LOUGHBOROUGH UNIVERSITY

Computer Aided Learning on the Internet For Engineering Mechanics

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DEPARTMENT OF MECHANICAL ENGINEERING

FINAL YEAR PROJECT REPORT 1998

LOUGHBOROUGH UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

PART C STUDENT PROJECT

OBJECTIVE FORM

Student ..... R. J. Kay ..... Supervisor ..... Dr. M. Acar .....

Second Reader ..... Dr. W. M. Malalasekera

Degree Programme:

BEng/MEng ..... B.Eng ..... Programme ..... Mechanical Engineering
(Mechanical Engineering/Engineering Science and Technology/EMPE/MOE)

Objectives:

To produce a number of World-Wide-Web pages to assist in the teaching of 1st Year undergraduate Engineering Mechanics.

The pages should present information and follow this with interactive tutorials if possible.

Deliverables:

The outcome of this project will be a Web Site for 1st year Engineering Mechanics on the Internet.

Proposed method of attack:

1. Investigate HTML/Java using different software Editors.
2. Develop WWW pages for use on the Loughborough Web Site.
3. Investigate methods of producing interactive tutorials.
4. Implement package on the Loughborough Web Site

Signed ..... R.J.Kay ..... (Student) ..... M.ACAR ..... (Supervisor)

..... (Second Reader)

To be copied and one copy returned by the student on or before Friday October 17 1997 to Dr B C Fisher. The other copy should be retained by the student and **must** be bound into the project report before submission. Supervisors should retain an extra copy for themselves.

Table of Contents

1. SUMMARY

Computer Aided Learning (CAL) provides the answer to tomorrows problems when teaching large numbers of students, especially in Higher Education where student numbers can reach 160 per module. The Internet will be the easiest way to reach this audience, and in the near future will be used for online assessment.

The objective of this project is to produce a number of World-Wide-Web pages to assist in the teaching of first year undergraduates at Loughborough University studying Engineering Mechanics, a compulsory module for reading Mechanical Engineering. The project looks at the use of HTML/Java/CGI in web pages, development of WWW pages for use on the Loughborough Server, methods of Interactive Tutorials and Implementation.

The page layout for the site has the appearance of HTML Forms but actually uses HTML Tables. This affect is used to create a Contents Bar on the left of the screen containing links to the following sections.

- **Interactive Tutorials**. Over 200 multiple-choice questions split into 16 Statics and 21 Dynamics sections, covering all topics of the syllabus. Created using the CASTLE toolkit, they use the CASTLE marking engine to generate user feedback.
- **Worked Examples**.
- **Past Exam Papers**. Online past papers have been created in Adobe Acrobat format, which requires Acrobat Reader to view (available free from http://www.adobe.com/prodindex/acrobat/readstep.html). All computers at Loughborough University have Acrobat Reader installed.
- **Reading Lists**. Reading lists for the module have hyperlinks to the library OPAC database, where availability of books can be checked instantly.
- **Related Web Links**. Hyperlinks to related web material.
- **Feedback form**. Online feedback form using CGI to email results to web master.

The project is being tested on a development server (http://www-student.lboro.ac.uk/~mcrjk/) until the end of the 97/98 academic year. The final position (http://www.lboro.ac.uk/faculty/eng/engtlsc/Eng_Mech/index.htm) will be on the Engineering Teaching and Learning Support Centre (TLSC) web site. The site is best viewed with Internet Explorer 3.0 or Netscape 3.0/4.0. Netscape 2.02 should be avoided because the use of Symbols is not supported.

Plans for the site include feedback to the tutor, keyword question matching and Hyperlinks connecting the tutorial feedback to example questions with fully explained solutions.

2. INTRODUCTION

2.1. Computer Aided Learning

Workload on lecturers in Higher Education is escalating rapidly because student numbers are increasing without a match in resources. Computer Aided Learning offers additional tools in the lecturer's armoury to supplement traditional methods. The wide scale use of the World Wide Web now offers a medium that can easily reach large numbers of people at relatively low cost. With campus wide networks and computers available for students, computer aided learning systems can be implemented in a relatively short time scale to a large audience.

The aim of the project is to design and implement a number of WWW (World Wide Web) pages for 1st year Undergraduates studying Engineering Mechanics. Engineering Mechanics is a compulsory module in part A for a Mechanical Engineering degree at Loughborough University. Student numbers for the module are in the range of 150 to 160.

It is hoped that introducing a Computer Web Based Learning Package will bring the following benefits:

1. **Immediate feedback.** Students do not have to wait until periods on their timetable to discover whether answers are correct or incorrect.

2. **Reduced contact time between Tutor and Student**. Feedback could reduce the time required with the tutor, or provide the tutor with extra time for more effective teaching.

3. **Personalised Learning**. The user can work through the topic at his/her own pace, identifying areas that require more work.

4. **Distance Learning.** With a web based CAL package, studying could take place at any time and at any place around the world.

5. **Assessment.** Online coursework tests could assess the student, and would require no marking from the lecturer.

2.2. Previous Work

This pilot project arose from a final year project last year for the Thermodynamics Module. This provided an insight into CAL on the Internet and some of the learning tools it could provide. This project was analysed and its ideas were worked upon to form the basis of the Engineering Mechanics Web Site.

2.3. Why the Internet?

Is the Internet the best medium for a CAL package? Below are some of the advantages and disadvantages of using the Internet and HTML[1] as a means of delivery.

Advantages

- Information on the Internet is updated instantly if changes are made to the CAL package on the Web Server[2]. If a stand alone package was used, upgrade disks would have to be distributed and installed on each PC on campus.
- No installation is required on the users PC if Internet connections already exist.
- It is the quickest and cheapest way to implement a CAL package over the computer network at Loughborough.

Disadvantages

- Difficult to achieve a standard layout of a WWW page that looks identical on all Web Browsers[3].
- Download time of WWW pages can be slow during peak use. Caused by a combination of old, slow computers in the computer labs and a congested Network.
- WWW pages on the Internet are not just available to everyone in Loughborough University, but to everyone in the world so security must be taken into consideration, especially if CGI scripts[4] are used. Does the CAL package need to be restricted to Loughborough students only?

2.4. Project Goals

The final goal of the project is to produce an interactive CAL web site to be online before the end of the academic year. The time scale of the project does not accommodate for the design of complex features (e.g. databases) and entering content for the site. A compromise of the two would have to be achieved.

[1] HTML (Hyper Text Mark-up Language). Basic code for a WWW page.
[2] Web servers are ordinary computers that are connected to the network that store the web site.
[3] Web browsers are programs used to 'surf' the Internet. They display HTML pages from the web server onto any computer with Internet Access. e.g. Netscape
[4] CGI scripts are executable programs stored on the web server that HTML pages can call upon to carry out complex tasks. e.g. databases

3. WWW FUNDAMENTALS

3.1. Web Browsers

As explained in the Conference Paper (Appendix A), Web Browsers are used to display WWW pages. Two main Browsers are used globally, Microsoft Internet Explorer (MSIE) and Netscape. Newer versions of Browser are released almost every six months. The most current versions are Netscape 4.04 and MSIE 4.0. These two Browsers interpret the same WWW page in different ways, which makes it difficult to design a page that looks identical on both.
At Loughborough, the Web Browsers used in the computer labs are Netscape 2.02 and MSIE 3.02.

3.2. Web Servers

Web Servers hold the WWW pages for a web site. Any computer can be converted to a Server by installing Web Server Software. The best Server software is commercial, however simple servers can be set-up on computers with permanent Internet connections using freeware programs such as Microsoft's Personal Web Server. Available from http://www.eu.microsoft.com/msdownload/ieplatform/pws/pws.htm.

When designing web pages, the operating system of the Server (eg Win 95, Unix) must be taken into consideration. The University web server operates on a Unix system. This differs to a Windows 95 system by allowing case sensitive file names. For example, "index.htm" is different to "Index.htm". If a web site is designed on a Windows 95 system with the aim of operating on a Unix Server, it is good practise to use lower case letters for all file names.

3.3. HTML (Hyper Text Mark-up Language)

A WWW page is a text file containing HTML tags that the browser interprets and displays. HTML tags control the layout of the page with features such as tables, paragraphs, headings, text fonts and formatted text eg, **Bold**, *Italics*, Subscript etc. HTML tags are written in-between the symbols "<..*HTML tag..*>" and "</..*end of HTML tag..*>".

An example of HTML code is shown below, and a Web Browsers interpretation of this, is displayed in figure 1.

```
<html>

<head>
<title>HTML code</title>
</head>

<body>

<h1>Test Page</h1>
```

```
<p>HTML can display text in <strong>Bold</strong>, <em>Italics</em>,
<sub>Subscript</sub>,
<sup>Superscript</sup>, etc</p>
</body>
</html>
```

Figure 1 – Picture of HTML page created from the above code

Images are represented on a page by the code:

```
<img align="middle" src="http://www.example.com/tutorials/images/pic.gif">
```

The SRC is the location of file stored on the web server. This can be either an absolute position, as shown above, or more commonly a relative position. In the above example the relative SRC for the image, if the HTML page were stored in the folder "tutorials", would be `src="images/pic.gif"`. The advantage of using relative addresses for all links is that they would still work if the web pages were transferred to different positions on the web server. If absolute address were used, each link must be changed to represent the new file location.

A disadvantage of HTML is that text is displayed in a similar output to a word processor and therefore, mathematical symbols and equations are hard to replicate.

HTML pages can be created using different types of software, described in the Conference Paper, Appendix A. This project will be created using FrontPage 98, the latest WYSIWYG (What You See Is What You Get) editor from Microsoft.

3.4. Images

Two forms of image files are used in web page design, GIF and JPEG. Each file format has its own advantages and disadvantages but generally, GIF is used for graphics with only a few colours and medium quality JPEG for photographic images[a].

Images for the Engineering Mechanics Web site will be created using Adobe PhotoShop 4.0.

3.5. Java/JavaScript

Java and JavaScript are not the same the same programming code but both can be applied to web pages in addition to HTML. They are used to increase the visual impact of pages with flashing and scrolling text etc., or display messages when certain features are activated by the mouse cursor.

3.6. CGI (Common Gateway Interface)

CGI is a standard way of running programs from a Web server. CGI programs are used to generate pages dynamically, interact with online web databases, or perform tasks when online HTML forms are submitted. The HTML tag for such a form could be.

```
<FORM METHOD="POST" ACTION="/cgi-bin/myprog">
```

To activate a CGI program, a reader sends a URL[5] that causes the Web server to use CGI to run a program. The server passes input from the reader to the program and output from the program back to the reader. CGI acts as a "gateway" between the server and the program code.

The program run by CGI can be any type of executable file on the server platform and can be written in Languages C, C++, Perl, Unix shell scripts, Fortran, or any other compiled or interpreted language.

Below shows a diagrammatic representation of communication between Web server, CGI program and reader[b].

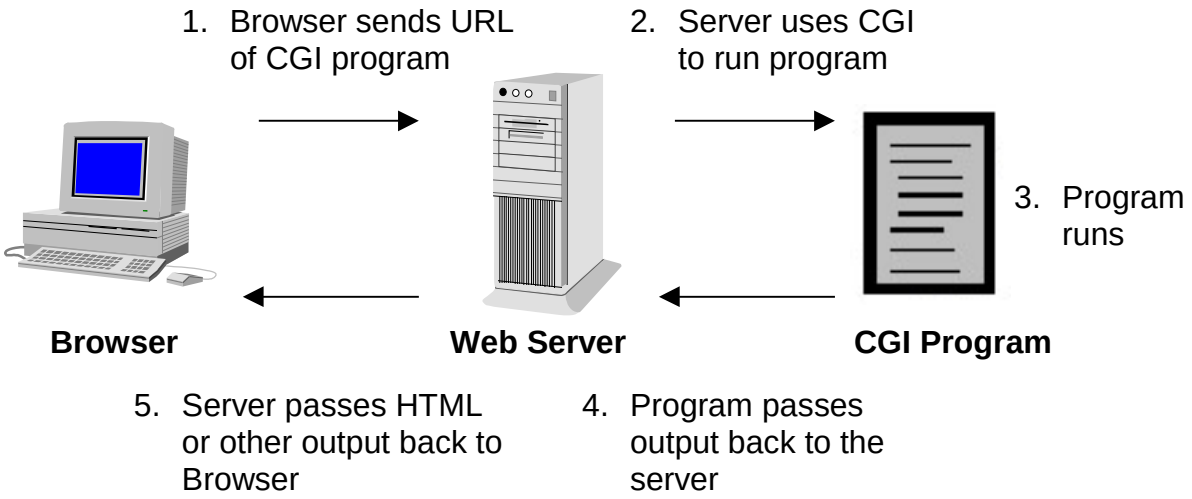

Figure 2 - Diagram showing communication between browser, server and CGI program

Disadvantages of CGI programs are that they can cause security problems if poorly written. A "hacker"[6] can break into a program and execute other files stored on the web server. Steps can be taken to avoid such problems, but the risk does exist.

