Design and Implementation of the
Web-Enabled Sun, Earth, and Moon Systems (SEMS)

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ABSTRACT

The objective of this project is to improve the functions provided by the SEMS (Sun Earth Moon Systems) website at the University of North Dakota. Required improvements to the system include:

1. Change and improve the existing design of SEMS website.
2. Provide a Windows-like menu based design for the SEMS website. This will ensure that the site is versatile and easier to maintain as well as user friendly too.

This system allows the future developers to easily manage the content, layout, and overall appearance of the SEMS system irrespective of the different pages and their content. Individuals can browse through the many menu options to reach a new page without having to use the back button on the browser. This system is an Apache Web Server driven with PHP, JavaScript, and CSS rendering dynamic user interface. The improved system makes the future development and maintenance scalable and simple. The look and design of the UND base template is ever changing. The improved system ensures the ease with which changes can be made to meet the requirements of the university web space standards. The final system has made the website simple to use as it allows users to navigate through a menu-based system similar to a windows based design.

The research process requires the involvement of analysis, specification, design, validation, and testing collectively. There are two steps involved in the process of requirement analysis:

1. A great deal of brainstorming is helpful in understanding the user requirements; and
2. Careful consideration of the client’s requirements is essential in order to develop a model-based system.

Verification and validation ensure that the system meets the requirements of the user and guarantees that each function works according to the specifications outlined. Research on framework for modeling, evaluation, and enhancement of the SEMS website will be presented. The study of framework classifies common design scenarios into a set of generic categories and represents each category using measurable objectives and constraints that can be further analyzed and solved for optimality. The framework for the SEMS website is divided into three layers: application layer, generic design layer, and analysis layer. According to this framework, real-world website designs can be classified into distinct general categories.
CHAPTER I

INTRODUCTION

1.1 Significance

SEMS (Sun Earth Moon Systems) at the University of North Dakota is a project collaboration between Dr. Ronald Marsh of the Department of Computer Science and Dr. Timothy Young of Department of Physics. Helping the average person understand astronomy is the main mission of this project. This is to be achieved with the assistance of information technology and modern learning techniques. Showing the exciting and adventurous world of eclipses by live broadcasts and open discussion forums will help to draw the public into the learning process. To make the broadcasts more exciting and life like, SEMS webcasts use streaming color video including audio to broadcast from several locations world wide. Broadcasts have been aired from India, Panama, Spain, Turkey, French Guiana, Italy, and several different locations in the United States. A public outreach and informal learning project, SEMS works to instill the excitement of participating in a global community event.

1.2 Objective

The objective of the SEMS is to draw the public into the learning process by sensationalizing the adventure of hunting down and webcasting eclipses. Additionally,
SEMS works to show how rare eclipses are and to show that science can be exciting and adventurous. Finally, SEMS wants the public to experience the event in real-time. This is accomplished by webcasting the event. Additionally SEMS offer viewers the opportunity to communicate with the rest of the world, encouraging live discussion in the chatroom.

Improving the design of the SEMS website while following the University of North Dakota template and creating a user friendly atmosphere is necessary. The essential improvements to the systems interface include:

1. Change and improve the existing design of the SEMS website.
2. Provide a windows-like menu based design for the SEMS website. This type of environment is not only easier to maintain, but also makes the system extremely user friendly, more versatile and easier to maintain.

This system allows future developers to easily manage the content, layout, and overall appearance of the SEMS system irrespective of the different pages and their content. Individuals can browse through the many menu options without having to use the back button on the browser to make a new selection. This system is an Apache Web Server driven with PHP, JavaScript and CSS rendering dynamic user interface. The improved design makes future development and maintenance scalable. To comply with the University of North Dakota web space standards the SEMS team wants to change and improve upon the design of its site. The final system is simple to use as it allows user to navigate through a menu-based system similar to a windows based design.
1.3 Project Outline

The development of any project requires four steps: (1) requirement analysis and specification, (2) design, (3) verification and validation, and (4) testing. The process of requirement and analysis involves understanding the client’s needs and then developing a model based on those needs. The behavior of the project is shown by the model that is developed. A benefit of creating a model is that it helps you visualize functions of the system. This enables the developer to account for the internal complexity of the system.

The design process was accomplished with the use of IBM Rational Rose and Microsoft Visio program. Upon the completion of the design process, the new software system can be implemented. PHP, JavaScript, and HTML were used to complete the implementation process. PHP is a server side scripting language which has full access to the information that the server has stored in it, but very little access to the information the client has. In fact, it only has the information that the client tells the server and that the server has passed on to PHP. Due to the fact that all the information about PHP is on the server, it cannot be modified by the client. Rational Rose is an object-oriented Unified Modeling Language (UML) software design tool. This tool is intended for visual modeling and component construction of enterprise-level software applications. Microsoft Visio is diagramming software for Microsoft Windows. It uses vector graphics to create diagrams. The combination of all these technologies helped to assimilate and satisfy all the requirements and design specifications of the client.
Following the design process is verification, validation, and testing. The purpose of verification and validation is to ensure the software conforms to the client’s requirements. The final stage in the development process is testing. The methods used for this step were unit testing, integration testing, and black box testing. The system is rigorously tested for isolation and grouping of all hyperlinks through these methods to ensure proper functioning at all levels.

The final product created is an Internet based web system utilizing technologies like PHP (Hypertext Preprocessor), JavaScript, and CSS (Cascading Style Sheets) which delivers a dynamic web interface. The system serves as an educational website promoting awareness for natural phenomenon like solar and lunar eclipses.

1.4 Report Organization

Implementation of framework for modeling, evaluation, and enhancement of the SEMS website is introduced in Chapter II. Chapter III discusses the foundation surrounding SEMS and gives a brief history of the of the SEMS team research. Chapter IV describes requirement analysis and specification. This chapter contains the requirements and specifications outlined by the client. Chapter V describes the design process using IBM Rational Rose and Microsoft Visio. Visual aids such as Use Case Diagram, Activity Diagrams, and finally a Deployment Diagram help to describe the system. Chapter VI describes the implementation process. With the aid of code samples, this chapter gives an overview of the different modules in the system. Chapter VII discusses the verification and validation of the system using three different testing techniques. These techniques are
Unit testing, Black Box testing, and Integration testing. Chapter VIII is the conclusion including a brief discussion of the advantages and disadvantages of the system as well as future considerations.
CHAPTER II

WORLD WIDE WEB PROGRAMMING SOFTWARE AND TOOLS

World Wide Web programming requires specific software and tools to build the Internet based applications. The major players in the industry are the big corporations like Microsoft, Adobe, and IBM. They introduce new applications and tools required for both the client-side and server-side programming regularly. These tools are introduced every year and make the creation of web applications easier and more user friendly. Additionally, these products offer flexibility and scalability on a larger scale. If low cost or free software is what you are looking for there are open source applications like PHP and ASP. These applications encourage more individuals to try their hands at developing web applications.

2.1 Basic Web Programming Languages and Tools

Client-side programming and Server-side programming are two techniques used in electronic commerce programming:

- *Client-side programming*: This technique is used to develop software for use by your clients on their computers. This type of programming is most often used for web interface construction. The most popular languages used for this type of programming include but are not limited to CSS, DOM, (X) HTML, JavaScript, WML, WMLScript, XML, and XSL (T). Client – side programming is also used to
build such applications as address and schedule books and web interface construction. Dependent on the client’s operating system, the tools and languages for the client-side application development is chosen.

