AN AJAX BASED TECHNICAL FORUM FOR THERMODYNAMICS COMMUNITY

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Master of Science
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Siva Krishna Hari
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The Undersigned Faculty Committee Approves the

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An AJAX Based Technical Forum for Thermodynamics community

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I dedicate this thesis to my family. I could not have completed this without their endless love and support.
ABSTRACT OF THE THESIS

An AJAX Based Technical Forum for Thermodynamics Community
by
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Master of Science in Computer Science
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Mechanical Engineering is a very traditional field where the advances of modern IT is yet to reach. At clearly, a need exists for facilitating discussion among a diverse group of engineering students, educators and professionals.

The purpose of the project is to provide the user with an interface that allows him to participate in discussions on various topics. It will use email (inbox) type of interface where users can add, delete, star, and archive a comment. Any new and unread comments will be highlighted. When a question is answered, user will be informed via email. It also includes a powerful nested search functionality where the user can search with in his previous search results.

Interface is developed using JavaScript with prototype framework. Java web service is used in back end with MySQL server handling the data.
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CHAPTER 1

INTRODUCTION

A Web Forum is a site where people interact by posting messages. These messages are saved and displayed when the user returns to the forum. These messages/discussions are visible to all the users using the Forum website depending on their access levels. Some common terms used in a Forum are threads, topic, reply, etc. A thread is the central part of a conversation. A thread can be started off with a question, suggestion, or a detail about a topic. A user can add his comments to a thread by replying to it. Forum has a hierarchical/tree-like structure, where thread acts as the root and the replies attached to the thread act as branches/leaves. In a forum, there can be any number of threads and a thread can have any number of replies. A forum may require you to sign in to read/post messages. Most of the forums allow users to read messages without having to log in. But to post messages user has to log in to the forum. To log in to a forum user has to complete a registration process and depending on the access level, he can post, update and delete messages from the forum. There are different access levels for a forum. The most basic access levels are Administrator, Moderator and User. An Administrator manages the technical details required for the forum like promoting/demoting a user to moderator, managing the rules, performing database operations. Moderators are the users with special permissions to edit or delete a post, keep a forum clean from spam messages, answer some specific questions from users related to forum. End users are the users with basic access rights; they can post a new thread or add reply to an existing thread. Their posts go through the moderators for review and then get published on the website. A forum is very helpful for users who need help or suggestions about something. Forums are very helpful in sharing information, getting help on a certain topic, suggestions, and also can be used as a help site for certain tool. Major software companies like Microsoft (MSDN), Google, and Apple use forums as a means of communication with their users. Forums save old messages, hence can be searched for a question that was posted a year ago and find the answer instantly [1].
The Expert System for Thermodynamics (TEST) is a web-based tool developed at San Diego State University for education of engineering thermodynamics. This tool has pages containing schematics, equations, animations, thermodynamic explanations, and embedded Java Applets, called daemons, organized in a hierarchical tree structure. TEST is being used vastly by the educators and students across the world.

This thesis focuses on designing a Web Forum for thermodynamics community where users of the TEST website can interact with each other and get help. This being an AJAX based forum, users can view new messages almost immediately. Users can mark a thread as important, archive threads of no interest, search for older threads, post new questions, and reply to existing threads. Students can post questions by categorizing their questions to a specific chapter/topic or set of chapters/topics. Administrator can moderate the forum by deleting spam messages, creating new threads, helping users by providing answers to their questions.

This thesis begins with a background on Blogs and Forums, the history of their development, usage and its significant contribution towards information sharing. Then I will discuss about the technologies used for building the forum, an introduction to the web based Thermodynamics tool ‘TEST’, features that were developed as part of this thesis for Forum and integration of Forum into TEST. Instructions are provided on how to use this forum, and best practices in using this forum. Finally, this thesis concludes with a summary of results, performance statistics and any future enhancements that can be done on this thesis.
CHAPTER 2

BLOGS AND FORUMS

Blogs are more like simple web pages or journals available on the web with other people contributing with comments. It is a collection of one person’s thoughts on a particular topic or a set of diverse topics. A typical blog combines text, images, and links to other blogs or web sites. The term ‘blog’ is a shortened form of weblog or web log. Individual articles on a blog are called “blog posts”, “posts” or “entries”. A person who posts these entries is called a “blogger”. A blog comprises of text, hypertext, images, and links (to other web pages, videos, audio and other files) [2]. Blog uses a conversational style of documentation often focusing on a particular area of interest of the blogger. The posts are arranged in a chronological order from the most recent post at the top of the main page to the older entries towards the bottom.

Like with the start of the most of the things, early bloggers did not have a name for what they were doing. Blogging has been around since the beginning of the internet but without a proper name. At the beginning of the internet Tim Berners-Lee at CERN begins keeping a list of all new sites. In June 1993, Netscape begins running it’s “What’s New!” list of sites. In January 1994, Swarthmore student Justin Hall created a blog, Links.net. In April 1997 Dave Winer launched Scripting News and later on his company, Userland, launched blog related software like Frontier, Manila, etc. [2].

In the early days of World Wide Web, programmers used typical markup languages in order to format the information for effective reading. Later, more What You See Is What You Get (WYSIWYG) tools arrived allowing more people including non-programmers to publish content over the internet with a much simpler way without needing to have any programming knowledge [3]. With the introduction of Content Management Systems (CMS), web management tools enabled people to add and edit information on their web pages merely by editing the text in a web form. Once the form is completed and submitted, the web page was updated immediately. Users are now able to publish their content to global audience. Once the websites/web pages started growing in number, some people made it a practice to
monitor the web, identify new sites of value to their readers and post the links and short
descriptions in their web pages. Justin Hall started his “Filter Log” in 1994 [4].