3.7. CGI Feasibility

CGI is used to make interactive web features, and could be used to produce interactive tutorials. Therefore, a feasibility to determine if CGI could be used on the University Web server was undertaken.

It was found the University does have a special CGI directory[7] on their Web server at http://www.lboro.ac.uk/cgi-bin. However, access to this directory is restricted because of the security risks described above, and students are not allowed to create CGI programs for use on the University Web server.

A solution would be for the Mechanical Engineering Department to set-up their own Web Server with CGI directory, which could hold all Departmental Web pages. This would increase the service for the department with such features like tutorial question databanks and mathematical calculation programs.

[5] URL. Unique address of a WWW page, e.g. http://www.lboro.ac.uk/
[6] "Hacker". Term for computer programmer who breaks into programs in an attempt to cause damage.
[7] CGI Directory. Special directory on web server that has read and executable properties and is often called "cgi-bin".

4. CONCEPT DESIGN

4.1. Web Site Content

This web site supports the Engineering Mechanics module so the contents were designed specifically to suit the needs of the module. It was decided lecture notes would not be included in the web site at this stage because the module is taught from the course text[c]. This provides the main core of lecture notes that need not be repeated in the web site.

Features listed as useful to students that the web site will aim to support are:

- Tutorial questions, possibly with feedback.
- Example questions, similar to the tutorial questions with full solutions.
- Past exam papers, possibly with solutions, or hints to the answers.
- Reading lists. Useful books relevant to the course and where they can be found
- Links to relevant material on the Internet

4.2. Page Layout

4.2.1. Basic Design

The Conference paper in Appendix A describes how the page design arose, and why it was created using HTML Tables instead of Frames.

Using FrontPage 98, table cells were created for the Contents Bar and main page titles. The left side cells were given a blue colour. The aim was to make a basic page that all other pages could be based upon (a Template). Appendix B shows the layout of cell borders in FrontPage 98, which are invisible when displayed in a Web Browser.

4.2.2. Contents Bar

The Contents bar provides links to all sections in the Web site, but the design is critical to achieve a professional, but not formal look. A simple Contents bar can be achieved with hyperlinks[8], using the HTML code: -

```
<a href="tutorials/tutorial_index.htm">Tutorial Questions</a>
```

A Browser would translate this and show "Tutorial Questions", that when clicked would open the page "tutorial_index.htm". This design is simple but looks plain and uninspiring. The best Contents bars on the Web are designed using image maps.

[8] Hyperlinks. Text that when clicked, open a new Web page. Generally designated by blue underlined text.

Image maps are HTML code that mark out hotspot[9] sections on an image that act as hyperlinks.

A Contents bar image must first be created, in this case using Adobe Photoshop 4.0. The design is critical for the look of the web page and must contain the required sections: -

- Tutorial Questions
- Worked Examples
- Further Reading
- Past exam papers
- Links
- Feedback

Appendix C shows three designs, each having their own look.

Contents bar A has a plain formal appearance. This is achieved by small text in Arial font style. The appearance of this was too small when viewed by a Web Browser, particularly if the computer screen had a large screen resolution, eg on a 17" monitor compared to a standard 14".

Contents bar B used the same background but the font was modified in attempt to bring the text out of the page. Adding a shadow to the text created this affect and it improved the appearance but it still appeared too plain for the average engineer.

Contents bar C uses bigger, bolder and a different font called Fresnel, available from the Internet[d]. This look was preferred by students. On a larger screen resolution the picture is still eye catching and the larger text provides an increased surface area for the hotspots which in turn makes the navigation of the site easier.

Contents bar C was chosen for the final design.

[9] Hotspot. Term for a designated area within an image.

4.3. Online Documents

4.3.1. PDF

PDF files are being increasingly used to display online documents over the World Wide Web.

PDF is a file format used to represent a document in a manner independent of the application software, hardware, and operating system used to create it. Each page in a document may contain any combination of text, graphics, and images in a device- and resolution-independent format. Hence, the document will appear identical on any computer regardless of web browser and operating system used.

A PDF document may also contain information possible only in an electronic representation, such as hypertext links. In addition to a document, a PDF file contains information about the file such as Title, Subject, Author, Keywords, and dates created and modified[e].

PDF files are created with commercial software, Adobe Acrobat Exchange or Distiller. Files are viewed using Adobe Acrobat Reader 3.0, which is available free from the Internet at http://www.adobe.com/prodindex/acrobat/readstep.html.

4.3.2. Online Past Papers

Past examination papers will take the form of online documents on the Web site. PDF is not the only method of producing online documents. Documents can be displayed as normal web pages using HTML, and as Word Processed files. The advantages and disadvantages are discussed below.

HTML Documents are displayed well in a Web Browser. Word processing features such as text search, copy and paste can be conducted. Documents can be printed, but layout will depend on Browser configuration. Different Browsers do not view an HTML page in the same manner.

PDF Acrobat Reader 3.0 is required to view documents (available at no cost). The original layout is preserved and can be printed to create a replica of the original document. Word processing features such as text search, copy and paste can be conducted. Acrobat Reader 3.0 is installed on all computers at Loughborough (Macintosh[10] and PC).

[10] Macintosh. Microcomputer with a different, incompatible hardware system to PC.

Word Documents The correct version of Microsoft Word is required to view the files. In Loughborough at least four versions currently exist, Word 6.0, Word 95, Word 97 and Word for Macintosh. Obviously with such inconsistencies word documents are not suitable for the Web. They also contain risks to macro[11] viruses.

PDF provides the best solution to displaying Past Papers on the Web site.

Past examination papers in PDF format can be created using two methods.
1. Scanned from the original paper copy
2. Converted to PDF from a word processed electronic copy

Scanned documents are effectively electronic photocopies, but PDFs converted from electronic Word Processed documents are replicas of the printed document that can be interrogated with word processing features such as text search.

To produce the best results PDF files should be converted from electronic word-processed documents. However, if large volumes of paper documents need to be converted to PDF then scanning is the quickest and cheapest way, providing word processing features on the document are not required.

4.4. Interactive Tutorials

4.4.1. Requirements

Tutorial questions are currently typed on paper. Students then calculate the answers in their own time and bring the solution to a tutorial session where they are discussed.

To replicate this procedure on the Web, the following process is required:

1. Display Tutorial questions.
2. Provide a means of answer questions.
3. Mark the answers.
4. Display feedback showing correct and incorrect answers.

This process may look simple, but to replicate it on the Web almost certainly requires a CGI program. The problem at this stage is that even if a CGI program were developed it would not be online until a web server with CGI access became available. Other solutions had to be found.

[11] Macro. Series of Word commands and instructions that group together as a single command to accomplish tasks automatically.

4.4.2. Question Types

Input to any web page is made through HTML form features such as drop down boxes, text area boxes and radio buttons. Problems arise when marking the input by comparing it to a reference value. The easiest questions to mark are multiple choice answers so these are usually developed first.

4.4.3. JavaScript Examples

Without the use of CGI, creating interactive tutorials would be restricted to using Java or JavaScript. Examples of these have been created for multiple choice questions by the Computing Studies department.

Using JavaScript a simple message can be displayed to the screen in response to the reader selecting an answer from a drop down box. Example questions of this type were created and are shown in Appendix D, and can be seen at http://www.lboro.ac.uk/faculty/eng/EngTLSC/Eng_Mech/tutorials/old/tut2_1.htm.

The JavaScript code shown below, is situated in the HTML page below the <head> section but before the <body> section.

```
<script language="JavaScript"><!-- start of script
function ans(obj,correct){
      if(obj.selectedIndex==correct)
            alert("Correct.....congratulations!");
      else
            alert("Wrong.  Please try again."); }
<!-- end of script --></script>
```

This function takes two values, the user response and correct response, from a multiple choice drop down box. An IF statement compares the two values which if equal displays a correct message, else an incorrect message. The messages are displayed in alert boxes.

An example of HTML code from a multiple-choice drop down box is shown below.

```
<select name="tut1_1" size="1" onchange="ans(this,3);">
      <option selected value="Choose a value.....">Choose a
      value.....</option>
      <option value="100">100</option>
      <option value="110">110</option>
      <option value="120">120</option>
      <option value="130">130</option>
</select>
```

Five choices are shown but the computer recognises them as selection 0, 1, 2, 3 and 4. The default selection is value 0. By selecting an answer (“onchange”), the JavaScript

function is activated and the number of the chosen selection (stored the field "this"), is compared to the correct choice "3".

This method for interactive tutorials was not used in the final design. Universities and software companies have been developing similar projects for many years that provide better alternatives. These are evaluated in the next section.

4.4.4. CAL Software on the World Wide Wed

The Flexible Learning Initiative (FLI) at Loughborough University encourages course tutors to implement Computer Aided Assessment packages that are felt to be appropriate to their teaching. Links to CAA packages on the WWW are found at the FLI web site[f]. Summarised below are some of the projects available on the Internet.

Question Mark - *http://www.qmark.com/home.html*
This commercial software offers online assessment tests and is one of the most advanced software packages available. It offers several different question types such as multiple choice, text input, numeric input, hotspots, matching/ranking lists[12] and fill-in-the-blanks. The FLI is developing this software for future use in Loughborough University. To use Question Mark licenses have to be bought for each computer. This is expensive and will prevent Implementation campus wide.

MedWeb, *Birmingham University* - *http://medweb.bham.ac.uk/http/caa/index.html*
The MedWeb server can generate an assessment exercise based upon questions either in one of the MCQ databases or using questions submitted via email or fill-out forms directly from the web. Questions are automatically marked where appropriate and a spreadsheet can be generated and sent to the question set owner containing a full record of attempts made at answering the questions. No knowledge of HTML or CGI is needed to submit questions.

TML and NetQuest, *Bristol University* - *http://www.ilrt.bris.ac.uk/mru/netquest/tml/*
The NetQuest project is developing TML (Tutorial Mark-up Language), a superset of HTML, enabling tutors and students to create sets of questions for self or course assessment with automatic marking and user authentication.
TML software distribution is freely available in the form of a CGI Perl script. However, a dedicated cgi-bin directory, and a considerable knowledge of CGI would be required.

WebMark, *South Bank University*-*http://pisces.sbu.ac.uk/BE/SUDP/W3/webmark.html*
WebMark is a CGI Perl application that will create a Perl script to set and mark a multiple choice questionnaire. The questions and specimen answers, provided by completing an online form, are displayed on the web.
When the student has completed this form and submitted their answers, the script compares the student response against the sample answers and returns the students

[12] Matching/ranking lists. Used for True/False, Yes/No questions or for arranging items in a required order.

score. Currently this only supports True/False question types and requires a cgi-bin directory.

DIADS/TRIADS, *University of Derby*
TRAIDS (Tripartite Interactive Assessment Delivery System) harnesses the full multimedia capabilities of Authorware Professional[13] and provides a very wide selection of question styles together with sign-on, results calculation and filing procedures for a variety of run modes[g]. This supports the largest range of question types in a WWW assessment engine. The FLI at Loughborough are developing an authoring shell that could be used by the University.