- **Server-side programming**: This technique is used to develop software for use on servers. Server-side software works by receiving requests from browsers then sending the results pulled from databases, files, or programs back to the browser for display. Popular languages for this type of programming include but are not limited to C/C++, Java, Perl, and PHP. This type of programming is used to implement many other applications, for example, instant messaging and telephony. Other common server-side programming software packages used for web development include; multimedia editors, HTML editors, and integrated development environment (IDE). These are discussed in detailed in the section that follows.

### 2.2 Multimedia Editors

Multimedia editors are used to create, edit, and post such applications as animation, audio files, images, and videos for web pages. Two popular multimedia editors provided by Adobe Systems Inc. are Flash and Photoshop. Flash, is an authoring environment for creating animation, advertisements, various web-page components, to integrate video into web pages, and more recently, to develop rich Internet applications. Flash Professional is an IDE while Flash Player is a virtual machine used to run, or parse, the Flash files. (Hu, 2007). Photoshop is software used in the creation of graphics and in image-editing.
2.3 HTML Editors

HTML editors are used in the creation of static web pages. Three of the most common HTML editors are:

- *Adobe Dreamweaver*, which is a WYSIWYG (What You See Is What You Get) authoring software that allows web developers to simultaneously generate HTML and JavaScript source code while viewing the site that they are working on.

- *Microsoft Expression Web* is used to develop more sophisticated standards-based websites. This is used for creating XHTML, CSS, XML, XSLT, and ASP.NET 2.0 and is a new user interface combining Visual Studio and FrontPage technologies. In some instances the interface and features of Expression Web and Visual Studio are identical.

- *Microsoft SharePoint Designer* allows information workers to develop applications and solutions on top of the SharePoint platform. This enables organizational agility, business process automation, and get the value of Microsoft Office applications on the SharePoint platform (Hu, 2007).

2.4 Integrated Development Environments

IDE (Integrated Development Environments) are software applications which provide web programmers a helpful platform for software development. An IDE generally consist of a source code editor, compiler and generally a debugger. Many modern IDE have a
class browser and class hierarchy diagrams for use with object oriented software development:

- **Adobe Cold Fusion** is an application server and software development framework used in the development of computer software for general and dynamic websites.

- **Microsoft ASP.NET** is part of Microsoft’s .NET platform. Programmers use ASP.NET to create dynamic web applications. This free technology is the replacement to ASP technology.

- **Microsoft Visual Studio** is Microsoft’s flagship development product for programmers working in web technology. This Microsoft Product is used by programmers to develop applications, websites, web applications, and Web Services.

### 2.5 Implementation of SEMS Framework

The framework (Yen et al, 2006) used for modeling, evaluation, and enhancement of the SEMS website is divided into three layers; application layer, generic design layer, and analysis layer. According to this framework, real world website designs can be classified into distinct general categories which can be further mapped into a particular graph modeled and solved by appropriate analytical techniques. This framework can be implored across different domains or sectors to evaluate and improve website performance. The study of framework classifies common design scenarios into a set of generic categories and represents each category using measurable objectives and constraints that can be further analyzed and solved for optimality.
2.5.1 Execution of the Framework—SEMS Project

The SEMS website is an ever growing project that has evolved from multiple stages of development with new web design evolving at many of the different stages. SEMS is a social media targeting website which demands effective web design for it to be successful. In the following paragraphs the different layers of the website design enhancement framework have been discussed and results show how the SEMS project has been analyzed and evaluated using the website design enhancement framework.

2.5.2 Application Layer—SEMS Project

At the application layer, requirement analysis was done to put together all the important features taken into consideration for a social media targeting website that meets the client’s requirements. One of the most important things for a social media website is that it should provide easy access to all the content on the website. This ensures that the process of learning is more interactive and convenient. Another requirement includes the speed with which page should load. It should be fast so the user has a minimal amount of time to wait to access content. The system should provide easy navigation for the users to access different WebPages on the system. The System structure should contain the entire website of a certain height and width. This will ensure ease of search. All related pages should be connected as well as limited links branching out from the target page. To guarantee easy navigation the number of pages should be kept to a minimum. The amount of time it takes to download a page should be kept to the bare minimum.
layout of each page should be kept consistent and is best if kept to one or two full screens limiting it to three. The background color for each page should be eye pleasing, and textual information should be presented in smaller units or with the use of multiple pages. All logos should be placed in the upper left and contained in a box on the home page. Additionally, a search box should be provided on the left corner of the page. Webmaster access to the administration page should ensure the content is secure and should be simple and easy so that website can be updated frequently and with ease.

2.5.3 Generic Design Layer—SEMS Project

In the process of transformation and exchange of data between the application layer and the graph based modeling layer, the user’s expectations need to be translated to specific website features. The general requirements of the website can be converted into objectives and constraints as follows (Yen et al, 2006):

- \((G1)\) Users should not be made to wait for too long for a page to download and the pages on the website should not be extremely busy:
  1. Number of hyperlinks on all of the pages of the website should have an upper limit. Not many pages should shoot or jump out of one page.
  2. Time taken to download a page should be limited. It should not take too long for the page to download and show up on the browser.

- \((G2)\) Users should be made aware of all the necessary minimum hardware and software requirements to access the website and those requirements should be minimal and readily available:
1. All the links should be provided on the website pages to download the necessary softwares and Plugins to access the website content fully.

2. Instructions should be provided on each webpage if it requires the downloading of new software or Plugins for its correct and proper functioning.

- (G3) All the pages on the website should be symmetrical and of same size and width. The content should be easily readable and easy to understand with the use of a more affable background color and font size:
  1. The background color used for the content should match a pleasing contrast with the color of the text fonts.
  2. Keeping the dimensions for all the pages the same make it easy for the user to interact with the system.

The same way the general requirements were converted into objectives and constraints the specific requirements can also be converted into constraints and requirements:

- (S1) The webmaster should be provided with a login interface to securely access the administration page. The login information should be kept secure and only the webmaster should be allowed access. Use of the back button on the browser should be discouraged after the login has been allowed access to the secure content.

- (S2) All the pages should be connected to ensure the user has access to all the pages at any given time.

- (S3) All different links for every page in the web system should be listed on every page for the user’s selection. It has been achieved in SEMS system using a navigation menu bar, which is present on every page.
• (S4) The time taken to load a page should be limited. The pages should not take too long to download or appear on the browser.

Next, all the constraints can be mapped into a four constraint-parameter tuple (Yen et al, 2006). Based on the accumulative objectives of the website, the design scenario is mapped using a minimum spanning tree to achieve maximum reachability with minimum cost and ease of reach to the user. Referring to Table for tuple formulation (Yen et al, 2006), the four constraint-parameter tuple can be methodized as follows:

• As per the casual observations, it has been determined that different pages on the SEMS system take different times to load. Accordingly, the first constraint of the tuple should be 2, as this means there is a nonsymmetrical cost of arc.

• There should not be too many hyperlinks coming out of any page. Accordingly, the second constraint should be 1.

• The users should be allowed to browse freely between all the pages. Therefore, the third constraint should be 1.

• Users should be allowed to reach the target through any number of pages in any sequence, this means the navigation design should be like a directed acyclic graph. Therefore, the fourth constraint should be 2. The design for SEMS website has been formulated by a tuple (2, 1, 1, 2).

2.5.4 Graph Based Modeling and Analysis Layer

The SEMS design scenario has been formulated into a four-parameter constraint tuple (2, 1, 1, 2). According to the author “The resulting four-parameter constraint tuple (2, 1, 1,
2) is a minimal spanning tree of NP complete” (Yen et al, 2006). Designing the website for the contribution toward the ease with which users can reach their main objective is of prime importance. It characterizes the mapping between the different layers, which has been instrumental in analyzing the website design scenario for the purpose and requirements of the webmaster and the users. The formulations demonstrated above can be examined for contradiction and further studied for web design enhancement. If inconsistencies are met then they can be improved on by defining the general and specific constraints again, maintaining compliance with the webmaster, designer, and the users in the generic web design layer.

