

Virtual Laboratory Web Application for the MET Heat Transfer Experiments

By

Jason Kumpf

Submitted to
the Faculty of the Information Engineering Technology Program
in Partial Fulfillment of the Requirements for
the Degree of Bachelor of Science
in Information Engineering Technology

University of Cincinnati
College of Applied Science

March 2001

Virtual Laboratory Web Application for the MET Heat Transfer Experiments

By

Jason Kumpf

Submitted to
the Faculty of the Information Engineering Technology Program
in Partial Fulfillment of the Requirements
for
the Degree of Bachelor of Science
in Information Engineering Technology

©Copyright 2001 Jason Kumpf

The author grants to the Information Engineering Technology Program permission to reproduce and distribute copies of this document in whole or in part.

Author: Jason P. Kumpf

Date

Faculty Project Advisor: Sam C. Geonetta

Date

Department Head: Lawrence G. Gilligan

Date

Acknowledgements

The department of Mechanical Engineering Technology deserves special thanks for the support and funding to make this project the best it could be. Thanks to Dr. Sam Geonetta for his guidance as an advisor and as a professional. Finally, the College of Applied Science, for the professionalism it instills in its students and graduates. This tradition is what makes the college and its graduates so successful.

Dedication

This project is dedicated to the efforts, as an instructor and as a friend, of Dr. Muthar Al-Ubaidi. Dr. Al-Ubaidi has played a very important part in my education since we first met. Dr. Al-Ubaidi had a great idea to help his students get more out of his classes and labs. The combination of Dr. Al-Ubaidi's idea of a Virtual Lab application, along with my knowledge of Information Technology, brought about a project that was exciting to be a part of and develop.

Table of Contents

Section	Page
Acknowledgements	i
Dedication	ii
Table of Contents	iii
List of Figures	iv
Abstract	1
1. Statement of the Problem	2
1.1 Definition of the Need	2
2. User Profile	3
3. Design Protocols	3
3.1 Project Structure	6
3.2 Project Functionality	9
4. Objectives of the Project	10
5. Design and Development	11
5.1 Budget	11
5.2 Timeline	12
6. Proof of Design	12
7. Conclusions and Recommendations	13
References	15
Appendix A. Project Timeline	16
Appendix B. Evaluation Forms	18
Appendix C. Virtual Lab Setup Instruction Manual	20
Appendix D. Virtual Laboratory Program Code	29

List of Figures

Figure 1. The main interface of the Virtual Lab Web site.

Figure 2. What the first step in an experiment looks like.

Figure 3. One of the pages in the Instructor interface.

Figure 4. Color Scheme and Hexadecimal Codes.

Figure 5. The Flowchart of the Student Interface.

Figure 6. The Flowchart of the Instructor Interface.

Figure 7. Table of Contents for the Student Interface.

Figure 8. Navigation between each step in the Table of Contents.

Figure 9. Navigation through the Instructor interface.

Figure 10. Step Instruction for Instructor.

Figure 11. Total Cost to Setup New Virtual Lab.

Figure 12. Server Hardware Specifications

Figure 13. Software Available for Development

Abstract

The Virtual Lab is a Web application that helps prepare students for lab experiments in the Mechanical Engineering Technology degree program. The lab experiments for the Heat Transfer class are the focus of this project because those experiments take the most preparation. The equipment used for most of the Heat Transfer experiments is complex and the processes involved require careful measurements. Since there are only two to three hours of lab time, the instructor has little time to explain the equipment and the procedure, and leave enough time to complete the experiment. The Virtual Lab is accessible to any student. It can be used to step through the procedure and equipment descriptions at a student's own pace before conducting the experiment. From the Web site instructors can keep the content of the Virtual Labs up-to-date and add new lab experiments. The Virtual Lab is a tool that can be used to better allocate lab experiment time, while making experiments available to anyone at any time.

Virtual Laboratory Web Application for the MET Heat Transfer Experiments

1. Statement of the Problem

The Mechanical Engineering Technology (MET) department has a course in Heat Transfer. This class has a laboratory section that requires students to run experiments that involve complex equipment. With limited class and laboratory time, there is little time to explain the equipment or the entire experiment procedure to new students.

1.1 Definition of the Need

One example of this problem is in the Composite Wall Experiment for the Heat Transfer course. This experiment takes almost 30 minutes to explain and involves taking over 20 temperature readings at a precise moment using different switches and gauges. If there is any error in this process it can have a significant effect on the outcome of the data and the calculated results for the lab report (1). Based on accounts of students and personal experience in various lab experiments, it is clear that many of the lab experiments could have been easier to complete and understand if there had been a better way to prepare for the experiment. A readily available tool is needed to help prepare students for these types of experiments. The tools must be able to be kept current, as well as cost effective to the department.

The Virtual Laboratory Experiment is a Web-based multimedia application that is used to prepare students for the Heat Transfer laboratory experiments. The Virtual Laboratory consists of three major parts forming an updateable, interactive, and cost

effective solution that will serve the Mechanical Engineering Technology department as an educational tool.

This tool is unique when compared to those products that can be bought to do similar tasks because the content can be updated through the Web. Most of the existing products that are used to instruct students on certain topics do not have the capability of being updated easily through a Web browser. The Virtual Lab needs no other software but a Web browser such as Internet Explorer®.

2. User Profile

The users of the Virtual Laboratory fall into two categories: the students who will use the Virtual Laboratory, and the instructors who will use the Virtual Laboratory to keep the experiment information current or add new experiments. The students will have basic computer knowledge, gained through requirements in various freshmen level classes in the MET department. Those classes will have prepared the students enough to be able to open an Internet browser and go to a Web site.

The instructor will have to have more Internet application experience. He/she will have to be able to fill out Web forms to update or add information to a Virtual Laboratory experiment, although there is guidance and help in each of the steps so the instructor knows what information is needed in a particular step.

3. Design Protocols

The colors, images, and icons used were all designed by me and were reviewed by Dr. Muthar Al-Ubaidi (1). Once the layouts were designed and the main stylesheet

was created the pages were based on three basic layouts as seen in **Figures 1.**
through 3..

All of the samples show the matching color schemes, the Help link, and a title for each page or section of the site.

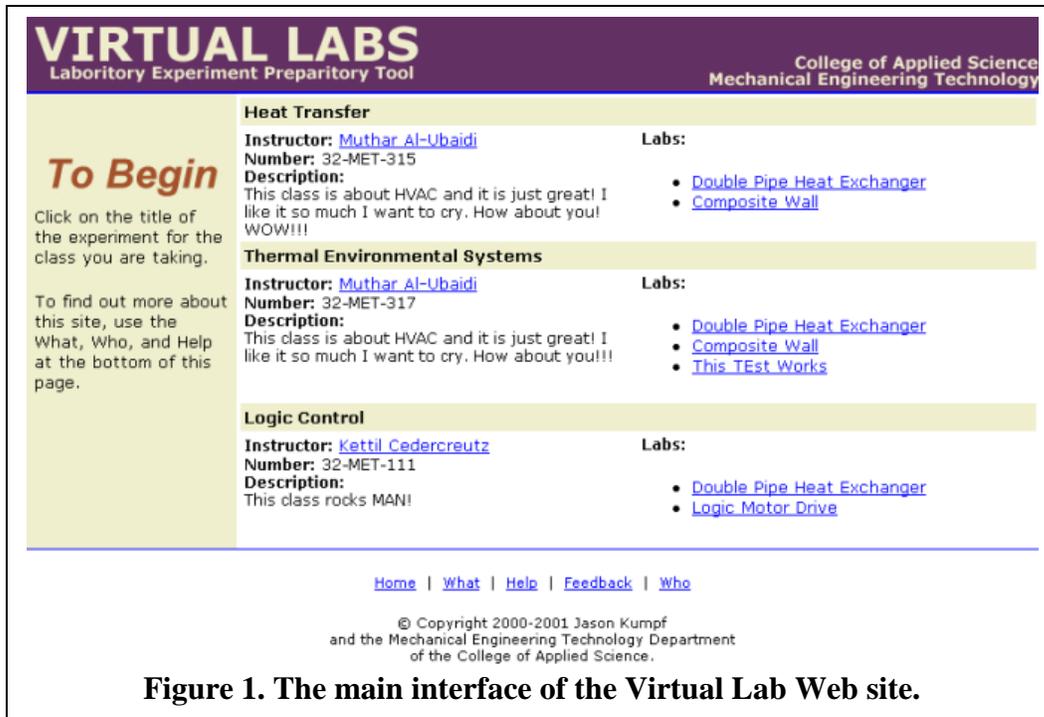


Figure 1. The main interface of the Virtual Lab Web site.