The term “weblog” was first introduced by an online diarist Jorn Barger on
December 17, 1997. He used the term “web log” to describe the simple web pages people
made to post links to interesting sites that they had found while surfing the web [5]. The short
form, “blog”, was first used by Peter Merholz, who jokingly broke the word weblog into the
phrase we blog in the sidebar of his blog peterme.com in April or May 1999. Shortly
thereafter, Evan Williams at Pyra Labs used “blog” as both noun and verb [5]. Evan used the
phrase “to blog” which meant “to edit one’s weblog or to post to one’s weblog” and finally
devised the term “blogger” in connection with Pyra Labs’ Blogger product, leading to the
popularization of the other terms. After a slow start, blogging rapidly gained in popularity.
Blog usage spread during 1999 and the years following. Since 2002, blogs have gained
increasing notice and coverage for their roles in breaking, shaping and spinning news stories.
In June 2003 Google launched Adsense which matches ads to the blog content. This way
blogs were a source of information and revenue [5].

In contrast to a blog, an internet forum is not a simple webpage. It is a discussion area
on a website, with website members able to post discussions and read and respond to posts
by other forum members. A forum can be focused on any subject and any number of users
can participate in the discussions. Users can start their own topics and any user using the
forum can participate by adding posts to the topic. There will be a forum administrator with
certain special rights and responsibilities. A forum administrator can modify threads as well
as move or delete threads if necessary.

The precursor of the discussion boards was the USENET [6]; a series of virtual
bulletin boards that as early as the mid-1970s allowed anyone with access to the Internet to
post a message to any “newsgroup” at any time. Early internet forums could be considered as
a web version of an electronic mailing list or newsgroup. Early web-based forums date back
as far as 1994. A sense of virtual community often develops around forums that have regular
users. Forum software packages are widely available on the Internet and are written in a
variety of programming languages such as PHP, Perl, Java and ASP. Each forum offers
different features, from the most basic, providing text-only postings, to more advanced
features, offering multimedia support and formatting code. These days several weblogs incorporate forum features by allowing users to post comments for any blog post.

An internet forum is referred to as “reader centered” or focusing upon the user of information as opposed to the creator of information. The forum is an integral part of e-learning; many of the major platforms for e-learning incorporate a Forum/Discussion board. The main reason to build a forum over a blog is the advantage of having user interaction. The main advantages of having a forum are:

1. Any user can start up a topic and discuss it with other people in the Forum.
2. A moderator can edit and reply other people’s posts to control the forums.
3. Forum helps the user to get more information about website it is built for.

Although there are some key advantages of having a forum, there are some disadvantages associated with them. One of the main disadvantages is to always have someone moderating the forum to avoid spam messages. One other disadvantage is security issues like SQL injection and XSS (cross site scripting). I will talk more about SQL injection and XSS in Chapter 6. If right measures are taken, above mentioned disadvantages can be overcome which will lead to a user friendly forum.
CHAPTER 3

WEB 2.0 METHODOLOGIES

3.1 INTRODUCTION

The first generation of World Wide Web consisted of static web pages published by individuals to their websites and all users could just passively read the published content. With the introduction of Web 2.0, users can not only access the data that is on a Web 2.0 site but can also control the data [7]. Web 2.0 mainly refers to the transformation of web pages from static to dynamic web sites that allows users to do more than just viewing the websites. A web 2.0 site gives the user ability to edit the current web pages and add more appropriate/relevant data without having access to the actual database or the web server. User can actually edit content with the user interface available due to the Web 2.0 methodology. All through the browser, Web 2.0 provides user with more user-centered design than Web 1.0 and promotes interactive information sharing and collaboration on web. A Web 2.0 site gives its users a choice to interact with each other in a virtual community.

3.2 TECHNOLOGIES USED IN WEB 2.0

Web 2.0 is a collection of different web development technologies. AJAX and JavaScript are used on client-side, while PHP, Perl, JSP, etc. are used as server-side languages. Here, for this thesis we have used AJAX, JavaScript, Java and PHP.

3.2.1 AJAX

AJAX stands for Asynchronous JavaScript and XML [8]. It is a group of interrelated web development methods used on the client side to create more interactive web applications. AJAX is used to create a web application that communicates with the server and updates the web page on the front end without having to refresh the current page. There is a very little lag time between the user click and the resultant output. For example, Google Maps is one of the major users of AJAX technology. There is a very little lag time when you scroll around the map, zoom in or out of a place and you don’t have to wait for a page to
refresh or reload. One other major usage of AJAX is auto-complete search box, which gives you related suggestions when you type in to the search box.

Any client-side activity such as data validation, which does not need to communicate with the server for a response, is handled by the engine itself. Only when the engine needs to communicate with the server for a response, the action takes place in the form of a JavaScript call to the AJAX engine [9]. This request is made asynchronously without interrupting user’s interaction with the application. Hence, the user will not even notice that an interaction with the server is taking place in the background.

### 3.2.2 JavaScript

JavaScript is an object-oriented scripting language which is used to enable programmatic access to objects within both the client application and other applications. It is simple to comprehend, easy to use, general purpose scripting language. When used in conjunction with a web browser’s Document Object Model (DOM) [10], it can produce powerful dynamic HTML browser-based applications. It is a cross-platform, object-based scripting language that can be included on web page to make it more interactive. You can use it to check or modify content of forms, change images, open new windows and write dynamic page content. You can even use it with CSS to make Dynamic Hyper Text Markup Language (DHTML) pages. This allows you to make parts of your web page appear, disappear or move around on the page. JavaScript only executes on page(s) that are on your browser window at any set time. When user stops viewing that page, any script that was running on it is immediately stopped [11].

JavaScript is an interpreted programming or scripting language supported by web browsers and other web tools. JavaScript is most often used for client-side web development. JavaScript code forms part of HTML page and can be used for things such as responding to user actions or performing data validation on the client side.

Prototype is a JavaScript Framework which was designed to ease development of dynamic web applications. Prototype provides various library functions for developing JavaScript applications. Functions may range from simple programming shortcuts to major functions for dealing with XMLHttpRequest (XHR). Prototype makes dealing with Ajax
calls very easy and it is cross-browser compatible. Prototype JavaScript Framework provides support for Object Oriented Programming [12].