2.6 Background for the Sun, Earth, and Moon Systems (SEMS)

SEMS has experimented with several forms of media such as video, audio, and chat rooms in addition to webpage design (Marsh, 2007). The addition of the chat room proved to be extremely well received as viewers could post questions for the SEMS team or chat with other viewers. In addition to this the team has begun to answer questions via audio stream. This however requires bandwidth which is not always readily available to everyone. This obstacle has sparked the SEMS team’s interest in the latest video compression techniques and their applicability to live camera originating streaming quality. To reduce the bandwidth requirements out of the University of North Dakota the SEMS team has developed a mirroring scheme enabling its world wide audience of more than 50,000 per broadcast to participate in their webcasts. To date SEMS’s webcasts have been mirrored by Penn State, Wilkes-Barre Campus in the US; the High Performance Computing Research Department at Lawrence Berkley National Lab in the US;
Universidad de Sonora in Mexico; University of Barcelona in Spain; Williston North Dakota School District in the US; and www.ParsSky.net in Iran.

Five computers currently make up the SEMS webcasting system. Currently, a User Datagram Protocol (UDP) connection is used to forward both audio and video from the laptop computer at the remote site to the servers located at the University of North Dakota. At UND there are four computers, one serves the website, another, the chat room, and two serve the streaming video to the world using IP multicast and two IP point-to-point techniques.

In the journal, Publications of the Astronomical Society of Australia, Dunlop (1999) reported that a significant portion of the Australian public did not know what caused the seasons, what caused the phases of the moon or if the moon rotates. Even more surprising and disturbing is that 59-74% of Australian elementary and high school teachers/trainees did not know the correct answers. U.S. Studies (Sadler, 1987; Baxter, 1989) have shown that only about 25-35% of middle school and high school level students could correctly answer questions about Moon Phases. A study conducted by Taragon (1987) found that these misconceptions seem to persist through college as 65% has no knowledge and 23% had fragmentary knowledge of the phases of the moon.

SEMS was created as part of a public outreach and informal learning project with the aim of increasing public interest in science. SEMS is primarily a website that uses educational materials about moon phases, lunar eclipses, and solar eclipses and hosts webcasts of
eclipses. To better meet the criteria of Social Media and given the public outreach nature of the SEMS website it has been redesigned several times. The Social Media criteria and SEMS meets them is as follows:

- Support conversational communication amongst participants. The SEMS site includes a chat room for this purpose.

- The website must be targeted towards people not organizations. The SEMS site is open and free to the public, the bandwidth requirements are kept low so more users can participate from home.

- Distribution instead of centralization. The SEMS chatroom is open and un-moderated, leaving users open to freely engage in conversations of their choosing.

- Use of a “push model” instead of a “pull model.”. SEMS ability to support a “push model” is limited because of the nature of the webcasts and the network bandwidth limits. However, participants are encouraged to contribute their photos for display on the SEMS website.

- Honesty and transparency by not attempting to control any conversation. No conversations are controlled as the SEMS chatroom is open and un-moderated.

Scientist too have fallen victim to stereotypes. To counteract the stereotype that scientists are boring we highlight the culture wherever our expedition is going. When possible the SEMS site provides links to local Internet radio stations and webcams. Attracting participants is important to social media targeted sites. Because SEMS is a social media oriented site to some extent, SEMS team is interested in website design and what might help attract participants.
Though there are some established criteria for the development of a website that includes a social media component; the development of such a site is not easy. According to a study by Channon and Simon (1996) which was focused on the development of a Graphic User Interface (GUI) for an instructional programming environment, it was found that the majority of students did not read handouts, did not follow verbal instructions, and became confused by the inevitable clutter of having too many windows open at one time. The study also found that the production of a system that is both functional and easy to use requires an early and continual focus on the part of the user, empirical measurement of usage, and iterative refinement of the design. Additionally it has been found that GUI’s are a good way to reduce the gulf between users and applications. The downside to GUI’s is that they are not easy to design effectively and poorly designed ones may be worse than a non-graphical alternative (Mackinlay, 1988).

According to Tan and Wei (2007), it doesn’t matter whether you use graphical or non-graphical websites as long as they exhibit consistency in design and conformance. Sites that do this will facilitate the cognitive mapping of the website forming better landmarks and route knowledge. This will reduce the cognitive load and in turn will improve perception of the information. Using a standard black on white for a website will enable the users to extract information more easily helping to establish a proper cognitive map. Another way to aid the users in developing a proper cognitive map is the use of navigation aids such as search engines. Yen et al. (2007) proposed a framework that consists of application analysis, generic design, and graph modeling to evaluate and improve website designs. Using their framework, website design could be mapped into a
generic design and then into an analytically solvable graph model; providing quantifiable measures rather than ad hoc approaches and qualitative assessments.

What types of graphics or images might be desired on a social media site? One might think that human images might make the site more intimate. However, several studies (Burgoon et al., 2000; Keisler et al., 1996; and Sproull et al., 1996) have shown that the issue is more about what images are better than text and less about whether images are better than text. A study conducted by Robins and Holmes (2008) looked at how the credibility of a website was impacted by its aesthetic treatment. This study showed that some amount of aesthetic treatment increased the credibility rating despite how low the rating originally was. Another study (Oh et al., 2007) found that consumers believe that they will save time and effort and obtain higher quality merchandise from websites that have pictures in the information displays. The study also states that retailers of web-based stores should use graphics that match to the needs and wants of their target consumers.

The rarity of eclipses, the number of participants, and the bandwidth required to support these webcasts makes designing a website very challenging. To overcome this, the SEMS team has an ongoing program to refine the website design keeping viewer feedback in consideration and while keeping the latest design criteria for social media websites in mind.

A websites success is also dependant on the design of the weblog. According to Du and Wagner (2006) the factors that determine a weblogs success are content, the technology used to support the weblog, and its social value. The content is either the written or
media provided. The technology used to support the weblog should be interactive and able to present and organize content facilitating social interaction among bloggers. The SEMS website has used pictures, interactive videos, and a chatroom which involves a user in not just a chatroom experience but a live experience. The weblog’s social value is measured by a community made up of the weblog host, frequent visitors, and the list of inter-connected blogs. Research by Shirky, 2003; Wagner and Bolloju, 2005 has shown that participants prefer a weblog that is read or commented on by many other people or linked by celebrities. Although the SEMS site does not yet have a user interactive weblog, technology options are being explored.