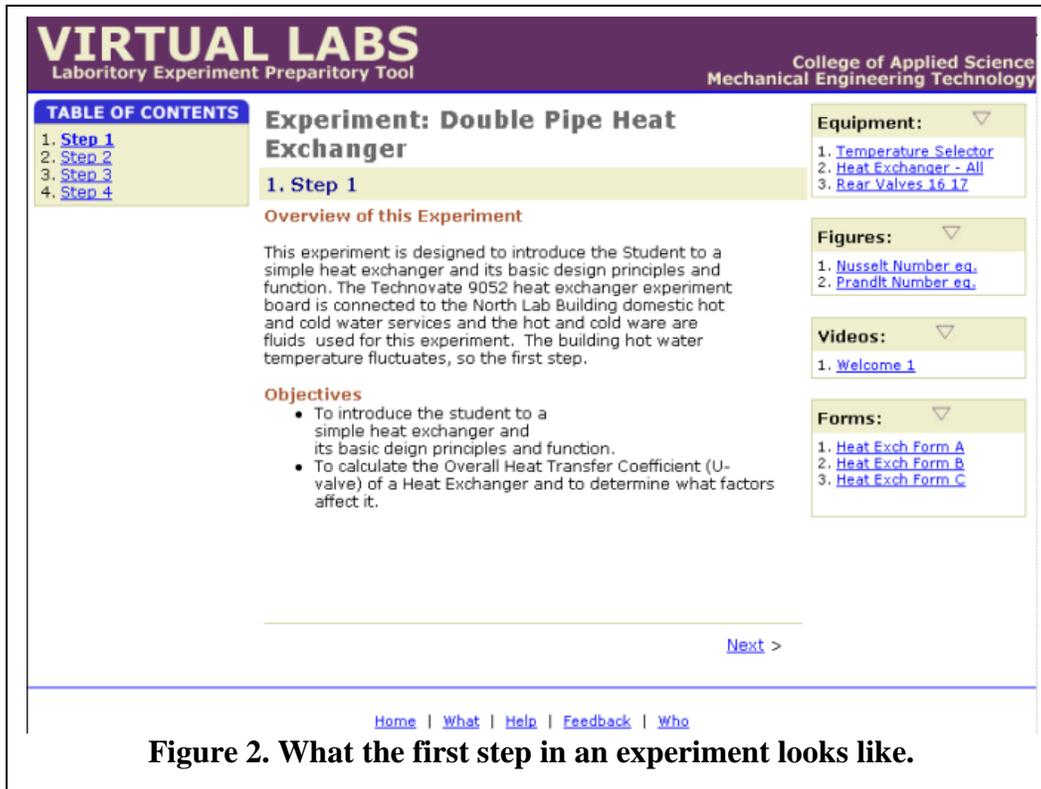


Figure 2. What the first step in an experiment looks like.

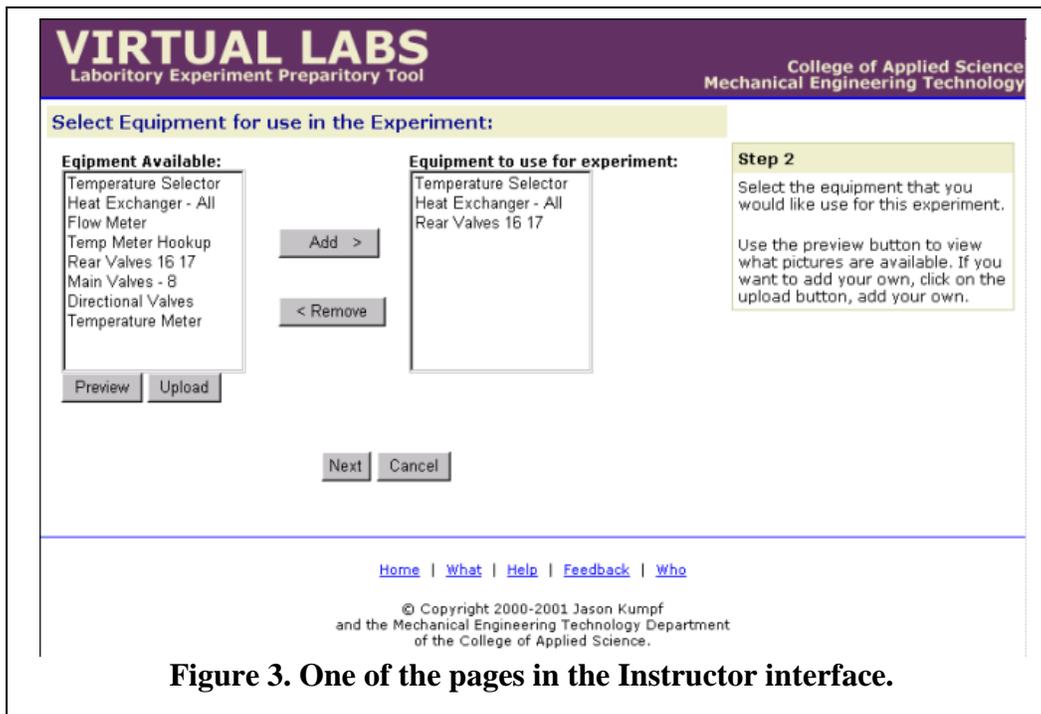
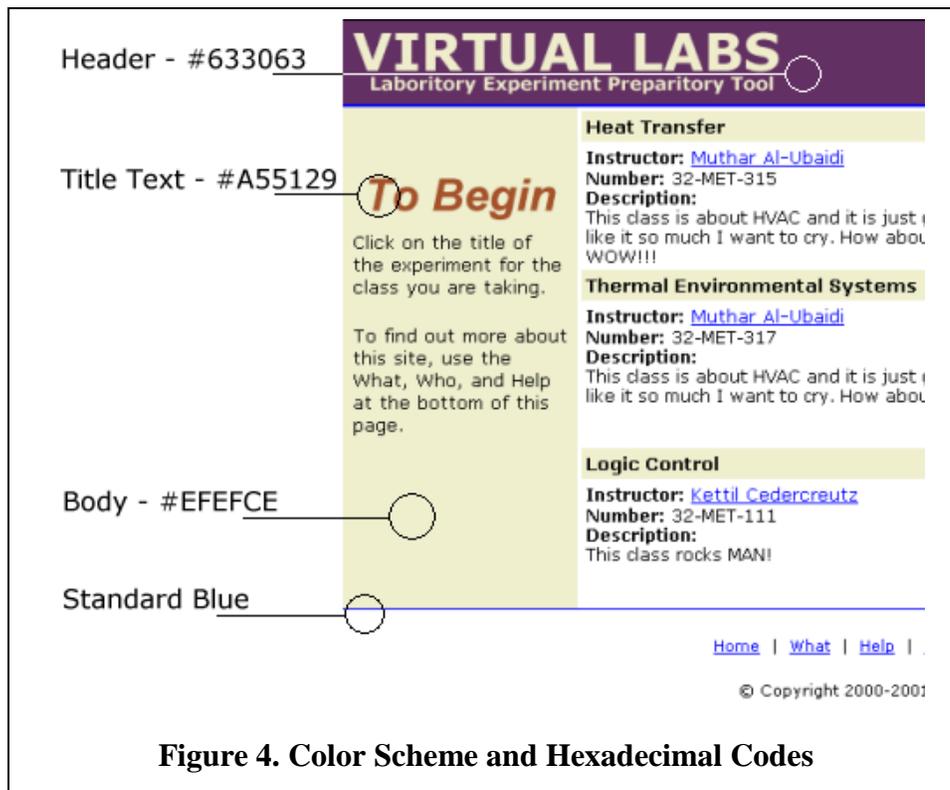


