CARDIFF UNIVERSITY - SCHOOL OF COMPUTER SCIENCE & INFORMATICS

Group Project Management Tool

Individual Project –Final Report

BSc Information Systems 2011/2012

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Abstract

Every year all 2nd year students within the school of computer science & informatics are required to undertake a group project. Individuals are required to deal with the challenges of working effectively in groups with the objective of planning and delivering a specified project within a set time scale. The key problem is the challenge of group collaboration and effective communication across a distributed team. The paper presents a proposed groupware solution designed for this use, which facilitates the shift from solely face-to-face collaboration to an environment within which face-to-face methods are integrated with computer supported collaborative learning and project management.

An analysis of a wide range of existing systems and an extensive literature review provided evidence of the benefits to be gained from developing a collaborative groupware system. Key stakeholders were surveyed to establish their requirements in order to achieve optimum usability. Requirements engineering, system modelling using UML and interaction design was undertaken and a web-based solution to the problem has been developed. The ultimate goal is to provide a system that can be made available for all group project work throughout the department.

Acknowledgements

I should like to take this opportunity to acknowledge and thank all staff at Cardiff University School of Computer Science & Informatics who have assisted me in this project. In particular I should like to express my thanks for the continued supported and guidance provided to me by my project supervisor Helen Phillips, together with assistance given to me by Prof Nick Avis and Dr Robert Evans.

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1. Introduction

1.1 Background and follow up to Interim Report

This project aims to develop a web-based system to assist students plan and manage their 2nd year group project, in particular focusing on project management and group collaboration aspects. The aim is to resolve and eliminate the typical problems encountered during 2nd year group projects by providing a web-based solution and to demonstrate how this will be beneficial for students.

In order to achieve the aim, the interim report presented a project introduction, which included the aims and objectives of the project, the project scope, an analysis of the problem situation, together with background study and research, identifying existing solutions to the problem situation and a description of the planned approach to address the problem. An initial requirement specification document was created along with the preliminary system designs and set out the decision to approach the problem situation by implementing a web-based system.

In response to Miss H.R. Phillips and Professor N.J. Avis' comments on my interim report I spent considerable time analysing their feedback and arranged meetings to discuss how the project should progress.

Following a meeting with Professor N.J. Avis we initially discussed how the CM2301/CM2304 module has changed from the CM240 module, and how I should endeavour to incorporate these new challenges into the proposed system. Following the discussion I decided to include the client and supervisor roles in the system; online submission of deliverables; authentication of users through their Cardiff username and password; and providing an administrator account for the module leader to deal with group grievances and non-performing team members. Furthermore, I planned to perform user acceptance testing with 2nd year students to establish whether the system was useful in a real project situation. Full notes of the meeting are contained in Appendix A.

Following discussions with Miss H.R. Phillips a decision was made to formulate a revised set of requirements and a more specific and clearer design prior to the implementation phase. The suggestion that system modelling should be undertaking using UML diagrams was adopted. This assisted the requirements engineering process by helping to clarify what the system actually does.

The incorporation of a literature review aimed to widen the scope of the project by examining existing research and literature in the fields of social constructivism and educational psychology, computer-supported collaborative learning (CSCL), team roles, team dynamics, project success factors, team building, academic teamwork, groupware and knowledge management.

2. Literature Review

Constructivism has become the most widely accepted model of learning in education today. Constructivism has its roots in psychology and philosophy and is based on the theory of learning by doing, by making tentative interpretation of experiences and linking new knowledge to existing knowledge, and going on to develop and test those interpretations (Perkins 1991). Social constructivism, strongly influenced by Vygotsky's work (Liu and Matthews 2005) suggests that at the outset, knowledge is constructed in a social context and is then appropriated by individuals. Scholars believe that learning is an active, social process as opposed to the traditional view of learning, they think that sharing individual experiences and views known as collaborative elaboration, can help aid improved understanding that would not be possible as an individual (Sweet and Michaelsen 2007).

The second year group project is directly related to the principles of social constructivism. It aims to give students an understanding of a professional approach to systems development which not only challenges their systems design and development skills but also tests the students ability to work in a large group with the objective to design and develop the optimum solution for the specific problem by working collaboratively as a team. It gives the opportunity for students to learn from others and is directly related to the principles of social constructivism, and in particular the concept developed by Vygotsky called 'zone of proximal development' which discusses the gap between the limitations of what an individual can perform on their own, and what they can do with facilitation from peers or experts (Vygotsky 1978). In the case of the project it would include contributions and collaboration from fellow students, the client and supervisor.

In the last decade rapid technological advancements, particularly the developments in mainstream information and communication technologies, that have been widely adopted by individuals and organisations, are changing the way learning and interaction can take place. Intra-group communication is not limited to face-to-face contact or telecommunications and since '80% of organisations with 100 or more employees use teams in some way' (Guzzo and Dickson 1996, p329) the challenge of teamwork in the second year group project is very important for employability prospects. Although virtual interaction through sophisticated ICT applications and infrastructures has help increase the efficiency, scope and automation of organisations for decades, collaboration technology differs as it is a special type of ICT application aimed at supporting co-operative work (Andriessen 2003 p5). Andreiessen (2003 p10) describes collaboration technology as "those ICT applications that support communication, co-ordination, co-operation, learning and/or social encounters through facilities such as information exchanges, shared repositories, discussion forums and messaging." Computer-supported collaborative learning (CSCL) can help to bridge the gap between informal and formal learning to attempt to create a more holistic learning experience (Carroll et al. 2008).

More recently the widespread emergence of social media has changed the way tools such as discussion forums, wikis and blogs are seen. Students now welcome such tools as they have discovered they are useful in helping them learn (Conole et al.2008). CSCL environments such as Collaborative Virtual Environments (CVEs) or simply discussion forums can lead to work becoming directed by the group rather than taking place on an individual level, and consequently can help group members build relationships and assist the sharing of thoughts and ideas (Carroll et al. 2011 p8). Discussion forums can enable students to informally ask questions and exchange points of view and also to make immediate connections, whilst being able to critically review and respond to others participation. In this sense it is quite different from traditional learning. Students should discover the benefits that collaboration can bring to a project in that it has the potential to make the outcome more diverse, interesting and comprehensive than originally anticipated.

However despite the fact that CSCL environments can facilitate improved group dynamics, interpersonal and intergroup problems can still exist. Some students may be resistant to learn from others as they may be sceptical of their knowledge or skills (Carroll et al. 2011 p10) and it is not uncommon for groups to be unwilling to work 'wholly' as a group but instead for individuals to contribute to the group on an individual basis. Although a group member may bring useful functional skills to a group, each team member will have a different way of interacting with group members and will approach tasks in different ways (Senior 1997 p242). Belbin developed the team role concept; this is the concept that a team member will naturally take up one or more team roles. For example, a person might be good at stepping back and seeing the big picture and would take the role as a 'coordinator' but someone else may naturally be creative, imaginative and good at developing ideas and would take the role as a 'plant'. This creates a conflict of interest between group members, but Belbin claimed that if each one of the nine team roles he identified was represented in a team it would enable the team to be more successful; with absent team roles the team would be lower performing (Belbin 1981). Teams must also inevitably go through development stages in order to work successfully and deliver optimum results. Bruce Tuckman developed the "Tuckman theory" based on team dynamics research. He developed four stages of group development: Forming (pretending to get along with others), Storming (dropping the politeness barrier and attempting to work regardless of issues occurring), Norming (getting used to team members and developing trust & productivity) and Performing (working in a cooperative manner at a highly efficient level to achieve the common goal) (Tuckman 1965). Groups need to embrace and tackle all the challenges arising within each phase if they are to deliver the optimum results, but if conflict and distrust between members persists a team may not pass the storming stage.

Students also face additional challenges of working within a group in an academic environment. Although the group project is compulsory and students must pass the module to progress to year 3, some students may exhibit a lack of team member commitment. Individual students will contribute different amounts and quality of input to the project based upon their academic ambition, their personal commitment or lack of interest in the task. This may result in further conflicts within the group as individuals may become frustrated with regards to the perceived and real degree of effort group members may be making and the potential that this may directly result in a poorer mark being achieved in the module. However, Slavin (1978) claims potential positive outcomes from academic teamwork, resulting in improved student academic performance and increased motivation due to the collective mutual concern of the team.

Project management has been recognised as the most effective way to manage such complex projects. It is concerned with the planning, securing, organising and management of resources in order to seek to achieve specific project goals within the prevailing constraints. However, there is a clear distinction between project success and project management success, the emphasis with project management is on short-term goals not the wider aims of the project and project success is usually concerned with other external criteria defined by the client (Munns & Bjeirmi 1996). Utilising project management techniques, procedures and tools can contribute to the enhanced success of a project. Whilst project management does not guarantee that a project will not fail, if a suitable project has been selected for an appropriately skilled team, project management can be used to their advantage to ensure total project success (Munns & Bjeirmi 1996).

The adoption and use of collaboration and project management technology can provide a number of favourable consequences, Andriessen (2003) describes these as:-

> 'Speeding up the exchange of information, easy access to new information, many people being able to receive information at the same time, increased number of potential participants in discussions, expanded horizontal and diagonal contacts and easier to reach people.'

This can provide groups with an enhanced chance of project success by providing tools that facilitate distributed working, teamwork and knowledge transfer. McGrath and Hollingshead (1994) concluded that collaboration software tools (groupware) if used in isolation will result in lower satisfaction. To maximise the benefits of collaborative software tools face-to-face group collaboration is also required. Other authors such as Sellen (1995) believe that collaborative technology can be as effective as face-to-face interaction in certain circumstances, but recognise that communication normally requires the adoption of a more structured way of interaction. However most authors have come to a consensus that groupware tends to result in increased productivity.

Electronic document management systems can be extremely useful to a group as opposed to paper-based systems, allowing documents to be published and updated instantly and to be made available to all group members. Document management systems can be simple or extremely sophisticated based on the needs of an organisation (Jashapara 2004). Typically facilities of a document management system might include an audit trail to monitor changes of a document, access control to ensure only one user modifies a document at any time, categorisation and organisation of documents to specific groups, using metadata to identify documents and using access control to monitor security over documents. When implementing a document management system concerns over privacy, currency of information, demanded volume and security must be considered (Jashapara 2004).

Developing appropriate technologies to facilitate collaboration and cooperation in groups can support face-to-face cohesion. Communication between members can for example, be facilitated through discussion forums. Knowledge sharing and learning can for example, be facilitated through data repositories. Similarly, cooperation and coordination can for example, be facilitated through document management systems, group calendars and social interaction such as Facebook integration (Jashapara 2004).

Research into previous success of groupware has determined that groupware systems must be designed around the needs of end users and the socio-technical processes required, rather than just providing the technology required to support a group. Andriessen (2003) argues that to improve the value of groupware systems, group work should also include face-to-face meetings, the ability to learn about group members backgrounds through ‘yellow pages’ style directories, well structured meetings with minutes, use of video links, consistent information on progress and project milestones together with attention to training and intercultural differences. Finally, it is recognised that the introduction of groupware can also give rise to additional challenges. Jashapara (2004) argues that groupware can cause information overload, the tendency to make riskier decisions and lead to group members becoming ‘free-riders’ getting others to do all the work. These risks should be made clear to the end users together with the potential benefits that groupware can bring to a project, in particular greater creativity which usually outweighs any risks that groupware may bring to a group or project.

Having conducted this literature review, the knowledge and associated learning that I have acquired has subsequently helped inform my research and decision making throughout the remainder of the project.

3. Specification, Modelling & Design

Based upon the background research, literature review and as a follow up to the interim report a revised requirements specification, system modelling and design has been developed.

3.1 Revised Requirements

The requirements originally specified in the interim report have changed throughout the project. The understanding of the problem situation increased as the project progressed, and as a result the requirements defined in the interim report were incomplete. Therefore the requirements have evolved to reflect this changed problem view. At the outset it was recognised that changes would inevitably need to be made, given the fact that new needs and priorities would arise during the implementation and testing phase. These changes could be included as I was using an agile approach to systems development, which has been designed to cope with requirements that change during the development process. No formal change management process was used to keep track of changes, but each proposed change was analysed using traceability information and general knowledge of the system requirements. A decision would then be made as to whether to include the change, and each requirement was prioritised according to the process defined in section 3.2.

3.2 Prioritisation of project requirements

When specifying the requirements the MoSCoW prioritisation technique (IIBA 2009) was used to differentiate each individual requirement. Whilst all the requirements were desirable, the requirements were prioritised, given the time parameters available, in order that weight could be given to the most important requirements, i.e. those that were considered essential in achieving the overall success of the project. The MoSCoW prioritisation technique differentiates four discrete criteria. Requirements categorised as ‘Must’ are critical to the success of the project and if not achieved would result in the project being considered a to be a failure. Requirements categorised as ‘Should’ are considered high priority and as such need to be achieved wherever possible, within the timebox parameters set out for the project. Requirements categorised as ‘Could’ are allocated a lower priority and as such would be nice to have if possible, but are not critical to project success. Requirements categorised as ‘Wont’ are allocated the lowest priority and as such have been removed from the project but may be included should additional future development work be undertaken.

3.1.1 Functional Requirements

1. The system must provide a web-based system.
    1.1The system should authenticate users through their Cardiff University standard username and password.

2. The system must provide interaction, between group members.
    2.1 The system must allow users to post a discussion.
    2.2 The system should allow exchange of information between members.
    2.3 The system should interaction that can be visible to the whole group.

3. The system should provide interaction, between the group and the client and supervisor.
    3.1 The group should be able to engage in discussion with the client/supervisor.
    3.2 The group could be able to share documents with the client/supervisor.
    3.3 The client/supervisor could have their own area on the system
        3.3.1 The client/supervisor could be able to post specific project information.
    3.4 The group, client and supervisor could have different access rights.

4. The system should facilitate the group to be kept up to date with relevant and real time information about the activities of the other members
    4.1 The system should provide group members with current information about group meetings.
        4.1.1 The system could provide a calendar with daily/weekly/monthly overview
        4.1.2 The system could provide group members with the location of meetings and date and time and information in regards to minutes of meetings
        4.1.3 The system could provide the ability to export calendar events to calendar applications.
        4.1.4 The system could provide the ability to repeat events
    4.2 The system could provide group members with information in regards to upcoming meetings/events

5. The system must provide external notifications to changes of activity of group members
    5.1 The system should provide email notifications of changes to group discussion
    5.2 The system should provide Facebook notifications of changes to group discussion
        5.2.1 The system should provide synchronised comments between Facebook and the system. E.g. comments on Facebook will automatically be posted onto the system and vice versa.
    5.3 The system could provide notifications of approaching deadlines of deliverables
    5.4 The system could provide notifications of changes to file sharing
    5.5 The system could provide an RSS feed of activity

6. The system must provide a file sharing facility with version control and the ability to ‘check in’ and ‘check out’ a file from the system.
    6.1 The system should allow group members to ‘check out’ a file when they are using it.

6.1.1 The system should prevent other users from accessing a file when it has been ‘checked out’, preventing duplication of group efforts.

6.2 The system could provide ‘ping’ facility which will ping the server every minute to inform it that the file is open. If for whatever reason connectivity is lost, the server will allow roughly a two minute grace period before it removes the file lock, thereby allowing access to other group members.

6.3 The system could provide a facility to define to current workflow state of a file e.g. draft, final.

6.4 The system could provide a version control revision log e.g. modified by, date and summary of changes.

6.4.1 The system could provide the ability to restore a file to a previous state.

6.5 The system could provide a full audit trail of activities on the file e.g. check in and check outs.

6.6 The system could provide notifications when the status of a file is updated.

7. The system should provide an online submission facility.

7.1 Users could be able to submit document deliverables online.

7.2 A MD5 checksum could be generated to help users verify the integrity of the file.

7.3 The client, supervisor and students could be able to access the submitted file/s.

7.4 A results and feedback area could be implemented.

8. The system should provide the ability to create tasks,

8..1. The system should be able to allocate group members to tasks.

8..2. The system should be able to create deadlines for tasks.

8..3. The system should be able to mark progress of tasks.

8..4. The system should be able to mark task priority e.g. important, low

8..5. The system could provide group members with information in regards to upcoming tasks

9. The system must provide the ability to define and management requirements.

9.1 The system must provide one single format that all group members will use for defining requirements

9.2 The system could provide ability for group members to review and accept/decline requirements before they are final.

9.3 The system could provide the ability to link requirements with tasks and deliverables

9.4 The system must cope with changing requirements

10. The system must provide the function for users to define available working times around lectures etc.

10.1 The system should automatically show university vacation/examination periods.

10.2 The system could provide ability to add deadlines from coursework timetables.

10.3 The system could provide the ability to repeat lectures.

11. The system must be accessible on and off campus
    - 11.1 The system must be hosted on the School of Computer Science project web server
    - 11.2 The system must be accessible within the schools intranet
    - 11.3 The system must be accessible on any computer on the Internet using an authorised secure connection, using https protocols which has been logged in with a School user name and password
    - 11.4 The system must be secure

12. The system should provide the module leader with administrator access to the group to assist with group grievances and non-performing team members.