Webcasting is becoming more and more popular; webcasts of animals and nature are recent additions. On some sites participants have the ability to control what they see by controlling the camera remotely. We believe these trends will continue to expand. As technologies mature we may see them incorporated into webcasts. Two technologies below are ones that some developers expect to see in webcasting in the future:

- **3-D video streams:** Both Carmike Cinemas, Inc. and the Regal Entertainment Group have made significant investments in digital projection with 3-D equipment at their respective theatres. Carmike reported an increase of 250% of their box office share in the third quarter of 2007. Regal announced in the 2007 third quarter the addition of 25 REAL D 3-D units bringing their total up to 134 units. Both Carmike Cinemas, Inc. and the Regal Group want to give their patrons a more life like experience. As the cost of technology goes down we believe we will see 3-D technology in webcasts.
• *Full duplex video:* Full duplex video becomes possible as high bandwidth networking expands its global coverage. The ability for every participant to be able to see all other participants is a concern for some. A study by Cinnirella and Green (2007) argues that as we spend more time online it becomes increasingly important to consider the similarities and differences between computer-mediated-communication (CMC) and face-to-face (FtF) settings. It is obvious that with CMC one’s appearance can be hidden and finding suggests that the role of visual anonymity is worth looking into. A well established finding is that physical appearance is an important factor in social interactions because people are treated differently based on gender, race, age, ethnicity, and attractiveness and it is assumed that CMC can filter out these social cues. There have been many studies focusing on both the positive and negative effects of anonymity. In terms of Internet communications, a person can remain completely anonymous while still being open to express thoughts and emotions without fear of being identified and socially evaluated. One can experiment with new behaviors without fearing social consequences. We do not expect to see a wide adoption of this trend in the near future because of the technological difficulties of supporting a many-to-many video stream and the growing privacy concerns.
CHAPTER III

REQUIREMENTS AND SPECIFICATIONS OF THE SEMS WEBSITE

Requirements are the functions, services, and constraints the system should provide. The software requirements document should be precise as it provides information to the software developer about what the system is supposed to do. This could be thought of as a contract between the software developer and the buyer, Dr. Ronald Marsh, an associate professor of Computer Science at the University of North Dakota, provided the requirements for the SEMS website.

3.1 The Webcast

The ability to webcast the video of current lunar and solar eclipses is of the utmost importance to the SEMS team. However, there are few options available when webcasting or streaming audio or video. The two most common techniques are

1. **Point-to-point/HTTP**: This technique of webcasting requires every viewer to have separate connection into the broadcasting machine. The available bandwidth of the broadcasting computer limits the number of viewers who can connect to it.

2. **Multicast**: This technique requires only one connection to the broadcasting computer. A single stream of data is used, which is replicated and retransmitted to every outgoing connection. With the use of this technique the number of users is unlimited.
However, it consumes a great deal of network bandwidth, which is why ISPs (Internet Service Providers) block all multicast signals.

The SEMS team has created a hierarchical system using a combination of both point-to-point and multicast technologies combined with mirror sites. This option serves many more users compared to either of the techniques above individually. Figure 1 shows the integration between the users at home, the webcast location, the webcast facility at the University of North Dakota, and the fellow universities and colleges.

Figure 1: UND SEMS webcast methodology
The multicast technique is used for the viewers in the university system whereas the point-to-point technique is used for viewers sitting in their homes or any other location. As shown in Figure 1 the computer at the webcast location is connected to Internet 1. The webcast is mirrored through Internet 1 to different universities. These include Penn State University and Lawrence Berkeley Lab. At the time of webcasting the chatroom is being used frequently. This requires a great deal of bandwidth and computing power in order to run it. For this reason, the SEMS team uses 4 computers. The team has named these computers as follows; SEMS1, SEMS2, SEMS3, and SEMS4. SEMS1 is used for serving the webpages. SEMS2 is used as a chatroom server and SEMS3 and SEMS4 are used for point-to-point and multicast webcasting respectively. This is depicted in Figure 2.

![Figure 2: UND SEMS webcast facility](image)
3.2 Requirements

The client has indicated that he would like to change the outward appearance of the SEMS website, implementing the system on a Linux server using PHP, JavaScript, Flash, and HTML. First and foremost, the system should provide for easy navigation within the website. The basic requirements outlined by the SEMS team include:

- It should conform to UND website template standards.
- The content, layout, and appearance of the system must be independent of each other. The overall appearance is controlled separately using CSS (Cascading Style Sheets). The webmaster has the ability to change the appearance of the system by making changes to the style sheets and this will not affect the content of the system.
- The system should provide a user-friendly dynamic menu-based navigation system, which allows for extra space in order to accommodate additional functions. The existing system does not have a menu. This means when the webmaster needs to add a new function he is required to add a new button or a feature on the interface to order for the users to access that function. The new system has a menu and it allows the webmaster to easily add new functions on the menu instead of adding a new feature on the user’s interface.
- There should be an administrator’s menu, which allows the webmaster to schedule the website to change between pre, post, or during webcast pages after the flash introductory video. One of the most important requirements of the SEMS team is that during an eclipse logging into the site should direct users to the webcast video page and after the eclipse is over logging in should take users to the webcast photos page.
3.3 Specifications

Per the requirements, SEMS has a UND website template with a unilateral design for every page. The main page shows an image of the SEMS team as shown in Figure 3. When the user logs in, the main page is displayed with three different menus:

- **Navigation Menu Bar** (Figure 4) here you can choose from many options including; About SEMS, The Webcast, The Schedule, The Chatroom, The Expedition, The Blog, Past and Future Webcasts, About Moon Phases, About Lunar Eclipses, About Solar Eclipses, About Webcasting, SEMS Press Coverage, SEMS Photos, SEMS Sponsors, SEMS Software and Plugins, Support the Webcast, or Webmaster Login. Clicking on any of these options will assist your navigation through the SEMS site.

- **Header Menu Bar** includes options that will assist you in navigating from the SEMS site to various pages on the UND website. This is depicted in Figure 5.

- **Footer Menu Bar** includes the following options; UND Homepage, Computer Science Homepage, Physics Homepage, email Dr. Ronald Marsh, email Dr. Timothy Young. Clicking on any of the homepages will take you to the named homepage, while clicking on either of the email links will take you too an email page and either of the SEMS team leaders can receive a message. This is shown in Figure 6.
Figure 3: The main page

### 3.3.1 Navigation Menu Bar

The navigation menu bar, shown in Figure 4, displays the different navigation links the user has to choose from. Clicking any of these links will display the information contained within that descriptive link. The links to browse the pages in the website are menu based, provide subtle navigation, and is contained on each and every page despite the user’s location within the site.
Each menu bar link invokes different page as described below:

- The “About SEMS” link opens the introduction page on the SEMS website. This page contains information about the mission, goal, and objective of the SEMS team.
- “The Webcast” link invokes the page for the solar or lunar eclipse live webcast video. Here you can watch the current eclipse or, if there is not an eclipse occurring, then you can select the most recent video webcast.
- “The Schedule” link opens the page that shows the location and schedule for the upcoming webcast.
- “The Chatroom” opens a new webpage with a chatroom application that allows users to communicate with each other while the webcast is taking place.
• “The Expedition” link opens a new webpage which introduces the individuals who make up the SEMS team. A map with the location of the next webcast is included on this page. Individuals visiting the site will learn about basic geographical information such as climate population and cultural information.

• “The Blog” link opens the page that talks about the SEMS team’s experience of the most recent eclipse.

• “Past and Future Webcasts” shows on the map, all the past solar and lunar eclipses and future solar and lunar eclipses that the team is preparing for.

• “About Moon Phases” talks about the different, various moon phases. This includes what causes moon phases and a moon phase animator, which graphically depicts the phenomenon.

• “About Lunar Eclipses” talks about how and why lunar eclipses occur. This page includes information about why lunar eclipse occurs, the many types of lunar eclipses, and links to more information on the topic.

• “About Solar Eclipse” talks about how and why solar eclipses take place. This page includes information about why solar eclipses occur, the many types of solar eclipses, and links to more information on the topic.

• “About Webcasting” opens a page, which gives an introduction to the concept of webcasting and tells visitors what webcasting is. It also tells how the SEMS team makes the live webcasting possible.

• “SEMS Press Coverage” opens a page, which talks about the achievements and publications about the SEMS team in international and national news columns.
• “SEMS Photo” opens a page where the user will find all the pictures taken on the many SEMS team trips to various countries and regions.

• “SEMS Sponsors” opens a page, which discusses the contributions of various people and agencies towards the SEMS project.

• “SEMS Software and Plugins” opens a page that talks about all the software and plugins users need to successfully run the SEMS website on their respective machines.

• “Support the Webcast” opens a page where users order SEMS products.