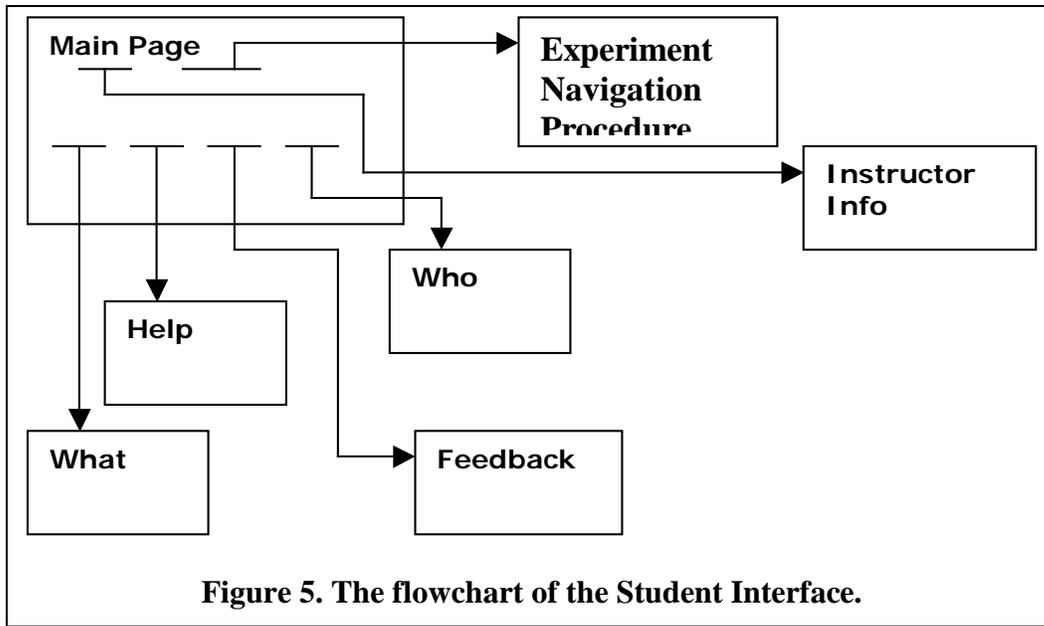
Figure 3. One of the pages in the Instructor interface.

The color choices were based on two variables: simplicity and attractiveness. The content had to be easy to follow but still catch the eye and make the user want to continue to use the Virtual Lab application. There also had to be a definite border between the content and the header and footer; these are the thin blue lines that stand out but still follow the color scheme. The color scheme was chosen based on personal preferences as an experienced student of other Web-based applications. The colors are soft but easy to differentiate. The color layout is highlighted in **Figure 4.**, along with the Hexadecimal codes for them.



3.1 Project Structure

The structure of this Web application is shown in **Figure 5.**, starting with the main page and the links to each page represented by lines.



The **Experiment Navigation Procedure** is the main functional element of this Web site. This ASP page does most of the work.

The **Instructor Info** page gives contact information, such as office phone and e-mail address, of the professor that teaches a particular class.

The **What** page describes the idea behind the Web application.

The **Help** page gets a user started with this application and highlights key elements for navigation.

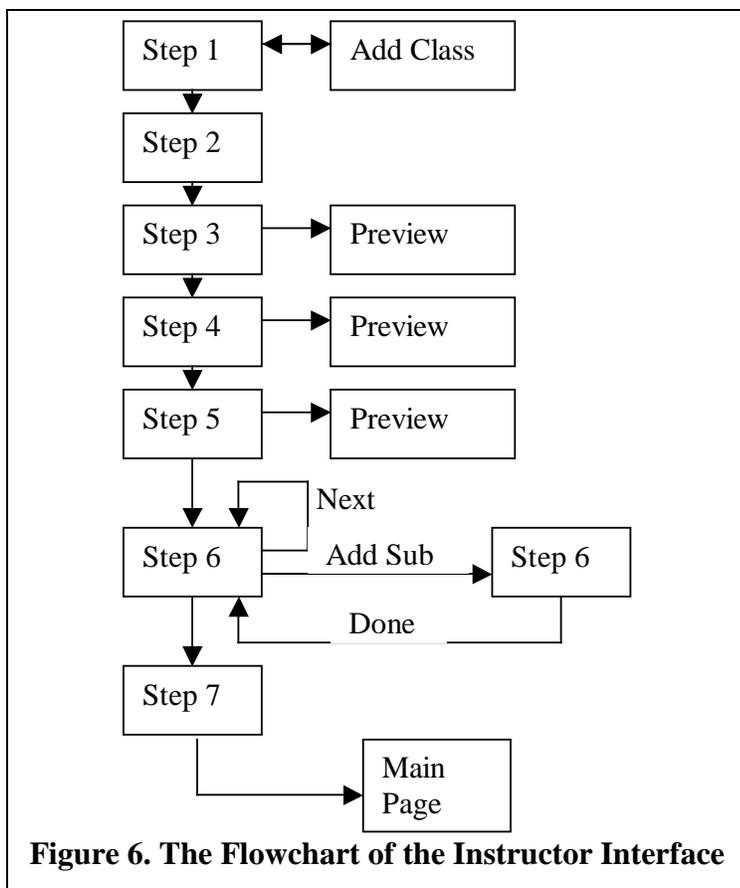
The **Who** page describes the intended users of the Web application.

The **Feedback** page allows users to report problems or bugs on the site.

There are header.asp and footer.asp pages that are included in each page; when one is changed, all pages are updated automatically.

The instructor interface is not accessible from the main page for security reasons. The faculty of the MET department will have the Instructor Interface's address or be able to get it from Dr. Muthar Al-Ubaidi. **Figure 3.** shows a page from the instructor

interface. This is not the default page for the instructor site, but step one in editing or adding an experiment. **Figure 6.** shows the flow for adding or editing an experiment.