WebCT - *http://homebrew.cs.ubc.ca/webct/*
WebCT is commercial software tool that facilitates the creation of sophisticated World Wide Web-based educational environments by non-technical users. It can be used to create entire online courses, or to simply publish materials that supplement existing courses.
WebCT can be downloaded free to develop a teaching aid, but to publish the site for students, licences must be bought. Implementing WebCT throughout Loughborough would be costly.

Top Class - *http://www.wbtsystems.com/*
TopClass Server provides a powerful virtual classroom environment to manage all aspects of content and class management and to deliver a flexible learning environment built entirely on the open, non-proprietary standards of the Web.
This is a very powerful commercial package.

CASTLE Project, *Leicester University* - *http://www.le.ac.uk/cc/ltg/castle/*
CASTLE (Computer ASsisted Teaching and LEarning) provides freely available tools for creating online multi-media assessments quickly and easily. It requires no prior knowledge of HTML, CGI or other scripting or mark-up language.
Self Assessment tests are created by submitting questions to an online form which then generates a test. Tests are saved to a local web server.

Students complete the test then submit it to the CASTLE marking engine where answers and feedback are provided.

The CASTLE project is in the first phase of its development, providing feedback to the reader only. Phase two hopes to include online course assessment and student progress monitoring.

The CASTLE project was chosen to create the Engineering Mechanics tutorial pages because it provides a quick solution with no required knowledge of CGI. The CASTLE CGI scripts are stored at Leicester, so interactive tutorials can be produced at no cost from any location with access to the Internet.

[13] Authorware Professional. Commercial CAL Software

5. FINAL DESIGN

5.1. Overview

This section describes how each part of the Engineering Mechanics was designed and created. When developing these pages it was important to remember these useful guidelines.

1. Quick download time
2. Aesthetically pleasing
3. Clear Content
4. Professional and Original appearance

A compromise always exists between the heavy use of colourful images and quick download time. When creating images it is important to consider the size because these are always the longest component to download on a Web page.

5.2. Web Site Structure

The whole Engineering Mechanics Web site contains over a hundred files so the folder (or directory) structure[14] must have a clear layout so future work can be easily conducted. Some files on the site will be used by all pages, such as the contents bar, while others will only appear in individual sections. Files must be arranged in section order to prevent confusion. The sections for the Web site are: -

- Tutorial Questions
- Worked Example
- Reading Lists
- Past Papers
- Links
- Feedback

The first page of a Web site is called the Home page. This is a general welcoming page to the site and contains links to all other sections. Home pages often contain useful related news, in this case news relating to the Engineering Mechanics module such as Coursework deadlines and exam dates.

The site map for the project is shown in Appendix E.

[14] Folder Structure. Location of files stored on a Hard Drive or Web Server.

5.3. Page Layout

5.3.1. Contents Bar

The design of the Contents Bar was decided in section 4.2.2 and was created using Adobe PhotoShop 4.0 with the sequence shown below.

Step 1. Create new image with the width equal to the cell width (148 pixels).
Step 2. Paint the image the identical colour used in the Web page cell (Red 0; Green 0; Blue 160).
Step 3. Add lens flare lighting effect.
Step 4. Insert text for section names. Font Fresnel, colour yellow, size 20 point.
Step 5. Select text and insert shadow.

The image was saved as a JPEG image to the "images" folder. Using FrontPage 98 the image was placed in the cell and an image map was created with Hotspots for each section title. Figure 4 shows the Contents bar viewed in FrontPage 98 with the Hotspots represented by rectangles.

Figure 2 - Contents Bar showing Hotspot areas

5.3.2. Main Page Title

The top left and top right cells of the page layout will accommodate the main page title. The desired affect of the page is to blend the Contents bar into the main page section.

Appendix F shows pictures at each step of the design process.

Step 1. Create an image. Width equals full page length (634 pixels). Height equals cell height (167 pixels). Colour a section of the image an identical colour to the Contents bar and the same width. Add lens flare effect.
Step 2. Paint the right hand section a faint yellow.
Step 3. To blend the two columns, paint a green section over the blue/white join. Add lighting effect to give 3D effect.
Step 4. Add the text "Engineering Mechanics". Font "Times New Roman".
Step 5. Add final touches. Random Engineering Mechanics terms in small font. Diagram taken from tutorial questions.
Step 6. Along the blue/white join split the image into two (148 pixels from left) and save the images as two different JPEG images.

When the two images are added to the top two table cells in the page layout, the join becomes invisible giving the effect of just a single image.

5.3.3. Section Titles

The section titles use the font “Trebuchet MS” which was given a 3D effect using the lighting effects filter and a shadow. The image was then saved in JPEG format. Figure 4 shows the result.

Figure 2 – Section Title of Tutorial Questions

5.3.4. Animated GIF

The Computer Aided Learning animated GIF displayed on the Home page was automatically created using the Web site “MediaBuilder Animated Banner Maker” at http://www.mediabuilder.com/abm.html.

5.3.5. Page Template

Once the images were added it was updated as the new template file. The pages for each section were created using this template, guaranteeing an identical layout.

5.4. Navigation

Navigation around a web site is important because it help the reader use the web site quickly and efficiently. The contents bar gives direct access to each section, but once there, a Home page link was required. Instead of including a Home page link on the contents bar, two buttons were added to each page.

1. Home page hyperlink
2. Back. A button replicating the back feature on a Web Browser.

Button Design

The button was designed using an Adobe Photoshop 4.0 extension called PhotoButton. Once the button was designed, a shadow was added and finally logos were placed on the buttons to represent their functions (see figure 5 below).

Figure 2 – Creation of the Navigation Buttons

The images were saved in GIF format and added to the section pages.

The hyperlink added to the Back image was the following JavaScript code.

```
JavaScript:onClick=history.go(-1)
```

This acts as a Hyperlink to the last record in the Browsers History list.

The homepage button used a simple relative link to the main index.htm page, "../index.htm".

Hyperlinks

It is common practise to provide Hyperlinks to each section of the web site located at the bottom of each web page. They act in the same way as the Hotspots on the Contents Bar and use the same "relative" URL's. Shown below is how they appear on the web page.

Home / Tutorials / Examples / Reading Lists / Past papers / Links / Feedback

5.5. Online Tutorial Questions

5.5.1. Overview

The self assessment tutorial section is the most useful section of the Engineering Mechanics Web Site. Considerable work was made in this area in the attempt to achieve a useful product that students could start using before the end of the academic year.

The process for making a tutorial page is as follows: -

Step 1. Select tutorial questions suitable for the web.
Step 2. Produce a hard copy of each tutorial page.
Step 3. Create the diagrams for the tutorial questions and convert them to GIF format.
Step 4. Prepare the questions in the CASTLE question format using Word Processor.
Step 5. Create a Tutorial web page with the CASTLE toolkit.
Step 6. Modify the pages using the CASTLE toolkit
Step 7. Edit each page to add guideline instructions and the Loughborough University logo.

5.5.2. Selecting Suitable Tutorial Questions

The tutorial questions for the Engineering Mechanics Web Site have been selected from two floppy disks that accompany the course text[h]. These disks provide questions

on each section in the book. Tutorial pages were made for all sections taught in the module, 16 Statics sections and 21 Dynamics sections.

Not all questions on the disks were suitable for the web. When choosing questions for a section, the easier questions were often omitted and questions requiring explanations were also not included. Some questions contained feedback once answered.

Approximately 5 to 10 questions were chosen from each section.

5.5.3. Producing a Hard Copy

Despite being in the computer age, it was still necessary to produce a paper copy of the tutorial tests for each section. Paper records were kept of questions, diagrams and feedback because text could not be copied and pasted from the DOS programs that contained the questions.

5.5.4. Creating Question Diagrams

Most questions had associated diagrams which were simple, using few colours and standard shapes. It was found the drawings could be sketched quickly in Microsoft PowerPoint rather than using a more accurate CAD system. PowerPoint files were made containing all the diagrams for each section and were saved with names, tut2_1.ppt, tut2_4.ppt, etc

Once the diagrams had been made they were converted for use on the Web by copying and pasting into Adobe Photoshop 4.0. From here they could be saved into GIF format and because of their simplicity the file size was kept small, approximately 2K. The files were saved to the "tutorials/image" folder with unique names referencing them to the questions they belong to, e.g., tut2_1_1.gif, tut2_1_2,gif, etc. Over 200 diagrams were created and using this naming sequence each picture could be easily linked to the relevant tutorial question.

5.5.5. Preparing Questions for the CASTLE toolkit

Tutorial questions are entered into the CASTLE toolkit using a special format, shown below. Preparation is quicker if the tutorial questions are prepared in a Word Processor, such as Microsoft's Word 97.

The questions are typed, or where possible copied and pasted from the source code of the original DOS programs. Added to the questions are the HTML tags to represent images, subscript text, superscript text and a change in Font used for symbols. Symbols such as θ, μ, Σ, β, γ and α are shown by the normal letters q, m, S, b, g and a respectively in "Symbol" font.

Image tags must be added using "absolute[15]" addresses because the feedback page, generated by the CASTLE CGI program, will associate "relative" links to files on its Web Server instead of the Loughborough Server.

An example from a prepared tutorial text file is shown below. The symbol * is used to tell the CASTLE toolkit the correct answer.

```
1) On a sheet of paper draw the free-body diagram of member AB then list the
number of unknowns. </p> <img align="middle" src="http://www-
student.lboro.ac.uk/~mcrjk/tutorials/images/tut5_1_1.gif"> </p> Number of
unknowns = ?

2

*3

4

None of the above
```

The text files are saved using the same naming sequence tut2_1.txt, tut2_2.txt, etc in the "tutorials" folder.

5.5.6. Creating a Tutorial Web page Using the CASTLE toolkit

The Tutorial Web pages were created using the online CASTLE "create" tool at http://www.le.ac.uk/cc/ltg/castle/tools/ImportTest.html. This contains three input boxes for the Quiz Title, Module Title and Questions.

The Module Title was not entered for the reason that 97MCA003 would have to be updated to 98MCA003 next year.

The tutorials questions were copied from the text file produced earlier and pasted into the web page. Once the Title was added and the colour for text and background chosen, the page was submitted to the CASTLE CGI program.

The CGI program instantly returns the created Tutorial Test which is displayed in the Web Browser. Using the "Save Frame As" feature in Netscape, the generated tests were saved to the local hard drive in the "tutorials" folder with the naming sequence tut2_1.htm, tut2_2.htm, etc.

5.5.7. Modifying a Tutorial Test

Once the test had been created, additions were made to the page. At present the feedback page will show HTML tags instead of the images and formatted text. To activate the tags, the CGI program must be told the questions contain tags. This can be done using the CASTLE "modify" tool, but for tests with many questions it is

[15] Absolute Address is "http://www.lboro.ac.uk/faculty/eng/EngTLSC/Eng_Mech/tutorials/images/tut2_1_1.gif."

quicker to edit the underlying HTML code. The HTML code that represents tags are used in the question, is:

```
<input TYPE=hidden NAME= Q0HTML VALUE=0>
```

Value 0 equals HTML tags are not used, value 1 equals HTML tags are used and Q0HTML represents question number 1 (Q1HTML represents question2 etc).

By default this value is 0, but for all questions containing images and formatted text must be changed to 1. This was quickly achieved by opening the HTML page in Microsoft Word and using the Find & Replace feature to replace "HTML VALUE=0" with "HTML VALUE=1".

Feedback

The next modification was to add feedback to the tutorial questions. This was done using the CASTLE "modify" tool (http://www.le.ac.uk/cc/ltg/castle/tools/). The page to be modified must first be on a web server with its own URL. The URL is submitted to the "modify" tool which then allows changes to be made to each question.

Upon modification, a text box is displayed for feedback. Here text, including HTML tags, can be added that will appear below the question once marked.

After the feedback and any errors are completed, the "modify" tool displays the test for saving and the page must be saved again to the local hard drive.

5.5.8. The Finishing Touches

It was felt each test needed guideline instructions so once the test was completed it was modified again using Microsoft Word. Brief instructions were added along with the Loughborough University Logo to give the self assessment tutorials a final professional look, seen in Appendix G.