3.2.3 JSON

JavaScript Object Notation (JSON) is derived from JavaScript programming language to represent simple data structures and associative arrays, called objects. Despite it being derived from JavaScript, it is language-independent and is available for most programming languages. It is an ideal data exchange format for Ajax web applications due to the fact that it can be easily parsed by JavaScript. Before an asynchronous call is made through JavaScript, client formats the data in JSON and sends it to the web server as a SOAP message. Web server receives SOAP message, parses JSON object and processes data [13].

JSON is a lightweight data interchange format built on two structures:

- A collection of name/value pairs. In various languages, this is realized as an object, record, struct, dictionary, hash table, keyed list, or associative array.
- An ordered list of values. In most languages, this is realized as an array, vector, list, or sequence [14].

The basic JSON types are:

- Object (a collection of key-value pairs, comma-separated and enclosed in curly brackets)
- Array (an ordered sequence of values, comma-separated and enclosed in square brackets)
- String (double-quoted Unicode with backslash escaping)
- Number (integer, real, or floating point)
- Boolean (true and false)

JSON format is an unordered set of name-value pair object which begins with a left brace and ends with right brace. Name and value are separated by a colon, and the pairs are separated by a comma. Following is an example of JSON string that represents an object Person. The object has string fields for first name and last name, contains an object representing address, and age.

```json
{
    "firstName": "Siva",
    "lastName": "Hari",
    "address": {
        "streetAddress": "6868",
        "city": "San Diego",
    }
}
```
Suppose the above string is contained in the JavaScript string variable JSON_Person. One can recreate the object describing Siva Hari with a simple eval() method as following:

```javascript
Var p = eval("{" + JSON_Person + "");
```

The fields with in the object can be accessed using object notation `p.firstname`, `p.lastname`, `p.address.city`, `p.age`. eval() should be used only to parse trusted JSON strings. Parsing a wrongly formatted JSON string will produce unexpected and unwanted results. JSON from only trusted sources should be executed using eval().

### 3.2.4 DOM

The Document Object Model (DOM) is a platform and language independent interface that allows programs and scripts to dynamically build documents, navigate through their structure, and add, modify or delete elements and content of documents. Programmers can access, update or delete the style and structure of any document. The document can be further processed and the results of that processing can be incorporated back into the presented page. Here, document is modeled as object which contain behaviors of document and objects inside it [15].

A W3C standard that defines a standard way to access and edit HTML documents is called HTML DOM. It provides an object model and programmatic interface for HTML. It also defines objects, properties and functions for HTML elements. The entire HTML document can be presented in a tree structure. Everything in a HTML document is considered as a node. All these nodes have a hierarchical relationship to each other. The nodes can be accessed with any programming language. Any node in HTML DOM can be accessed either by its ID or tag name or navigating the entire node tree [15]. Document is root object and we can use different methods defined in the DOM to access any node by simply passing the id or tag name to the calling function. Once we get node reference, we can use different methods of node object to modify HTML DOM at runtime by programming languages like JavaScript and provide user with better client side experience.
3.2.5 CSS

Cascading Style Sheets (CSS) were designed for separating the content from its presentation. Once the browsers started supporting many tags, it became necessary to create web sites where the content of HTML documents was separated from the presentation. Users can define colors, fonts, layout, and other aspects of document presentation in the CSS [16]. Every HTML element can be assigned a specific set of styles which are defined in the CSS and apply it to as many web pages as you want. All elements in the web page having the same style can be updated automatically by only making one change in the style sheet. Styles can be either attached as a separate document or embedded in the HTML document. Also, multiple style sheets can be imported in the same HTML document. Styles can be defined in various places like in an outside file, that means as External style sheet, inside the <head> tag, that means, as Internal style sheet, or inside a HTML element, that means, as Inline style [17].
CHAPTER 4

THE EXPERT SYSTEM FOR THERMODYNAMICS – TEST

4.1 INTRODUCTION TO TEST

TEST is a web-based tool developed at San Diego State University for a wide-ranging education of engineering thermodynamics. It is a grouping of hundreds of HTML pages combined with the power of Java and AJAX programming to offer a visual environment for students and educators to analyze thermodynamic problems. These pages have schematics, equations, animations, thermodynamic explanations, and embedded Java Applets, called daemons, organized in a hierarchical tree structure which make TEST a general-purpose visual tool for solving thermodynamic problems and performing what-if scenarios online for students and professionals [18].

TEST is an extremely powerful and unique web ware for learning, teaching, and practicing thermodynamics. It covers entire range of topics taught in most engineering thermodynamic courses distributed across 16 chapters. TEST stands out of the other available software owing to its visual effects which allow users to visualize thermodynamic principles and systems through animations and solve complex problems using its daemons and RIAs. EES [19] is a comprehensive thermal-science programming language that runs in the Microsoft Windows environment. TPX [20] is an Excel plug-in where the core thermodynamic state can be evaluated by entering two independent properties. Thermoptim [21] is Java application for analyzing thermodynamic cycles and can be run over the web. The Qualitative Reasoning Group at Northwestern University has developed a Windows installable application named CyclePad [22] which allows users to construct and analyze a wide variety of thermodynamic cycles. None of these packages, however, are comprehensive enough to cover the diverse range of topics covered in engineering thermodynamics.
4.2 Reason for Building a Forum

TEST is an extremely powerful tool for learning and sharing information about thermodynamics. With the increase in number of users and newer web technologies like Web 2.0, TEST needs a user friendly interface to communicate. Emailing can be an option, but it will be really difficult for the administrator to reply to each email and it will limit the expertise knowledge to just one person. There is a need for a medium for the users using this tool to communicate with other thermodynamics community members to share information. They need a way to communicate their views, questions, answers, and discuss about various thermodynamics topics. And Forum fulfills the need perfectly as this will allow any member of the thermodynamics community to post a comment, question or a discussion topic that can be viewed and replied by any user in TEST. You will be surprised how fast moderators can incorporate user feedback using Forums. Moderators will be notified once a question is posted to the forum and user will be notified once a question or comment posted by the user is answered.