3.1.2 Non-functional requirements

13. The system should implement a simple user interface
    - 13.1 The system must use a familiar web-based style GUI
    - 13.2 The system should make use of icons
    - 13.3 The system should well designed visual aesthetics
    - 13.4 The system must not be too cluttered with unnecessary functionality
    - 13.5 The system should make use of layman's terms instead of technical language
    - 13.6 The system should provide useful and relevant content
    - 13.7 The system should implement clear and concise error messages
    - 13.8 The system could adhere to ISO 9241 standard, covering ergonomics and human computer interaction.

14 The system must provide a consistent interface
- 14.1 The system must use a consistent design and layout
- 14.2 The system should make users select from a list of pre-selected typefaces and fonts for all activities
- 14.3 The system should provide templates for weekly reports

15 The system must be reliable
- 15.1 The system must work on Microsoft Windows 7/Vista/XP
- 15.2 The system must work on Mac OS X 10.6/10.5
- 15.3 The system could work on Ubuntu 11 (Linux)
- 15.4 The system could support iOS 4/5 and Android 4
- 15.5 The system must handle - .docx, .doc, .rtf, .odt, file formats
- 15.6 The system must handle PDF, JPEG, PNG, TIF, GIF, BMP, MP3 file formats
- 15.7 The system should work on Mozilla Firefox, Google Chrome, and Safari & Internet Explorer.

16 The system must be accessible
- 16.1 The system must make use of a suitable colours and font use to ensure people with visual impairments have the same experience.
- 16.2 The system could follow Cardiff University's web accessibility principles.

17 The system must be recoverable
- 17.1 The system must backup database (user) information and web files daily and compress to a zip archive.
- 17.2 The system should provide restored functionality with 24hours of failure

3.3 Interaction Design

The ultimate goal of interaction design is to make a product effective and simple to use. However, interaction and interface design are often isolated from the development process and postponed until after programming is completed at which stage design is added. Cooper (2004) argues 'interaction design refers to the selection of behaviour, function and information and in which way they are presented to users.' As most mainstream users are not technical uses and are unaware of complex issues, their main concern is the ease of use of a system. The central concern of interaction design is the user experience and if interaction design has been successfully implemented it should be unnoticeable (Cooper 2004 p.199).

Alan Cooper (2004) developed the concept of Goal-Directed design, which is concerned with developing a precise description of the user and what he wishes to accomplish. Goal-Directed design advocates the use of Personas.

3.3.1 Personas

Personas are necessary for good interaction design. It involves making up pretend users and designing specifically for them. One persona must model one specific type of person, and therefore software should be designed for the one person, instead of trying to produce a one size fits all system that endeavours to please a wide audience. When designing with personas a cast of characters are developed. The purpose of this is to clarify the make up of the user population.

For this project I developed the following cast of characters:

Primary Persona:

Jack is a 20-year-old student currently studying Information Systems at the School of Computer Science, Cardiff University, living with undergraduates in shared accommodation in Cathays, Cardiff. Jack is always on the run, an active member of the student newspaper and the student rugby team and studies wherever is convenient at any time. He carries his iPhone around at all times and checks class times and study material through his laptop and iPhone. Jack is always in a rush and finds it difficult to check multiple websites and his university and college email for announcements and to check information. He sometimes does not see information about lecture amendments or group project meetings. Since Jack has started to use CPMS, Jack has been able to receive notifications on his iPhone and laptop through Facebook with regards to activity on CPMS. As Jack checks his Facebook every morning and his phone sends push notifications, this has allowed Jack to become more organised and allowed him to collaborate with the group in a much wider range of situations.

Persona 2:

Robert is a 25-year-old visual computing research student specialising in modelling and transferring geometric details over 3D Shapes at Cardiff University, living with young professionals in the Roath, Cardiff. He teaches a limited number of tutorials and is a group project supervisor to earn additional income to supplement his research commitments. Robert is often very busy out of university hours as he is a guitarist in an upcoming band. He integrates IT into all aspects of his life, but he often forgets to respond to emails or submits a delayed response. Since Robert has had the opportunity to supervise the project using CPMS, he has been able to easily check on meetings etc. by simply logging onto the site. CPMS has also allowed him greater flexibility and enabled him to give students more support and advice together with the ability to receive online submissions for weekly reports.

Persona 3:

Susan is a 35-year-old lecturer at Cardiff University specialising in applied geometry and computational modelling, married with two children, living in the Vale of Glamorgan. Her mornings are busy both with the commute to work and lecture commitments often commencing from 9-11am. Once free from teaching, she often returns to her office to find a large build up of emails. As she is a lecturer, client for the second year project, a final year project supervisor and a personal tutor she receives a significant volume of emails from students. This can cause confusion especially with group project work, as many different students often separately request group assistance. Since Susan has been able to act as the client for the 2nd year project using CPMS, it has allowed her to monitor group members and manage groups more effectively and has resulted in a direct reduction in the volume of emails received.

3.3.2 Purpose

The interaction design was conducted not to define a particular way of proceeding with the design, but is more eclectic, and is concerned with good practice e.g. how to design effective user experiences. Interaction design helps guide the design process to create user experiences that ‘enhance and augment the way people work, communicate and interact’ (Rogers et al. 2011). The interaction design process took into account the different users, technologies and interactions between them, this in turn aided the UML design process and the construction of the user interfaces to create effective user experiences.

3.4 System Modelling

In this section a number of abstract models of the system have been developed. The models were developed to clarify what the system actually does to assist the requirements engineering process. The models were used to analyse the systems strengths and weaknesses, which in turn helped define the requirements set out in Section 3.1.

Based on these criteria I have produced a number of UML (Unified Modelling Language) interaction models, in particular use case and sequence diagrams, which describe a detailed system description facilitating the design and implementation process. The use case and sequence diagrams portray interaction at different levels and consequently can be used together. 'The details of the interactions involved in a high-level use case may be documented in a sequence diagram' (Sommerville 2011). Therefore sequence diagrams have been produced to expand upon use case diagrams where required.

3.4.1 UML Use Case Diagrams

A use case describes the functional and non-functional requirements from the perspective of an actor achieving particular goals. The actors defined in this system are students, the group, supervisor and client. The use cases describe clusters of the requirements (section 3.1) based upon specific goals. The use case diagrams have four major elements the actors, the system itself, the use cases and the lines that represent relationships between these elements. Use case diagrams represent the system in a horizontal way and attempt to show all of the available functionality, rather than representing the order of the systems actions that take place. Based on the complexity of the system I have produced several use case diagrams.

3.4.1.1 Use Case Diagram – Login

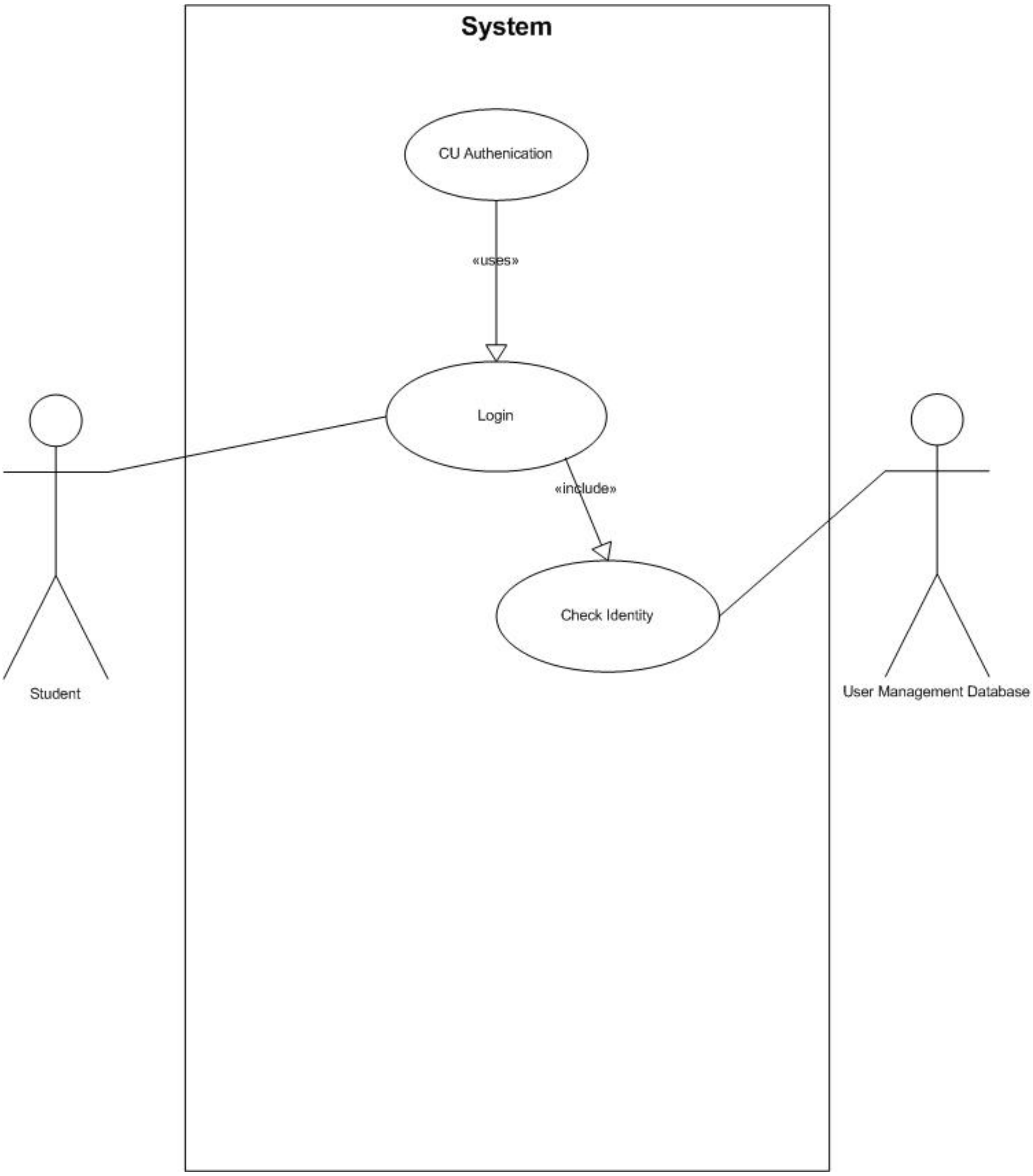


Figure 1 – UML Use Case Diagram - Login

3.4.1.2 Use Case Diagram – Group Discussion, Files

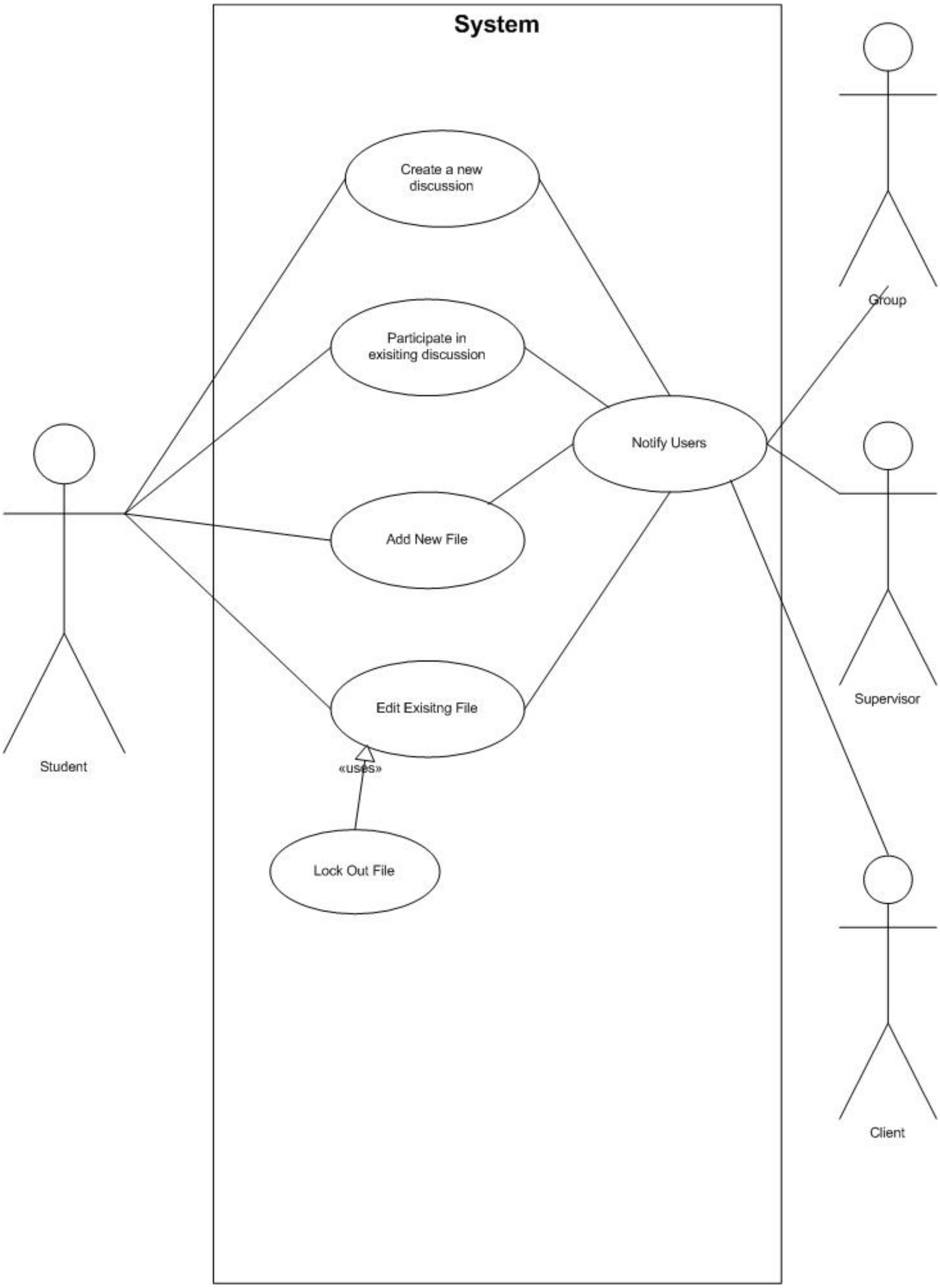
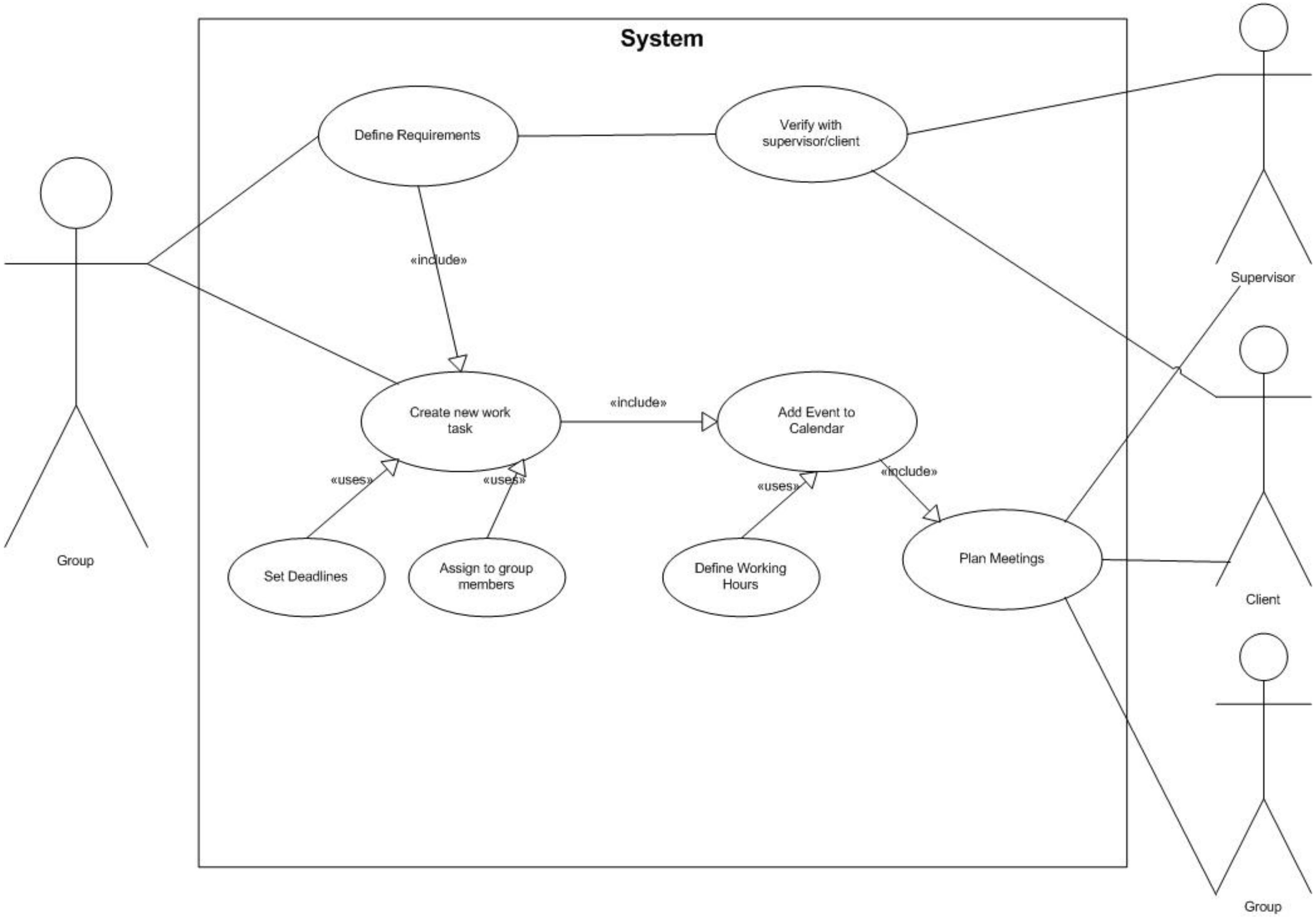