5.6. Online Past Exam Papers

It was recommended that PDF files were to be produced from an electronic copy of the past paper using a Word Processor.

The most recent exam paper, Summer 1997, was chosen for the conversion process which was as follows:

Step 1. Re-type the exam paper in Microsoft Word, or scan the past paper and use OCR (Optical Character Recognition) to import the text into Word.

Step 2. Scan the past paper and save the diagrams for each question in GIF format.

Step 3. Reformat the text and add the pictures to the Word document to produce a near identical copy of the past paper when printed.

Step 4. In Word 97, click the toolbar button "Create a PDF File". A PDF file is automatically created of the Word Document. (This is not a standard Word 97 feature, Adobe Acrobat 3.0 is required).

Step 5. Save the PDF file to the "pastpapers" folder in the Web Server.

When testing the PDF file online, it was found that only the first page of the document could be viewed. This problem was traced to the Web Server. The PDF file was tested on Microsoft Personal Web Server, which is available for free. This Web Server does not support "byte-serving", a necessary feature for a web server to display online PDF files. The Web Server was immediately replaced with O'Reilly WebSite Professional 2.0 demo, which does support PDF.

No problems were encountered when testing the PDF file on the University Web Server.

The PDF file can be accessed through a hyperlink just like any HTML page. If the browser is configured with Adobe Acrobat 3.0, it will automatically be displayed. If not, the Web Browser will display a prompt asking to download the file. The file can be downloaded to the PC and opened in Acrobat Reader at any time. Acrobat Reader can print the PDF file to produce a hard copy replica of the examination paper. The past paper is available at:
http://www.lboro.ac.uk/faculty/eng/EngTLSC/Eng_Mech /pastpapers/exam1997.pdf.

5.7. Online Reading Lists

Module reading lists would be useful information for students that could be easily displayed on the web. As well as displaying the name and author of the book, it was possible to create a hyperlink to the library OPAC database. OPAC is the library online database that provides information on books such as reference number, availability and even offers services to place a reservation and renew library books in your account electronically.

Hyperlinks to OPAC are made in the same way as any other web page. Using a Web Browser, the books on the reading list were found using the library OPAC search feature. The URL was copied from the Browser and pasted into the hyperlink on the Reading Lists web page.

Three books are recommend for the module:
1. Engineering Mechanics. - 1997. - Hibbeler, R (Dynamics)
2. Engineering mechanics. - 1997. - Hibbeler, R (Statics)
3. Engineering mechanics : statics & dynamics. - 1995. - Hibbeler, R. C., Russell Charles

A fourth book displayed is "Tutorial Solutions, 97MCA003 Engineering Mechanics - Spring 1998 - Dr Memis Acar". This is classed as a Short Loan Paper and is not featured in the OPAC database at present.

The Reading List Web page was saved as “reading_index.htm” to the “reading” folder on the web server.

5.8. Online Links

No web site is complete without a page of useful links to other related web sites. This page contains links under three main headings.

- Loughborough University
- Engineering Organisations
- Computer Assisted Learning Projects

This page was created in FrontPage 98 using the standard template for the project and was saved as “links_index.htm” to the “links” folder on the web server.

5.9. Online Feedback Form

5.9.1. Overview

Feedback for a web site is vital to help maintenance and to understand the requirements of the audience. Mistakes can be reported and improvements can be suggested that over time will be help develop the web site.

Feedback forms can be used for different purposes. To carry out a survey on the site, questions with set answers can be used, for example.

How would you rate the presentation of the web site?

○ Below Average ○ Average ○ Above average

A more general feedback form can include a text box for the reader to type his/her own message. This could be used to report faults and give constructive criticism.

At the current development stage, a general feedback form would be more constructive. Perhaps once the web site has been implemented and is used regularly an online survey could be developed.

5.9.2. Which method to use?

There are two ways an online feedback form can generate an email.
1. HTML “mailto” command.
2. CGI Program

They both perform the same function, which is taking information from the HTML form and emailing them to the webmaster. The advantages and disadvantages of each method are outlined below:

HTML "mailto" command	CGI Program
Advantages	
1. No CGI script is required. 2. Quick and easy to implement.	1. Emailed response can be customised. 2. Feedback will work on every Browser. 3. Web Browser need not be configured for sending email. 4. A response page can be generated after feedback has been sent.
Disadvantages	
1. Mailto forms only work on Netscape Browsers. They do not work with Internet Explorer. 2. A response page cannot be generated once feedback is sent. 3. Web Browser must be configured to send email. 4. Format of the email is very unclear and cannot be customised.	1. More time taken designing the HTML form fields for the CGI program

From the above benefits, CGI is the preferred method.

CGI scripts for converting HTML forms to email can be downloaded at no cost from the Internet[i]. However CGI programs need special directories and access to the University CGI directory is forbidden.

Free services exist on the Internet that provide CGI "form mailer" programs for use, already in a CGI directory[j].
However this is not ideal because of the following reasons:

- CGI Scripts are often situated in the USA so considerable time is taken to process the form.
- Once submitted, the reader is automatically sent to the URL of the service provider.

Upon further investigation it was discovered a "form mailer" CGI script already existed in the University CGI directory. This was available for use by any web page in the "lboro.ac.uk" domain.

5.9.3. Creating the Feedback form

The feedback form contains the following HTML code:

```
<FORM METHOD="POST" ACTION="http://www.lboro.ac.uk/cgi-bin/cgi-mailer.pl">
```

This declares the use of a form. The action statement is the URL of the CGI script that will process the form once submitted.

```
<INPUT TYPE="hidden" NAME="to" VALUE="mcrjk@student.lboro.ac.uk">
<INPUT type="hidden" NAME="subject" VALUE="Feedback from Engineering
Mechanics">
```

This code declares two form fields that are hidden so they cannot be edited in the Web Browser. In the “to” field, the VALUE entry holds the email address that the results of the form are sent to. The “subject” VALUE contains the text that appears as the subject on the email.

```
<input type="radio" name="type_of_comment" value="Complaint">
<input type="radio" name="type_of_comment" value="Problem">
<input type="radio" name="type_of_comment" value="Suggestion " checked>
<input type="radio" name="type_of_comment" value="Praise">
```

This code creates four radio buttons that are displayed in the Browser. Only one of the four options (Complaint, Problem, Suggestion and Praise) can be selected at any time. The default selection is “Suggestion”.

```
<textarea name="comment" rows="5" cols="41"></textarea>
```

This displays a large text box in the web page that the reader can type into.

```
<input name="name" size="30">
<input name="from" size="30">
```

These fields allow the reader to enter their personal details. The field “name” can be left anonymous, however “from” is required by the CGI program and must contain a valid email address otherwise an error message is displayed and the results are not sent.

```
<input type="checkbox" name="important" value="Please contact me regarding
this comment.">
```

The final field can be selected if the reader would like to be contacted regarding his query.

The layout of the feedback form can be seen in Appendix H and is online is at http://www.lboro.ac.uk/faculty/eng/engtlsc/Eng_Mech /feedback/feedback_index.htm.

5.9.4. Customising the Email and Response Page

The format of the data that is returned in the email, and the response page that is displayed after submitting the form can be customised[k].

Customising email

Customising the email is achieved by using a text file that contains the layout of the email. The file name must be called the same as the form, except using a "dat" extension and saved in the same folder on the web server. In this case "feedback_index.dat" was created in the "feedback" folder and its contents is shown below.

```
To:    $to
From:  $from
Name:  $name
Subject:$subject

Type of Comment: $type_of_comment
Comment: $comment

$important

*---End of feedback---*
```

The contents of the form fields are represented by $Field_Name.

Customising the response to the user

After submitting the form, a response page is displayed confirming the message has been sent. This is designed in the same way as the email, by creating a response file, using a ".res" file extension. However, note that since this is going to be displayed in a web browser, HTML can be included. The response page was created in FrontPage 98 and saved as "feedback_index.res" in the "feedback" folder on the web server. Appendix H shows the result.

Note: All links used in the response page must be "absolute" because the CGI script effectively displays the page.

If a response file is not used, a standard response is generated.

5.10. Implementation

The ultimate aim of the project was to implement the Engineering Mechanics Web Site on the Loughborough University Web Server. This section describes the process that led to this achievement.

Design first started using a Personal Computer operating Windows 95 and a local web server. The web server was able to provide instant viewing of the web site in a browser after each page was developed. The computer had a permanent Internet

connection so pages could be viewed from different computers around campus. This provided vital information for the page layout design that would suit all Browsers on all computers.

A web site can only be viewed on the Internet when the computer operating the Web Server is switched on. As demand increased for the Web Site, a more permanent place was found that could operate 24 hours a day. The University provides Web space for students so the Engineering Mechanics Web Site was transferred to http://www-student.lboro.ac.uk/~mcrjk/.

This web site operates on a Unix system so files were copied to the new space using ftp (file transfer protocol). WS_FTP is a popular choice of ftp software and is used extensively through-out the University. The new web site position generated an increase in feedback from staff and students and new ideas were tested.

Although the current web position was on the University Server, the web space will disappear at the start of the next academic year. A permanent place was found on the web server of the Faculty of Engineering Teaching and Learning Support Centre[l] (TLSC). This centre researches CAL projects for the Engineering Faculty at Loughborough. The permanent URL for the Engineering Mechanics Web Site is: http://www.lboro.ac.uk/faculty/eng/engtlsc/Eng_Mech/index.htm.

A benefit of being on this web Server is that web pages can be found using the search engine on the Loughborough University Home Page[m]. The search can accept strings such as “Engineering Mechanics Tutorial Questions” and after submission displays the nearest matches in a results page.

Because this site can only be updated by the TLSC web master, the Engineering Mechanics Web Site will only be launched at this URL once all work is completed. Testing has begun under the TLSC server but the most up to date site will remain at http://www-student.lboro.ac.uk/~mcrjk/ until the end of the academic year.

5.11. Testing

5.11.1. De-bugging

Testing of the web site was necessary to find “bugs” in the HTML code, and to investigate the differences in layout when viewed in different Browsers.

Most bugs arose from the changing between a Win 95 and UNIX Web Server.
A mistake was made in the template used to create each page. The Navigation Hyperlink to the Examples section was incorrectly named as “Examples_index.htm” instead of “examples_index.htm”. Each page was subsequently corrected.

5.11.2. Compatibility Survey

As explained earlier, a web page can have a different appearance when viewed by different computers. An investigation was conducted to the compatibility of the Engineering Mechanics Web Site with the computer labs around the University Campus. The main areas of investigation were as follows.

Page Layout in Web Browser
Six types of web browser are used throughout the University. Differences found in page layout for each are given below.

Make of Browser	Problems with layout
Netscape 1.1N	1. Does not support Image maps 2. Background colour in Castle tutorials appears blue instead of white 3. Does not support Subscript and Superscript formatted text 4. Different fonts not permitted. (Symbols used in tutorial questions are not displayed.) 5. Colour in table cells not permitted. (Affects Contents Bar on left of page)
Netscape 2.02	1. Subscript and Superscript formatted text not supported 2. Different fonts not permitted. 3. Colour in table cells not permitted
Netscape 3.0	No problems
Netscape 4.0	No problems
Microsoft Internet Explorer 3.02a.2916	Castle tutorials slightly misaligned
Microsoft Internet Explorer 3.02(4.70.1300)	No Problems

Quality of images
The quality of images is controlled by the quality of graphics card used in the computer. Older computers tended to have poorer graphics cards and this affected all graphics displayed on the computer, not just those on the Engineering Mechanics Web Site.

Page download time
Download time for any web site is very important. Download time changes throughout the day and is especially a problem at peak times. The results from this survey were taken during the evening at off peak time.

Configuration of Adobe Acrobat with Browser
Although Adobe Acrobat 3.0 is installed in every computer lab apart from the Mac labs, not all were configured to operate with the web browser. Configuration is not

vital, the PDF file can be downloaded and opened separately, but less experienced users may not be aware of this.