Using AJAX, Forum can unobtrusively store and retrieve related data from database. When users interact with the Forum, browser will asynchronously transfer only relevant data required to complete a transaction. This results in a better application performance and in turn a better user experience. With a registered user base of more than 10,000 educators, professionals and students, TEST Forum can be used as a very good and efficient means of communication between the Thermodynamics community.

4.3 Forum

TEST is divided into different sections for ease of access to its users. Forum is one of the sections and requires a user login to access the Forum. Forum tab is present in the navigation bar present at the bottom of the web page (see Figure 4.1).

![Bottom tool bar on TEST home page.](image)

The bottom navigation bar makes moving to another module just one click away. This bar always stays at the bottom of page no matter what section you are accessing, hence making every part of website quickly accessible for user.
The forum has a layout of a typical email inbox with every comment treated like an email. Given the variety of thermodynamics topics, Forum has been organized based on the topics. Forum has two lists of topics organized on both sides of the page. They are always present when clicked on the Forum section. Left side list contains different modules of TEST, bug report, overall comments, etc. The right side list contains 15 different thermodynamics topics. Clicking on each of the topics will populate the central div with threads related to that specific selected topic.

The Forum is designed in order to have more user friendly experience with more user controls similar to an email account. User can select a topic by checking on the check box available and latest 100 threads along with their comments/replies will be populated in the central div. Users can star important comments, archive them, edit any of their existing comments, add a new comment/thread, search for any of the string in the comments list, etc. User can edit a comment only if it is posted by him/her. User cannot edit comments that are posted by other users. User can post a new thread by clicking on New Thread button.

Following are the features available for the users when using this Forum:

1. Post a thread/comment
2. Search for a thread/comment
3. Tag/untag a thread/comment
4. Archive/un-archive a thread/comment
5. Edit an existing thread/comment
6. Perform a deep search
7. Traverse to an older/newer batch of comments
8. Perform AND/OR selections of the topics and view threads based on the selection
9. Delete a thread/comment (Admin only)
10. Move a thread from one topic to another (Admin only)

All the above features and others will be discussed in the following sections.

4.4 Design of Web Forum

The first step of the project was to build a web service to facilitate the data transfer between the browser and the database. This synchronizer is called from the front end to make a web service call. The parameters are sent to the backend java file which builds a query dynamically based on the request from the client and queries the database and then sends
back the results. These results are rendered on the front end to the user by BlogDiscuss.js file by building the page dynamically (see Figure 4.2).

Major objects involved in the project are: oComment, oTopic, oBlogProfile. Figure 4.3 shows the structure of each of these objects.

- **Topic class** contains the data related to the chapters/topics available in the forum. ForumProfile contains information related to the user’s personal settings for the forum. Comment is the class which contains all the information about a comment.

  Under Topic class, sTopicKey contains the key of the topic/chapter. This is the identifier for the topic. sValue is a string that contains the value of topic which will be displayed to the user. iIndex and sOrientation control the location of the topic/chapter within the selection tables. sOrientation defines if the topic belongs to left or right chapter table and iIndex defines the row at which the topic should be displayed. sTopicToolTip contains the tool tip about the topic which will be displayed to the user when he/she hovers over the topic.
**Figure 4.3. Key classes used in forum.**

<table>
<thead>
<tr>
<th>Topic</th>
<th>ForumProfile</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>sTopicKey: string</td>
<td>aiStar: array</td>
<td>iCID: int</td>
</tr>
<tr>
<td>sValue: string</td>
<td>aiArchive: array</td>
<td>iTID: int</td>
</tr>
<tr>
<td>iIndex: int</td>
<td>aiRead: array</td>
<td>iPID: int</td>
</tr>
<tr>
<td>sOrientation: string</td>
<td>aiNew: array</td>
<td>iFID: int</td>
</tr>
<tr>
<td>sTopicToolTip: string</td>
<td>aiArchiveT: array</td>
<td>iAccessLevel: int</td>
</tr>
<tr>
<td>sExplanation: string</td>
<td>aiPrefView: array</td>
<td>asChapter: array</td>
</tr>
<tr>
<td>iCount: int</td>
<td>aiChapSelect: array</td>
<td>sSubject: string</td>
</tr>
<tr>
<td>iMaxId: int</td>
<td></td>
<td>sBody: string</td>
</tr>
</tbody>
</table>

iCount contains the number of comments that belong to each topic. iMaxId is the latest comment id within the topic.

ForumProfile class contains the customized information for each user that was saved from user’s last visit to the forum. aiStar is an array that contains all the comment ids that were marked as star by the user. aiArchive is the list of comment ids that were marked as archived. aiNew is the list of comment ids which help in tagging new comments that were added between the user’s last and current visit. aiArchiveT contains the list of threads that were archived. This is used in marking all the threads and its child comments to be displayed as archived. aiPrefView contains the default view of the comments that was selected by the user. aiChapSelect contains the list of chapters that were selected when the user logged out of the forum from his/her last visit.

Comment class contains all the details about each comment. iCID is the comment id, iTID is the thread id that the comment belongs to. iPID contains the parent id of the comment which is different from iTID. Parent id is the comment id to which the current comment has been replied. iFID is the forward comment id which contains the comment id of the next comment that follows this comment. asChapter contains the list of chapters that this comment belongs to. sSubject is the subject of the comment, sBody contains the actual comment made by the user. sType is used to check if the comment made was a question, comment or an
answer to some question that was posted in the forum. sTimeCreated and sTimeModified contains the dates when the current comment was created and when it was last modified. There are many other classes defined as part of this application but the above mentioned classes are the key ones that drive the application.
CHAPTER 5

FORUM

This chapter explains the layout of the forum and various features available for the users.

5.1 LAYOUT

TEST Forum is structured in a very simple and easy to use manner keeping in mind that most of the users are not computer savvy. It is very easy for the users to find what they are looking for.

There are two tables on the left and right side of the forum. These two tables contain the topics which can be selected to view the threads related to that topic. Left table contains topics related to TEST website. Questions related to Animations, Problems, Examples, etc. present in the TEST website are available in the left topics. Users can report any bugs under “Bug Report” topic, give any suggestions under “Suggestion” topic. Right table contains all the chapters present in the text book that is going to be published soon. These topics contain questions and comments related to the chapters from the textbook. User can select one or more topics to view the cumulative number of threads (as shown in Figure 5.1).