Figure 2 – UML Use Case Diagram – Group Discussion & Files

3.4.1.3 Use Case Diagram – Requirements, Tasks & Events

Figure 3 – UML Use Case Diagram – Requirements, Tasks & Events



3.2.1.4 Use Case Diagram – Submit Deliverables & Results

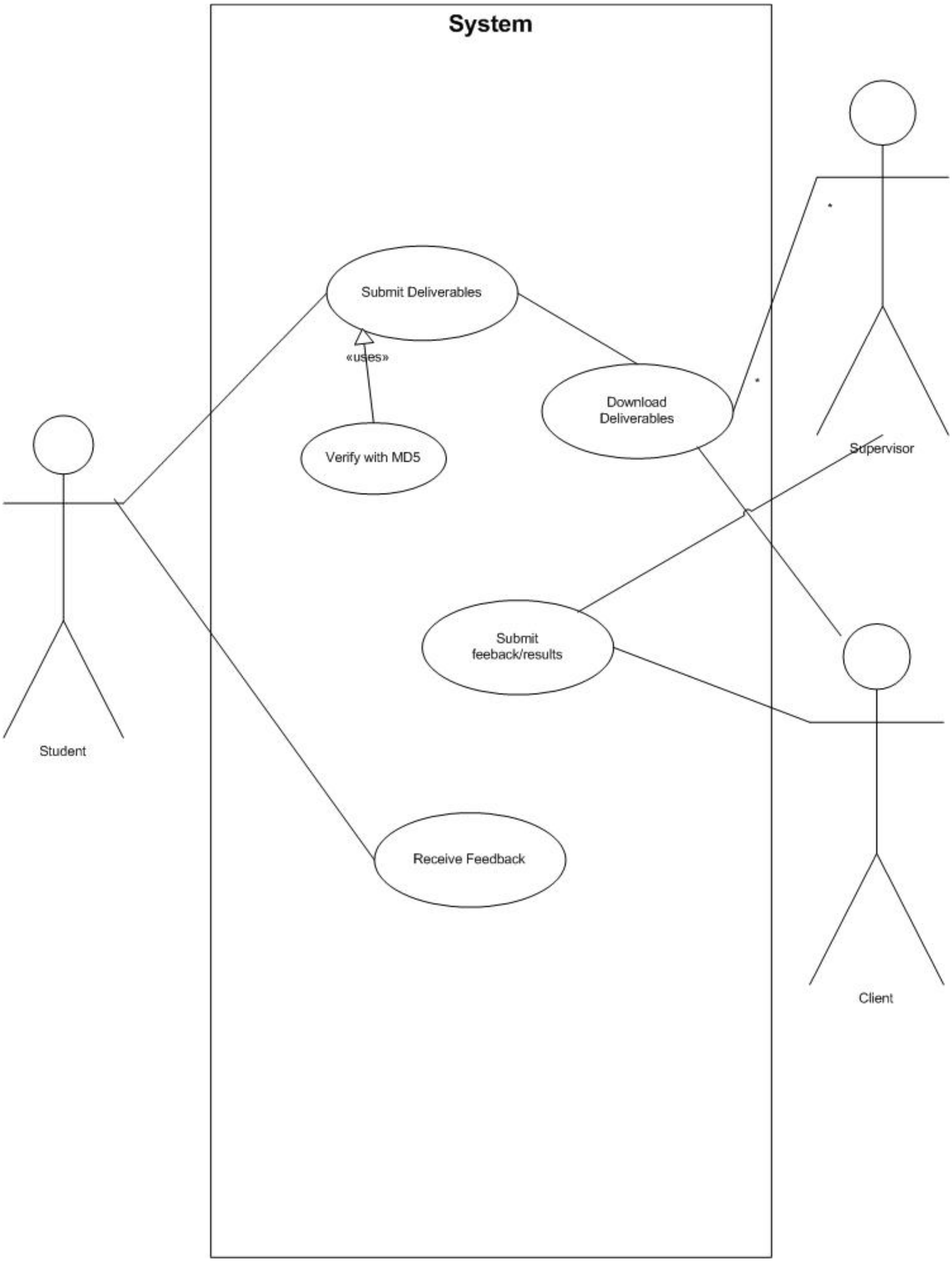


Figure 4 – UML Use Case Diagram – Submit Deliverables & Results

3.4.2 UML Sequence Diagrams

UML sequence diagrams model the flow of logic within a system. Sequence diagrams show the interactions between objects and the sequential order in which those interactions occur. The sequence diagrams have been produced to expand upon the use cases diagrams in order to produce a more formal level of requirements.

3.4.2.1 Sequence Diagram – Login

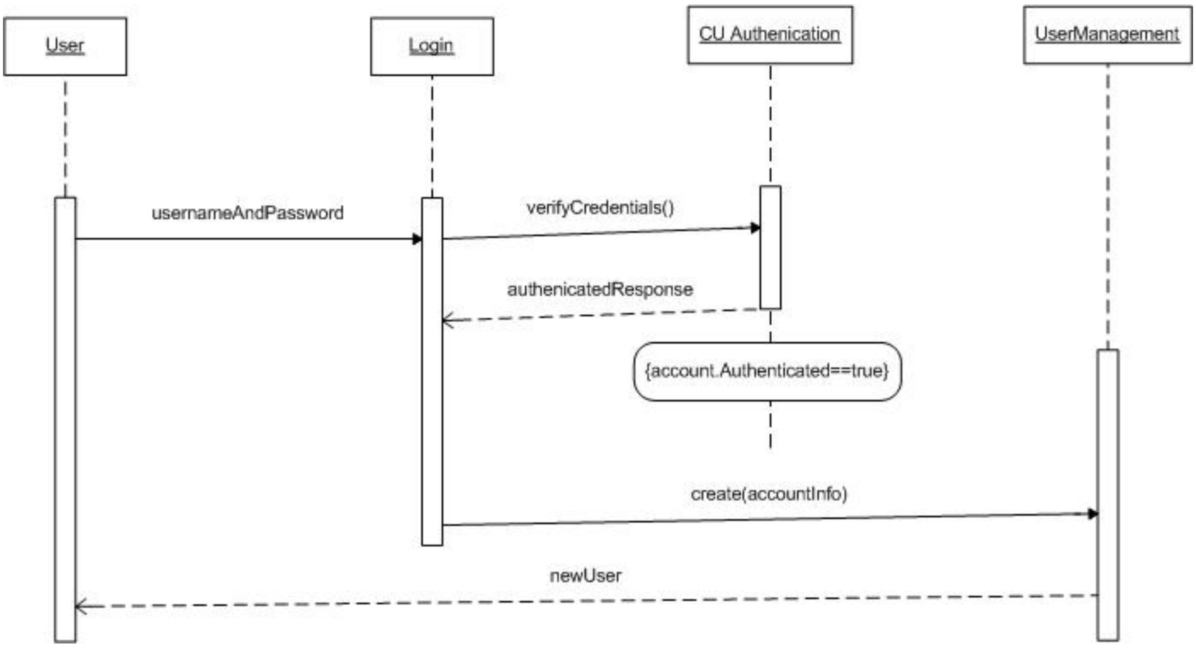


Figure 5 – UML Sequence Diagram - Login

3.4.2.2 Sequence Diagram - Group Discussion, Files

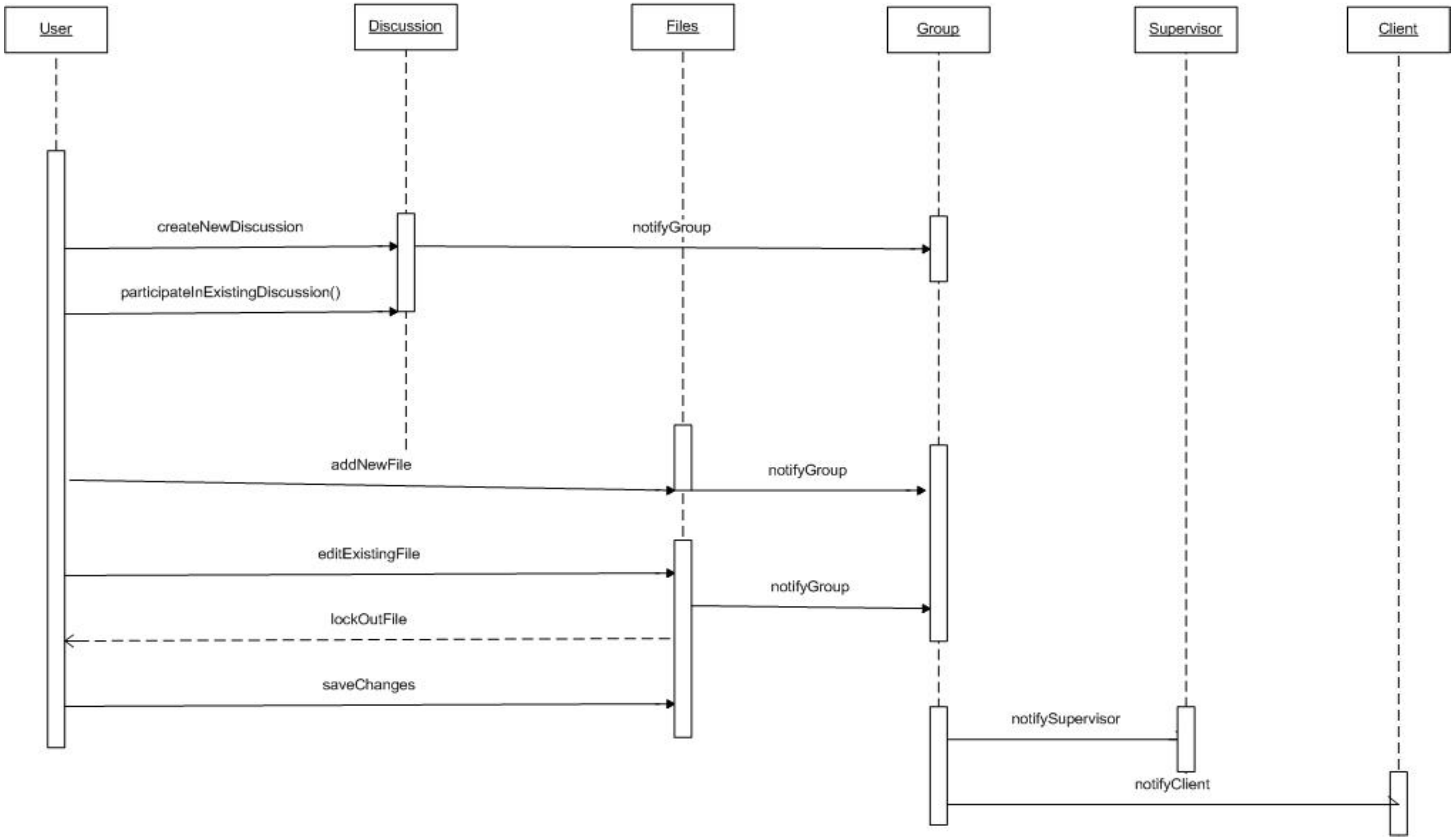


Figure 6 – UML Use Case Diagram - Login

3.5 User Interface

The user interface provides a simple, easy to use group collaboration and project management system that is not aimed at expert users or project managers, unlike many commercial products, and does not include over-complex functionality. The design and implementation process has been built around user/human-centred design principles, to represent students and academic staff.

The user interface is built around the interactive cycle shown below (Figure 7). The user should be able to understand and evaluate what has been displayed and take action based on their goals. The user will then generate inputs based on their goals. The interface must interpret those actions and generate the requested changes from the user.

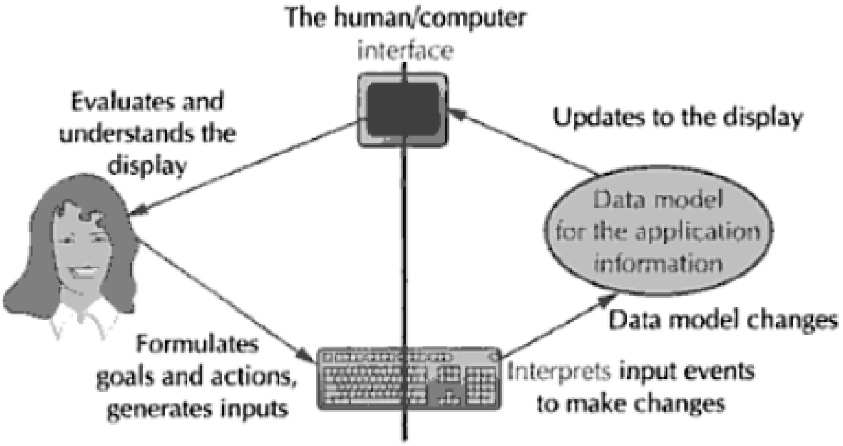
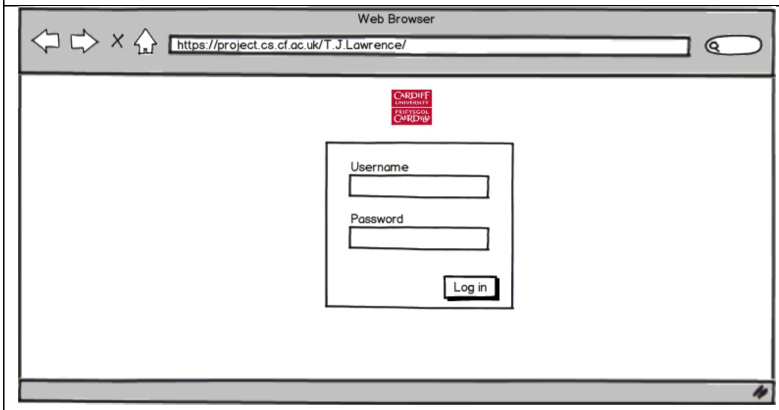
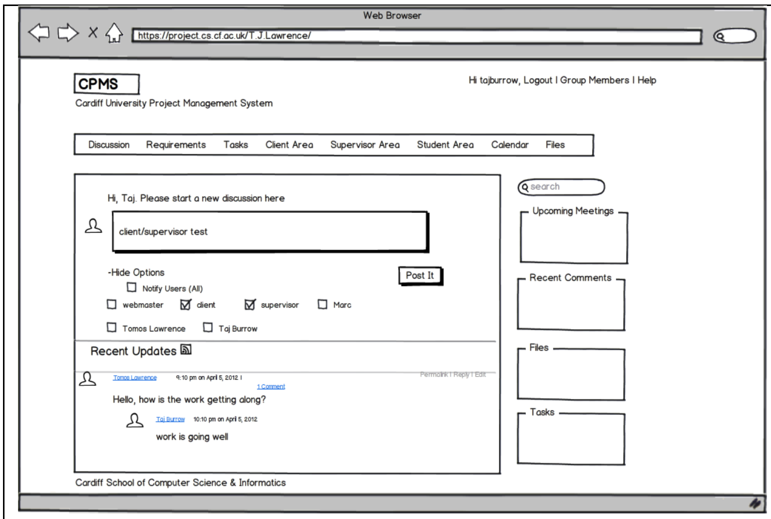

The human/computer interface
Evaluates and understands the display
Updates to the display
Data model for the application information
Data model changes
Formulates goals and actions, generates inputs
Interprets input events to make changes

Figure 7 – Interactive Cycle - Olsen (1998)

The interim report included some early user interface prototypes (section 3.2.2). Since the interim report the system has become more complex and the following section represents the revised graphical user interface (GUI).

GUI Prototype	**Description**
 Web Browser https://project.cs.cf.ac.uk/T.J.Lawrence/ Username Password Log in	Figure 8 – GUI - Login page



Hi, Taj. Please start a new discussion here

client/supervisor test

□ Notify Users (All)

□ webmaster ☑ client ☑ supervisor □ Marc

□ Tomos Lawrence □ Taj Burrow

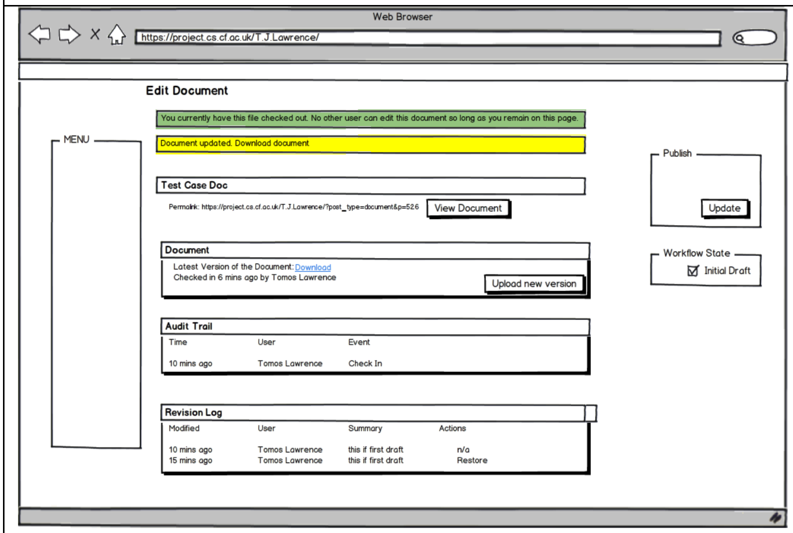
Tomos Lawrence 9:10 pm on April 5, 2012 I

Hello, how is the work getting along?