Step 1: Preliminary Experiment Info

Step 2: Equipment Add/Edit

Step 3: Figures Add/Edit

Step 4: Video Add/Edit

Step 5: Forms Add/Edit

Step 6: Section and Subsection Add/Edit

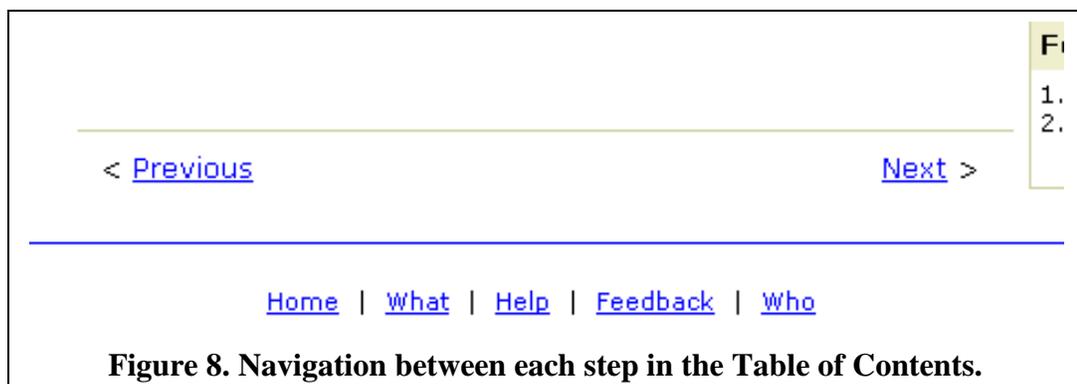
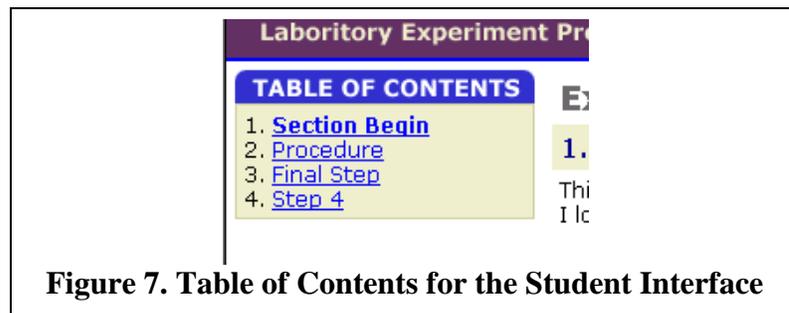
Step 7: Finalize Experiment or Remove

Go back to Main Instructor Page

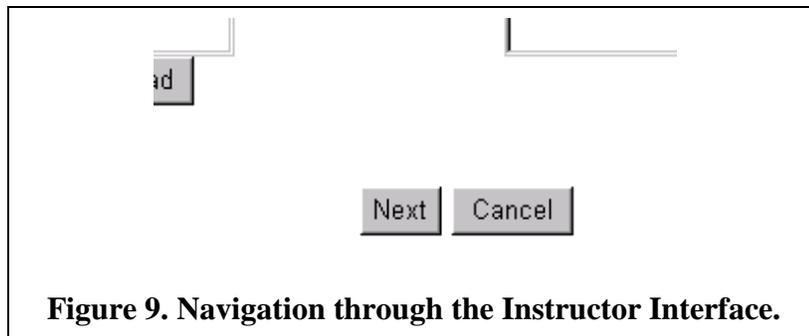
3.2 Project Functionality

This project is linear in structure for navigation and content editing. This is because this project is a learning tool for students and also used by instructors who are not Internet experts. Each page has the header and footer on it, which provides links to other information (see **Figure 5.** and **Figure 6.**).

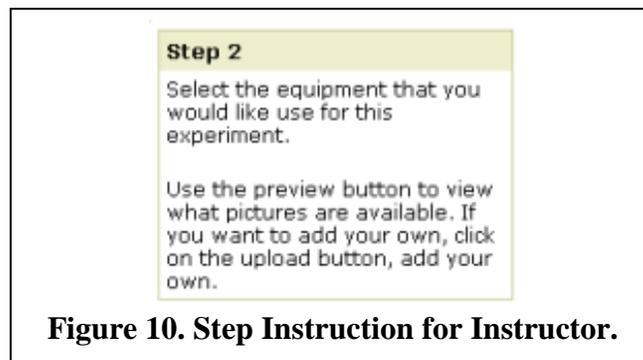
The navigation for the Student Interface is shown in **Figure 7.** and **Figure 8.** There is a “Next” and “Previous” link on every page but the first and last, and a table of contents for quick movement to a particular section.



The navigation for the Instructor Interface is shown in **Figure 6.** Each page will have buttons at the bottom to guide the instructor to the next step, to cancel the process, or to go to a branch page. **Figure 9.** shows the basic navigation buttons for any page in the Instructor's Interface.



For each step there is also be a brief explanation of the current step separate from the rest of the page content in a small table as shown in **Figure 10.**



4. Objectives of the Project

The Virtual Laboratory is a fully updateable and editable resource for the MET faculty to use to help prepare their students for lab experiments. This tool has a fully integrated Instructor Interface to edit content, add pictures, add video, add charts, and add figures and formulas along with step-by-step content. This tool also has help

options available and the contact information of the instructor. The students are able to step through the Virtual Laboratory experiments at their own pace with an easy-to-use interface. There are many other places to find help throughout the application, which makes this solution a full Web application.

5. Design and Development

The development of this project for the Mechanical Engineering Technology department was inexpensive for many reasons. The budget below highlights these reasons, as well as the development schedule and the resources available.

5.1 Budget

The cost of the server and development tools used, if purchased from retailers, is shown in **Figure 11.**

Server	\$4500.00
Windows 2000 Server	850.00
SQL Server 7.0	1000.00
Visual Interdev	<u>550.00</u>
Total Cost	\$6900.00

Figure 11. Total Cost to Setup New Virtual Lab

The amounts in **Figure 11.** show what it would cost to set up the Virtual Lab application on a new server if bought through a retailer. All the hardware was purchased by the MET department for other applications, but has been fully allocated for the Virtual Laboratory application. The software is free under the Microsoft contract with the University of Cincinnati. Nothing needed to be purchased for this project. **Figure 12.** shows the hardware specifications of the server in the MET

department. The performance of the server was very good even with more than 5 users connecting to the Virtual Lab website at one time.

<p>Processor: Pentium III 500MHz Memory: 384MB Hard Drive: 18GB SCSI 10,000 RPM Network Card: 3Com 10/100 MB</p> <p>Figure 12. Server Hardware Specifications</p>
--

Figure 13. shows the software that was available and used for the development of the Virtual Lab Web Application.

<p>Visual Interdev 6.0 Microsoft Scripting Debugger Paint Shop Pro 5.0</p> <p>Figure 13. Software Available for Development</p>
--

5.2 Timeline

The project started in April of 2000 and finished on March 2, 2001. The Timeline is shown in Appendix A..

6. Proof of Design

To determine if the project solved the major problem it was designed to solve, testing and evaluation was necessary. The first step was to research Web sites that are used to teach. This was done to find effective interface designs. The most common interfaces that were effective, but also aesthetically pleasing, had Web safe color schemes, standard navigation systems, easy-to-read fonts, and easy-to-follow layouts. The Virtual Lab was developed from those designs.

These designs were then evaluated by MET seniors using the form shown in Appendix B., page 17. The results of the evaluation showed positive results. There were four questions that used a ranking of: Excellent, Good, Fair, and Poor. The first two questions had seven out of seven selected as “Excellent”. The next two questions had six out of seven select “Excellent” and the other two were both “Good”. The students all thought the application was successful and easy-to-use. The results can be seen in parentheses next to each survey question in Appendix B., page 17.

The next step was to evaluate the instructor interface, which has much more interactive steps to it. After the interface was designed and the application was developed, three of the MET faculty evaluated the instructor interface using the form in Appendix B., page 18. Overall the faculty found the application to be very successful; the results can be seen in Appendix B, page 18 in the parentheses next to each question on the form.