To select or unselect the topic, user will have to click on the topic. Clicking on the Topic will only select the Topic and will not cumulate the selection. Clicking on one topic will select that topic and will unselect all the other topics that were selected earlier. To select multiple topics, user will have to select the check box present by the side of the Topic.

The numbers in the brackets present on the side of the Topic represents the total number of comments present in that Topic. The green dot on the left side of the Topic represents that there are new threads/comments present for the Topic that the user has not viewed from his last visit. The green dot will not disappear until the user explicitly selects the Topic to view the comments. When a user selects a topic with green dot, some of the comments listed will have a green dot. This represents that these comments are the new ones that were not viewed by the user. Once the user selects and unselects the topic, the green dot
Clicking on Instructions button will provide user with instructions on how to browse though the forum. Instructions will be provided on how to create a new thread, add a new comment, and search the forum using keywords, star/un I star a comment, archive/un-archive a comment. Clicking on Organization button will provide information on the forum’s organization and layout.

Selected topics will be listed at the top of the Forum page titled “Discussion on” and followed by the topics selected.

User is provided with selection options “Intersection” and “Union” (see Figure 5.2). Selecting one of these options will return results containing either just the common threads between multiple topics or the combination of all threads between multiple topics.

Selecting “Intersection” radio button will let the application know that the user wants to see a list of comments which are common between the selected topics. For example, if two topics are selected, the threads that are present in both the chapters will be displayed. The threads that are present in one chapter and not present in the other chapter will be ignored.

**Figure 5.1. Forum screen showing the comments present in animations topic.**

will disappear from both the topic and the comment header and user profile will be updated with this information.
In Figure 5.3, two topics are selected with intersection as the selection option. This returns threads that are common between both the chapters. In this example topic selection returned only one thread with two comments that belongs to both the topics.

If you select “Union” as the selection option, it will return cumulative results containing all the threads between Suggestion and Questions. In Figure 5.4, two topics Suggestion and Questions are selected with ‘Union’ as the selection option. This returned a cumulative threads present in both the topics, i.e., 5 threads and 9 comments in total.

**5.2 USER VIEWS**

There are different views in which users can view the threads and comments. Users can customize the view settings by clicking on the blue arrow button available at the top of the Forum table. These settings will be saved with user’s profile.
Figure 5.4. Two topics are selected with union as selection option; returns cumulative threads.

Different comment views are as follows:

- View all Threads and related replies in expanded form (see Figure 5.5).
- View only the headers of all threads and related replies (see Figure 5.6).
- View only the thread headers (see Figure 5.7).

Figure 5.5. Threads and related replies are displayed expanded under “Daemons” topic.

Figure 5.6. Headers of all threads and replies are displayed present under “Daemons”.
User can click on header of the comment to change the view of the comment alone. Clicking on the header will either shrink or expand the comment body based on its current state. This change of view is temporary and will be reset once the user refreshes the forum or replies to a thread or comment (see Figure 5.8).

Figure 5.8. Threads are in expanded form and replies are hidden.

### 5.3 POST A COMMENT

Forum’s interface is very user friendly; users can post a comment with just one click. There are two types of posting a comment, one is creating a new thread and the other is to reply to an existing thread.

#### 5.3.1 New Thread

A user can add a new thread by clicking on the New Thread button or by selecting the “Post a New Comment (Thread)” option from the Action Menu drop down. This will display a text box for the user to add content to the new thread (see Figure 5.9).
When adding a new thread, user will provide with the content by typing in the text in to the textbox. User can also provide with keywords associated with that thread. Keywords are used when searching for a thread within the topic list. User has options to distinguish the thread based on whether it is a question, an answer or just a comment. This way user will know what exactly the thread is about. User’s name will be pre-populated in the “From” field, which can be changed by the user (see Figure 5.10). User can post a thread as anonymous by selecting the check box for “Make Me Anonymous”. If the name field is left blank, an alert message is shown to the user.

Figure 5.9. Text box to enter a new thread with post new thread button.

Figure 5.10. Message pop up when a user did not enter the “from” field.
Once all the details are entered, user needs to click on Post New Thread. This will post the thread to the forum with all the information user entered and will be visible under the topics that were selected while posting the thread. A thread should belong to at least one topic and it cannot belong to more than three topics.

If no topic is selected for a thread, a message will be shown to the user saying one or more topics has to be selected for a new thread to be posted (see Figure 5.11). If more than three topics are selected for a thread, a different error message will be shown to the user (see Figure 5.12).

![Error: Select one or more topics where your comment belongs and try again.](image)

**Figure 5.11.** Message to user saying at least one chapter has to be selected for the thread to be posted.

After getting this error, user will have to uncheck some of the topics to make the selected topics count less than or equal to three and then click on Post New Thread button. Once a thread is posted, it will be assigned a new thread id number displayed on the header of the thread.

### 5.3.2 Add a Reply

User can add a reply to the thread/reply by clicking on “reply” link available in the thread/reply footer. This will open a textbox for the user to enter the text for the reply (see Figure 5.13).
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Figure 5.12. Message to the user that selecting more than three chapters is not allowed in the application.

Figure 5.13. Clicking on reply link will show the reply text box.

User can mark himself anonymous while replying to a thread. User can select the reply type, i.e., Question, Answer or a comment. Once he enters all the required details, user will need to click on “Post Reply” button to post the reply.

After the reply is posted, it will be added to the topic list with a different formatting from that of a thread (see Figure 5.14). Reply will have the thread id number appended with the reply id number.
5.4 ACTION MENU

Forum has a one central drop down menu that has features like viewing archived threads, tagged comments, posting a new comment, etc. (see Figure 5.15).

