
- Push competitive aspect of Kukui Cup as much as possible. Possibly have comical “Sports-Center” type daily wrap up show to highlight certain efforts.
- Allow participants to play the game a little more before getting let into the canopy. Higher point minimum for canopy access.
- Scoreboards rotate too fast
- More prominence for Secrets of the Kukui Cup video
- Canopy was boring compared to SGG activities
- Some videos were too long and/or boring, leading to just trying to answer the question without watching the video and just skimming if the answer was unknown
- Fix IE problem, many students use IE and UH computer labs default to IE
- Teams play a big role in motivation, suggests connecting to team leaders [will these be the RAs? we shall see...]
- Add reward component to Canopy to continue motivation
- Give out points or badge for useful feedback/bug reports
- Only award prizes after survey is complete [won’t work since we are decoupling the survey from the competition]
- What happened to the post test on energy literacy?
- More (optional) email reminders

Q4: What did you find to be your primary motivators and de-motivators for participating in the beta test?

- Demotivator: lack of activities available in round 2 due to completing most of them (except advanced activities) in round 1.
- Motivator: being able to actually affect energy use (during the October competition)
- Demotivator: lack of real energy data for competition
- Motivator: point total. Would have also been highly motivated by real energy data if that had been available. Suggests awarding more points for energy conservation compared to activities since energy conservation will be harder.
- Motivators: points, beating other team members, prizes
- Motivators: points
- Motivator: points, not wanting to be lowest scoring member of team
- Motivator: prizes
- Motivator: prizes, but after winning a prize completely stopped playing (though partly due to time constraints)
- Demotivators: commitments are confusing, mobile interface
- Motivator: videos help inform, thereby motivating activity
- Motivator: interested in this area, but didn't know much going in
- Motivator: initially "Spouse PhD badge/prize", but later the engaging interface and competition kept up motivation

Q5: Any other comments you'd like to share with us?

- Content is wonderful, but can be improved over time.
- Trash is Treasure video narrator accent made video hard to follow.
- Repeating content to allow it to sink in is beneficial.
- Interested to hear if the 3 week competition can have any long lasting impacts on energy conservation

- Suggestion to pursue financial motivations: floor pays more or less money based on energy use, with running total and projected cost available to all floor residents.
- Surprised by how much they wanted to play
- Just due to beta test, being more conscious about energy use
- Video content should be more “modern”
- Starting competition over a weekend is hard [shouldn’t be a problem in October]
- Wish for questions to be multiple choice or T/F so feedback would be instant.
- Waiting for answer verification not fun, and leads to uncertainty of whether points were counted or not
- Good luck!
- I was so impressed!
- Great job on the site! It’s very well done, especially some of the visual design aesthetics. I don’t need to call it a “purely functional” site or anything.

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