7. Conclusions and Recommendations

The Virtual Lab Web Application is a learning tool that is easy to use, easy to maintain, and accessible from anywhere with an Internet connection. Seven out of seven people thought the overall success and organization of the application is excellent. Six out of seven people thought the methods used, the graphics and text of the application are excellent and rest other people thought they are good. The Virtual Lab can be used to explain and prepare for a lab experiment that requires valuable time.

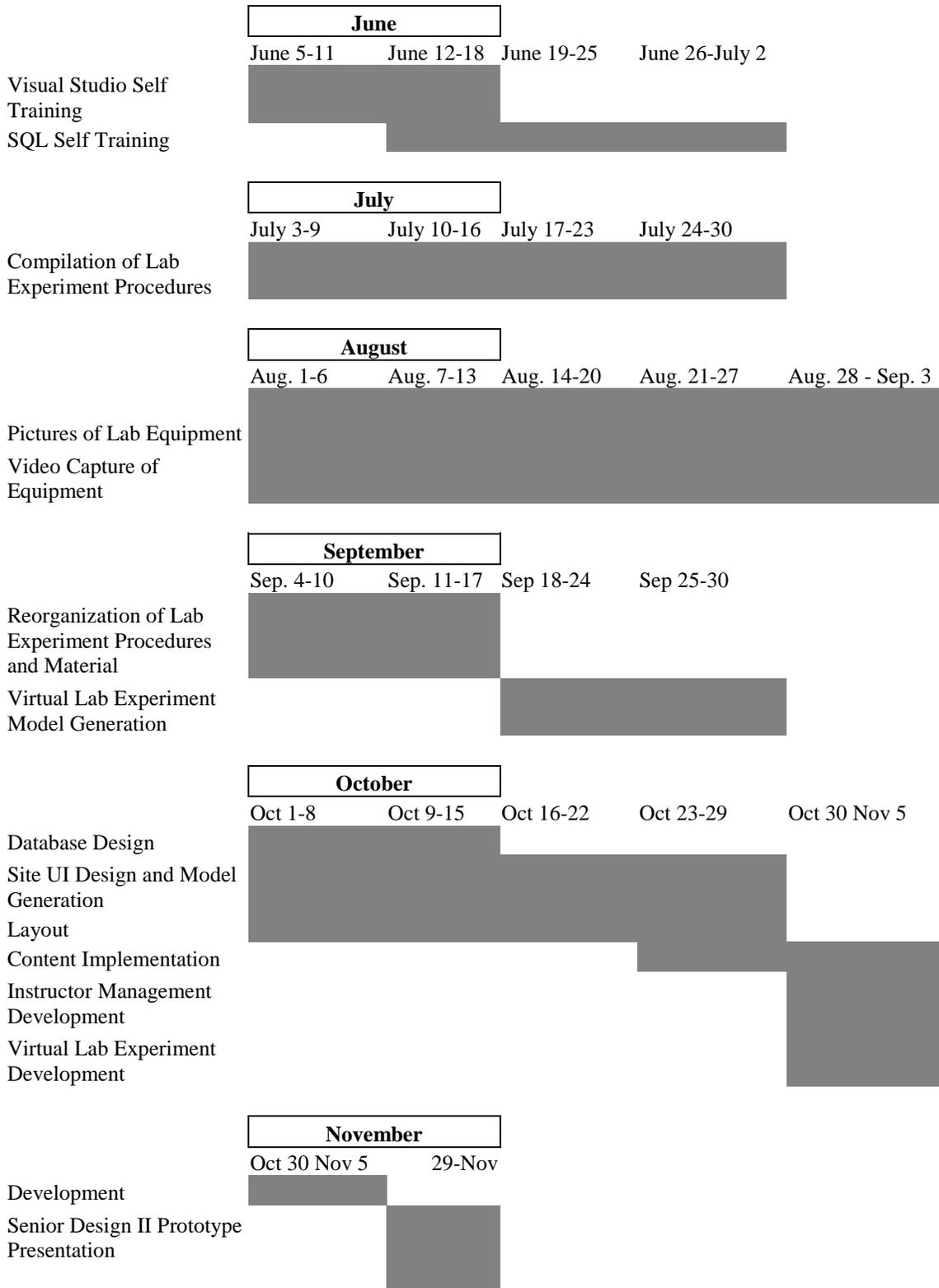
The only thing that would be recommended for the Virtual Lab to be more successful is to make the Virtual Lab a requirement for class. This can be done by

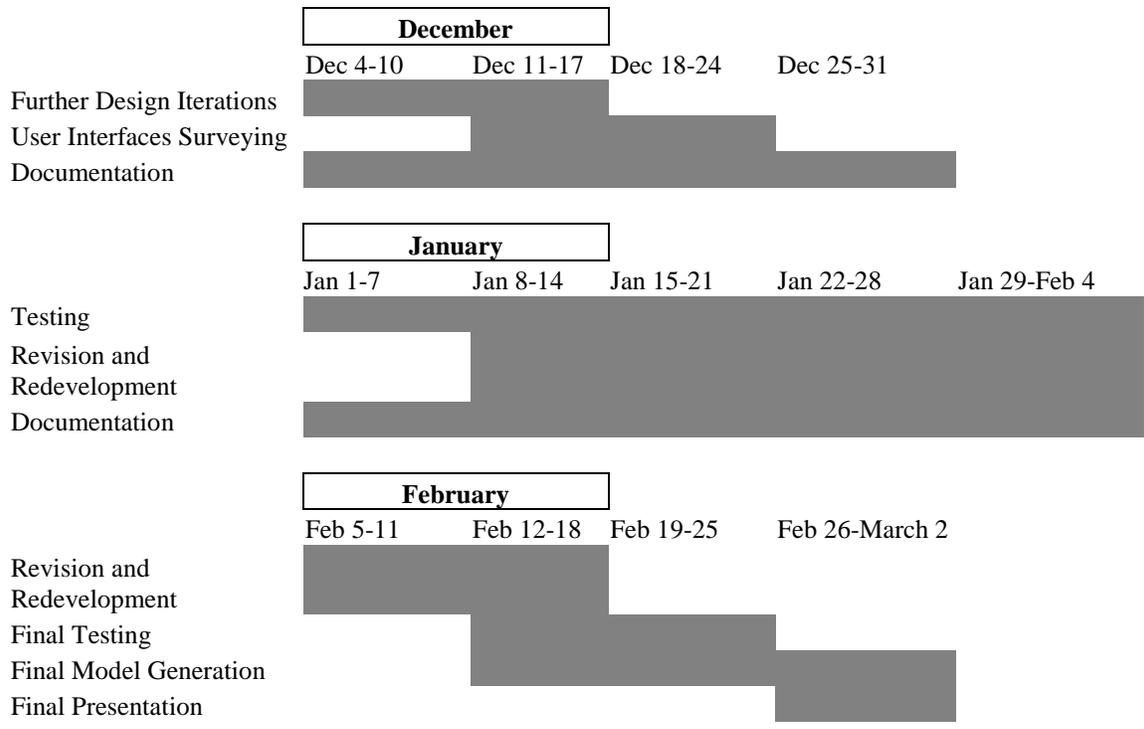
requiring the students to print out the forms that are part of the Virtual Lab experiments. The reason for this is because most students will not realize how much preparing for a lab experiment can help reduce confusion during the experiment and make writing the lab report less difficult.

References

1. Al-Ubaidi, Muthar Dr. Professor, Mechanical Engineering Technology Department, College of Applied Science. Personal Interview. May 2, 2000.
2. Cedercreutz, Kettel. Department Head, Mechanical Engineering Technology Department, College of Applied Science. Personal Interview. May 3, 2000.
3. CNET, "CNET Help.com". [Http://www.help.com](http://www.help.com). September 2000 – January 2001.
4. Lycos, "Webmonkey". [Http://hotwired.lycos.com/webmonkey](http://hotwired.lycos.com/webmonkey). June 2000 - January 2001.