From the drop down user can select from options “Newest Comments (Batch 1)”, Older Comments (Batch+), “Newer Comments (Batch-)”, “Post a New Comment (Thread)”, “Display Archived Threads”, “Show Starred Comments”. Selecting a topic will show only the first 100 threads from that topic. Selecting Newest Comments will display the latest batch of 100 threads for the selected topic. Selecting Older Comments will display the older batch of 100 comments. User can select this option until there are older comments available. Newest Comments will display a new batch of comments until the user reaches the end of newest comments. Post a New comment displays the text box to post a new thread to the selected topic. Display Archived Threads displays all the archived threads for the selected
topic. Show Starred Comments displays the threads that have tagged comments. All these features will be explained in the following sections.

There is another additional option for Administrator called “Reassign Topics”. This will let the administrator to move the threads from one topic to another. He can assign a maximum of three topics that best describes the thread.

5.5 Tag a Comment

Users are provided with a feature called “Tag Comment”. This feature can be used to tag any important thread or a comment. Tagging a comment will add a star to the comment making it easy to identify between all the threads (see Figure 5.16).

![Discussion on Tutorial](image)

Figure 5.16. One of the threads is starred/tagged using “tag comment” link.

Users can tag a comment by either clicking on “Tag Comment” link or clicking on “star” present on the comment header. Clicking will enable a star on the comment header. Users can untag a comment by clicking on the star again. This will remove the star from comment header.

Users can view all starred/tagged comments in a topic by selecting the topic and clicking on “Show Starred Comments” from Action Menu (see Figure 5.17).

By selecting the “Show Starred Comments”, all the comments that are starred and its related threads are displayed. User can reply to a thread/comment or just refresh the forum to get back to the original view of the forum.
Figure 5.17. Show starred comments is selected from the action menu to view all starred comments present in the selected topic.

5.6 ARCHIVE

Archive is another feature where users can hide a comment or a thread from showing up in the topics list. This way user can hide threads and comments which are not very important in the user’s view.

5.6.1 Archive a Comment

Users are provided with a feature called “Archive”. This feature is used to archive/hide any comment from showing up in future (see Figure 5.18). To archive a comment, users have to click on Archive link present in the comment footer.

Figure 5.18. A thread with four comments with no archived comments.
Clicking on archive link will archive the comment and hide it from displaying. Once a user clicks on archive link, the thread footer will be populated with a new link to un-archive the archived comments (see Figure 5.19).

![Figure 5.19. Two of the comments/replies are archived and thread contains a link to un-archive those replies.](image)

The un-archive link also contains a number, which is the total number of comments/replies that were archived. Clicking on un-archive replies will unhide all the archived replies and append them to the thread.

### 5.6.2 Archive Thread

Users are provided with another feature called Archive Thread. This feature is used to archive the thread and its replies (see Figure 5.20).

Clicking on Archive Thread will archive the thread and its replies. All the archived threads’ information will be stored along with user’s personal settings in the form of a JSON array (see Figure 5.21).

User can view all archived threads for a topic by clicking on the topic and selecting Display Archived Threads from Action Menu. This will display all the archived threads within the selected topic (see Figure 5.22).

If a user wants to un-archive the whole thread, he will have to reply to the thread. This will un-archive the thread and populate in the topic list. No other operations are supported in this page.
5.20 Figure. Two threads with one of the thread having two replies.

5.21 Figure. A thread is archived. User can view archived threads by selecting display archived threads from action menu.

5.7 DELETE

Administrator has an additional option of deleting a thread/comment which will delete the thread/comment from the database thereby deleting it for all the users. Once a thread/comment is deleted it is deleted forever and cannot be restored. This is the reason for not providing the delete button for users other than administrator. Admin has options to either delete the entire thread or delete a comment of the thread (see Figure 5.23).

Deleting a thread will delete all comments associated with that thread. Deleting a comment will delete just that comment and will not affect any other comments in that thread.
5.8 Types of Users

TEST is a web based tool used by educators and students to learn and solve thermodynamic problems. Forum provides different rights for its users based on their access levels. All users need to register to use the forum. There is another special way of accessing the forum without having to register for every user. A specific IP address can be registered once and whoever logs in from that IP address can access the forum without having to register. These types of users have limited access to forum, where they can just read the existing threads and comments. These users are site licensed users and cannot add a new thread or comment on an existing thread. Whereas, users who register can add comments and
add threads. They also have access to some other important features of the forum which are mentioned in the sections to come. This section explains the different types of users available in this forum.

### 5.8.1 Guest Users

When guests try to access the forum, they will be asked to log in. If their campus has a license, guest can log in by just clicking on the log in button. This feature is called single click sign on, where the users can login from anywhere in the campus that shares common IP. Users who use the campus license to access the forum will have read only access to the forum. When they try to add a new thread or a new comment they will get an error message saying they should be logged in using their personal account to post a comment (see Figure 5.24).

![Figure 5.24](image)

**Figure 5.24. Guest user is not able to post a new comment or new thread.**

Other features such as tagging an important comment, archiving a thread work momentarily for that session. None of these settings are saved in the database for the guest user.

### 5.8.2 Registered Users

Registered users will be able to add a new thread or a new comment to the existing thread. To add a new thread to the forum, user has to select the New Thread button, which brings up the text box for the user to enter the content.
5.8.2.1 STUDENTS

Students have access to posting a comment, creating a new thread in the Forum (see Figure 5.25).

![Figure 5.25. Students can post a new comment/thread.](image)

When the user clicks on the New Thread button, a text box will be displayed to the user with options to enter the content for new thread, keywords to enter, chapters the thread belongs to and the thread type. The thread can be a question related to a topic, an answer to some other question or just a comment on the topic that is useful to other members in the forum. The name of the user is automatically filled from his/her profile. User can choose to be anonymous by checking the “Make Me Anonymous” checkbox. This way user’s name will not be shown on the thread header. User has to select the topics to which the thread belongs, keeping in mind that a thread can belong to no more than three chapters.