Taj Burrow 10:10 pm on April 5, 2012

work is going well

Figure 9 – GUI - The discussion page



Edit Document

You currently have this file checked out. No other user can edit this document so long as you remain on this page.

Document updated. Download document

Test Case Doc

Permalink: https://project.cs.cf.ac.uk/T.J.Lawrence/?post_type=document&p=526

Document

Latest Version of the Document: Download
Checked in 6 mins ago by Tomos Lawrence

☑ Initial Draft

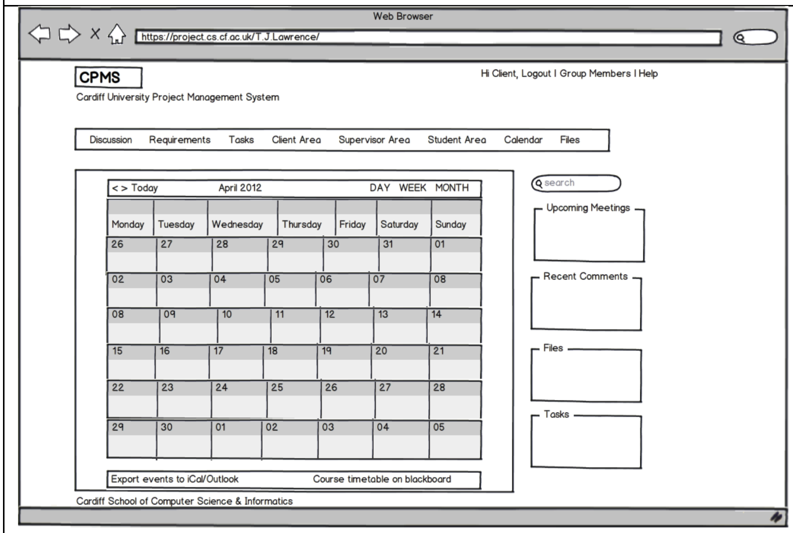
Audit Trail

Time	User	Event
10 mins ago	Tomos Lawrence	Check In

Revision Log

Modified	User	Summary	Actions
10 mins ago	Tomos Lawrence	this if first draft	n/a
15 mins ago	Tomos Lawrence	this if first draft	Restore

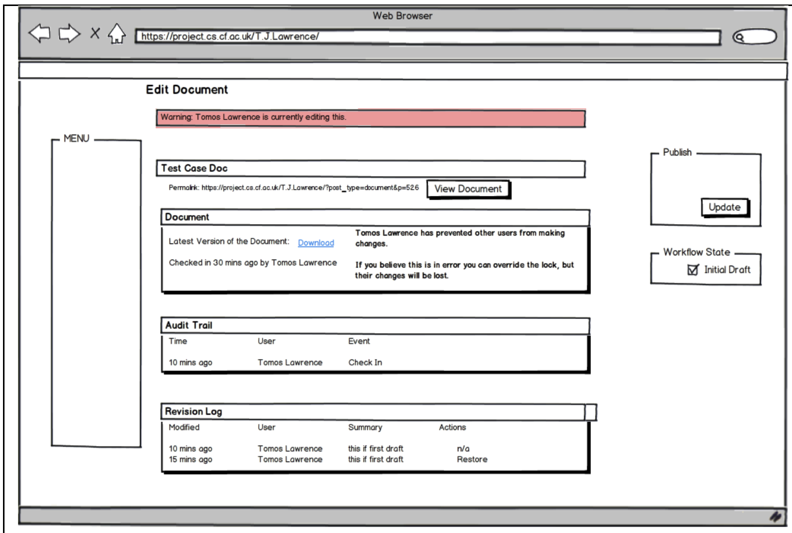
Figure 10 – GUI -The files page


Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
CPMS
Cardiff University Project Management System
Hi Client, Logout I Group Members I Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
< > Today
DAY WEEK MONTH
search
Upcoming Meetings
Recent Comments
Files
Tasks
Export events to iCal/Outlook
Course timetable on blackboard
Cardiff School of Computer Science & Informatics

April 2012

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
26	27	28	29	30	31	01
02	03	04	05	06	07	08
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	01	02	03	04	05

Figure 11 – GUI -The calendar page



Edit Document

Warning: Tomos Lawrence is currently editing this.

Test Case Doc

Permalink: https://project.cs.cf.ac.uk/T.J.Lawrence/?post_type=document&p=526

Document

Latest Version of the Document: Download

Checked in 30 mins ago by Tomos Lawrence

Tomos Lawrence has prevented other users from making changes.

If you believe this is in error you can override the lock, but their changes will be lost.

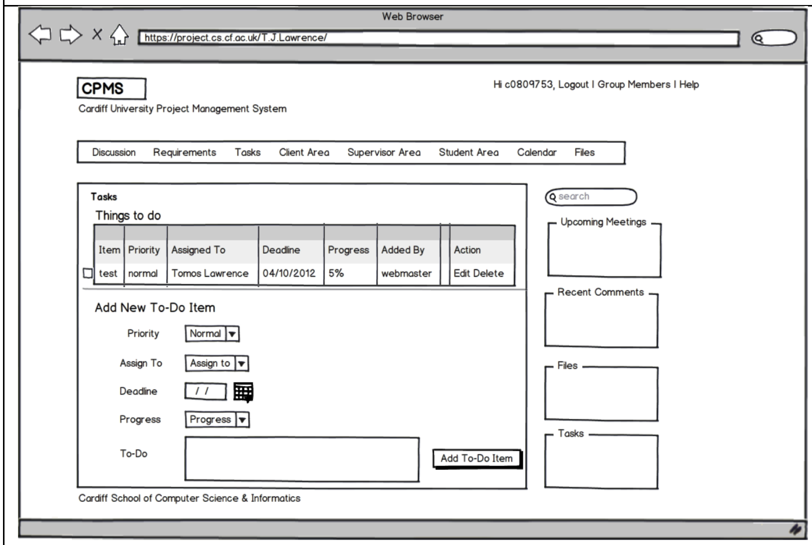
Audit Trail

Time	User	Event
10 mins ago	Tomos Lawrence	Check In

Revision Log

Modified	User	Summary	Actions
10 mins ago	Tomos Lawrence	this if first draft	n/a
15 mins ago	Tomos Lawrence	this if first draft	Restore

Figure 12 – GUI - The files page – when a file is 'checked out'


Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
CPMS
Cardiff University Project Management System
Hi c0809753, Logout I Group Members I Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
search
Upcoming Meetings
Recent Comments
Files
Tasks
Add To-Do Item
Cardiff School of Computer Science & Informatics

Tasks

Things to do

	Item	Priority	Assigned To	Deadline	Progress	Added By	Action
□	test	normal	Tomos Lawrence	04/10/2012	5%	webmaster	Edit Delete

Add New To-Do Item

Priority: Normal ▾

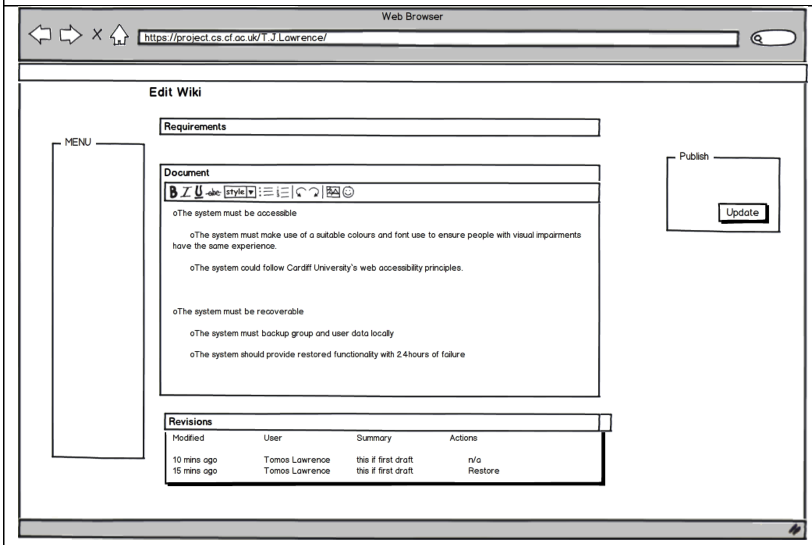
Assign To: Assign to ▾

Deadline: / /

Progress: Progress ▾

To-Do:

Figure 13 – GUI -The tasks page



Edit Wiki

Requirements

Document

oThe system must be accessible

oThe system must make use of a suitable colours and font use to ensure people with visual impairments have the same experience.

oThe system could follow Cardiff University's web accessibility principles.

oThe system must be recoverable

oThe system must backup group and user data locally

oThe system should provide restored functionality with 24hours of failure

Revisions

Modified	User	Summary	Actions
10 mins ago	Tomos Lawrence	this if first draft	n/a
15 mins ago	Tomos Lawrence	this if first draft	Restore

Figure 14 – GUI -The requirements page

4. Implementation

Based on the requirements specification and the system design I have developed a prototype web-based system to attempt to meet the needs of the problem situation.

The system can be run at https://project.cs.cf.ac.uk/T.J.Lawrence/. Students and staff at Cardiff University School of Computer Science & Informatics will be able to log in with their standard username and password. This is by far the best way to demonstrate and review the system as the system cannot be run locally without installing a local PHP server and MySQL server or running the system inside an application such as MAMP. Additionally a list of existing user accounts that have been used for the testing of CPMS can be found in Appendix K.

In addition to this the MySQL database that contains user information, pages, discussions and comments that were created for the testing purposes would need to be imported into the system if it was to be installed again on a new server or as a local installation. I have provided a MySQL dump file that is included in the archive section of PATS2 for this purpose, which can be imported using for example phpMyAdmin. Additionally a Wordpress extended RSS/WXR XML file is included in the 'other files' section of PATS2, which can be imported using the Wordpress interface.

A selection of the code examples used can be found in section 4.4, whilst a full code listing is available in the archive files section of PATS2.

I have concluded the review of the implementation process with an illustration of the major problems and challenges encountered during this phase (see section 4.4)

4.1 Implementation Coding Process

Based on the complexity of the requirements (see section 3.2) and the need for the system to be web-based and accessible by multiple users running different platforms, I will not be implementing the system in an object-oriented language. Alternatively, using PHP & MySQL offers significant benefits given the fact that the tools are free and open source, making the system free from commercial dependencies, and also provides excellent interoperability between multiple operating systems. However the proposed system required additional functionality such as a user management system, file management system and a discussion board. Consequently I elected to base the system around Wordpress. Wordpress is an open source content management system (CMS) better known as a blogging tool, which based around PHP and MySQL.

Wordpress is highly customisable both at the core level when constructing the CMS, and at the user level providing excellent end user functionality, together with a rich plugin architecture supporting languages such as JavaScript & AJAX. Plugins developed from these languages provide extra functionality to the end user e.g. integration with social networks.

Lastly, I have adapted Wordpress into a highly customised system that is fit for purpose. Using, 13 of the available free plugins to provide extra functionality, provided under the GNU licence.

I adapted the vast majority of the plugins with PHP or HTML to customise the software to ensure that it was suitable for the end purpose, to remove unwanted functionality and to supplement the system with additional functionality.

4.2 Software Used

The software selected for this project is the latest version of Wordpress (version 3.3.1). This software is being run by the School of Computer Science project server (Apache/2.2.8 –Fedora) at project.cs.cf.ac.uk, which runs PHP 5.2.6 and MySQL version 5.0.77.

For the graphical user interface and the look and feel of the website, Wordpress uses 'themes' which can be described as a collection of files which working together produce a GUI with an underlying unified design for a website (Wordpress 2012a). This includes standard web styling such as CSS and more powerful features such as page templates. It was not necessary to develop a new theme given that there were ample well-designed themes freely available under the GNU GPL (General Public License) (GNU 2007). I selected the 'GTD theme' developed by the company 'Templatic' for the basis of my web-based system. As the theme was not entirely fit for purpose I have removed some functionality and design elements where appropriate and modified the code to meet the requirements of my web-based system.

I used a variety of 'Wordpress plugins' which offer many functions and features, several of which I customised in order to meet my project requirements. I have listed below the Wordpress plugins used within the project:

- The plugin '3rd Party Authentication' [version 0.2.3] was used to allow students to be able to log in and be authenticated with their Cardiff University username and password. It uses IMAP authentication to connect to the schools mail server (on portico.cs.cf.ac.uk) and the IMAP server uses PAM authentication, which uses LDAP to the schools and universities LDAP servers. It will connect on port 389 and use TLS to encrypt the transaction. The first time a user logs into the system the plugin will create an account in the Wordpress user management system with the credentials supplied. The plugin was modified to allow the login process to work using the schools 'dovecot' IMAP server.
- The plugin 'Add link to Facebook' [version 1.146] was used to allow students discussions on CPMS to be integrated with a specified Facebook group. It allows users to be notified of CPMS discussions through Facebook and it allows users to post comments through Facebook, which will automatically be copied to CPMS and vice versa. The plugin required development of a Facebook app called CPMS (Cardiff University Project Management System) app id '375485165808971' which can be found at https://apps.facebook.com/375485165808971/
- The plugin 'Admin Menu Editor' [version 1.1.6] was used to edit the backend site of Wordpress, known as the 'Dashboard Menu'. This plugin was used to edit the menus, disable certain features and modify Wordpress text to ensure that it was appropriate for the selected end users. The default menu for students, clients and supervisors was amended to ensure that the backend appearance matched the

front-end wording e.g. changing 'posts' to discussion. Lastly, unnecessary administrative features were removed.

- The plugin 'Backup Wordpress' [version 1.6.7] was used to provide the daily automated backups of the website. The plugin provides the facility to backup the Wordpress database and website files automatically daily, it also compresses the file to a zip archive.
- The plugin 'Clean Admin Bar Removal' [version 1.0] was used to remove the 'admin bar' from the pages appearing in Wordpress. This enabled a customised user experience to be created, featuring a clear user interface, which is simple to use.
- The plugin 'Cleverness To-Do List' [version 3.0.6] was used to create the tasks section of CPMS. It enables users to view tasks and assign new tasks with levels of priority, deadlines, progress made and the ability to assign tasks to specified users. The plugin was modified to change the way the front end is displayed to users.
- The plugin 'Event Calendar / Scheduler' [version 2.3.1] was used to create an Ajax-based scheduling interface that is featured on the 'calendar page'. It allows users to create and view events in a monthly, weekly or daily view. The plugin was modified to provide the functionality for room bookings to be made and to add meeting minutes to an event.
- The plugin 'Front File Manager' [version 0.1] was used to create the submission facility found in the client and supervisor area. The plugin was modified to change the 'media category' text to 'submission category'.
- The plugin 'Peter's Login Redirect' [version 2.5.2] was used to redirect users to the site homepage after logging-in, in place of the default setting used in Wordpress, this being the backend 'Dashboard' Menu.
- The plugin 'Redirection' [2.2.10] was used to redirect several Wordpress default pages to custom URLs.
- The plugin 'Simple Local Avatars' [1.3.1] was used to give the user an option to add a profile picture or 'avatar' to their profile. The plugin was modified to display the words 'Profile Picture' as opposed to 'Custom Avatar'.
- The plugin 'User Role Editor' [3.5.4] was used to edit the access permissions of the student, client and supervisor roles. This enabled controls to be set limiting the functionality available to specified users.
- The plugin 'Wiki Lite' [1.0.8] was used to create the 'requirements functionality'. This enabled provision to be made for a front-end editor in which users can readily view and change requirements.
- The plugin 'WP Document Revisions' was used to create the document management system. The plugin enables users to upload files with a full version control system and associated audit log. Additionally it provides users with the functionality to 'check out' a file and submit edits, whilst temporarily restricting access to other users.

4.3 Code Examples

Use of Code: Post New Discussion Code

```
<?php
$user = get_userdata( $current_user->ID );
$name = isset( $user->first_name ) && $user->first_name? $user->first_name : $user->display_name;
?>

<div id="postbox">
        <form id="new_post" name="new_post" method="post" action="<?php bloginfo( 'url' ); ?>/" >
                <input type="hidden" name="action" value="post" />
    <input type="hidden" name="notification_usersid" id="notification_usersid" value="" />
                <?php wp_nonce_field( 'new-post' ); ?>
                <div class="avatar"><?php echo prologue_get_avatar( $user->ID, $user->user_email, 48 );
?></div>
                <div class="inputarea">
                        <label for="posttext"><?php printf( __('Hi, %s. Please start a new discussion here,
'p2'), wp_specialchars( $name ) ) ?></label>
                        <div>
                                <textarea name="posttext" id="posttext" tabindex="1" rows="50"
cols="600"></textarea>
                        </div>
```

Explanation: This allows the users to post a new discussion. It includes the user data and name to pull the users name automatically and uses a form, which can be seen on the discussion page that and allows a user to create a new 'post' discussion.