Appendix A. Project Timeline





Appendix B. Evaluation Forms

Sample of Student Evaluation Form

Please take a moment to complete this evaluation form. Your comments are important to improve this product. Please fill out this form after completing the Virtual Lab Web application. Your comments are appreciated.

Name of Product: Virtual Laboratory Web Application

1. Overall Successfulness of the program	Excellent (7)	Good	Fair	Poor
2. Program organization and execution	Excellent (7)	Good	Fair	Poor
3. Do you like the methods used in the program?	Excellent (6)	Good (1)	Fair	Poor
4. How do you like the graphics, sounds and text?	Excellent (6)	Good (1)	Fair	Poor

5. General comments/suggestions:

- Add a menu bar to print the forms.
- Navigation was very easy to understand.
- 3C's Clean, Clear, Concise

6. Features that would make the program better:

* Results were based on 7 surveys that were filled out and returned.

Sample of Usability Report for the Virtual Lab

Name of Product: Virtual Laboratory Web Application

Environments for Use: ___Home ___School (3 surveys checked both)

User computer Literacy: ___Low ___Medium ___High (3 surveys checked “___Low”)

Preparations to Use Product: (3 surveys checked “___None”)

___None ___Needs subject matter knowledge ___Needs workshop or training

Ease of Use/Interface design

(rate each criterion on scale of 1 (poor) to 5 (excellent) no N/A (not applicable))

1 2 3 4 5 ___N/A – Program organized? (3 surveys circled 5)

1 2 3 4 5 ___N/A – Navigation within page? (3 surveys circled 5)

1 2 3 4 5 ___N/A – Icons and graphic symbols? (3 surveys circled 5)

1 2 3 4 5 ___N/A – Help available? (3 surveys circled 5)

1 2 3 4 5 ___N/A – Overall ease of use: what’s the learning curve? (3 surveys circled 5)

1 2 3 4 5 ___N/A – Does it enable the user to do what the program is apparently designed to? (3 surveys circled 5)

Design Features

1 2 3 4 5 Clean interface (3 surveys circled 5)

1 2 3 4 5 Good level of interactivity (3 surveys circled 5)

1 2 3 4 5 Clear Help (3 surveys circled 5)

1 2 3 4 5 Use of color, icons, etc. (3 surveys circled 5)

1 2 3 4 5 Satisfies intended use (3 surveys circled 5)

Strengths:

Weaknesses:

Overall Rating:

(low) 1 2 3 4 5 (high) (3 surveys circled 5)

Appendix C. Virtual Lab Setup Instruction Manual

Setup and Installation Instructions for the Virtual Lab Web Application

This documentation is to help setup and install everything needed to run the Virtual Lab Web application on a server. This documentation does not give installation instructions for the server or application software. The following should already be installed on the server before using this documentation:

- Windows 2000 Server with IIS 5.0 service
- SQL Server 7.0
- Visual InterDev 6.0 (Optional – not needed to complete the installation)

Once the above criteria are met, you may begin the installation process.

Table of Contents

Table of Contents _____	21
Step 1: Creating and Populating the Database _____	22
Step 2: Setting up the DSN _____	23
Step 3: Setting up the Shares and Upload _____	25
Step 4: Uploading the Virtual Lab Website Code _____	25
Step 5: The Virtual Lab Configuration Files _____	27
Conclusion _____	28

Step 1: Creating and Populating the Database

In order to have the site be a database driven Web application, the database must be setup before anything else can be done. There are two ways to create the database, one with sample data imported from an Access Database, or the other by running an SQL script that creates the tables for the database.

A. To import sample data that will build the tables and populate them with sample data.

This process is simpler and requires running Enterprise Manager, as part of Microsoft SQL Server.

1. In Enterprise Manager, create a database and name it something like “virtual_lab”. This is up to you and the code does not depend on the database name.
2. Once the database is created, click on the database and then right click, and choose All Tasks – Import Data. This is shown in **Figure 1**.

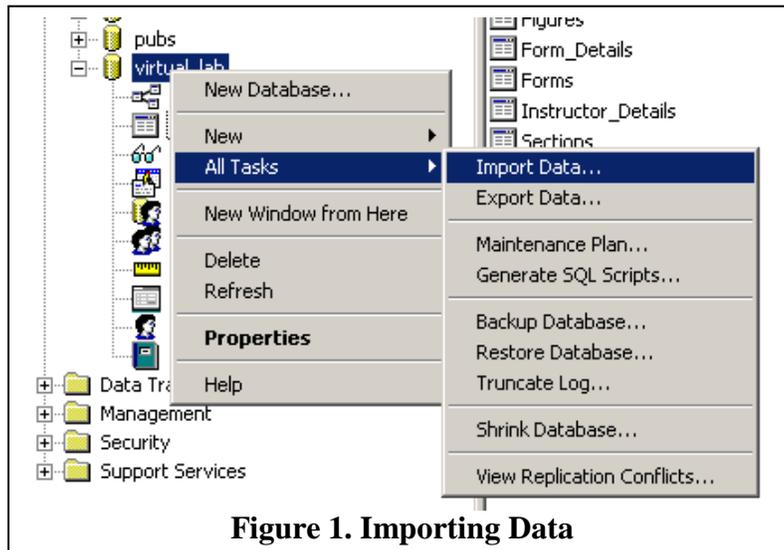


Figure 1. Importing Data

3. The Data Transformation Services Import Wizard begins. Select the local server as the Data Source. For Destination select Microsoft Access from the drop down box. Select the database from the CD ROM in the folder labeled “sql-scripts”. For the rest of the screens select “Next” to accept the default settings and the data should be imported with no problems.

B. To build the tables from the SQL script.

On the CD-ROM, there is a folder labeled “sql-scripts”. The script “virtual_lab.sql” is used to build the database and tables.

1. First complete step 1 from the directions above and make sure to name the database virtual_lab.

2. To run this script, open Query Analyzer and then open the file “virtual_lab.sql” in the “sql-scripts” folder on the CD-ROM.
3. Run the script just by pushing the play button in the tool bar at the top.
4. The script should run and all the tables, keys, and views should be created.
5. To Double check, open Enterprise Manager and look under the virtual_lab database in the Tables to see if there are 14 tables. If so, everything is correct.

Step 2: Setting up the DSN

This step entails setting up the ODBC connection to the database, so that the web application can connect to the database.

1. Go to the Control Panel, and double click “Administration Tools”, and then double click “Data Sources”.
2. On the dialog box that comes up, click the “System DSN” tab.
3. Click “Add”, select “SQL server” and click “Finish”.
4. In the name type a name for your DSN like virtlab – **NOTE: The name you choose here needs to be remembered for future steps.**
5. In the server drop down, select (local), and click “Next”.
6. See Figure 2 for the correct settings, and click “Next”. **NOTE: the password might be blank if you did not specify a password to connect to your SQL server.**
7. See Figure 3 for the correct settings, and click “Next”.
8. See Figure 4 for the correct settings, and click “Finish”.
9. Then click Test Data Source and if successful then click OK, and then OK.