The results of the survey are shown below. Graphics quality and download times were given a rating between one star (poor) and five star (excellent).

Computer Lab	Operating System	Browsers Available	Download Time	Graphics Quality	PDF Configuration
Library	Win 3.1	Netscape 3.0	***	*	Yes
N128	Mac	Netscape 2.02	*****	****	No
N312	Win 3.1	Netscape 2.02	*****	***	Yes
		MSIE 3.02a.2916	Installed but not working at time of test		
N313	Mac	Netscape1.1N	****	****	No
S006	Win 3.1	MSIE 3.02a.2916	*****	****	No
		Netscape 2.02	*****	****	Yes
T211	Win 3.1	MSIE 3.02a.2916	**	**	No
		Netscape 2.02	**	**	Yes
XX031	Win NT 4	MSIE 3.02(4.70.1300)	*****	*****	Yes
XX031a	Win 3.1	MSIE 3.02a.2916	*****	*****	No
		Netscape 2.02	*****	*****	Yes
For Comparison					
N. Wales 28.8K modem	Win 95	MSIE 3.02(4.70.1300)	***	*****	Yes
		Netscape 4.0	***	*****	Yes

Table 1- Results of Compatability Survey

5.12. Critical Analysis

5.12.1. Engineering Mechanics Web Site

In the time available for the project, good progress has been made and the site is now ready for testing by students.

Staff Views
Critical analysis has been warmly received by some members of Staff.

Myles Danson, Computer Aided Assessment Officer, Loughborough University.
"Looks very smart. You have the front end and middle well covered, but what about the back? Front is your user interface, middle is the CASTLE marking engine, the back would be recording student performance, statistical analysis that the computerised system can offer, maybe candidate authentication if you are going to supply a copy to the tutor? This is perhaps over the top for your time scale, but worth including as a section on Recommendations for Further Work?"

"Using CASTLE provided a quick result without the need for CGI scripting."

Navigation
Navigation around the site has been made easy by the use of the Contents Bar and Hyperlinks at the bottom of each page. However, navigation becomes harder when viewing the interactive tutorials. These pages are automatically generated by the CASTLE toolkit, and although they can be edited afterwards it is not recommended because these changes will be lost if the test is subsequently modified.

Netscape 2.02
Netscape 2.02 is still the most used web browser on the Campus despite being well out of date. The largest problem with Netscape 2.02 is that it does not support different Text Fonts. This is a significant problem when viewing tutorial questions. Many questions contain symbols (α, θ) which are standard letters (a, q) in "Symbol" font. Because the Browser does not recognise "Symbol" font these letters are displayed in the default Font, usually "Times New Roman".

On most computers Microsoft Internet Explorer 3.02 is now offered that does not have this fault.

There is no realistic alternative to using "Symbol" font in questions on a web page. Symbols could be represented as images but this would make creation of CASTLE tutorial question considerably harder and the appearance would look far from professional because images would be independent of text size.

Feedback
Feedback uses CGI scripting to email the results back to the webmaster. The current feedback form provides an ideal method of reporting faults, but contains no formal questions and answers. Formal responses to a survey could be used to gain an overall opinion of the web site by its users.

Online Links Section
The Links section contains useful links to related web sites. However the Engineering Mechanics Web Site is now a part of the Engineering TLSC site which contains its own Useful Links page. Some links are repeated in both pages so the Engineering Mechanics Links page should concentrate on Links relating to Engineering Mechanics only.

Online Help Guide
The Engineering Mechanics web site is aimed at 1st year Undergraduates who will not have much experience with "surfing" the web. A guide to using the site might be helpful and should be considered for further work.

Finding the site
At present the site can be found using the search feature on the Loughborough homepage and through a link the Engineering TLSC site. First time users will look for the site from the Mechanical Engineering homepage but this contains no Hyperlinks to the project.

Reliability of the site
Reliability of the web site depends on the Loughborough Web Server, however the tutorial pages also depend on the Leicester University Web Server for the CASTLE CGI marking engine. Computer failures are rare but do occur. Relying on two Web Servers for the project increases the possibility of disruption to the web site.

5.12.2. CASTLE Project

The CASTLE project should be praised for providing its free service over the Internet and when critically analysing the project it must be remembered it is still only in the beta-testing phase. Suggestions may even have been corrected since the report was written.

Test Instructions and logo
A newly generated CASTLE tutorial page looks plain. The appearance of the test can be improved significantly with a small logo and instructions on how to complete the test. Because these are not automatically generated by the CASTLE toolkit, they are lost from the page if questions are modified using CASTLE "modify" tool.

Question Numbering
At present the question number sequence can only be 1, 2, 3, 4, etc. Many questions require a number of answers to one question and a sequence 1a, 1b, etc would be more appropriate.
This is being amended in phase 2 of the CASTLE project.

Types of Questions
At the current stage, only multiple choice answers can be used for the CASTLE project. However, development work is in progress to use text area answers (see Further Work).

Castle "modify" tool
CASTLE pages are created using the "create" tool with Netscape or Internet Explorer web browsers, but modifying the pages with the "modify" tool can only be achieved using Netscape. This could be made clearer to users when modifying their pages.

Using "Absolute" addresses for images
Images used in the CASTLE tests must be linked with "Absolute" addressees for reasons described in section 5.5.5. This creates problems when moving the position of the web pages on a web server because all the "absolute" links must be changed. This can be significant when over 200 images have been used.
It would be helpful if the CASTLE script could be modified to accept "Relative" links.

6. CONCLUSIONS

Limitations of Computer Aided Assessment
Computer Aided Assessment is not intended to be a complete substitute for traditional methods of assessment, but is an additional tool in the lecturer's armoury to supplement traditional methods. CAA should not be introduced as an 'add-on' facility, but needs to be considered as a possibility at module review, and, if appropriate, fully integrated into the module content.

CAA is not a quick solution to current marking loads. It has proven to save time in marking, and to provide valuable analyses of individual and group student performance once set up. However, it cannot give these benefits unless there is a substantial initial investment of time in creating and setting up the tests and exercises. The creation of suitable questions, answers and feedback is much more time consuming than traditional methods of assessment[n].

Cost
If the infrastructure to create a web site already exists then it is possible to create any web site for a worldwide audience at no additional cost.

Speed
Factors used to reduce download time are:

1. The page layout has been designed in Tables to replicate the look of Frames.
2. JPEG images with medium quality have been used for the Contents Bar and Main page titles. This reduces file size.
3. The Contents Bar and Main page title images are stored in the Web Browsers cache after the first download. This prevents repeated downloading of duplicate images when viewing other pages in different sections of the site.

Appearance
Using carefully selected colours and Text Font, the Engineering Mechanics web site offers a professional look without a formal appearance.

Web Browsers
In the Computer labs at Loughborough, Netscape 2.02 and Internet Explorer 3.02 are installed. Netscape 2.02 has a serious drawback that prevents changes in Fonts to an HTML web page. This causes Symbols displayed in the CASTLE tutorial questions to be not shown. It is recommended that Internet Explorer 3.02 is used to view the Engineering Mechanics Web Page and that Netscape should be immediately upgraded to at least Netscape 3.0. With the increase in CAL material on the Internet, Netscape 2.02 will hinder the possible benefits for Loughborough University.

Computer Labs
The results from the Compatibility Survey (Table 1) show the most suitable computer labs for viewing the Engineering Mechanics web site are S006, XX031 and XX031a. The results also show the worst computer lab, in terms of speed and graphics is in Mechanical Engineering, T211. In comparison, it is quicker to view the site from

North Wales using a Pentium computer and a 28.8K modem. These results are slightly misleading because the computers hardware specification are not taken into consideration.

Finding the site

The final web site can easily be found using the search facility on the Loughborough University homepage. One hyperlink for the project exists on the Eng. TLSC projects page[o] but more are needed, especially from the Mechanical Engineering homepage. To promote the project to a worldwide audience, the projects URL could be added at no cost to the major search organisations (Excite[p], Yahoo[q], AltaVista[r], etc). However, copyright protection laws for the tutorial questions may restrict the Engineering Mechanics Web Site for viewing only by Loughborough Students.

Interactive Tutorials

Over 200 tutorial questions have been created using the CASTLE toolkit. They cover all topics taught on the Engineering Mechanics Module MCA003. The self-assessment tests have a professional feel and provide informative feedback once completed. The CASTLE project has enabled a quick result without the need for CGI scripting. The next stage of the project would be to provide feedback to the tutor of the students performance.

Online Feedback

To develop the site further an online feedback form has been developed, but this could be extended further to receive formal feedback.

7. FURTHER WORK

There is no restriction to the amount of information that can be provided on the Internet. A web site's size is only restricted by the amount of storage space on a web servers hard drive. Technology and Internet software is developing at a phenomenal rate, especially interactive elements such as databases, which will soon be even easier to create. Recommendations for future work are as follows.

Tutor Feedback
Currently the Engineering Mechanics web site has a good user interface and middle medium, the CASTLE marking engine. However, the ultimate aim of the project is to provide feedback of the students performance to the tutor. This would enable electronic assessment and the reduction of tutors workload. This work would involve tackling problems such as providing statistical analysis, candidate authentication and security problems.

Possible solutions to this will require CGI programs and therefore a CGI directory, which currently does not exist. CGI scripts can be downloaded from the Internet[i] that transfer data from HTML forms into different types of database e.g., Microsoft Access and Paradox. Alternatively, results could be converted to simple text files and saved to a secure directory where they can be swept off and converted to spreadsheet files by the tutor.

Phase two of the CASTLE project looks to tackle this problem and could provide the idea solution in the near future. Tutorial questions will already be in the CASTLE format so questions need not be converted.

Tutorial Question Types
Currently CASTLE only supports multiple choice questions but testing is being undertaken to develop text box questions as well. An example tutorial page has been developed using this new format at
http://www.lboro.ac.uk/faculty/eng/engtlsc/Eng_Mech/tutorials/tut4_6test.htm.

Keyword Question Matching
Keyword question matching would be an ideal way of searching for questions that contain particular problems. For example, if a student needed to revise Free Body Diagrams, he/she could conduct a keyword question search that could return all the question numbers or even generate a test for that related topic. This could be done with some form of simple Java database or a more complex question databank.

Online Worked Examples
Work on this section was unable to start but provision was left for work at some future date. This section could contain example tutorial questions, similar to ones in the tutorial section, except with full solutions. Hyperlinks could be created from the CASTLE generated feedback tutorial pages to related example questions.

Past Papers
Currently only summer 1997 past paper has been converted to PDF format. Provision has been left for more past papers to be added. It is recommended that all exam papers written in the future be retained in electronic Word Processed format. This enables quick easy conversion to PDF using Adobe Distiller commercial software.

Solutions to past papers would be of great benefit to students and should be considered for the next phase of the project.

Online Help
All CAL packages should contain help. It will help first time users understand what services it can offer, and how to get the most out of the web site.

Maintenance
Regular maintenance is required on every web site. The Internet is a forever-changing environment and Links to external web pages will eventually change and will need updating. For example, the link to the module details will change next year when the module name is updated from 97MCA003 to 98MCA003.

8. REFERENCES

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[i] Matt's CGI script Archive, http://worldwidemart.com/scripts/

[j] FreeForm, http://www.note.com/success/public/freeform/

[k] Customising a feedback form,
http://www.lboro.ac.uk/computing/providers/forms/custom.html

[l] Engineering TLSC, http://www.lboro.ac.uk/faculty/eng/engtlsc/

[m] Loughborough University Home Page, http://www.lboro.ac.uk/

[n] Introduction to CAA, by Flexible Learning Initiative.
http://www.lboro.ac.uk/service/fli/caapage2.html

[o] Engineering TLSC projects page,
http://www.lboro.ac.uk/faculty/eng/engtlsc/Frame_3/Current.html

[p] Excite Search Engine, http://www.excite.com

[q] Yahoo Search Engine, http://www.yahoo.co.uk

[r] AltaVista Search Engine, http://www.altavista.digital.com

Loughborough University

APPENDIX A – CONFERENCE PAPER

Computer Aided Learning on the Internet for Engineering Mechanics

Robert Kay

DEPARTMENT OF MECHANICAL ENGINEERING

Project Conference Paper

January 1998

Module 97MCC002
Individual Project

Supervisor: Dr. M Acar
Second Reader: Dr W Malalasekera

TABLE OF CONTENTS

1. INTRODUCTION

In 1993 the Oxford Popular Dictionary did not contain the word 'Internet', now it's a buzz word spoken in thousands of different languages in almost every country in the world. Access to the Internet and the World Wide Web (WWW) has never been easier, with connections in almost every house and business in the country via phones or networks. The information available is immense, everything you ever want or need is there and probably more.