Use of Code: To show the name of the user if they have a file locked out.

```
/**
         * Checks if document is locked, if so, returns the lock holder's name
         * @since 0.5
         * @param object|int $post the post object or postID
         * @return bool|string false if no lock, user's display name if locked
         */
        function get_document_lock( $post ) {

                if ( !is_object( $post ) )
                        $post = get_post( $post );
                if ( !$post )
                        return false;
                //get the post lock
                if ( !( $user = wp_check_post_lock( $post->ID ) ) )
                        $user = false;
                //allow others to shortcircuit
                $user = apply_filters( 'document_lock_check', $user, $post );
                if ( !$user )
                        return false;
                //get displayname from userID
                $last_user = get_userdata( $user );
                return ( $last_user ) ? $last_user->display_name : __( 'Somebody' );
        }
```

Explanation: The code checks if a document is locked, and if so returns the lock holder's name which is displayed in the files page if a user currently has a document 'checked out'.

Use of Code: To allow users to be authenticated against dovecot Computer Science IMAP server

```
function authenticate($username, $password) {
                        $ssl = fsockopen($this->getURL(), $this->port, $err, $errdata, 40);
                        if ($ssl) {
                                $auth = fgets($ssl, 256);
                                fputs($ssl, '0000 CAPABILITY'."\n");
                                $auth = fgets($ssl);            /* read as much as there is to end of line */
                                $auth = fgets($ssl);            /* read as much as there is */
                                fputs($ssl, '0001 LOGIN '.$username.' '.$password."\n");
                                $auth = fgets($ssl);            /* read as much as there is */
                                fclose ($ssl);
                                if(preg_match('/Success/',$auth) || preg_match('/Ok/',$auth) ||
preg_match('/Logged in/',$auth)) { /* "Logged in" is retrned by dovecot */
                                        return true;
                                } else {
                                        return false;
                                }
                        }
                        return false;
                }
```

Explanation: The code uses the username and password fields to check against the computer science Dovecot IMAP server. If the response Logged In is returned, the user will successfully be authenticated.

Use of Code: To display the to-do tasks list in the front end of the system

```
/**
        * Generate the To-Do List
        * @param $todo_items
        * @param $priorities
        * @param $url
        * @param int $completed
        * @param $visible
        * @return array $posts_to_exclude
        */
        public function show_todo_list_items( $todo_items, $priorities, $url, $completed = 0, $visible = 0 ) {
                extract( shortcode_atts( array(
                        'priority'   => 0,
                        'assigned'   => 0,
                        'deadline'   => 0,
                        'progress'   => 0,
                        'categories' => 0,
                        'addedby'    => 0,
                        'editlink'   => 1
                ), $this->atts ) );

                while ( $todo_items->have_posts() ) : $todo_items->the_post();
                        $id = get_the_ID();
                        $posts_to_exclude[] = $id;

                        if ( $visible == 0 ) {
                                $the_priority = get_post_meta( $id, '_priority', true );
                                $priority_class = '';
                                if ( $the_priority == '0' ) $priority_class = ' class="todo-important"';
                                if ( $the_priority == '2' ) $priority_class = ' class="todo-low"';
```

```
                                        $this->list .= '<tr id="todo-'.esc_attr( $id ).'"' . $priority_class . '>';
                                        $this->show_checkbox( $id, $completed );
                                        $this->show_todo_text( get_the_content() );

                                        /** @var $priority int */
                                        if ( $priority == 1 ) $this->show_priority( $the_priority, $priorities );
                                        /** @var $assigned int */
                                        if ( $assigned == 1 ) $this->show_assigned( get_post_meta( $id, '_assign',
true ) );
                                        /** @var $deadline int */
                                        if ( $deadline == 1 ) $this->show_deadline( get_post_meta( $id, '_deadline',
true ) );
                                        /** @var $progress int */
                                        if ( $progress == 1 ) $this->show_progress( get_post_meta( $id, '_progress',
true ) );
                                        /** @var $categories int */
                                        if ( $categories == 1 ) $this->show_category( get_the_terms( $id,
'todocategories' ) );
                                        /** @var $addedby int */
                                        if ( $addedby == 1 ) $this->show_addedby( get_the_author() );
                                        /** @var $editlink int */
                                        if ( $editlink == 1 ) $this->show_edit_link( $id, $url );
                                        $this->list .= '</tr>';
                              }
                    endwhile;

                    return $posts_to_exclude;
          }
```

Explanation: The code looks for the shortcode provided and displays the appropriate elements e.g. priority, assigned to etc. as requested.

4.4 Problems Encountered

I encountered several problems whilst trying to implement the system. When I was trying to introduce Cardiff University authentication the first approach was to just use the schools LDAP (ldap.cs.cf.ac.uk) server. However I established that although the schools server contains the same usernames as those of the university, they are stored without the passwords (generally in an unusable impossible password). The solution I adopted was to use IMAP, which in turn used PAM, which uses the university LDAP and the school LDAP servers for user authentication.

Whilst attempting to integrate Facebook I encountered another issue. Facebook requires authorisation for an application to be able to post through a users Facebook account. Ideally each user would have the ability to authorise the 'CPMS Facebook App' so posts could be made from their account. However to do this each user would have to manually provide the Facebook 'App ID', 'App Secret' and 'Group ID'. Given the complexity of this task I was unable to create an automated method to enable each user to individually authorise the Facebook App. To overcome this limitation I created a new Facebook account (CPMS) which I set as a default account to be used by all users to 'post' to Facebook and share the access token.

Providing a file sharing facility was challenging. Although I sourced a very useful piece of software 'wp-document revisions' I had originally envisaged that users would be able to perform all required tasks from the 'front-end'. However when users accessed the files page, due to the complexity of the file sharing requirements, they were redirected to the modified Wordpress 'back-end'. In order to solve this problem I first created the facility to view documents and upload documents in the front end but this in turn had associated issues and problems, for example, uploaded documents would require a 'default author', and the front end would not support the advanced 'check out' control system. Therefore, the solution I implemented was to adapt the back-end to provide an easy to use GUI and I customised the menu to enable users to be able to return to the front end with one click. To avoid confusion arising for the user I also made the 'files' page open in a new target.

Although Wordpress can provide a number of 'roles', which essentially determine a users access privileges, I identified several problems in this regard. I needed to ensure that the end-users 'students, supervisors & clients' could not access Wordpress administrative features, to prevent them, for example, from modifying the structure of the site or deleting software plugins. I established that the role I assigned to the end users enabled them to access certain capabilities that should not be permitted. Therefore, I used the plugin 'user role editor' that provided me with the ability to specifically customise the capabilities available to end-users and associated permissions.

By default, after users log in on Wordpress, they are directed to the Wordpress backend 'Dashboard' menu. This is not suitable for the system, and if users are unfamiliar with Wordpress it could prove to be confusing. To eliminate this project I added a redirect to the site home page.

Upon implementing the file submission feature I tested a number of 'file uploader' software plugins. I first used a plugin, which I managed to integrate the PHP function date_timestamp_set to give a front-end view of the time and date on which a file, was uploaded e.g. 19/04/2012 09:48:15.

However, despite the advantages of providing this feature, the plugin used a flash based uploader with AJAX based validation. This caused a conflict with my calendar software. After failing to resolve the conflict I opted to use an alternative file uploader ‘Front File Manager’ which does not offer some of the advanced functionally but does provide better interoperability with a range of devices e.g. iOS as the plugin does not use flash.

I attempted to provide a separate discussion area for the client and supervisor in order to allow the group to engage in private discussions if they did not want the supervisor or client to be involved. However I was unable to replicate the discussion facility and have two different discussion areas, due to the complexity of discussion functionality. The ‘discussion’ feature creates a Wordpress ‘post’ and as discussions are created through the discussion form these entries are then pulled to the ‘recent updates’ section on the discussion page. I could have added the discussion form box to a separate client/supervisor discussion area, however I experienced difficulty when attempting to create two or more separate and discrete feeds of ‘posts’ directing appropriate posts to the client or supervisor as required. I was therefore unable to implement this feature and as an alternative I have provided a single discussion facility with the option to notify selected users.

I also encountered problems in the email notification functionality. By default the notification functionality did not notify other users by email when a new topic was posted on CPMS. Email notifications would only be created after comments had been posted. I attempted to resolve this by adding a new function to the notify.php file but I was unable to develop an adequate solution. Given this limitation I focused my efforts on providing Facebook notifications, in particular given the fact that end users expressed greater interest in having this feature.

Lastly, on the page ‘group members’ I wished to display a list of the group members registered on the site excluding, the users ‘webmaster’ and ‘module leader’. These accounts are reserved for administrative privileges only. Although Wordpress offers a function ‘wp_list_members’ to show a list of all the users on the site, it does not provide the function to exclude any users. This proved to be problematic. However, I resolved the problem by adding an IF statement stating the user IDs to exclude from the group list. I added the IF statement to the file ‘authortemplate.php’ which contained the function ‘wp_list_members’. This action has provided an effective workaround. However the users ‘webmaster’ and ‘ModuleLeader’ still appear in the ‘notify’ section of the discussion page as these user accounts are generated from a different function ‘get_users_of_blog’.

4.5 Configuration Management

As software and system requirements are a continually evolving process, configuration management was used to keep track of changes, to ensure that all changes made are recorded.

Version management was used to keep track of multiple versions of system components and to ensure that the correct version was being used for development.

The version control log can be found in Appendix J.

5. Results & Evaluation

This section details the scope of the testing process undertaken after the implementation of the system together with an evaluation of the tests and an evaluation of the project against the results obtained.

5.1 Testing

Testing is an essential task to assess the quality of a system. I carried out testing throughout the entire development phase, rather than basing my approach to the testing on the philosophy that I would be able to fix all the problems after the system development has been completed. This compares to traditional approaches such as the waterfall model, which is often unsuccessful and can result in project failure. Instead a test-driven development (TDD) approach was used in which the system was developed incrementally, and I did not proceed to the next set of functionality until each phase of development had successfully been tested. The basis of the TDD approach is shown below in figure 15.

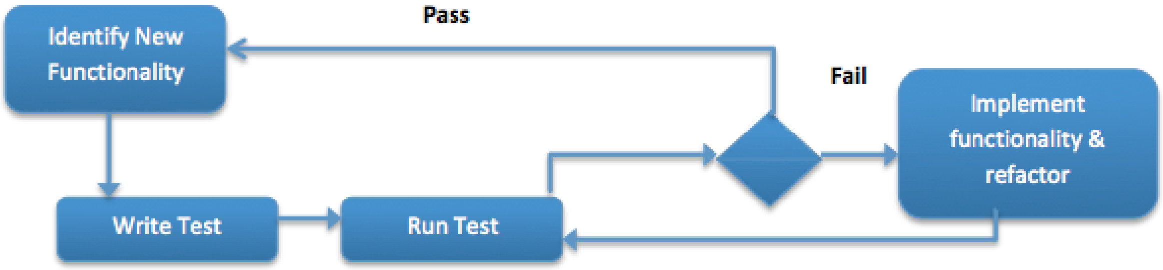

Identify New Functionality
Pass
Fail
Implement functionality & refactor
Write Test
Run Test

Figure 15 – Test-Driven Development

The purpose of the testing to establish whether the system meets the requirements by testing against the requirements specification. Testing is also designed to identify situations where the system fails to perform as intended, and to detect any bugs, issues and defects.

The main focus was on black-box testing, given that this project was primarily concerned with the quality of the user experience and not how well the code was written. Although white box testing such as unit testing in PHP is possible, it is more useful when testing in object-oriented languages and programming languages that directly support unit testing such as C# and Cobra. The system has not been designed by a computer science student. Consequently, the main benefits arising from white-box testing for example, to improve the quality of source code and to reduce the incidence of bugs was deemed to be unnecessary for the purpose of this project.

Finally, each release of Wordpress is now rigorously tested given that it is used many people worldwide (Rao 2011). It is unlikely that the minor modifications and other changes that I have made to the Wordpress core and the associated plugins will result in any significant bugs. However I have conducted basic white-box testing.

5.1.1 White-Box Testing

5.1.1.1 Unit Testing

The purpose of unit testing is to verify that the code does what it is intended to do at a very low structural level, to ensure that that each individual unit or groups of related units satisfies quality standards and system requirements (Williams 2006).

To perform unit testing in my Wordpress based system I used SimpleTest 1.0.1 (SimpleTest 2012), which is a PHP unit test and web test framework.

The unit test undertaken can be found in Appendix B. The unit tests used *mock versions* of the plugins external dependencies (on Wordpress functions and the file system).

Unit Test Result:

```
1/1 test cases complete: 6 passes, 0 fails and 0 exceptions.
```

The outputs of the tests run are shown below:

```
Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php-
>UnitWpSimpleTest->testSetShortcodeWithNoPath->Equal expectation [Array: 3 items] at
[/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php line
27]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php-
>UnitWpSimpleTest->testSetShortcodeWithBadPath->Equal expectation [Array: 3 items] at
[/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php line
34]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php-
>UnitWpSimpleTest->testSetShortcodeWithGoodPath->Equal expectation [Array: 3 items] at
[/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php line
41]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php-
>UnitWpSimpleTest->testConfirmTestFileExistsWithNoPath->Pass at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-
content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php line 52]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php-
>UnitWpSimpleTest->testConfirmTestFileExistsWithBadPath->Pass at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-
content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php line 64]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php-
>UnitWpSimpleTest->testConfirmTestFileExistsWithGoodPath-> at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-
content/plugins/simpletest-for-wordpress/tests/UnitWpSimpleTest.php line 72]
```

5.1.1.2 Integration Testing

The purpose of integration testing is to check that units work together in the overall environment, and when integrated into a larger code base, as opposed to components simply working as individual entities (Williams 2006).

To perform integration testing in my Wordpress based system I again used SimpleTest 1.0.1.

The integration tests undertaken can be found in Appendix C. The integration tests were run against the *actual versions* of the plugins external dependencies, as opposed to mock versions.

Integration Test Result:

```
1/1 test cases complete: 6 passes, 0 fails and 0 exceptions.
```

The outputs of the tests run are shown below:

```
Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php->IntegrationTestOfWpSimpleTest->testSetShortcodeWithNoPath->Equal
expectation [Array: 3 items] at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php line 29]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php->IntegrationTestOfWpSimpleTest->testSetShortcodeWithBadPath->Equal
expectation [Array: 3 items] at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php line 36]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php->IntegrationTestOfWpSimpleTest->testSetShortcodeWithGoodPath->Equal
expectation [Array: 3 items] at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php line 43]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php->IntegrationTestOfWpSimpleTest->testConfirmTestFileExistsWithNoPath-
>Pass at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php line 53]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php->IntegrationTestOfWpSimpleTest->testConfirmTestFileExistsWithBadPath-
>Pass at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php line 64]


Pass: /nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php->IntegrationTestOfWpSimpleTest->testConfirmTestFileExistsWithGoodPath->
at [/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/plugins/simpletest-for-
wordpress/tests/IntegrationWpSimpleTest.php line 71]
```

5.1.2 Black-Box Testing

The purpose of the black-box testing is to test the functionality of the system against the business requirements. It ignores the internal lines of code and mechanisms of a system, and focuses solely on the outputs generated by a certain set of inputs.

After successful white-box testing I performed several types of black-box tests to further assess the quality of the system.

5.1.2.1 Functional testing

The purpose of functional testing is to test all the functionality of a system to ensure the requirements have been met. The testing was conducted on the complete, integrated system.

The functional test cases can be found in Appendix D. Each test case involved the following stages:

- Definition of the purpose of the test
- Identification of the tester
- Identification of the test environment
- Identification of the test procedure - the functions the software is expected to perform
- Creation of the test input data – defined explicitly to ensure tests could be reproduced
- Determination of the expected output with explanation of what should be expected and mockup prototype
- The execution of the test case
- Identification of the actual result with explanation/comparison and actual screen capture of the system
- Decision if the test case has passed or failed

Functional Test Results:

```
49/49 test cases complete: 42 passes, 7 fails and 0 exceptions.
```

5.1.2.2 Compatibility testing

The purpose of compatibility testing is to evaluate the applications compatibility against the computer environment in which it is designed to work. Tests completed in the compatibility testing stage assessed the compatibility of the system in terms of:

- Cross platform compatibility, including mobile operating systems
- Browser compatibility
- File type compatibility

The compatibility test cases can be found in Appendix E.

Compatibility Test Results:

```
17/17 test cases complete: 15 passes, 2 fails and 0 exceptions.
```

Test Case 08: Failure Windows XP – Internet Explorer. The system does not display correctly on legacy versions of Internet Explorer including IE7 and all older versions.

Test Case 15: Failure –Android Mobile operating system. The system has display issues when using a mobile device running Android.