• “Webmaster Login” opens up a page for webmaster’s administration of the site.

3.3.2 The Header Menu Bar

The header menu bar in Figure 5 is located under the header and contains the links to different departments and services provided by the University of North Dakota. The header menu bar has the following links:

• The “About UND” link invokes a new page, which talks about UND’s background and structure.

• The “Academics” link invokes a new page that is a resource for academic programs and services.

• The “Administration” link opens a new page which takes you to the administration page of University of North Dakota.

• The “GO.UND.EDU” link takes you to the admissions main page for information on the University of North Dakota.

• The “Athletics” link takes you to the athletics home page at the university.
The “Libraries” link invokes a page which talks about all the Libraries University located on the University of North Dakota campus.

The “Research” link invokes a new page which talks about the current and past university research interests.

The “Service” link invokes a new page that talks about the services the university has available.

The “Student Life” link invokes a new page, which talks about a student’s life on the campus. These include; activities, organizations, and services provided to the students.

3.3.3 The Footer Menu Bar

The footer menu bar shown in Figure 6 contains links to the UND home page, the Computer Science home page, the Physics Department home page, and links to email either Dr. Ronald Marsh or Dr. Timothy Young:

The “UND Home” link invokes a new page that takes you to the home page of the University of North Dakota.
• The “Computer Science Home” link directs the user to the home page for the Department of Computer Science. Here individuals will find information about the faculty and staff, admission requirements and courses offered.

• The “Physics Home” link directs the user to the home page for the Department of Physics. Here individuals will find information about the faculty and staff, admission requirements and courses offered.

• “Email Ronald Marsh” link prompts Microsoft Outlook to open a new page to email Dr. Ronald Marsh.

• “Email Timothy Young” link prompts Microsoft Outlook to open a new page to email Dr. Timothy Young.

3.3.4 Icons for Departments of Computer Science and Physics

Every page on the website contains the image logo for the Department of Computer Science and Department of Physics, shown in Figure 7.

![Figure 7: Icons for departments of computer science and physics](image)

3.3.5 The Administrator’s Menu

The webmaster is provided with an administration menu option. According to the requirements of the SEMS team, it works in different phases. It is necessary that after the introductory Flash video that the main page automatically switches to the appropriate page according to the specification of the webmaster. The options are “Pre-Webcast,”
“In-Webcast,” and “Post-Webcast.” In the “Pre-Webcast” phase, when the user logs in, the website shows the SEMS team photograph on the main page after the completion of the flash video introduction. In the “In-Webcast” phase, when the user logs in, the website switches from the main page to the live webcast video page after the completion of flash introduction video. In the “Post-Webcast” phase, when a user logs on the webpage, then the website takes them to the page where the photos for the most current eclipse are posted upon the completion of the flash introduction video. The administrator’s menu has a drop down list which allows the webmaster to choose from three options: “Pre-Webcast,” “In-Webcast,” and “Post-Webcast” accordingly. This is depicted in Figure 8. The selected option works by changing the front page of the website to the desired location according to the administrator’s selection.

Figure 8: Administrator's menu
3.3.6 Phases of the Moon

Figure 9 shows the phases of the moon page, which describes the many different moon phases. Basic information about the cause of the many moon phases is discussed on this page. Additionally, this page contains a moon phase animator that shows graphically the various moon phases and their scientific titles.

![Figure 9: Phases of the moon](image)

3.3.7 The Chatroom

Figure 10 shows the page containing the chatroom. This is where the users have the ability to chat with each other while the eclipse is going on. This encourages the exchange of information and sharing of experiences.
3.3.8 Past and Future Webcasts

Figure 11 is the page where information about all the previous and future webcasts can be retrieved. Here the users gain information about the past eclipses by clicking on the links. Additionally, hovering the mouse over the links shows the path of the eclipse on the world map.
3.3.9 Expedition Photos

Figure 12 is the page, which shows all the solar eclipse expedition photos. These photos were taken on the many expeditions by the SEMS team. They show landmarks, people, and other cultural experiences.
3.3.10 Solar Eclipses

Figure 13 is the page, which provides information about the solar eclipses. This page shows how solar eclipses take place, the reasoning behind the phenomenon, and the many types of solar eclipses that occur.

![Solar Eclipses Image](image)

Figure 13: Solar eclipses

3.3.11 Software and Plugins

Figure 14 is the page, which shows all the software and plugins required for running the SEMS website on individual user’s machines. This page contains images and logos for the software individuals may need to install plugins for. Clicking on the logo image will direct the user to a webpage where plugins for that software can be downloaded and installed.
3.3.12 Sponsors

Figure 15 shows the page, which has the listing of all the sponsors of SEMS project. Entering this page provides users with information regarding how to contribute financially to the project. It lists the names of individuals who have contributed towards monetary donations to the project. Moreover, logos containing links to other contributor’s website are also present here.
3.3.13 The Blog

Figure 16 shows the blog page where the SEMS team discusses their experience with the last solar or lunar eclipse. The SEMS team shares information such as their locations, the weather, and how the expedition is progressing.

3.3.14 Expedition

Figure 17 is a page about the expedition. This page is used to inform the user about the SEMS team, and its members. It introduces the individuals who make up the SEMS team. A map with the location of the next webcast is included on this page. Individuals visiting the site will learn about basic geographical information such as climate population and cultural information.
3.3.15 The Webcast

The Webcast page shows the video for the current solar or lunar eclipse, this is depicted in Figure 18. Here you can watch the current eclipse or, if there is not an eclipse occurring, then you can select the most recent video webcast.
3.3.16 The Schedule

Figure 19 shows the schedule for the current solar or lunar eclipse. This includes the location and time according to time zone. Below the schedule, there is a map that shows the location of the time zones.

![Figure 19: The schedule](image)

3.3.17 About SEMS

Figure 20 is the page that lists the mission, goal, and the objective of the SEMS team. Additionally, the logos of the SEMS team affiliations are located on this page.

![Figure 20: About SEMS](image)
CHAPTER IV

SOFTWARE DESIGN

IBM Rational Rose Real Time and Microsoft Visio have been used for designing and modeling of the software according to the specifications and requirements. Modeling is an essential part of any software system and plays a vital role in any development process. The language used for modeling, Unified Modeling Language (UML) is a language used for specifying, visualizing, constructing and documenting software systems. It uses various notations to express a software system in symbols and diagrams.

4.1 Use Case Diagram

Unified Modeling Language (UML) uses behavioral diagrams called use case diagrams. These diagrams provide a visual clarity and explanation of the functionality provided by the software systems in terms of their actors (users) and goals. A use case diagram usually has actors, associations, and various cases. A single use case is defined in the form of a horizontal eclipse and it represents a specific functionality of the software system. The actor in a use case diagram is the depiction of a human figure using sticks and figures; this represents the user working with the software system. Associations between the actor and the horizontal eclipses are represented by using a dotted line with arrows. Figure 21 is the use case diagram used in the development of the SEMS website.
Figure 21: Use case diagram
4.2 Activity Diagram

In Unified Modeling Language, an activity diagram represents the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control and data in a system. Activity diagrams and flow charts are extremely similar as they both show how data flows. Activity diagrams also show parallel and concurrent flows. In activity diagrams, we use activity nodes and edges to depict flow. Activity diagrams are used prior to the implementation of a project to model the flows. During analysis and design, activity diagrams are used to show behavior of operations. Two activity diagrams have been used. Figure 22 is the first activity diagram and shows the data flow in selecting one of the three options in the administrator’s menu. Figure 23 is the second activity diagram and shows the data flow for the webcast video page.
Figure 22: Activity diagram for selecting the options in administrator’s menu
Figure 23: Activity diagram for webcast page
4.3 Deployment Diagram

Deployment diagrams show the hardware for the system, the software that is installed on that hardware, and the middleware used to connect the disparate machines to one another. Figure 24 gives an overview of the software and hardware components of the system.