Registered users also have access to replying to a thread and editing the current thread/comment posted by the user. Users can also tag a comment by marking a star alongside the comment. This will let the users keep track of important threads and get back to them when needed. User can also archive a thread and its comments. If the user feels that the comment is not that important and if the user feels that the comment should not show up in his/her queue, user can simply archive the thread and all its comments will be archived. User can also archive just the comment and not the whole thread. User’s UI state from his last
session will be saved and will be shown once he logs back in. For example, if a user has
selected a topic named “Bug Report” and exited the application, this information will be
saved in his user profile. When the user logs back in, he will be taken to the “Bug Report”
topic and in a view he has last selected. All this information will be saved in the database and
will be updated as the user changes his preferences.

When a user tries to edit comments posted by other users, he will get a permission violation error message. From Figure 5.26, permissions for this user let him edit comments that are posted by him and the user will not be able to edit someone else’s comments.

![Alert message showing that a user tried to edit someone else’s comment.](image)

**Figure 5.26.** Alert message showing that a user tried to edit someone else’s comment.

### 5.8.2.2 MODERATORS

Moderators are another type of registered users who have all the access as the students do with some additional rights. Moderator rights are given to users who are more responsible and knowledgeable. Usually moderator rights are given to educators who can answer student’s questions. Moderators have access to edit other user’s contents. They can edit any part of the thread if they think that part is not proper. Comments added by a moderator will be highlighted in a different color than that of a regular user. This will help the users to identify which comment was added by a moderator and which one belongs to a regular user.

Moderators will be able to moderate specific topics of their expertise. With moderator rights users will receive an email whenever someone posts a comment to the topic of their
expertise. This way user can get back to the posts more quickly with their suggestions and answers.

5.8.2.3 Administrator

Administrator is like the super user of the forum. He has all the access rights as that of a regular user and a moderator along with some additional functionality. Administrator can delete a thread or a comment from the topic list. Administrator can also re-order a thread from one topic to another topic. Administrator can make all the necessary changes to make the forum look better (see Figure 5.27).

![Figure 5.27. Action menu for administrator showing an additional option “reassign topics”](image)

Administrator can reassign a thread to a different topic by selecting the check box on the thread, then selecting the topics he want the thread to be in and finally selecting the “Reassign Topics” option from the “Action Menu” drop down. This will reassign the thread to the newly selected topics keeping in mind that the number of topics should not exceed three.

Administrators can delete a thread/comment by clicking on “delete thread” or “delete” links available on the comment. Deleting a thread will delete the thread and all its child comments. Deleting a comment will delete just the comment without affecting its parent thread or the other comments that belong to the same thread. Deleting a thread or a
comment will be deleted forever and cannot be recovered by any means. This is the reason why administrator rights are given only to one or two users who control the forum.

5.9 Search

Forum has Search functionality where user can search for a term present within a comment. After a topic is selected and comments are populated, user can type the search term in the search box and press ‘Enter’. This will return the search results with the threads and comments containing the search term, with search term highlighted (see Figure 5.28).

Figure 5.28. Search results are highlighted when searching for a string.

This search functionality is a unique type of functionality. When you search for a term, application will return all the threads and its replies that contain the searched string. In addition to this, application also highlights the terms that match the searched string. This will help the user in finding the term easily. Once the results are returned, user can further search within the search results. User can just clear the search string from the search box and enter a new string for search. This will search the already returned threads. This way user can refine his/her search and get to the exact thread he/she is looking for. If the user wants to view all the threads again, he just needs to click on the clear icon to clear the search and this will display all the available threads within the selected topic. One thing to note is that the search will just search through the first batch of the threads. If the user wants to search in the older batches, he can just click to view older batches. If the search string is already present in the text box, application will return results that match the search string. If not, user can still
search the older batches by entering the search string. Archived and deleted threads are excluded from search.

If there are no results found or if the results returned were just part of the first 100 threads, user has an option to re-search on the server for all the threads available for the selected topics. Once the user searches the first 100 threads, he/she will be provided with a button “Search Entire Database”. By clicking on this button user will initiate a server side search and the threads returned are the search results for all the available threads in the selected topics. Server side search can only be initiated by clicking on the provided button.
CHAPTER 6

SQL INJECTION AND XSS

Cross site scripting (XSS) and SQL injection has been one of the major concerns in the modern internet world. SQL injection and XSS vulnerabilities occur when unfiltered user input is displayed to other users or executed on the server side code. Forums, Message Boards, Wikis, Social networking sites are the most common websites which are vulnerable to these kind of attacks. The primary purpose of this type of websites is to take user input and display it to other users. These attacks can affect a website if the user input is not processed before saving to the database or if the unprocessed data is displayed to the end user.

SQL injection is a parameter manipulation attack in which malicious SQL code is inserted onto SQL commands executed in the dynamic logic layer of a Web Application. The most common target for this type of attack is a database query that executes in response to a search initiated by a user action. The vulnerability is present when user input is not filtered properly for escape characters. Hacker can attack any database that is SQL injection vulnerable and gain access over all secured data and can manipulate or wipe out the whole database. Hackers can also use SQL injection to bypass login forms by injecting an always true statement into the authentication routine. Hackers usually use this method to attack the Web Server [23].

The following example for SQL injection is taken from the book Ajax Security by Hoffman and Sullivan. Let’s take an example of a sample DVD store application. In this application there is an image of each DVD available in the store and each image is a hyperlink to a product details page with product ID as part of the hyperlink. Clicking on the image will request a page “http://www.webserver.com/product_detail.asp?id=1”. The code that gets executed on this click will execute a SQL query which looks something like

\[
\text{selectQuery} = \text{"SELECT product_description FROM tbl_products WHERE product_id =\"} + \text{selectedProduct}\text{"}
\]

This query looks straight forward with no issues when ran as part of the application. Since the id was 1 from the previous image click, the “selectedProduct” will be replaced with
1. Now, let’s say if someone intentionally changes the URL of the requested page to something like “http://www.webserver.com/product_detail.asp?id=1 UNION SELECT name from sysobjects WHERE xtype='U’’. This will execute on the DB server which the programmer was not intending to run. Union can be replaced with anything like DROP, UPDATE, etc. which would execute just fine without having issues and this will cause the application to behave abnormally. One other example is a sign in page. Let’s say a SQL query “SELECT * FROM Users where username = ‘username’ AND password=’password’” is executed when a user tries to login. Suppose if the query can be modified to “SELECT * FROM Users where username = ‘username’ AND password=‘password’ OR 1=1”. This modified query will always be true and the authentication code will grant access assuming that the user is valid irrespective of credentials. One of the best ways to handle this kind of security issues is to use stored procedures. Encoding the input before using it as part of a query or inserting into the database is another way of handling SQL injection [23].