5.1.2.3 Security Testing

The purpose of security testing is to establish whether users are able to change the functionality of system in unintended ways and to ensure that the system adequately protects data.

Tests completed in the security testing stage assessed the security of the system in terms of:

- A security assessment
- Vulnerability scan

Security Test Results:

```
02/02 test cases complete: 2 passes, 0 fails and 0 exceptions.
```

5.1.2.4 Usability testing

5.1.2.4.1 Heuristic Evaluation

Methodology

A "heuristic evaluation is a discount usability engineering method for quick, cheap and easy evaluation of a user interface design" (Jakob Nielsen 2005). This method has been used to produce the usability findings summarised in this report. It allows evaluators to identify usability problems quickly at low cost, after which more extensive testing can be conducted to target the problems found in the heuristic evaluation.

In order to make this heuristic evaluation effective, the use of appropriate heuristics developed by experts is critical. I therefore selected ten heuristics suggested by Nielsen (1994) and three additional content management system heuristics suggested by Bos Et al (2005) for the purposes of my heuristic evaludation

The heuristics used and heuristic evaluation used can be found in Appendix G.

Summary of Key Results & Findings

Conducting the heuristic evaluation was a useful exercise, and resulted in the identification of several usability problems.

To evaluate the findings from the Heuristic Evaluation, a dual rating system was used to identify specific problems areas and make recommendations in respect of each of the problems found.

The tables used to define the severity and ease of fix ratings can be found in Appendix G.

A summary of the results can be found below:

#	Problem	Severity Rating	Ease of Fix Rating	Heuristic Number	Broad Heuristic
1	Users cannot keep track of their location in terms of where they have navigated from the starting point.	2	1	#1	The system should keep users informed about what is going on.
2	The system does not provide sufficient feedback relating to information processing and loading of new pages	2	1	#1	The system should keep users informed about what is going on.

3	The system has a rigid layout, which can result in accessibility and usability issues when using low screen resolutions e.g. 800x600	2	2	#3	Users should have control and freedom to leave the system in an unwanted state without having to go through an extended dialogue
4	The 'files page', 'requirements edit page' & 'profile page' are not consistent with the rest of the site	3	3	#4	The users should not have to get confused in different situations.
5	The system does not make use of any obvious accelerators e.g. keyboard shortcuts.	0	2	#7	The system does not allow users to tailor frequent actions to speed upon interaction for experienced users.
6	The system repeats information creating clutter on the pages	0	2	#8	Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
7	The system does not underline most hyperlinks	1	0	#11	Use standard web conventions when using text as a hyperlink, underline it.
8	The system looses a users unsaved data if they accidentally close the browser	2	3	#12	Accidentally closing the browser should not result in data loss

5.1.2.5 Accessibility testing

The purpose of accessibility testing is to determine if the information and resources provided via the system is accessible to all users. Tests completed in the accessibility testing stage tested the web accessibility in terms of:

- Colour blind computer simulation checks, conducted in respect of:
    - Deuteranope (a form of red/green colour deficit)
    - Protanope (another form of red/green colour deficit)
    - Tritanope (a blue/yellow deficit- very rare)
- W3C's WAI Web Content Accessibility Guidelines at Level AA assessment

The tools used for the tests were recommended by the Web Accessibility Initiative, published by the W3C.

The accessibly test cases used can be found in appendix H.

Accessibility Test Results:

```
04/04 test cases complete: 3 passes, 1 fails and 0 exceptions.
```

5.1.2.6 Maintenance & Recovery testing

The purpose of maintenance & recovery testing is to determine if the system can be recovered in the event of crashes, hardware failures or catastrophic problems.

Tests completed in the maintenance & recovery-testing stage tested the system in terms of:

- Backup procedures
    - Frequency of backups
    - Integrity of data
- Hardware failure assessment

The hardware failure assessment showed that the system is installed on School of Computer Science project server (project.cs.cf.ac.uk). The file space where the system CPMS and all web files are located is in the 'document root'. The document root is located on 'Nisien' one of the schools Linux file servers, and is backed up every night. The project.cs.cf.ac.uk web server accesses this document root using NFS file protocols.

In the event of failure, the project server can be rebuilt on another server, and spare servers are available for this purpose. The files located on the project server change very little as changing files are stored on the document root, which is stored on the 'Nisien' server. Restoration can be done from a backup taken when the project server was configured.

If the file server 'Nisien' fails, the project server will not work because it will be unable to see the document root. If this occurs the 'Nisien' server can be rebuild on another server (one of the spare servers available for this purpose) and can be restored from the nightly backup.

The maintenance and recovery test cases used can be found in appendix I.

Maintenance & Recovery Test Results:

```
02/02 test cases complete: 2 passes, 0 fails and 0 exceptions.
```

```
01/01 test assessment complete: 1 pass, 0 fails and 0 exceptions.
```

5.1.2.7 Other testing

I originally intended to perform relevant *performance testing* to evaluate the perceived and real performance of the system, and perform debugging. However as I was using the schools project server I was unable to install XDebug on the server side or configure the php.ini file as I was not granted appropriate permission to do so. Ideally I would of liked to conduct additional *endurance* and *spike* testing to establish whether the system could cope with continuous expected load or a sudden increase in load, however I did not have the resources or equipment to set up several PCs or a server to act as an injector.

Upon completion of the white box, functional and system testing I would ideally have wished to perform *acceptance testing.* Acceptance testing can be performed to determine whether the system satisfied appropriate users acceptance criteria. Unfortunately due to the timescale and complexity of this project I was not able to conduct any user acceptance testing for several reasons. The time required for the implementation and design phases was under estimated. Attempting to meet almost all the requirements was a time-consuming and challenging task. By the time the initial functional testing was complete it left a very short timescale in order to get students to participate in user acceptance testing. Furthermore the system was completed in the Easter recess and students had upcoming assignments and examinations to focus upon.

5.2 Evaluation

Having concluded the testing (section 5.1) the next step was to conduct a full evaluation of the project in order to measure the overall success of the project. The testing was focused around black-box testing and in particular functional testing, to determine whether the functionality of the system met the defined system requirements.

Further non-functional testing was conducted to evaluate system compatibility and interoperability, robustness of security and maintainability and the quality of the user interface and accessibility, as an adjunct to the core assessment of project success and to provide a foundation for future work.

5.2.1 Evaluation of Test Results

The testing process commenced with basic white-box testing (section 5.1.1). The unit tests all passed the test criteria and verified that the code does as intended at a very low level. The unit testing used mock objects with the same interface as the external objects being used (plugins) to simulate the plugins functionality. Thereafter integration testing was used to verify that the units work together in the overall environment. The integration tests used actual versions of the plugins external dependencies. All of the integration testing was also successful, all testing having passed the appropriate criteria. The main purpose of the white-box testing was not to check conformance with the requirements specification, but to validate the software technically and to ensure that the system meets end users needs and expectations and to ensure that the system is fit for purpose and suitable for the intended use.

The black-box testing (section 5.1.2) was undertaken to verify that the system met the stated functional and non-functional requirements (section 3.2).

The functional testing utilised a comprehensive set of test cases (Appendix D), which were specifically written to test each functional requirement and to identify any remaining defects present within the system. The testing followed a systematic approach whereby each specific requirement was reviewed and having done so appropriate test cases were then written and run. The functional testing was primarily concerned with validation e.g. demonstrating that the system has fully implemented the specified requirements (section 3.2).

In accordance with the MoSCoW prioritisation technique, which was used to define the importance of all requirements (section 3.2), the evaluation conducted upon completion of the project showed that all ‘Must and ‘Should’ criteria were delivered. Therefore, the project has been successful in that the final system has met all the essential and high priority requirements. Additionally the majority of the ‘Could’ requirements have also been delivered. The system has therefore provided an appropriate overall solution to the original problem situation.

During the course of the project, additional requirements were added and other requirements revised, as can be seen when comparing the original proposed requirements specified in the interim report (section 3.1 – interim report) against the final revised requirements (section 3.1 – final report). All changes to the requirements were made in accordance with increased knowledge and understanding of the original problem situation enabling additional functionality to be delivered and an improved and enhanced final project solution.

Only 9 of the 27 non-essential ‘could’ requirements were not implemented (33%). The reason being that these requirements either failed to pass the relevant testing procedures or could not be implemented within the limited time constraints set for the project.

The following functional ‘could’ requirements are those, which were not implemented:

- Requirement 4.1.3 (section 3.1.1) ‘to provide the ability to export calendar events to calendar applications’. Whilst the system exports the correct file format, it is not readable by calendar applications e.g. Microsoft Outlook. Attempts to resolve this problem within the project timebox were not successful, and as such as this requirement failed to be achieved.

- Requirement 9.2 (section 3.1.1) ‘to provide the ability for group members to review and accept/decline requirements before they are final’ and 9.3 (section 3.1.1) ‘to provide the ability for group members to link requirements with tasks and deliverables failed as no attempt was made to implement these requirements. Requirement management software is complex and although the system provides an area for groups to define requirements in a standard format it does not provide the non-essential desirable additional functionality that requirements 9.1 and 9.3 defined. Complex functionality would require large amounts of development effort. Potentially this could be a standalone project, or included in a development programme should it be decided to implement this system.

- Requirement 3.4 (section 3.1.1) ‘to provide group, client and supervisor with different access rights’ was not implemented due to complications concerning automatic creation of Wordpress user accounts and enabling users the facility to be authenticated using the Cardiff University authentication LDAP. Details and a possible solution are contained in section 6.

- Requirement 5.3, 5.4 & 5.6 (section 3.1.1) ‘to provide an RSS feed of activity, notifications of changes to file sharing and notifications of approaching deadlines of deliverables’ were not implemented due to time constraints. These requirements were added to the project as non-essential ‘could requirements’ after the original requirements specification had been written.

- Requirement 6.6 (section 3.1.1) ‘to provide notifications when the status of a file is updated’ was not implemented due to time constraints. This requirement was added to the project as non-essential ‘could requirement’ after the original requirements specification had been written.

- Requirements 7.2 & 7.4 (section 3.1.1) ‘to MD5 checksum could be generated to help users verify the integrity of the file’ and ‘to provide a results are feedback area.’ were not implemented due to time constraints. These requirements were added to the project as non-essential ‘could requirements’ after the original requirements specification had been written.

Of those requirements which failed to be implemented the majority were not included in the original requirements specification but were added when the final requirements were revised. If at a future date circumstances arose which necessitated the priority of these requirements being increased, it is likely that additional development work would enable these features to be delivered.

The remaining black-box testing was undertaken in order to verify whether the system met the specified non-functional requirements.

Compatibility testing (section 5.1.2.2) was conducted to assess the cross platform compatibility of the system. The tests were created to meet the non-functional requirements concerning reliability (section 3.1.2 - requirements 15). The tests conducted determined that the system worked successfully across multiple operating systems, including the latest and most recent legacy versions of Microsoft Windows, Mac OS X, iOS and Ubuntu.

Secondly testing was conducted which determined that the system supports the latest and most recent legacy versions of multiple web browsers including Google Chrome, Mozilla Firefox, and Safari & Internet Explorer. However compatibility testing identified display issues in older versions of Internet Explorer (IE 6/7) and the Browser for the Android mobile operating system. As indicated previously (section 3.1.2) in the non-functional requirements these objectives were both categorised, as 'could' requirements in part because of the complexity and effort required in supporting all older versions of web browsers and mobile browsers.

Lastly, compatibility testing returned satisfactory results on all the upload file types that were described in the requirements (section 3.1.2 – requirements 15.5 & 15.6). However, although the requirements did not specify that the system must handle source code files e.g. '.php' '.xml', additional testing identified that the system does not support such files. Should in future it be decided that this functionality is required additional development work will need to be undertaken.

Relevant security testing (section 5.1.2.3) was undertaken in order to ensure that critical security measures were not left unaddressed. Although security considerations were not explicitly defined in the requirements, a basic security flaw could lead to catastrophic consequences. If the system was breached, it could affect the reliability, accessibility and recoverability requirements. However the tests conducted showed that there were no vulnerabilities concerning the Wordpress installation and similarly no port vulnerabilities were left exposed.

Usability testing (section 5.1.2.4) was conducted to attempt to ensure the system was fit for purpose for the intended end users, and that the user interface meets non-functional requirements 13 & 14 (section 3.1.2). The heuristic evaluation (section 5.1.2.4.1) returned satisfactory results on the system usability. It is a very comprehensive technique, and from the wide range of heuristics I used it covered the vast majority of the usability and consistency requirements (section 5.1.2.4 – requirements 13 & 14). The heuristic evaluation identified eight usability problems. Only one of the problems identified was ranked as a '3', which constitutes a major usability problem. The nature of the problem is that the 'files' page is inconsistent with the rest of the system and this problem should be prioritised to be fixed in the next iteration of future development work. A further four problems were ranked as a '2', which constitutes a minor usability problem. A further single problem was ranked as a '1', this being a cosmetic problem only. Lastly, two problems were ranked as a '0' in that these problems violated a heuristic but do not constitute usability problems. Work was conducted to identify whether the system adhered to ISO 9241 standard. This standard covers ergonomics and HCI issues. It was however difficult to determine the exact quality requirements that the system should attain in order to meet this standard within the project timescale.

Accessibility testing (section 5.1.2.5) was undertaken to ensure that the system was accessible to all end users. The system attained the necessary standard in respect of three of the four tests conducted. As such the system is usable by end users with visual impairments, and in particular those users who are colour-blind. Users with the three most common types of colour blindness, these being deuteranope, protanope and tritanope are therefore able to access and use the system, meeting requirements, 16.1 (section 3.1.2).

However the system did not meet the W3C's WAI Web Content Accessibility Guidelines (WCAG) at Level AA assessment as recommended by Cardiff University's web accessibility principles (requirement 16.2 – section 3.1.2). Attempts to resolve this problem identified that it will be very difficult to meet WCAG at level AA, although the system does meet the majority the requirements within the guidelines and as such the system is accessible when, for example using screen reading software. It should be noted however that the Cardiff University main website also fails to meet the WCAG AA guidelines despite the university policy statement on web accessibility stating that it should. The standard of the system delivered at the time of this report is therefore consistent with the standard reached by the Cardiff University main websites. Should in future accessibility improvements be made to the main Cardiff University websites, through which these websites attain the W3C's WAI Web Content Accessibility Guidelines (WCAG) at Level AA assessment or even AAA, this would require additional development work to be undertaken on the CPMS system to ensure that this system similarly attains the higher standard.

Maintenance and recovery testing (section 5.1.2.6) was conducted which returned successful results. Tests conducted successfully demonstrated that the system was able to create backups of data and files and having done so compressed these backups into a zip archive, thereby ensuring data integrity, which is supported automated daily backups. This meets the non-functional requirement 17.1 (section 3.1.2). A hardware failure assessment (section 5.1.2.6) was conducted which identified the system infrastructure and the contingency plans in place in the event of failure. This meets the non-functional requirement 17.2 (section 3.1.2).

In summary the vast majority of the testing conducted was successful proving that the system is fit for purpose, appropriate for the intended use and will meet the expectations of future end users. The comprehensive nature of the range of tests conducted demonstrates that the system meets nearly all of the functional and non-functional requirements specified and that there are no significant extant errors or issues within the system.

5.2.2 Evaluation of Project

Several iterations of the project took place. The final design and implementation of the system proved to be much more intricate and sophisticated than that originally anticipated in the initial project plan and interim report. Whilst the project did not remain entirely on-track, the outcome of the project has predominately been successful.

The system has been thoroughly researched using appropriate academic literature and background information regarding existing solutions that fit the problem situation. The system was explicitly specified, refined and revised in the requirements specification and implemented meeting almost all of the proposed requirements. Successful rigorous testing was then conducted in order to evaluate the system within the constraints imposed by the agreed timescale.

The time management and project planning failed to remain on-track. The design and development phase overran by a significant time element. During the initial planning phase insufficient consideration was given to the magnitude of the task and the issues that would arise during the development phase. However issues are not uncommon in software projects. As the project progressed 'scope creep' set in, which consequently led to additional requirements, which were not initially accounted for in the project plan. The result of these changes led to substantial improvements in the final implementation of the system and delivery of the project, although as a direct consequence significant additional development time was required to provide the additional functionality. Similarly the revised timescale as specified in the interim report proved to be optimistic and failed to reflect in full the man-hours required to deliver the project requirements by the specified deadline. Insufficient time had also been scheduled to conduct a thorough literature review. The project plan initially omitted to include a literature review section, however I determined that it would be necessary to include a full literature review to specify the academic sources used to inform the research conducted throughout the project.

The research conducted of existing systems and their functionality facilitated the fine-tuning of the requirements and objectives. Critical evaluation of this research enabled improved functionality to be developed and, where appropriate, unwanted and unnecessary functionality was removed. Similarly a review of existing commercial systems greatly informed the final development of the system and emphasised the critical importance of a good and effective graphical user interface for end users.