Figure 24: Deployment diagram
CHAPTER V

IMPLEMENTATION

HTML, JavaScript and PHP are used for implementation processes. The two types of modules used are client side modules and server side modules.

5.1 Client-side Modules

In the implementation of client side modules, HTML and JavaScript are commonly used. JavaScript has been used when launching a page in a new browser window. Below is a JavaScript sample code used to open a link in a new pop up webpage. The HTML code for the static pages is divided into three different files which are Header.html, Menu.html, and Footer.html and these files are called dynamically on every page using PHP. The primary reason for creating these files is to make the design of the system separate from the functionality. This ensures the ease with which a developer can add or change pages in the future.

```javascript
<SCRIPT TYPE="text/javascript">
    function popup( mylink, windowname ) {
        if ( ! window.focus ) return true;
        var href;
        if ( typeof( mylink ) == 'string' )
            href=mylink;
        else
            href=mylink.href;
        window.open( href, windowname, 'width=880, height=550, scrollbars=yes,
```
The JavaScript code above is used for opening a new page in a pop up window. This is done using JavaScript’s built in object named window, and properties like focus and open to execute the request. For the property open, the values tell the JavaScript object to open the window with a height 550 and a width 880, it should be resizable, and it should contain a scrollbar. The header, footer, and menu files are divided into separate files and called dynamically on every page using PHP as this enables the webmaster to more easily make additions to the page. For the client side coding please refer to Appendix II: Source Code.

5.2 Server-side Modules

The server-side module was implemented using PHP programming language. PHP is a widely used server-side scripting language which allows the programmer to build different web applications and has the ability to be embedded in HTML pages. All the interactions with the user are done through the HTML pages and a PHP callback file is then associated with every user action. The PHP files have various call back methods that can be executed. These include every user action and other actions such as logging in and uploading or downloading images. Below is an example of one of the PHP files.
The PHP script shown above has been used to switch between the three different versions of the home page. This is accomplished using the header method of PHP. As you can see on the second line of the code, the header function has been used to declare that the content type for the header should be html or text. This code is reading input from a file named home.txt. It redirects the browser to different header locations according to the value read from the file. The various PHP files used in the development of the SEMS website are as follows:

- **Index.php**: This page is loaded for the first time when the user logs in. It is here that all the different menus for the website are loaded.

- **Index_AboutSems.php**: This page loads the information about SEMS. This includes the goal, mission and objective of the SEMS team.
• *Index_AboutWebcasting.php*: This page loads the information about the technology of webcasting and how the SEMS team makes it possible to webcast the video.

• *Index_Expedition.php*: This page loads the information about the SEMS team expedition.

• *Index_LunarEclipse.php*: This page shares us the information about the lunar eclipses and educates the general public about how and why lunar eclipses take place.

• *Index_MoonPhases.php*: This page discusses the many moon phases. It talks about why the various moon phases occur. Additionally, this page contains JAVA-based moon phase animator, which graphically shows the phenomenon behind moon phases.

• *Index_SolarEclipse.php*: This page discusses solar eclipses and explains why they take place. It educates individuals about the many types of solar eclipses that occur, for example, the annular, total, and partial eclipse.

• *Index_Past_and_Future_Webcast.php*: This page shows a JavaScript based application which allows users to hover the over past and future eclipse listed dates. The result shows the path of the eclipse on the map. Moreover, if a user clicks on those links then it takes them to the page that discusses the past eclipse.

• *Index_Products.php*: This page shows the products for sale on the SEMS website. These include sunglasses and an SEMS T-shirts.

• *Index_Sponsors.php*: This page lists all the sponsors of the SEMS project. It includes all the images for the sponsors and if clicked they direct the user to the respective sponsors home page.
• *Index_Photos.php:* This page shares the photos from the recent and past eclipses. It includes pictures from the SEMS team’s many expeditions to various parts of the world.

• *Administrator.php:* When the webmaster logs in to the administrator’s menu and makes the change through a drop down table in the menu file then *write.php* saves the change in a text file.

• *Index_TheBlog.php:* This page shares the experiences of the SEMS team in regard to the most recent eclipse. There are also images for the most recent eclipse posted by the webmaster.
CHAPTER VI

SOFTWARE VERIFICATION AND VALIDATION

After the implementation of the software system, it is necessary to ensure that the system is built correctly and delivers the expected output, while maintaining accuracy. Verification answers the question, is the right product being built. Validation answers the question, is the product being built in right manner. Verification and validation are used to find any defects that may exist in the system. To ensure that all required specifications are met, the product development proceeds through many stages. Analysis is required to guarantee that all the functions have been implemented correctly and they perform according to the predefined specifications of the client. Before delivering the product to the client it is necessary to thoroughly test the software. This is an extremely crucial step in the software development process as it ensures all errors are uncovered and corrected.

- Unit testing
- Black box testing
- Integration testing

6.1 Unit Testing

The testing performed on every individual software component or module is called unit testing. The concept of unit testing differs when web systems are taken into consideration. Web pages consist of hyperlinks, content, and processes. Unit testing can
be performed on a webpage by testing links, buttons, and drop down lists. This highlights any errors encountered or associated with a particular page, although, it is not practical to test every possible link on the webpage as in many cases a web page is considered a single unit. Data validation is also performed for pages individually. In this project all PHP files were individually tested for links and buttons. JavaScript files were tested for every page to see if the pages opened in a popup window when required. Menu bars were checked individually to see if the links on them were working correctly. Every page of the project was tested individually and all conform to the specifications and needs of the client.

### 6.2 Integration Testing

Integration testing is the phase of testing where all the modules are combined and tested to insure that they work in coordination with each other. To discover errors in interfacing, integration testing is used. This is a technique used in developing the structure of the program in addition to conducting tests. The purpose of integration testing is to verify the functional performance and reliability of a software system. There are three different types of integration testing:

- **Top down**: As the name suggests this kind of integration testing requires the higher level modules to be tested first. This allows the high-level logic and data flow to be tested early in the system, while minimizing the need for the drivers.

- **Bottom up**: This technique is exactly opposite of top down testing technique. It starts testing at the unit level and deals with the simplest module before covering the high-level logic and data flow.
Big Bang: This technique can also be called umbrella testing as it performs the testing using both top down and bottom up approaches.

Integration testing starts at the index.php file, otherwise known as the main page. When the user types the URL in the web browser, they are directed to the main page of the website where an introduction flash video plays in integration with the loading of navigation menu bar, header menu bar, and footer menu bar. Any links clicked on the menu bars direct the user to the corresponding pages. A few of these instances are as follows. When a user clicks on the “past and future webcast” link on the navigation menu bar, a new page is invoked. This new page loads the links for all the past and future eclipses in integration with a world map in the middle of pages. A user can click on any of the links then hover the mouse over the map to see the path of the eclipse. Integration testing was used to examine this process and everything worked according to the specifications outlined by the client. On the webcast page the user can click on the drop down menu to select a webcast location. After selecting the webcast mirror, the user can click the “Play,” “Stop,” or “Mute” buttons under the video according to their needs. Integration testing was performed to ensure the proper functioning of this page.

6.3 Black Box Testing

Testing of a system without the internal knowledge of the system is called Black Box Testing. This type of testing ensures the correct functionality of the software. It includes the test samples as input, and then the software system is tested for output. It can be done by a group of users or an individual user. If it is done by the developers then it is called alpha testing and if done by an end user then it is called beta testing. Black box testing
has been performed for Administrator’s Menu, Header Menu Bar, Footer Menu Bar, and Bottom Links. The steps involved in this process are listed in the sections below.