Write down the DSN name here: _____

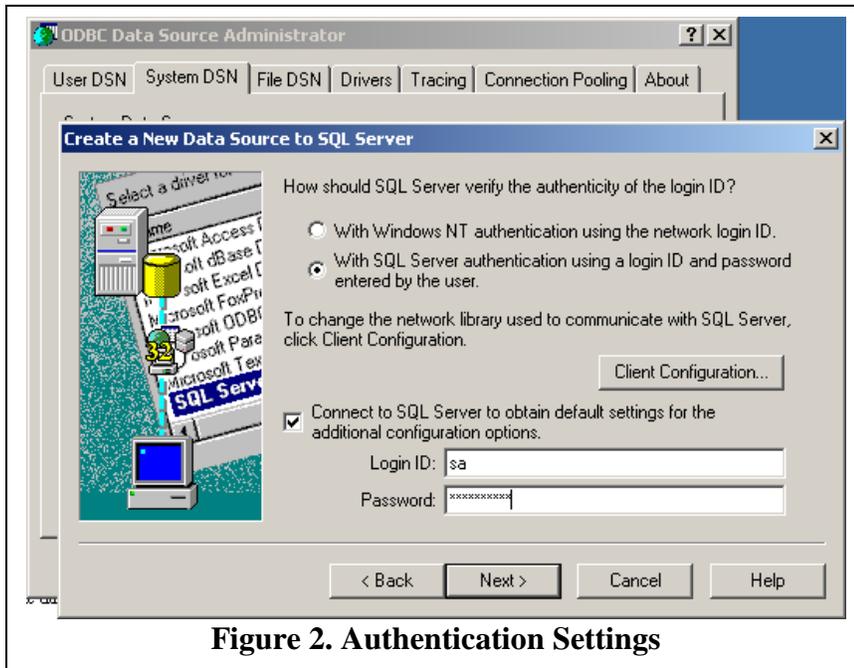


Figure 2. Authentication Settings

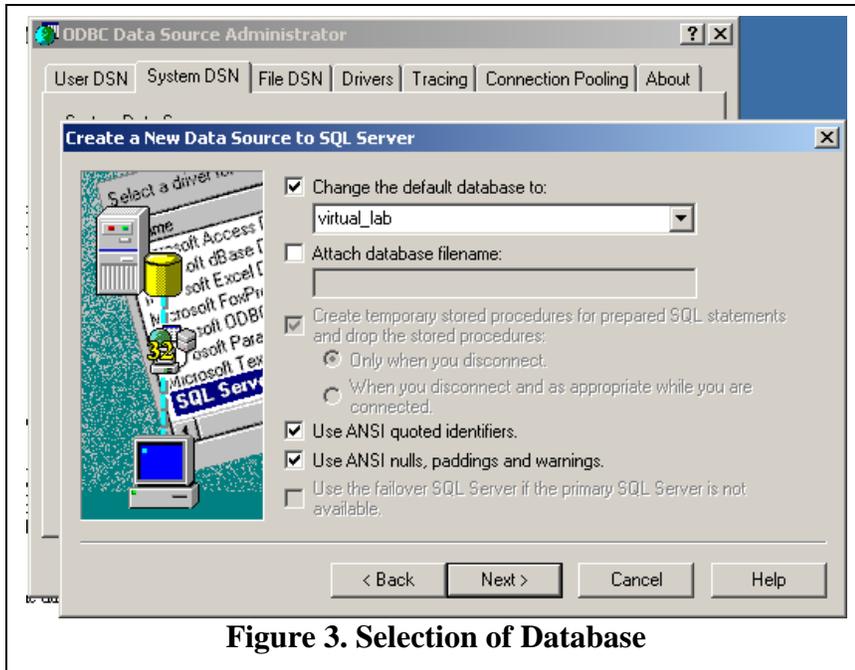


Figure 3. Selection of Database

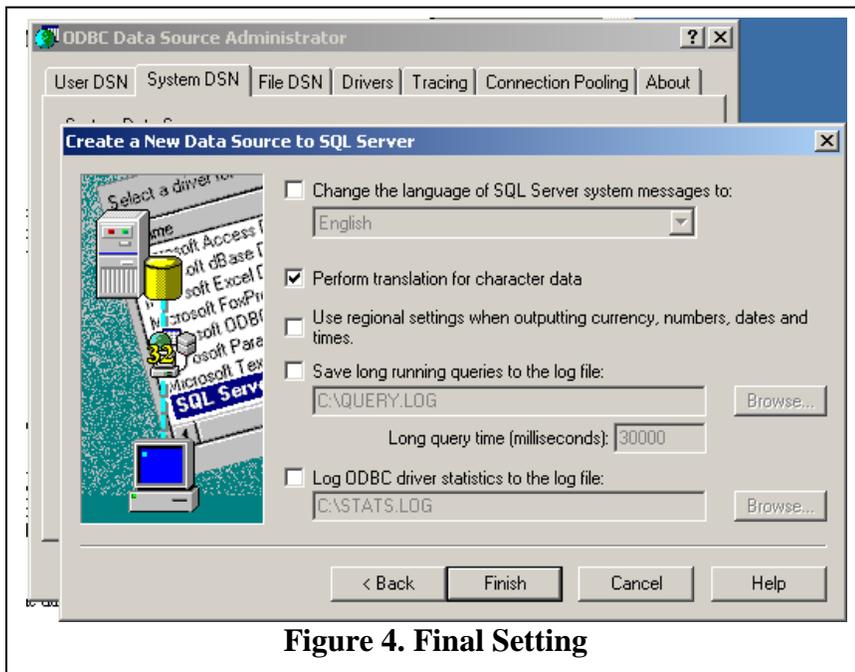


Figure 4. Final Setting

Step 3: Setting up the Shares and Upload

In order for the upload functions of the Virtual Lab to work, a component must be installed to enable this functionality with the code in the virtual lab site.

1. Copy the file called “aspsmartupload.dll” (from the CD-ROM) to a directory on the C drive. For example: C:\aspsmart
2. Open a DOS command prompt and change to the path of the folder where the aspsmartupload.dll file is and run this command:
regsvr32 aspsmartupload.dll
3. Copy the file called aspsmartuploadutil.dll (from the CD ROM) to the “C:\winnt\system32” directory.
4. Reboot the server.

In order for the code to work with the upload utility, you must setup the directories where all the files will reside. **NOTE: Once this is setup, the database will have to be updated if the location is changed.**

1. Open the Internet Services Manager for IIS, and right click the default web site, click “New”, “Virtual Directory”. Shown in **Figure 5**.
2. Name the directory something like “upload”. **NOTE: This may be done under the root of the default web site or under the Virtual Lab web site.**
3. Create four folders under this folder called: “equipment”, “equations”, “forms”, “profpics”.
4. If you have Windows Media Services installed, then there should already be a folder called “C:\asfroot” on your hard drive. If not then consider having this package installed to have video content available in the Virtual Lab application. This package comes with Windows 2000, but may need to be added.

Write down the whole path to the folder here: _____
(Example: c:\upload)

Write down the relative path to this folder from the root web: _____
(Example: <rootweb>/upload/)

Step 4: Uploading the Virtual Lab Web site Code

In order to upload the files successfully, the permissions and the directories must be established correctly. The application can be installed under the root web site or under a directory of the website for the server. This will not have an effect on the code or the functionality, but will have an effect if the location of the site is not properly setup for publishing. See your system administrator to get the proper login and password if you do not know the administrator password to the server

1. Copy all of the contents of the folder on the CD-ROM called “Source” to a folder of your choice on your hard drive. **NOTE: This is a temporary place for the files until they are added to your own Visual Interdev Project. If you do not plan to use Visual Interdev, then skip to the section on Installing without an HTML Editor.**
2. Once the files are copied the Virtual Interdev project needs to be created.