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6. Future Work

Throughout the course of the project lifecycle several areas were identified that could be added to, improved or expanded upon given additional time and resources. These are listed below in suggested order of priority:

1. Whilst the system has been subject to significant and extensive testing no user testing has been conducted. This may be regarded as a weakness given that no time was scheduled within the acceptance criteria for end user testing by 2nd year students, for whom the system has been primarily designed. User testing is clearly desirable, however, as previously stated the project timescales did not allow sufficient time for this to be conducted. Consequently user testing should be afforded top priority with regard to future work. User testing is essential as the users working environment may have major impacts upon a system, in comparison to the artificial nature of the developers test environment. I recommend that beta testing of the existing system should be undertaken using a small sample of future second year students during the forthcoming university summer vacation. Doing so would enable the identification of any interaction problems with the student environment. Thereafter the system could be piloted with forthcoming second year students and used to manage their group projects. This would provide an informal method of acceptance testing using large numbers of users within different environments. It is recognised however that in contrast to a commercial project, students may not willingly volunteer to formally test the system and provide feedback in respect of whether the system should be accepted or rejected. Such a pilot scheme would however enable students to identify any remaining problems or issues and request changes. On the basis of responses and feedback provided by students a decision could then be taken as to whether the system is fit for purpose and suitable to be implemented on a permanent basis.

2. There may be issues regarding scalability given that the initial design and implementation has been based upon a single group. Users within this group are automatically registered on the system having first logged with their standard university username and password, which uses Cardiff University authentication. This procedure would not be appropriate should the system be rolled out for all groups participating within the 2nd year group project, as the current installation of the system at http://project.cs.cf.ac.uk/T.J.Lawrence/ is unable to support multiple groups. One workaround would be to install the system several times for individual groups. For example, group number one would then be able to access the system at www.cpms.cs.cf.ac.uk/group1 and group three at www.cpms.cs.cf.ac.uk/group3. This would not however represent a scalable system, as it requires manual installation for each group and the related issues surrounding the software evolution process in particular system maintenance. System maintenance could range from corrective maintenance e.g. fixing bugs, environmental adaptation e.g. if the servers have changed or functionality addition e.g. additional requirements added to the system. This workaround would therefore require maintenance to be conducted on each installation of the system, and as such, would be vastly time consuming and inefficient. Consequently I recommend that

development work should be undertaken to enable multiple groups to be consolidated within a single installation. This could be achieved in variety of ways. For example by adding additional functionality to the core of Wordpress which would allow users to be categorised into discrete groups and prompt users to join their appropriate group upon initial log in. Alternatively future work could investigate the use of Wordpress multisite, which can enable central maintenance of one system across several Wordpress installations.

3. The system currently affords all users the same access rights given that users are automatically allocated accounts when authenticated by Cardiff University LDAP. Ideally students, clients and supervisors should have different access rights and privileges and be presented with a different view of the system. Several Wordpress plugins were sourced e.g. ‘wp-members’ and ‘wishlist member’, that transforms Wordpress into a multiple user level platform. However these have not been integrated with the ‘3rd party authentication’ plugin, which authenticates users through their Cardiff University username and password and creates their user account on Wordpress. Ultimately the decision was made that authentication was the most important feature, if only one feature could be delivered. As such adaptations were made to the client and supervisor pages, which provided an adequate alternative. If different access rights could have been provided for specified end-users, each specific type of user could have been presented with a different view of the system. For example, when a student logs on they could have received a reminder/notification that they are due to submit an interim report by a specified date. Similarly a supervisor could be reminded that they must complete all marking and feedback by a specified date and clients could be reminded that a follow up meeting is due or has been scheduled.

4. The system could be enhanced to provide an improved submission and feedback area. Whilst the current system allows users to submit and download the submitted files, a number of extra features could be included. The submission facility does not currently allow source files to be uploaded e.g. ‘.php’ nor does it properly manage ‘zip’ files, and the upload size is limited to 2MB. The limited uploaded size could however be readily changed subject to configuration on the server side. Additionally, the submission facility could be enhanced to provide discrete upload sections for appropriate files such as document files, appendix files and archive files. It would also be beneficial for the system to provide an MD5 hash of the uploaded files, so that students can verify integrity. PATS2, the existing 3rd year project allocation & tracking system provides the facility for examiners to make available feedback and results. Additional future work could be undertaken to enable this feature to be included in CPMS.

5. Given that 2nd year group projects now include implementation within the project scope, it would be useful to include a software development 'coding repository' similar to GitHub within CPMS. This would provide a 'pastebin' style functionality that would provide users with the ability to share source code in a development style environment. CPMS would also benefit from the use of the Git revision control system providing collaboration and project management conventions to distributed coding teams.

6. Development could be undertaken to better integrate CPMS with Facebook. The objective would be to provide users with the facility to authorise the Facebook app individually instead of using one 'master account', which grants the authority for CPMS to automatically post to Facebook. Additionally the Facebook App could be further developed to allow integration between the calendar events within CPMS and Facebook events.

7. The calendar functionality could be expanded in order to make it easier for users to add events and view others events. For example, the calendar could be amended to provide a feature enabling the import of events from Microsoft Outlook (.pst/.csv format) or from iCal (.ical/.ics format) and the calendar could synchronise with Google Calendar or even IBM iNotes calendar (as used in Cardiff Portal). This would enable end users to further integrate the CPMS system within their daily tasks and workflow.

8. Additional work could be carried out in respect of information ethics. Firstly the CPMS system should consider the moral issues regarding information privacy given that the system collects personal information, which is shared with other users and 3rd party applications such as Facebook. Work could be undertaken to develop a privacy policy and to allow users to control, select and specify their chosen privacy options. Secondly, the system creates, stores, distributes and processes a significant amount of information, the quality of which is dependant upon the end users. Consequently end users should be reminded of their responsibilities for accuracy and integrity of all information inputted into the system and their personal ownership of information. The CPMS system cannot be held accountable for errors in information or late deliverables etc. Failsafe protocols could be developed within CPMS system to ensure this issue is addressed. Thirdly, the CPMS system allows users to upload files, which could potentially allow students using the system to share copyright material. Controls could be implemented to ensure that all files uploaded to the system do not breach intellectual property rights or copyright laws. Finally, whilst Cardiff University are the owners and operators of the system appropriate assurances should be given to the students that the data entered onto the system will not be used inappropriately. For example, discussions posted on the system should not be used surreptitiously for assessment purposes without the students content. This does not however exempt users from their personal responsibility to ensure that all opinions and posts made meet current legal and ethical standards. To this end, further development work should be undertaken

to ensure that the system adheres to the BCS code of conduct, which details the professional code of standards applicable to the United Kingdom.

I believe that the developments listed above are realistic and achievable and could have been developed and implemented with future work.

7. Conclusions

The aim of the project was to develop a web-based system to assist students plan and manage their 2nd year group project, with the emphasis upon project management and group collaboration. The objective was to enable groups to better manage project work and to minimise previous problems encountered during 2nd year group projects. Initial background research was conducted regarding the problem situation in order to identity all potential issues, and to identify whether any existing systems or tools were available to support the project. Finally it was determined that the project should provide a bespoke system to facilitate enhanced group collaboration and more effective project management.

The project succeeded in achieving all the original aims and objectives. Furthermore, as greater understanding of the project was achieved, the scope, design and implementation of the project was enhanced and increased in complexity.

Despite requirement creep the system development has been successful. All of the core requirements were met and many were expanded upon, enabling an enhanced end product to be delivered.

I am confident that should the university adopt the system it will provide significant benefits to students and all other parties involved in the 2nd year group project. The system will provide a robust, bespoke and usable group collaboration and project management tool. When combined with face-to-face interaction the system will facilitate greater creativity and problem solving within groups, increase knowledge sharing, improve cooperation and coordination and increase social interaction.

8. Reflection

The project process has both simulating and challenging in equal part. Since I first initiated the project in the final semester of year two, the scope, complexity and the understanding of the potential of the project has increased significantly. Initially, I was apprehensive about my ability to implement an effective system given my limited programming knowledge and experience acquired through my studies on the Information Systems course. However, the skills and experience I gained from my summer web development internship and part-time web development employment in my third year has changed the perspective of the project. As such, a decision was made to design, develop and implement a full web-based system as opposed to the initial plan to produce a system that would only have partially met the ideal requirements. The problem solving skills and knowledge required to meet the challenges of the implementation has been a critical learning experience for me. The project has challenged me personally and required me to conduct extensive research and wider reading which in turn has enabled me to not only achieve my original proposals but to expand upon the objectives and the scope of the project considerably. As a result I have achieved an outcome of which I am proud, in that I have exceeded my original expectations, and I believe that the system, which I have developed, does provide the School of Computer Science & Informatics with a potentially useful tool which could be made available for future second year group project students.

The project has greatly improved my web programming skills. I expanded upon my previous experience in Wordpress development, which includes working in PHP, MySQL, HTML, CSS and JavaScript. The knowledge and experience I have gained has greatly enhanced my skill sets.

Such tacit technical skills are sought by many employers, given the fact that Wordpress CMS is evolving into a more popular platform for websites. Additionally, my problem solving skills have greatly improved, given the fact that there was no ‘generic solution’ available for my project. This required me to review existing solutions, and modify appropriate solutions to meet the requirements of my project. Over the course of the project, especially in the implementation phase I was required to solve problems on a daily basis. At the start, coding problems appeared overwhelming and very frustrating. Over time however, I developed greater personal resilience to enable me to handle the challenges and pressures these problems brought. I developed a logical and methodical approach, I utilised new knowledge and information acquired from Internet repositories and I was required to think creatively and use my personal initiative in order to develop appropriate solutions.

The project has also greatly improved my research skills. As this project had such a diverse range of aspects there were no suitable specific literature or software solutions available to meet the exact needs of the project. Therefore, this required me to conduct diverse and wide ranging academic research. It helped me improve my ability to find suitable literature and the skills required to assess whether or not such information was suitable to be adapted for use in my project. My evaluation skills and my ability to accurately summarise, understand and scrutinise technical data, journals and literature has greatly improved.

I now understand that although the testing phase is a long and tedious task, it is critical to the ultimate success of a software project. The process involved in completing the project has provided me with extensive knowledge and technical testing skills, which I believe, will be of great use to me in my future career.

Although my time scale was over optimistic, even when taking into account Hofstadter's Law, my time management has improved over the duration of the project. I continually reviewed my time still available for the project in order to prioritise the most important tasks and to ensure that the relevant work was completed within the remaining timescale. This ensured that I did not waste too much time on a specific task, for example, improving the functionality of a non-essential requirement but instead I organised my time to ensure that all aspects of the project were delivered on time and to an adequate standard. In the final weeks leading up to the deadline for submission I used my remaining time wisely to enable me to enhance and improve upon the project deliverables and the final project report.

Appendix

Appendix A – Meeting with Project Moderator

Notes from meeting with Project Moderator: Professor N.J. Avis – 10/02/2012

When I met with Professor N.J. Avis we initially discussed how the CM2301/CM2304 module has changed from the CM240 module (which I studied in my second year), and how I should endeavour to incorporate these new challenges into the proposed system.

- We discussed how the students are not only required to produce requirement and systems design but how they have got to implement a prototype using agile development and test the system with a number of different deliverables.
- The system could be something similar to PATS2, used to manage the final year projects but with more advanced features.
- Would like to include the client and supervisor interaction with the system, meaning multi level accounts.
- We discussed human factors of the project, and if they could be addressed in my project, in particular:
    - Student's uncertainty of the tasks and when tasks are due to be delivered and to what standard.
    - Certain students not doing their share of the work and other difficulties that exist in group work.
    - Certain group members trying to dominate the group with their ideas or take excessive workload.
    - Groups planning low levels of ambition for requirements, knowing that they will be easily able to meet the targets.
    - The dilemma of how different supervisors/clients will mark work at different levels, e.g. some markers may be tough – others could be lenient, and the moderation process that exists.
- The change control process. At the moment if a group of students has difficulty in meeting certain requirements, they can simply change the requirements and explain the problems. Prof Avis said a more stringent change control process could be beneficial e.g. if students change their requirements they must request electronic approval from their client/supervisor. This would reflect how commercial projects would operate.
- We discussed the future possibility of students possibility be allowed to select/bid on projects from small range of projects to reflect their interests and the chance for students to select their group using the system.
- I suggested the idea of all submitting al deliverables electronically using the system and Prof Avis agreed it would be the way forward for these projects.
- Finally we discussed user acceptance testing. Getting a group to test the system to see how it would perform and be beneficial in a real project situation.

Appendix B – Unit Test

UnitWpSimpleTest.php

```
<?php

require_once(dirname(__FILE__) . '/../../toppa-plugin-libraries-for-
wordpress/ToppaFunctions.php');
require_once(dirname(__FILE__) . '/../../toppa-plugin-libraries-for-
wordpress/ToppaFunctionsFacadeWp.php');
require_once(dirname(__FILE__) . '/../WpSimpleTest.php');
Mock::generate('ToppaFunctionsFacadeWp');

class UnitWpSimpleTest extends UnitTestCase {
    private $functionsFacade;
    private $shortcodeNoPath = array('name' => 'Test Results', 'path' => '',
'passes' => 'n');
    private $shortcodeBadPath = array('path' => '/nowhere');
    private $shortcodeGoodPath = array('name' => 'Wp Simpletest', 'path' => '/wp-
simpletest/tests', 'passes' => 'y');

    public function __construct() {
        $this->UnitTestCase();
    }

    public function setUp() {
        $this->functionsFacade = new MockToppaFunctionsFacadeWp();
        $this->functionsFacade->setReturnValue('getPluginsPath',
'/opt/lampp/htdocs/wordpress/wp-content/plugins');
    }

    public function testSetShortcodeWithNoPath() {
        $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
        $expectedShortcodeNoPath = array('name' => 'Test Results', 'path' => '',
'passes' => 'n');
        $wpSimpleTest->setShortcode($this->shortcodeNoPath);
        $this->assertEqual($expectedShortcodeNoPath, $wpSimpleTest-
>getShortcode());
    }

    public function testSetShortcodeWithBadPath() {
        $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
        $expectedShortcodeBadPath = array('name' => 'Test Results', 'path' =>
'/nowhere', 'passes' => '');
        $wpSimpleTest->setShortcode($this->shortcodeBadPath);
        $this->assertEqual($expectedShortcodeBadPath, $wpSimpleTest-
>getShortcode());
    }

    public function testSetShortcodeWithGoodPath() {
        $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
        $expectedShortcodeGoodPath = array('name' => 'Wp Simpletest', 'path' =>
'/wp-simpletest/tests', 'passes' => 'y');
        $wpSimpleTest->setShortcode($this->shortcodeGoodPath);
        $this->assertEqual($expectedShortcodeGoodPath, $wpSimpleTest-
>getShortcode());
    }

    public function testConfirmTestFileExistsWithNoPath() {
        try {
            $this->functionsFacade->setReturnValue('checkFileExists', false);
            $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
            $wpSimpleTest->confirmTestFileExists($this->shortcodeNoPath['path']);
        }
        catch (Exception $e) {
            $this->pass();
        }
    }

    public function testConfirmTestFileExistsWithBadPath() {
        try {
            $this->functionsFacade->setReturnValue('checkFileExists', false);
            $wpSimpleTest = new WpSimpleTest($this->functionsFacade, $this-
>hooksFacade);
            $wpSimpleTest->confirmTestFileExists($this->shortcodeBadPath['path']);
        }

        catch (Exception $e) {
            $this->pass();
        }
    }

    public function testConfirmTestFileExistsWithGoodPath() {
        try {
            $this->functionsFacade->setReturnValue('checkFileExists', true);
            $wpSimpleTest = new WpSimpleTest($this->functionsFacade, $this-
>hooksFacade);
            $this->assertTrue($wpSimpleTest->confirmTestFileExists($this-
>shortcodeGoodPath['path']));

        }

        catch (Exception $e) {
            $this->fail("Exception was not expected: " . $e->getMessage());
        }
    }
}
```