### 6.3.1 Administrator’s Menu

The testing includes the following steps:

1. Click on Webmaster Login link.
2. Enter the Login Name.
3. Enter the Password.
4. Click the Login button.
5. Check if the page has a drop down menu with the options “Pre-Webcast,” “In-Webcast,” and “Post-Webcast.”
6. Select the option according to your choice.
7. Click on the Submit Button.
8. Check if a new page appears with “Click here to see the changes” hyperlink.
9. Click on the link and see if it takes you to the home page.
10. After reaching home page click on the “Skip Intro” link on the Flash video to see if it takes you to the previously selected choice on the administrator’s menu.
11. Repeat steps 1 to 5 and select all the options one by one to check their correct functionality.

### 6.3.2 Header Menu Bar

The testing includes the following steps:

1. On the home page Header Menu click on “About UND” link
2. Check if the About UND home page opens up.
3. Click Back button on the browser
4. Click the link “Academics” on the Header Menu.
5. Check if the home page of UND Academics opens up.
6. Click Back button on the browser
7. Click the link “Administration” on the Header Menu.
8. Check if the home page of UND Administration opens up.
9. Click Back button on the browser.
10. Click the link “GO.UND.EDU” on the Header Menu.
11. Check if the home page of UND Admissions opens up.
12. Click Back button on the browser.
13. Click the link “Athletics” on the Header Menu.
14. Check if the home page of UND Athletics opens up.
15. Click Back button on the browser.
16. Click the link “Libraries” on the Header Menu.
17. Check if the home page of UND Libraries opens up.
18. Click Back button on the browser.
19. Click the link “Research” on the Header Menu.
20. Check if the home page of UND Research opens up.
21. Click Back button on the browser.
22. Click the link “Research” on the Header Menu.
23. Click the link “Service” on the Header Menu.
24. Check if the home page of UND Services opens up.
25. Click Back button on the browser.
26. Click the link “Student” on the Header Menu.
27. Check if the home page of UND Student Life opens up.
28. Click Back button on the browser.

6.3.3 Footer Menu Bar

The testing includes the following steps:

1. On the home page Footer Menu click on “UND Home” link
2. Check if the home page of UND Home opens up.
3. Click Back button on the browser.
4. Click the link “Computer Science Home” on the Footer Menu.
5. Check if the home page of Computer Science Department opens up.
6. Click Back button on the browser.
7. Click the link “Physics Home” on the Footer Menu.
8. Check if the home page of Physics Department opens up.
9. Click Back button on the browser.
10. Click the link “Email Ronald Marsh” on the Footer Menu.
11. Check if the Microsoft Outlook’s email compose window opens up with Ronald Marsh’s address in it.
12. Click Back button on the browser.
13. Click the link “Email Timothy Young” on the Footer Menu.
14. Check if the Microsoft Outlook’s email compose window opens up with Timothy Young’s email address in it.
15. Click Back button on the browser.

### 6.3.4 Bottom Links

The testing includes the following steps:

1. On the home page Footer Menu, click on the Bottom links.
2. Click on the link “My UND.”
3. Check if the home page of UND Online Education opens up.
4. Click Back button on the browser.
5. Click on the link “A to Z index.”
6. Check if the home page of UND A to Z index opens up.
7. Click Back button on the browser.
8. Click on the link “Contact UND.”
9. Check if the Contact UND home page opens up.
10. Click Back button on the browser.
11. Click on the link “Spotlights.”
12. Check if the UND Spotlights home page opens up.
13. Click Back button on the browser.
14. Click on the link “Campus Scenes.”
15. Check if the Campus Scenes home page opens up.
16. Click Back button on the browser.
17. Click on the link “Calendars.”
18. Check if the Calendar home page opens up.
19. Click Back button on the browser.
20. Click on the link “Events and Features.”
21. Check if the Events and Features home page opens up.
22. Click Back button on the browser.
23. Click on the link “UND News.”
24. Check if the UND News home page opens up.
25. Click Back button on the browser.

6.4 Comprehensive Testing of SEMS system

Validation for web based system requires attention towards the user-visible actions and user’s awareness towards the output they are going to see. SEMS system has a dynamic menu which is the main focus for any user’s interaction with the system. Different changes in interface of the system are perceived on different actions performed by the user. Use cases defined by the use case diagram contribute too uncovering the errors found in the user’s interaction with the system. Many different test cases are used to uncover the errors are discussed in the following sections.

6.4.1 Administrator’s Menu

It can be discussed with two cases:

1. Webmaster login page (Figures 25 and 26) has the following anticipated results:
   - Change in the interface of the webpage.
   - After a successful login the webmaster is shown the administrator’s menu with different options.
2. Webmaster clicking on one of the options has the following anticipated results:

- System records the webmaster input into a file.
- System provides a link to see the changes created by selecting one of the options on the administrator’s menu.
A new webpage with a link to check the changes appears on the screen. After clicking on the link the system takes the control to the main page and changes can be seen after the introductory video.

6.4.2 Past and Future Webcasts

Past and Future Webcast Page (Figure 27) has the following anticipated results:

- A new webpage should appear with the whole world map in the middle of the interface.
- There should be hyperlinks all around the world map containing the links to the pages for past and future webcast

![Past and future webcast page before the user clicks on any links](image)

Figure 27: Past and future webcast page before the user clicks on any links

The provided links around the world map can take the users to desired page of past or future eclipse when clicked. Hovering the mouse over different links shows the
different paths the solar or lunar eclipse goes through in parts of the world (Figure 28).

![Figure 28: Past and future page after the user hovering the mouse on 2004 Oct 28 Total Lunar Eclipse link](image)

- Clicking on one of the links will open up a new page for the previous webcast showing information about it (Figure 29).

![Figure 29: Old SEMS website opening up after clicking on one of the links for Past and Future webcast page](image)
6.4.3 Chatroom

Chatroom Page (Figures 30 and 31) has the following anticipated results:

- A new Java chatroom application window should open up.
- The orientation of the application on the page should be like that it should not hide the webcast video if it is open in the background.

Figure 30: Main page before clicking on the chatroom link.

Figure 31: The webcast page after clicking on the chatroom link.
During the testing, it was found that whenever the link for chatroom was clicked, the system opened up the application in the center of the page, therefore hiding the webcast video if the webcast page was open in the background. Changes were made to the application so that it opens up on the left side of the page without hiding the video and letting the users watch the video and chat at the same time. The bug has been fixed.

6.5 Usability testing for the SEMS system

Usability testing is done with the users in the real time environment. It measures how easy it is to use the product and whether it meet the needs of the user. The aim of usability testing is to keep the users using the products under observation to discover errors and find out the areas of improvement. It follows the “Observe and Learn” approach and is a one on one process. The development team gets involved with the users of the software systems to resolve most of the internal issues. There are two different ways in which usability testing can be done.

1. *Format usability testing:* Formal testing involves building a usability testing lab which is equipped with several computing machines of different configurations and equipments for recording audio and video. It is also assisted with a team or staff of psychologists, technicians, and human-computer interaction specialists

2. *Informal usability testing:* It is entirely different from the formal setting. It does not require different equipment and does not include any audio and video recordings. The developers themselves can write down the plan and a task list on paper and
execute their plan with an unbiased view. The main advantage of this technique is that developers can actually see how users are interacting with the system in real life conditions.