Cross-Site Scripting (XSS) works similar to SQL injection but this will affect the Web Client rather than a Web Server. This vulnerability occurs when unfiltered user input is displayed on the web page. The very common instances of this type of attack includes Search results, Forums, Message Boards, Personalization features, etc. These are some of the most common places where a user input is required and displayed on a webpage. If the input values are not filtered accordingly then your code is vulnerable to XSS [24].

How does a hacker infect a webpage? These days’ internet applications are not static HTML pages. Modern web pages allow users to input data, search for a keyword, add comments, etc. Hacker targets the sites where the user input is allowed and the input data is posted back to the web page. Scripts can be added to these input fields and when a user tries to access the website, this added script will be executed on user’s browser leading to undesirable behavior. The <SCRIPT> tag is the most popular way and sometimes easiest to detect. This tag can be used to enter a script and execute on the web page [25]. A sample script would be “<SCRIPT>alert(“XSS”); </SCRIPT>”. This script will execute on the browser and will pop up an alert to the user.
CHAPTER 7

TESTS AND RESULTS

This chapter is to focus on the tests performed on the Forum application and the results. I performed many tests while the application was being built to make sure the expected behavior persists even after a major change. Positive and negative testing was performed on the application to make sure everything works as expected. I will go over some of the major tests I have performed while building this application and some statistics of the application response time.

One of the major tests performed was the security testing. In this test, I entered some scripts as part of the input to make sure there is no XSS vulnerability (see Figure 7.1).

![Figure 7.1. Script is entered as part of testing when creating a new thread.](image)

I tested around the lines of user rights to make sure that no administrative rights are available for any other roles. Only administrator should be able to see some features such as delete a thread, move threads from one topic to another, and edit other user’s threads (see Figure 7.2). Other tests involved were to make sure that if a user is changed from Administrator to regular user, he should not be able to see any of the administrative options.

An email notification will be sent to the creator of the thread whenever there is a new message posted by any of the forum users. I have performed some tests to make sure that every time someone posts a message, the creator of the thread receives an email. Email contains the thread id and the body of the new post (see Figure 7.3).
Figure 7.2. Administrative rights to delete a thread, comment, reassign topics.

Someone just responded to your comment, #568, in the TEST blog.

A similar email will be sent to the Administrator of the Forum saying that a Forum user has created a post on forum and this email will contain the message/content of the post. This way administrator is immediately notified of any forum activities.

I performed some tests to make sure that any special character that was encoded while inserting into database is decoded before adding as subject to the email. I made sure that no encoded string is sent as part of the email.
Since forum deals with displaying data on to a web browser from a web server, performance plays a key role in increasing the number of users using a forum. The turnaround time for each request is important and it has to be quick so that user will not have to wait for long to view his requests on the browser. I created a list of tests performed and the average response time for each of the requests made. To capture response time I used a Firefox add-on called Firebug© [26] and created Table 7.1.

**Table 7.1. Performance Results**

<table>
<thead>
<tr>
<th>Activity Performed</th>
<th>Time Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Forum</td>
<td>573ms</td>
</tr>
<tr>
<td>Load 10 comments</td>
<td>203ms</td>
</tr>
<tr>
<td>Load 100 comments</td>
<td>480ms</td>
</tr>
<tr>
<td>Posting a new thread/comment</td>
<td>136ms</td>
</tr>
<tr>
<td>Tag/Untag a comment</td>
<td>51ms</td>
</tr>
<tr>
<td>Archive/un-archive comment</td>
<td>63ms</td>
</tr>
<tr>
<td>Re-assign topics</td>
<td>1s</td>
</tr>
</tbody>
</table>

Processing time for most of the requests is well below 1 sec; “Re-assign topics” is the only request that takes up to 1 sec. Above mentioned test results are performed when the application was installed on a Sun Microsystems Sun Fire X4450 rack mount server. This server is configured with two Intel Xeon 2.13GHz processors (Dual Core Intel Xeon 7200 series) and 12G of physical memory. The storage disk used is a 546.42GB RAID5 subsystem. The Operating System is Solaris 10 Update 4. Network access is provided through 4, 10/100/1000 Mbps auto-negotiating Ethernet interfaces.
CHAPTER 8

CONCLUSION AND FUTURE ENHANCEMENTS

8.1 CONCLUSION

This thesis sets an initiative towards creating an online discussion forum for the thermodynamics community. A simple design and easy to understand features let the users share information with ease. Open source technologies used to build the forum let the users access the forum from any machine that has internet connection with no extra cost to the users. There is no need to install any software in the user’s machine to use the forum. This forum can be further integrated with various parts of TEST which I will discuss in the next section.

8.2 FUTURE ENHANCEMENTS

After the development of Web Forum, I feel there is a scope for following enhancements in the future:

• An email can be sent to all the users involved in a thread conversation when someone posts a comment or reply. The content of the new comment can be added as part of the reply.

• Adding a feature where user should be able to respond to a comment via email. Once the user sends an email, reply should be added as a comment to the respective thread.

• Forum can be integrated with various sections of TEST such that a user should be able to post a question or comment from that tab/section without having to navigate to the Forum tab. This can be done by providing a link/button in every tab and providing an interface to post a comment in the forum.

• At present there is no UI setting to set the user type, i.e., Moderator, Admin or regular user. This feature would be a great deal of help to the administrator in controlling the type of users

• RSS can be added to the forum so that the users can subscribe and get notifications about new discussions in the forum on time to time basis.

• Right now most of the SQL queries are part of the backend code. It is a good idea to have all SQL queries changed to Stored Procedures. This will allow having better security in the overall application.
BIBLIOGRAPHY