Adding to a Visual Interdev Project

1. Start Visual Interdev and fill in the settings for the new destination of the project files as well as the web server to host the application. **NOTE: If you are unsure of how to do this, see the help files on Starting a Visual Interdev project on the MSDN network at <http://msdn.microsoft.com>**
2. After the project is created, create the folders in the Visual Interdev project as seen in the folder called “Virtual_Lab_Local” where the source code was copied from the CDROM. **NOTE: Make sure to check all the folders for subfolders.**
3. Select the root of the project and right click and click “Add” then “Add Item”. Then select the Existing tab and select the folder “Virtual_Lab_Local” under the place where the source code was copied. This is shown in **Figure 5**.
4. Select the “File Types” drop down, and select “All Files”.
5. Then select all the files listed, this is shown in **Figure 6**.
6. Repeat steps 3 through 5 for each folder created as well as the images folder for the Visual Interdev project.
7. Once this is complete the project is added and added to the server. The next step is to change the configuration files in the project to work with your server and settings from above. Skip to step 5 below.

Installing without an HTML Editor

1. Copy all the files from the “Virtual_Lab_Local” folder under the “Source” folder on the CD-ROM to the folder in the web server where the application is going to run.
2. Once this is complete follow the steps below in Step 5, but Notepad may be used to open, edit and save the files in the location from above where copied.

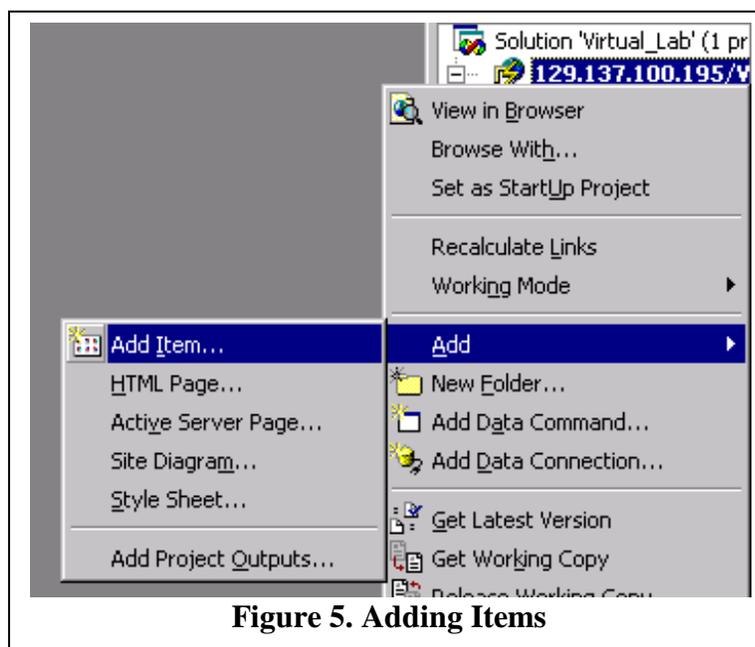


Figure 5. Adding Items

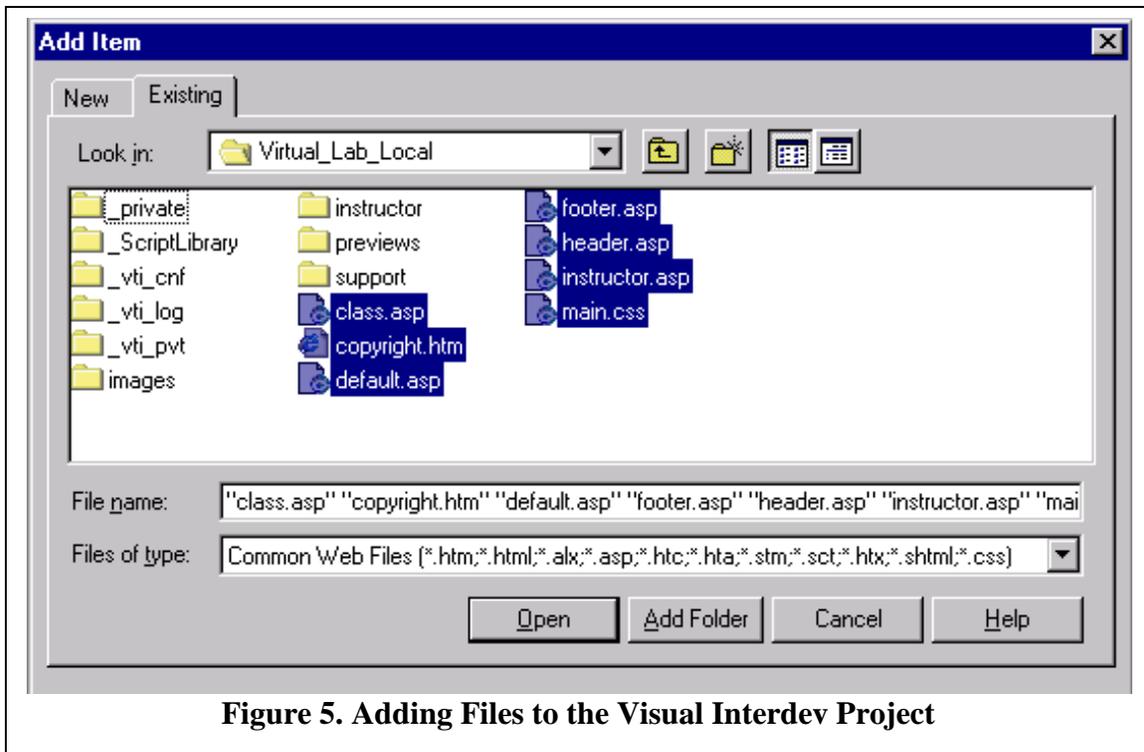


Figure 5. Adding Files to the Visual Interdev Project

Step 5: Virtual Lab Configuration Files

Based on the settings from the previous steps, the configurations files in the code for the Virtual Lab application must be set up correctly in order for the application to work at all. There are three files to modify the “connection.inc” file, the “upload_folders.inc” file, and the “contact.inc” file. They are located in the folders shown below:

connection.inc root of the project.
 contact.inc support/
 upload_folders.inc instructor/upload/

Modifying the “connection.inc” file:

1. Open the file with any editor of your choice and be sure to save it to the right place.
2. In the line starting with:
`conn.open "virtlab", "sa", ""`
 put the DSN written above where it says: virtlab
 If there is a password to the SQL server put in between the two quotes that have nothing between them.
3. The “connection.inc” file is now configured.

Modifying the “contact.inc” file:

1. Open the “contact.inc” file
2. Where it says: “strWebAdminE = someone@mail.com” replace that email with the e-mail address of the Webmaster that receives support e-mail about the Virtual Lab application.
3. Where it says: “strAnotherE = your_email@email.net” replace the e-mail with another e-mail address if you wish to have more options for contact. NOTE: For any others, add them appropriately, but file called feedback.asp will have to be modified to add any new contacts.

Modifying the upload_folders.inc file:

1. For each place it shows: “E:\upload\” replace with the full path you specified in step 3 above. Do not change the “C:\asfroot”
2. For each place it shows: “/upload/” replace the upload part with the path after the root web site.
3. Once this is done the Virtual Lab application is now configured and know where to place files uploaded and where they are relative to the web site.

Conclusion

The Virtual Lab application is now setup and configured. Some of the files may need to be tailored to the department and/or college that this product is intended for. This is evident in the “header.asp” and “footer.asp” pages. When those files are opened or the site is previewed you will notice the College of Applied Science image and the copyright information. This information must be changed as per the agreement when this product was purchased.

If there are any problems please contact either your system administrator or myself at email: jasonkumpf@mail.com

Appendix D. Virtual Laboratory Program Code