This informal technique has been used to perform usability testing for the SEMS system. It was done on a real-time basis with the users involved and provided a great deal of input on how things can be made better. The users involved in the testing were family members and friends. The obtained feedbacks from the users are:

1. When the users wanted to use the webcast video page or the chatroom for watching the webcast video a popup appears for installing the required Plugins for VLC media player for the webcast video and JAVA for the chatroom. A new webpage named Software and Plugins was added to the system with links to various Plugins required for proper functioning of the system. Clicking on these links will take the user to the appropriate page where they can download the Plugins and install them on their machines to make the system work to its full capability on their machine.

2. While clicking on the schedule link the current time under different time zones did not appear. The problem was taken into account and was fixed by modifying the JavaScript code used for generating the time under different time zones.

3. The SEMS website was rendering in a different manner in different internet browsers. Now it has been fixed.
CHAPTER VII

CONCLUSION

This project meets all the requirements and specifications stated by the SEMS team. Overall this project was an effort towards educating and making the general public more aware of scientific phenomenon like solar and lunar eclipses. Moreover, it invokes new interest in the general public by involving them in live video webcast and chatting systems. This enables them to communicate with other while indulged in learning about these scientific phenomena. Although the design of the SEMS website is bound by a requirement of conformance to UND templates, the SEMS team has great interest in the development of a website that provides educational material and that uses social media design precepts to provide webcast participants with the most interactive experience possible. Therefore, the SEMS team has explored and touched upon the many criteria desired for the design of a successful website. A continual iterative refinement of the SEMS website design was also embarked upon.

7.1 Advantages and Disadvantages

The primary advantage of this system is that it educates the general public in a classroom like environment. The interested public can read about the different astronomical phenomenon on the webpages of the website and at the same time they can communicate with each other in the live chatroom. This simulates a classroom environment. This
encourages active exchange of knowledge between individuals promoting the education aspect of the mission of SEMS. Another advantage is that the structure of this website is extremely user friendly. Individuals with little or no knowledge about sun and moon phases can easily navigate their way about the site all the while learning about these sun and moon phases. The language contained was kept simple to ensure that the average person would be able to understand.

A major disadvantage of this system is that the site is not well advertised. There is not a wide knowledge base about this site. The average individual wouldn’t know about the live webcast or know where to look for it. Another disadvantage is that the current system is built using static HTML pages and PHP which makes it difficult to debug the current system and add new functionalities; it also hinders the developer’s ability to add advance features into it easily.

### 7.2 Future Considerations

The whole system can be implemented in a new way by the future developers using new technology like ASP.net. The main advantage of using technology like ASP.net is that it allows for object oriented programming techniques. These provide a great deal of scalability and flexibility. The most important aspect of the ASP.net technology is that it makes the application fast by using compiled code and caching. In the past the code was interpreted into machine language when the user visited your page. Now, ASP.net code is already compiled into “machine language” before the visitor ever comes to your site. This greatly improves the performance of the system. AJAX can be used in the future
development of this website. It helps to create better and faster web applications as it uses asynchronous data transfer between the browser and the web server. This allows the webpage to request small bits of information from the server instead of requesting the whole page. It is used to bring down the bandwidth requirement by generating the HTML locally within the browser. With AJAX the HTML code of the page (e.g. table with structures like `<td>` and `<tr>`) can be generated locally in the browser. This makes the AJAX webpage open faster than the HTML webpage as the total data coming down from the server is much smaller in size. Caching is another technique, which is used by the ASP.net technology. Basically, it is the storage of the information that will be reused in the memory location for faster access in the future. The future developers can set up pages that are commonly used to be cached in the memory. This can drastically improve the performance of the system as it allows fewer visits to the database.
REFERENCES


APPENDIX I

USER’S MANUAL

The developed web system allows the webmaster to login into the Administrator’s Menu, which allows the webmaster to change the settings for the page to follow up after the introductory flash video.

![Interface for administrator's menu](image)

Figure 32: Interface for administrator's menu

Change the Administrator’s Options

Take the following steps for changing the administrator’s options (Figure 32):

1. To change the options on the administrator’s menu click on “Webmaster login.”
2. Enter the user name and the password for webmaster.
3. Click on the drop down menu on the Administrator’s menu.
4. Check one of the options.
5. Press the submit button.
6. Click on the link “Click here to see changes.”
7. Reach the home page to see the changes.

Figure 33: Webcast menu

**View the Webcast**

Take the following steps for viewing the webcast (Figure 33):

1. Click on the link “The Webcast” on the main page.
2. Click on the drop down menu on the webcast page.
3. Choose amongst the “webcast video recording locations” options on the webcast menu.
4. Click on the Select button.
5. Click “Play” to play the video.
6. Click “Stop” to stop the video.
7. Click “Mute” to turn off all sounds related to the video.
Using the Chatroom

Take the following steps for using the chatroom (Figure 34):

1. Click the link Chatroom on the main page.
2. On the topmost left corner of the chatroom click on the button “Connect.”
3. Look on the bottom of the text box to confirm a valid connection with the chat server.
4. After connection confirmation message appears on the big text box enter your message in the chat text box and press enter.
5. Click in the text box under “Change nick to” to enter you nickname for chat purposes.
6. Enter your nickname and press enter.
7. Click on the help button to activate the help.
APPENDIX II

Source Code

Please contact Dr. Ronald Marsh (rmash@cs.und.edu) at the Department of Computer Science, University of North Dakota for the PHP source code of this project.

HEADER.html

The header.html file contains all the code for the UND header image (Figure 35) and the SEMS header image. It also contains the code for the header menu.

Figure 35: Header

```html
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">
<html lang="en">
<head>
<title>SEMS - Sun, Earth, Moon System</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<meta name="Description" content="SEMS - Sun, Earth, Moon System">
<meta name="Keywords" content="SEMS, Eclipses, University of North Dakota">
<link href="/web_assets/stylesheets/und.css" rel="stylesheet" type="text/css">
</head>
<body bgcolor="#E6E6DC" PreloadImages('web_assets/graphics/misc/nav_search.gif">
<div align="center">
<table border="0" cellpadding="0" cellspacing="0" class="POSITION_website">
<tr>
<td class="LINK_hidden"> <a href="#maincontent">Skip to main content.</a> </td>
</tr> <tr>
<td class="POSITION_header">
<table width="100%" border="0" cellspacing="0" cellpadding="0">
```

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MENU.html

The menu.html file consists of the code for the Navigation Menu Bar. The navigation menu bar (Figure 36) allows the user access to any page through from one menu bar. This helps make it easier to navigate through the website.
Figure 36: Menu Bar
<table>
<thead>
<tr>
<th>Link</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>About Solar Eclipses</td>
<td><code>index_SolarEclipse.php</code></td>
</tr>
<tr>
<td>About SEMS</td>
<td><code>index_AboutSEMs.php</code></td>
</tr>
<tr>
<td>About Webcasting</td>
<td><code>index_AboutWebcasting.php</code></td>
</tr>
<tr>
<td>SEMS Press Coverage</td>
<td><code>index_Press_Coverage.php</code></td>
</tr>
<tr>
<td>SEMS Photos</td>
<td><code>index_Photos.php</code></td>
</tr>
<tr>
<td>SEMS Sponsors</td>
<td><code>index_Sponsors.php</code></td>
</tr>
<tr>
<td>SEMS Software &amp; Plugins</td>
<td><code>index_Software.php</code></td>
</tr>
<tr>
<td>Support The Webcast</td>
<td><code>index_Products.php</code></td>
</tr>
<tr>
<td>Webmaster Login</td>
<td><code>Administrator.php</code></td>
</tr>
</tbody>
</table>
The footer.html file has the code for the Footer images (Figure 37) and the links for the emails to the SEMS team. It contains the Footer menu bar, which contains other UND links.

Figure 37: Footer