With so much information available to so many, Computer Aided Learning (CAL) is an obvious use and is catching on, especially in Universities where every student has access to the Internet through the computer centre or networked Halls of Residence. Loughborough has started to make use of this, but has yet to fully utilise the potential. Imagine what the future could hold? Lecture notes, tutorials, class tests, past exam papers, all online and available from anywhere in the World. Why come to Loughborough to study your degree when you could do it at home!

2. OBJECTIVES

To produce a number of World-Wide-Web pages to assist in the teaching of 1st Year Undergraduate Engineering Mechanics. The pages should present information and be followed with interactive tutorials if possible.

3. DELIVERABLES

The outcome of this project will be a Web Site for 1st Year Engineering Mechanics on the Internet

The work plan and schedule is shown in Appendix A.

4. METHOD OF ATTACK

The project can be separated into four areas, these are:-
1. Investigate HTML/Java using different software Editors.
2. Develop WWW pages for use on the Loughborough site.
3. Investigate methods of producing interactive tutorials.
4. Implement package on the Loughborough site.

The first 3 phases run concurrently and phase 4 is carried out at the final stage of the project.

5. SOFTWARE

5.1. Web Browsers

WWW pages are written in HyperText Mark-up Language (HTML) code and are viewed with software known as a Browsers. The most common Browser makes are Netscape and Microsoft Internet Explorer. HTML is always developing (latest version is HTML 4.0) with new features being added to increase the power and flexibility of WWW pages. Browsers must be kept up to date with the language so newer versions of these are always being produced. Latest versions of Browsers are Netscape 4.04 and Microsoft Internet Explorer 4.0. As you would expect, the latest versions require faster computers to run them efficiently.

HTML can display the following features in a browser:-

- Formatted Text - Same as a Word Processor, **bold**, *italics*, $_{\text{subscript}}$,etc in any colour
- Lists - Bulleted and numbered lists
- Tables - Letting you line up information with boarders around it
- Images - View graphic files (JPG or GIF), colourful backgrounds
- Links - When clicked on by the mouse can transfer to different WWW sites
- Forms - Lets readers talk back to you, with text input boxes
- Frames - View different pages on same display, explained later

Different makes of HTML browser do not display the same standard WWW pages even though the HTML code is the same. Each display is unique and also extra HTML code exists which only certain browsers recognise. This makes creating a WWW page with a standard layout that looks the same on every computer difficult. Layouts also change on different screen sizes.

This project is aimed at students studying at Loughborough, so it is imperative that the WWW pages are designed to be fully compatible with the browsers used by the University, currently Netscape 2 and Microsoft Internet Explorer 3.0. Netscape 2 is very old and is being phased out, with the trend turning towards Microsoft Internet Explorer 3.0.

5.2. HTML Editors

To make a WWW page, some sort of HTML editor is required. There are three types of software that can make WWW pages.

1. Text Editors - HTML is not complied and linked like most languages so a simple text editor can create a WWW page, such as notepad, Microsoft Word. However the program could not detect any errors in the code and check the syntax. This would make it near impossible to create a page from scratch, but very useful to make small quick changes.

2. HTML code editors - This software usually gives assistance in making HTML code, containing buttons to press for different features. These buttons will insert general HTML code into the page, then the author can make minor adjustments to suit his/her needs. A HTML editor can Debug your code, checking for syntax errors and highlight them. The drawback with this software is viewing the page layout, the page must be opened in a Web Browser to see the final result. A large understanding of HTML code is required to use this type of editor.

3. WYSIWYG Editors - What you see is what you get (WYSIWYG) editors are the latest development in WWW page creation, with no knowledge of HTML required. A WWW page is produced in a similar way to a Word Processor document. Text, tables, pictures and links can be inserted into the page, with the underlying code automatically written. These editors are ideal for beginners but an experience user still needs to make minor adjustments to the HTML code to give the finishing touch.

Many HTML editors are available free and can be downloaded free from the Internet. For the beginner AOL Press is an ideal WYSIWYG editor available for no cost from http://www.aolpress.com/. However, the best-undisputed software to use is Microsoft FrontPage. This is the latest HTML editor and by far the most advanced. It combines HTML code editors and WYSIWYG into one giving the best of both worlds. Pages can be created in WYSIWYG but the underlying code is also shown and can be edited. This software handles Web Sites with ease. It can automatically check links and if a page is renamed it will update all links connecting to it.

However Microsoft FrontPage does have a disadvantage, it's not available for free. However the latest beta version of FrontPage 98 is available for download and a three month free trial from http://www.eu.microsoft.com. I have chosen to use this editor for the project.

5.3. Common Gateway Interface (CGI)

The main aim of the project is to provide interactive tutorials. A possible idea for this is to use Form input boxes, see example below.

Answer: 

The user can write answers in the box and press the submit button. This will then save the value in the box to a database that can be viewed by the tutor to evaluate progress of the student.

An extra program is required for this action because HTML only displays screen images. Java language can read text boxes and manipulate data but databases are beyond its scope. Databases can be made using CGI programs. The database program is made in 'C language' or 'Perl' and is stored on the Web Server. This file is different to HTML files because it is made Executable while HTML files are Read Only. The program is executed using the submit button and the program is run.

5.4. Web Servers

Web Servers are where HTML and CGI files are stored. It is just a computer permanently connected to the network, so its WWW pages can be viewed by anyone accessing them. The Web Server for the Loughborough University Web Site is in the Computer Centre, but the Department of Mechanical Engineering also has Web Servers. Some servers do not allow CGI programs on them because it posses a security risk if not monitored correctly. This will have to studied further if the final project requires CGI.

While the Engineering Mechanics Web Site is being developed it will be saved on my personal computer until completion when it will be transferred to the University Web Server. I have simulated the University Web Server by establishing my computer on the Hall of Residence Network as a Web Server. The software used is called Microsoft Personal Web Server and is available free from http://www.eu.microsoft.com. This helps testing because every computer on the Internet can view the project, so download time can be measured when accessed from the computer centre.

Student Web Space is available on the University Web Site but does not support CGI so could not be used.

5.5. Graphics

Graphic Images are very important and can change the appeal and look of the Web page. The first page of a Web Site is the most important, if it does not look good and attractive to the eye then the user will go elsewhere.

Many graphic editors are available, some free like Paintshop Pro, but Adobe Photoshop 4.0 will be used because it is especially aimed at Web designers, but it is not available for free.

6. WWW PAGE DESIGN

6.1. Layout

WWW pages must be designed to be user friendly with information clearly presented. Web Pages can have many different layouts, so I undertook an investigation into web designs by looking at large popular sites already on the Internet. The Underlying HTML code can be seen using a normal browser.

The best sites had a common theme, clear, attractive Contents Bars. They contain links to the main areas on the Web Site and take up approximately 1/5 of the page, running along the top side or bottom. On every page the bars design and contents are the same or similar. This layout is used in the project and can be seen on the left hand side of the title page in Appendix B.

This affect can be achieved in two ways, using web features “Frames” or “Tables”. Advantages and Disadvantage for each are shown below.

Frames

Advantages

- Contents bar is displayed all the time, making navigation easy.

Disadvantages

- Slow to download. To achieve the look of Contents Bars, three HTML pages must be downloaded and displayed on the browser.

1. Contents bar
2. Main information of the page
3. HTML code to arrange other two pages.

- Some old browsers do not support frames.

Tables

Advantages

- Very quick to download. One page contains everything
- All browsers can support Tables.

Disadvantages

- Contents Bar scrolls down with main information.

FrontPage 98 can estimate the download of WWW pages and suggests a Frames page takes 30 secs while the equivalent Tables page takes just 15 secs.
However, each person has their own preference but the common trend is now turning towards Tables, so this will be used for this project. HTML code for title page can be seen in
Appendix C.

6.2. Contents

Appendix D shows the site map for the project and displays which pages have been completed and pages still being developed. The feasibility of the CGI database is still being investigated.

Figure 1 below shows the Contents bar of the Engineering Mechanics Web Site.

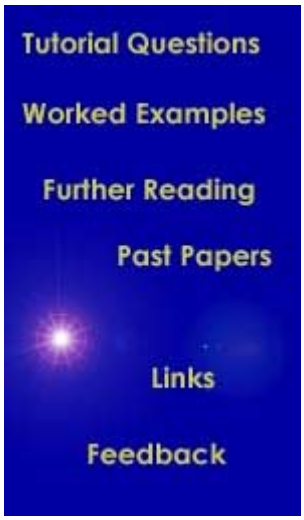


Figure 1. Contents Bar

Interactive Tutorial Questions for each section of the syllabus, with answers stored in a database and viewed by tutor.

Fully worked example questions to similar problems in tutorial

Further Reading with broader knowledge and information of Engineering Mechanics.

Past Papers of Engineering Mechanics exams, showing questions and fully explained answers.

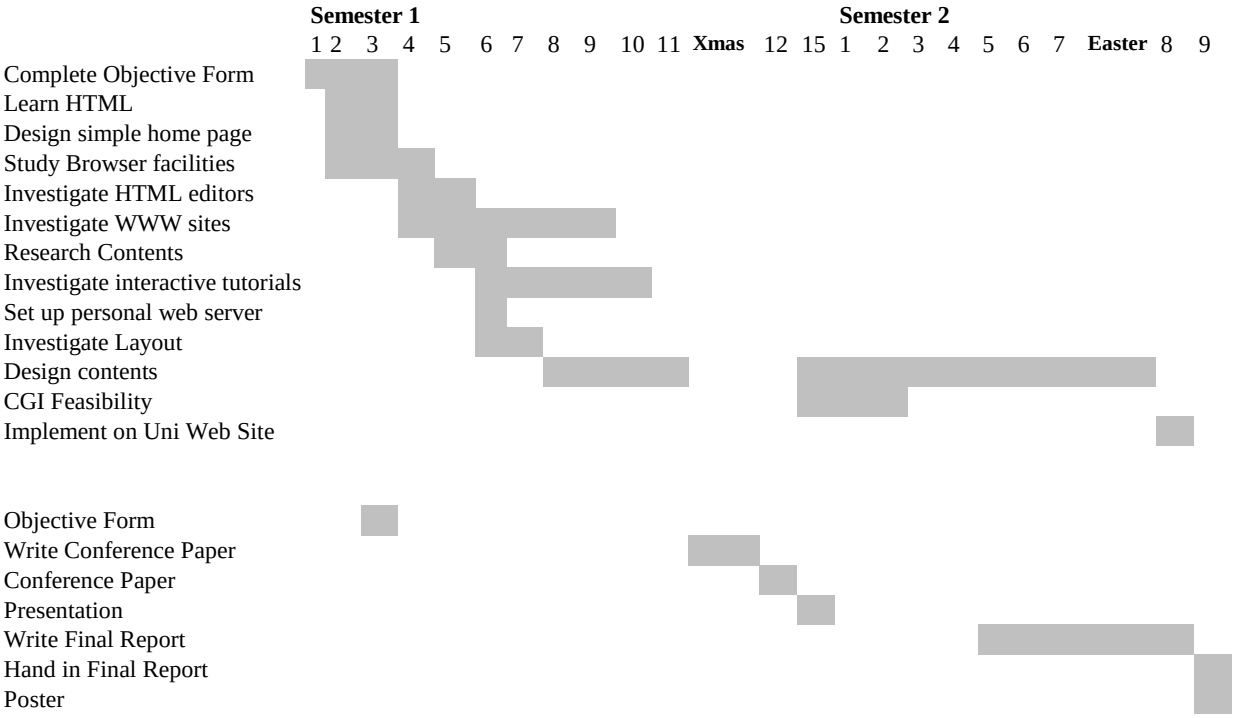
Links to other relevant sites

A guest book using a CGI program where students can leave comments to improve the site in a database which is viewed online

7. CONCLUSIONS

- The Engineering Mechanics Web Site works alongside lectures and will be beneficial to Students, providing them with tutorials and addition learning material.
- It will benefit the tutors by using the Tutorial Answers Database as a feedback to monitor student progress. The database could give statistics showing percentage of wrong answers and questions students are struggling with, which could then be looked at during tutorials.
- Further Investigation is required into CGI, how it operates and if the University can support it on there Web Site
- The Web Pages must be attractive and aesthetically pleasing. A wide range of colours and graphics will be used.
- One of the most important features of a Web page is download time. If pages take too long to load, users will go elsewhere and avoid the site.
- The Web Pages must look the same on all browsers.
- Further work is required on all pages. The Contents has also not been finalised, and may be changed.

Appendix A - Work Plan & Schedule

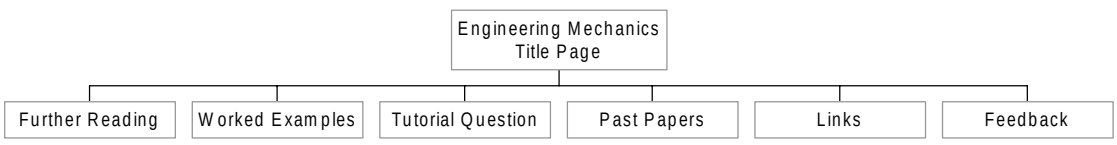


Appendix B - Engineering Mechanics Title Page

Appendix C - HTML Code

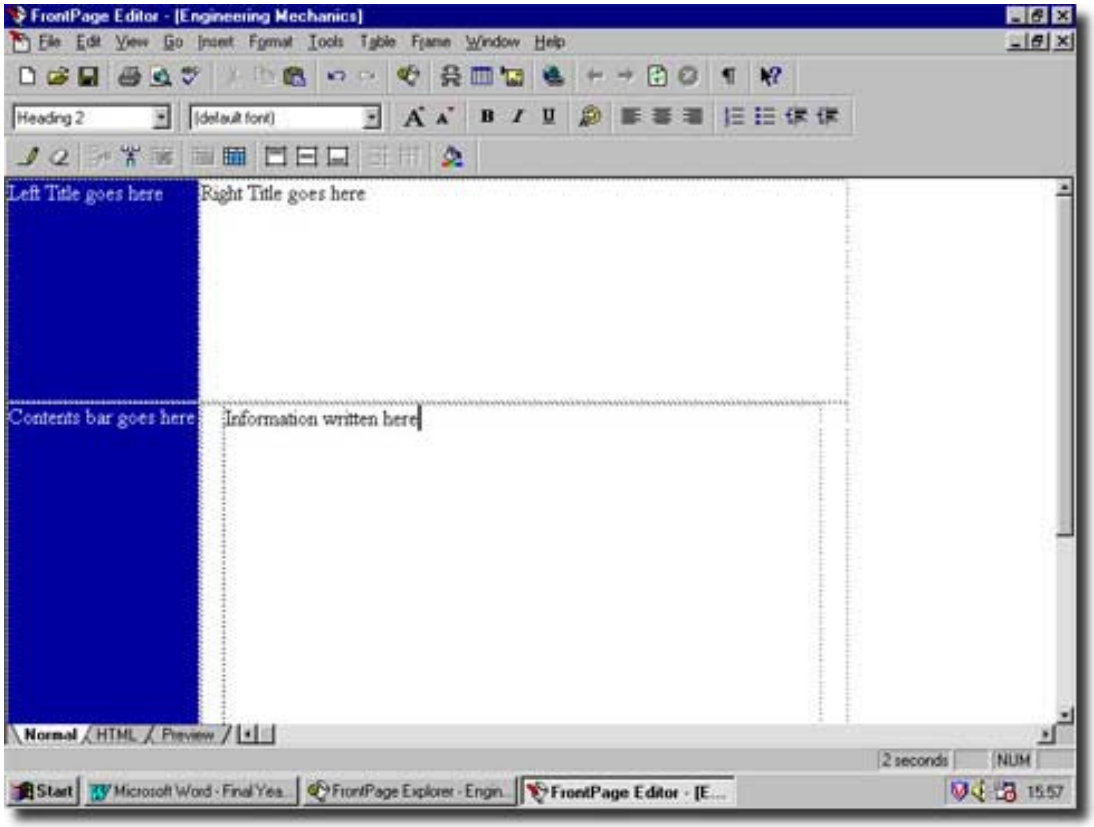
```
<html>

<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<title>Engineering Mechanics</title>
<meta name="GENERATOR" content="Microsoft FrontPage 3.0">
</head>

<body bgcolor="#FFFFFF" text="#000000" topmargin="0" leftmargin="0">
<div align="left">

<table border="0" width="628" height="523" cellspacing="0" cellpadding="0">
  <tr>
    <td width="148" valign="top" height="167"><img src="images/Title_left.JPG"
width="148"
    alt="Title_left.JPG (6946 bytes)"></td>
    <td width="486" valign="top" height="167"><img src="images/Title_right.JPG"
width="476"
    height="170"></td>
  </tr>
  <tr>
    <td bgcolor="#0000A0" width="148" height="356" valign="top"><img
src="images/Menu.jpg"
    width="148" height="255"></td>
    <td width="478" height="356" bgcolor="#FFFFFF"><table border="0" width="461"
height="335"
    cellspacing="0" cellpadding="0">
      <tr>
        <td width="17" valign="top"></td>
        <td width="444" height="329" valign="top"><font face="Arial"><big>Computer
Aided Learning
        for the Internet</big></font><p><font face="Times New Roman">This web site is
to accompany
        the Part A Engineering Mechanics module at Loughborough University.  Its
primary aim
        is to provide additional learning material which will give students a better
understanding
        of the topic and help them with their technique of answering exam
questions.</font></p>
        <p> </p>
        <p> </p>
        <hr>
        <p align="center"><small>Tutorials / Examples / Further Reading / Past papers
/ Links /
        Feedback</small></p>
        <hr>
        <p>Developed by <a href="mailto:R.J.Kay-95@student.lboro.ac.uk">R.J.Kay-
95@student.lboro.ac.uk</a></p>
        <hr>
        <p>Copyright © Loughborough University</p>
        <p> </td>
      </tr>
    </table>
    </td>
  </tr>
</table>
</div>
</body>
</html>
```

Appendix D - Current Site Map

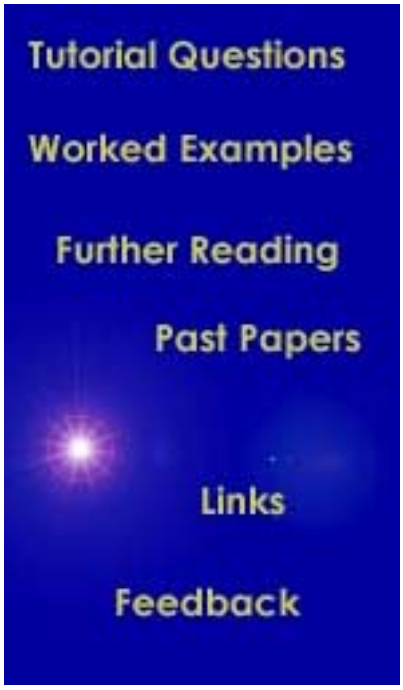


Rest of the site still under development.

Appendix B - Page Layout in FrontPage 98

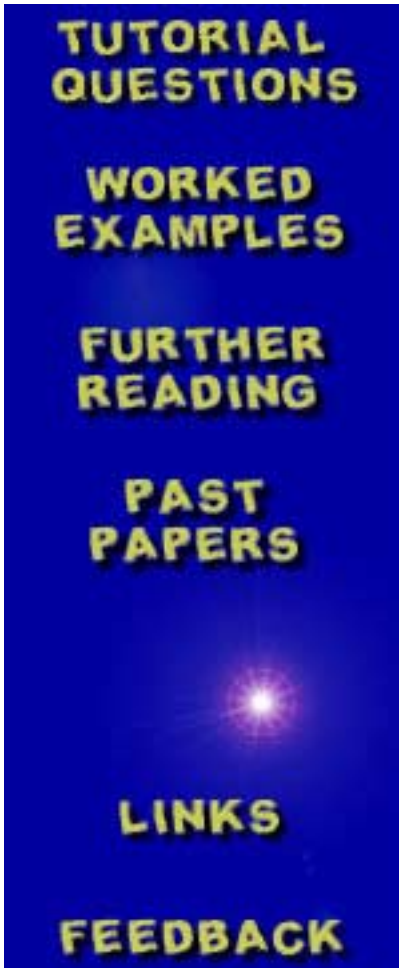


Appendix C - Contents Bar Designs



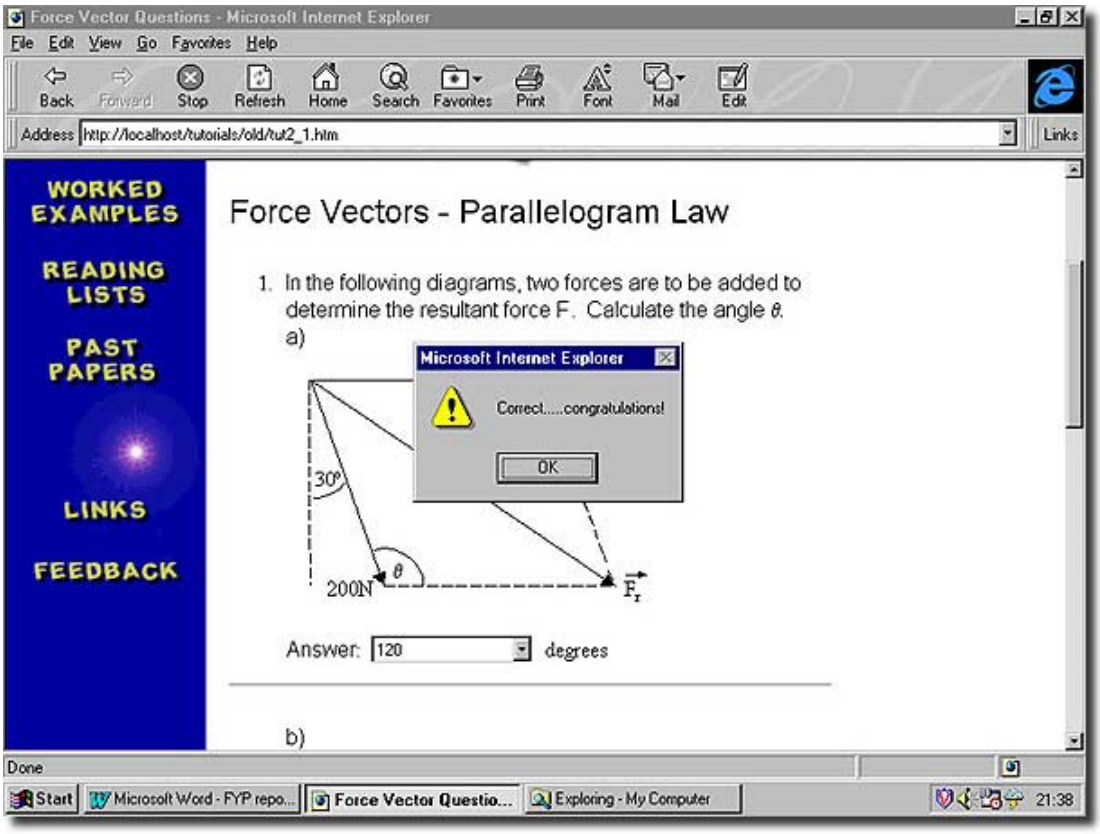
Contents bar A - Formal Design

Contents bar B - Less Formal, still plain

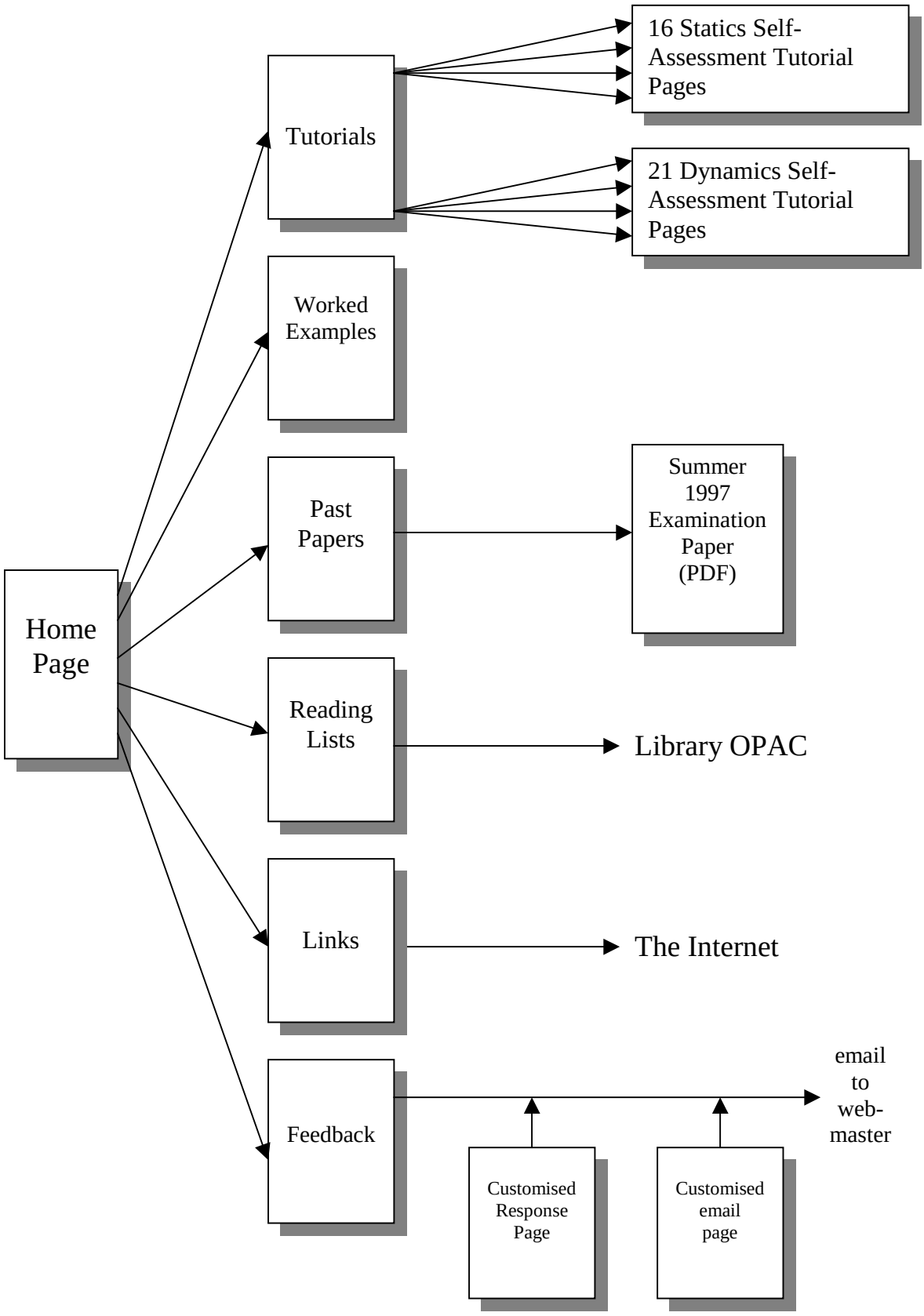


Contents bar C - More bolder design prefered by Students

Appendix D - Interactive Tutorials Using JavaScript



Appendix E - Site Map



Appendix F - Design Sequence of Page Title

1.

2.

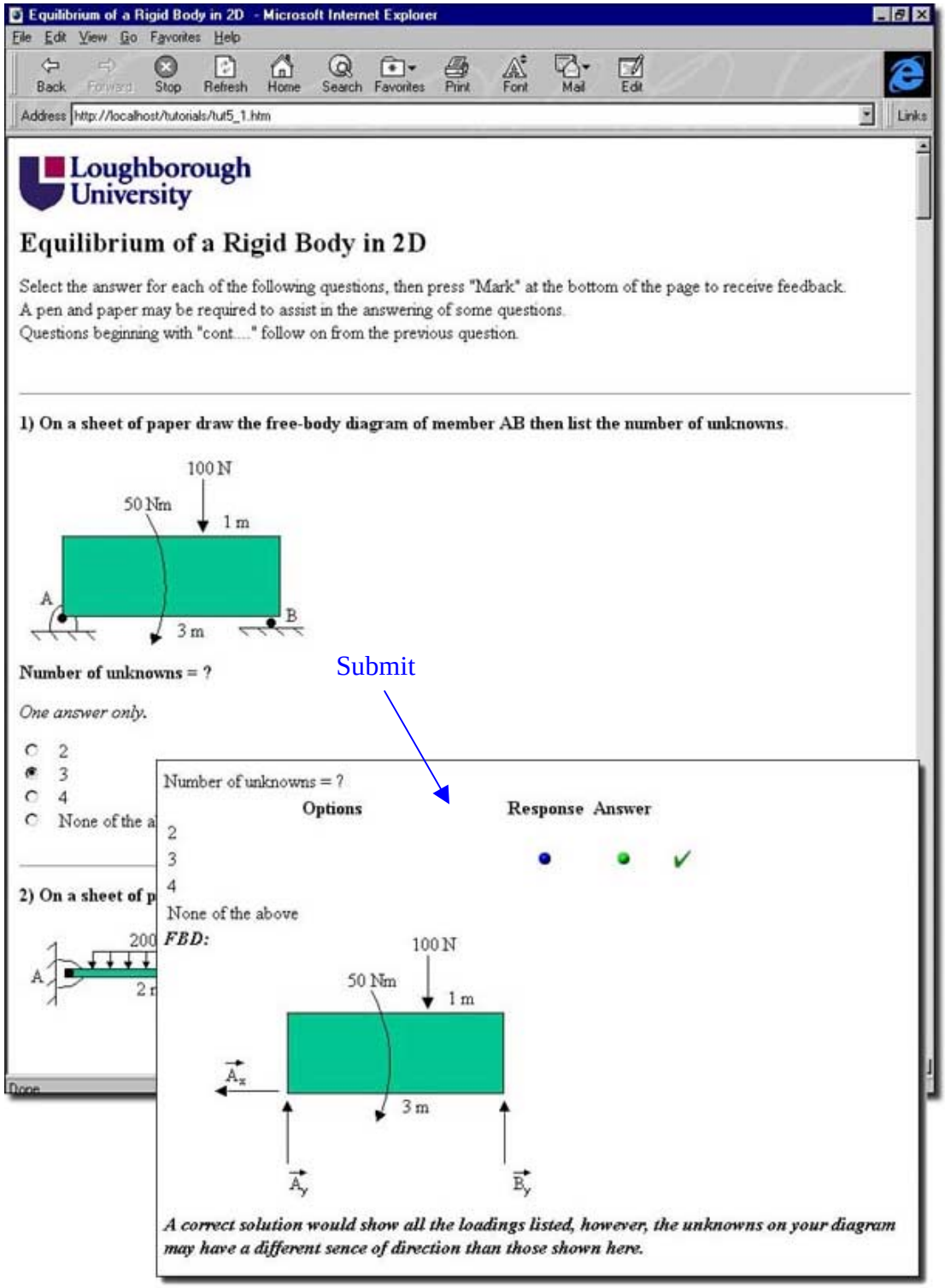
3.

4.

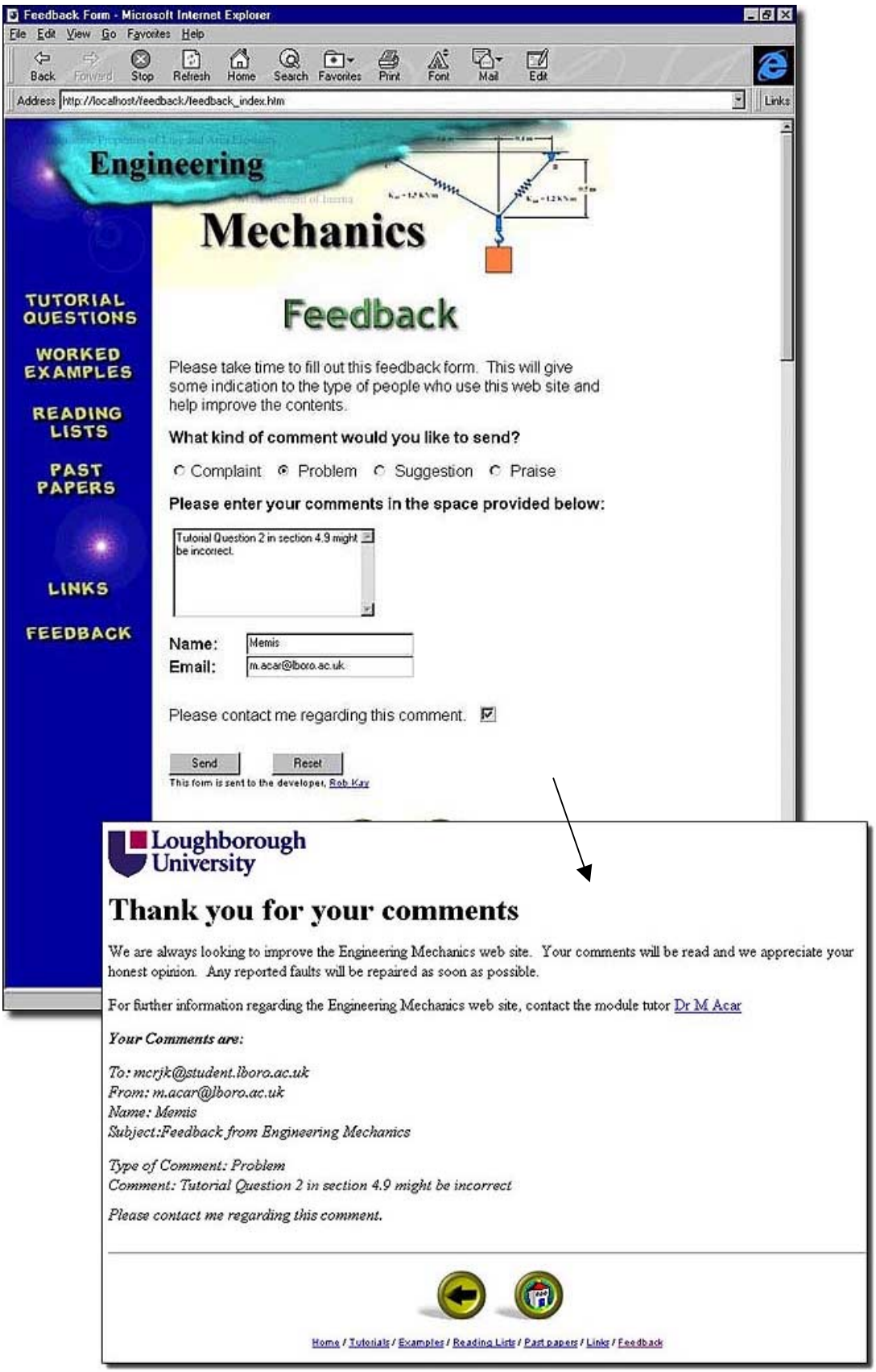
5.

6.

Appendix G - CASTLE Interactive Tutorial Questions



Appendix H - Feedback Form



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Thanks to a number of friends who gave assistance and advice when developing the web site.