Appendix C – Integration Test

IntegrationWpSimpleTest.php

```
<?php

// the autoloader can be used with tests only if you don't need SimpleTest's mocks
for your tests
// so it's good for integration tests
require_once(dirname(__FILE__) . '/../../toppa-plugin-libraries-for-
wordpress/ToppaAutoLoaderWp.php');

class IntegrationTestOfWpSimpleTest extends UnitTestCase {
    private $functionsFacade;
    private $toppaAutoLoader;
    private $wpSimpleTestAutoLoader;
    private $shortcodeNoPath = array('name' => 'Test Results', 'path' => '',
'passes' => 'n');
    private $shortcodeBadPath = array('path' => '/nowhere');
    private $shortcodeGoodPath = array('name' => 'Wp Simpletest', 'path' =>
'/simpletest-for-wordpress/tests', 'passes' => 'y');

    public function __construct() {
        $this->UnitTestCase();
    }

    public function setUp() {
        $this->toppaAutoLoader = new ToppaAutoLoaderWp('/toppa-plugin-libraries-
for-wordpress');
        $this->wpSimpleTestAutoLoader = new ToppaAutoLoaderWp('/simpletest-for-
wordpress');
        $this->functionsFacade = new ToppaFunctionsFacadeWp();
    }

    public function testSetShortcodeWithNoPath() {
        $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
        $expectedShortcodeNoPath = array('name' => 'Test Results', 'path' => '',
'passes' => 'n');
        $wpSimpleTest->setShortcode($this->shortcodeNoPath);
        $this->assertEqual($expectedShortcodeNoPath, $wpSimpleTest-
>getShortcode());
    }

    public function testSetShortcodeWithBadPath() {
        $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
        $expectedShortcodeBadPath = array('name' => 'Test Results', 'path' =>
'/nowhere', 'passes' => '');
        $wpSimpleTest->setShortcode($this->shortcodeBadPath);
        $this->assertEqual($expectedShortcodeBadPath, $wpSimpleTest-
>getShortcode());
    }

    public function testSetShortcodeWithGoodPath() {
        $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
        $expectedShortcodeGoodPath = array('name' => 'Wp Simpletest', 'path' =>
'/simpletest-for-wordpress/tests', 'passes' => 'y');
        $wpSimpleTest->setShortcode($this->shortcodeGoodPath);
        $this->assertEqual($expectedShortcodeGoodPath, $wpSimpleTest-
>getShortcode());
    }

    public function testConfirmTestFileExistsWithNoPath() {
        try {
            $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
            $wpSimpleTest->confirmTestFileExists($this->shortcodeNoPath['path']);
        }

        catch (Exception $e) {
            $this->pass();
        }
    }

    public function testConfirmTestFileExistsWithBadPath() {
        try {
            $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
            $wpSimpleTest->confirmTestFileExists($this->shortcodeBadPath['path']);
        }

        catch (Exception $e) {
            $this->pass();
        }
    }

    public function testConfirmTestFileExistsWithGoodPath() {
        try {
            $wpSimpleTest = new WpSimpleTest($this->functionsFacade);
            $this->assertTrue($wpSimpleTest->confirmTestFileExists($this-
>shortcodeGoodPath['path']));
        }

        catch (Exception $e) {
            $this->fail("Exception was not expected: " . $e->getMessage());
        }
    }
}
```

WpSimpleTestSuite.php

// this is needed for simpletest's addFile method

```
<?php

set_include_path(get_include_path() . PATH_SEPARATOR . dirname(__FILE__));

class WpSimpleTestSuite extends TestSuite {
   function __construct() {
       parent::__construct();
       $this->addFile('UnitWpSimpleTest.php');
       $this->addFile('IntegrationWpSimpleTest.php');
   }
}
```

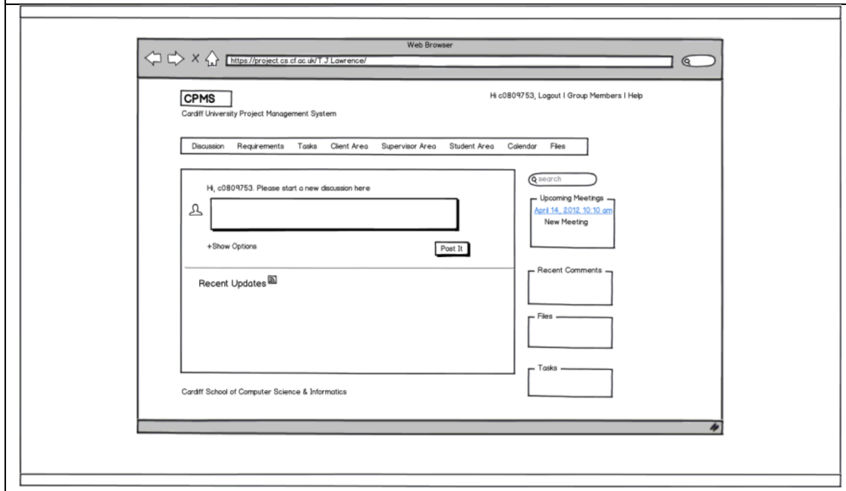
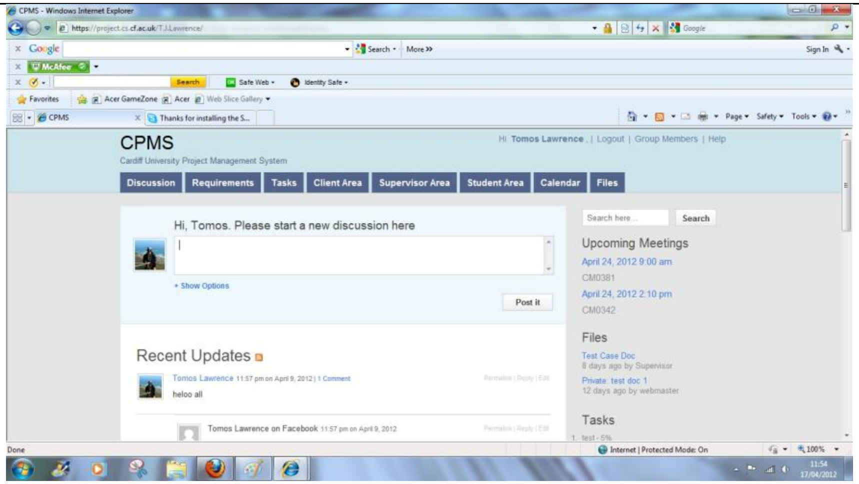
Appendix D – Functional Test Cases

The test cases are contained within a separate in the Appendix section on PATS2

Appendix E – Compatibility Test Cases

COMPATABILITY TESTING

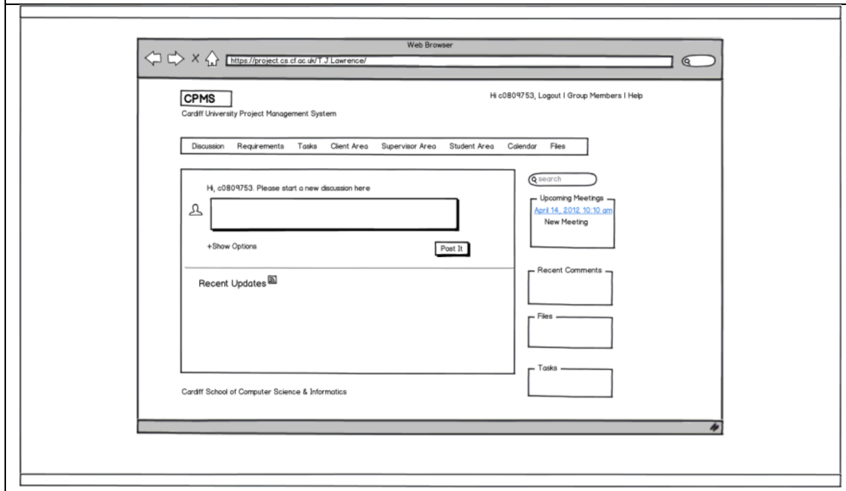
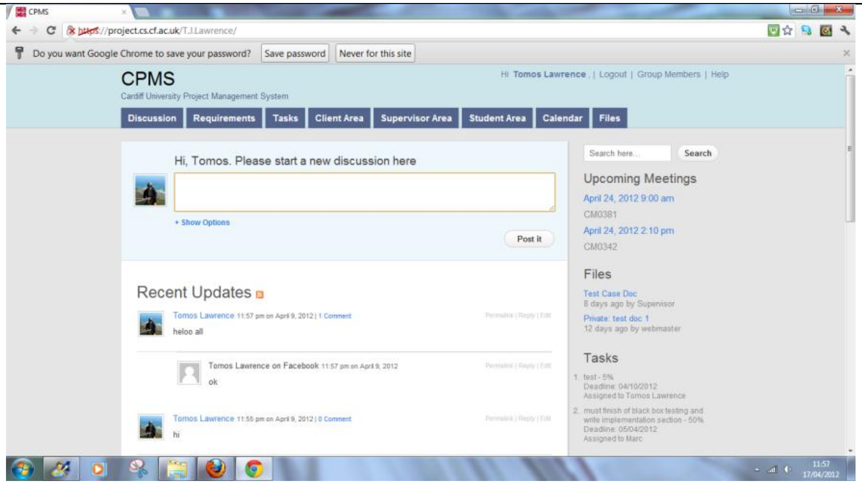
Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
01	To test the functionality of software against non functional requirement 15 section 3.1.2]	Tomos Lawrence	Windows 7 – Mozilla Firefox **Prerequisites**	Check the system works on Microsoft Windows 7 using the browser Firefox	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
		Pass

Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
CPMS
Cardiff University Project Management System
Hi c0809753, Logout I Group Members I Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
Hi, c0809753. Please start a new discussion here
+Show Options
Post It
Recent Updates
search
Upcoming Meetings
April 14, 2012 10:10 am
New Meeting
Recent Comments
Files
Tasks
Cardiff School of Computer Science & Informatics

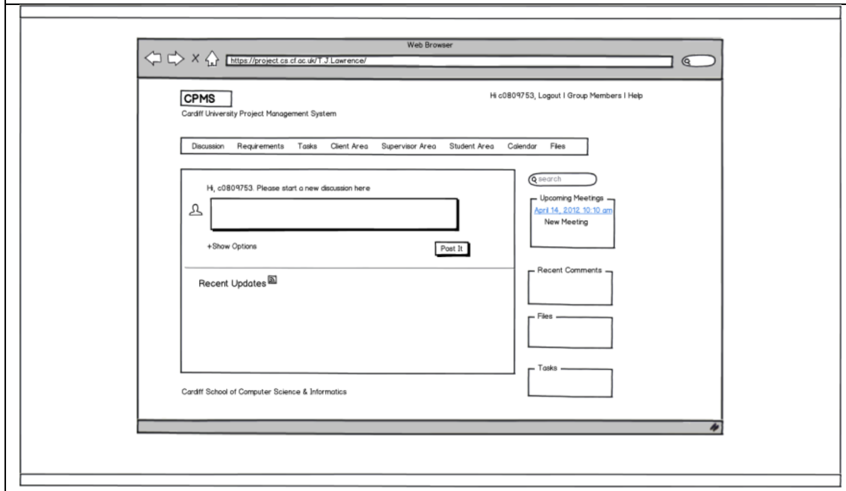
COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
02	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Windows 7 – Google Chrome **Prerequisites**	Check the system works on Microsoft Windows 7 using the browser Google Chrome	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
 Web Browser https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi c0809753, Logout I Group Members I Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, c0809753. Please start a new discussion here +Show Options Post It Recent Updates search Upcoming Meetings April 14, 2012 10:10 am New Meeting Recent Comments Files Tasks Cardiff School of Computer Science & Informatics	Do you want Google Chrome to save your password? Save password Never for this site CPMS https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi Tomos Lawrence , | Logout | Group Members | Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Search here... Search + Show Options Post it Recent Updates Upcoming Meetings Files Tasks Permalink | Reply | Edit 11:57 17/04/2012 Hi, Tomos. Please start a new discussion here Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment heloo all Tomos Lawrence on Facebook 11:57 pm on April 9, 2012 ok Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment hi April 24, 2012 9:00 am CM0381 April 24, 2012 2:10 pm CM0342 Test Case Doc 8 days ago by Supervisor Private: test doc 1 12 days ago by webmaster 1. test - 5% Deadline: 04/10/2012 Assigned to Tomos Lawrence 2. must finish of black box testing and write implementation section - 50% Deadline: 05/04/2012 Assigned to Marc	Pass

COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment		Test Procedure	Test Data
03	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Windows 7 – Internet Explorer		Check the system works on Microsoft Windows 7 using the browser IE	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.
			Prerequisites			

<table>
<tr><th>Expected Result</th><th>Actual Result</th><th>Pass/Fail</th></tr>
<tr>
<td>

Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
CPMS
Cardiff University Project Management System
Hi c0809753, Logout I Group Members I Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
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Hi, c0809753. Please start a new discussion here
+Show Options
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search
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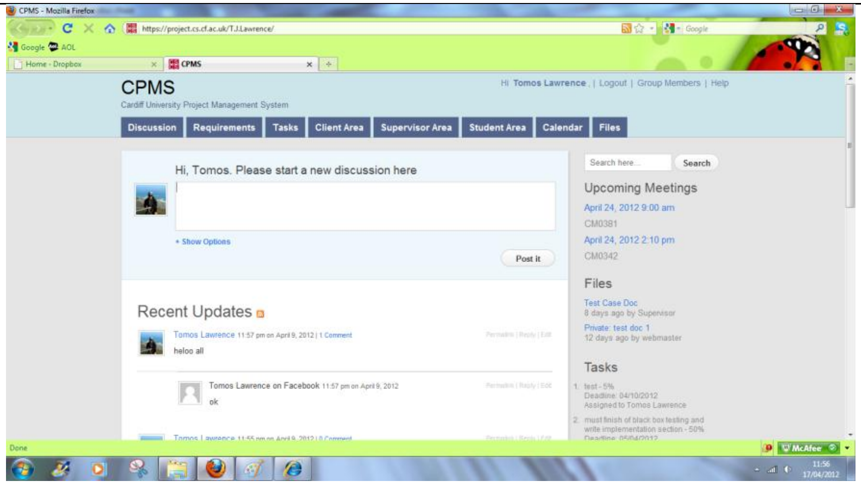
April 14, 2012 10:10 am
New Meeting
Recent Comments
Files
Tasks
Cardiff School of Computer Science & Informatics
</td>
<td>


Hi, Tomos. Please start a new discussion here

Recent Updates

Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment
heloo all

Tomos Lawrence on Facebook 11:57 pm on April 9, 2012
ok

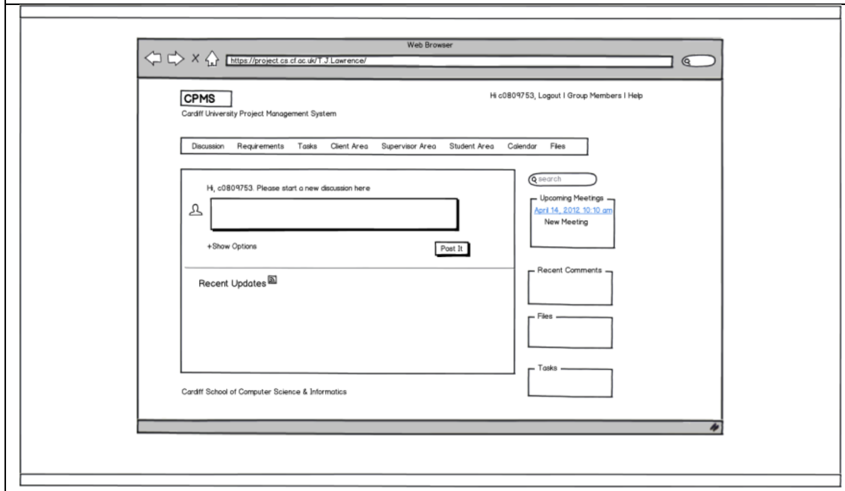
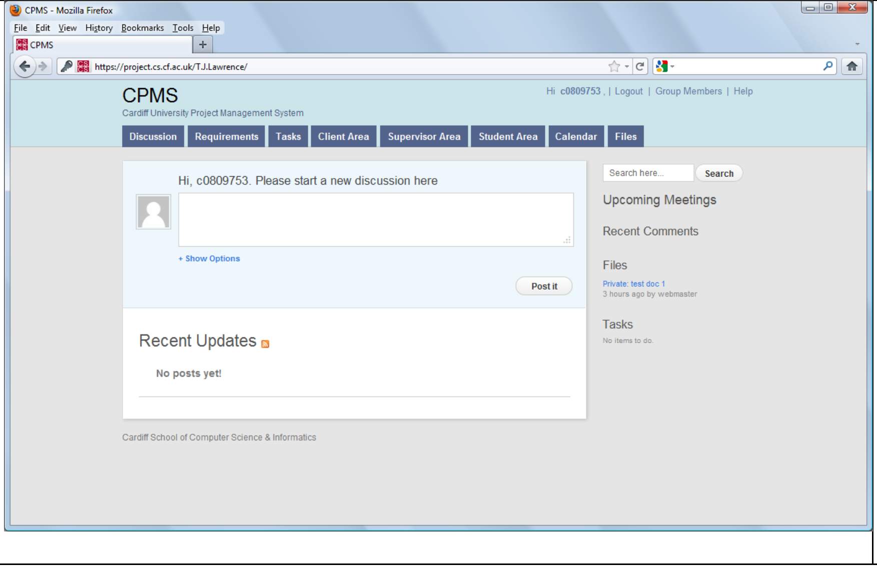
Upcoming Meetings
April 24, 2012 9:00 am
CM0381
April 24, 2012 2:10 pm
CM0342

Files
Test Case Doc
8 days ago by Supervisor
Private: test doc 1
12 days ago by webmaster

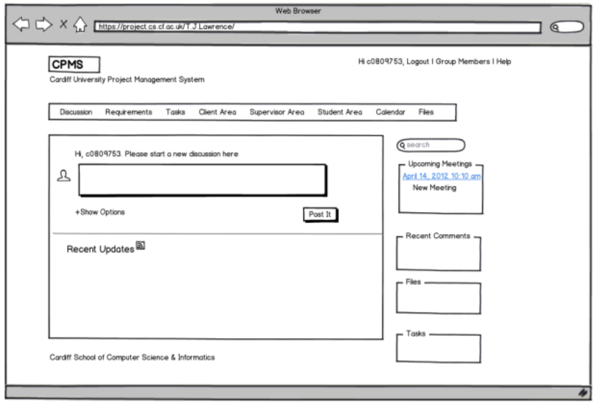
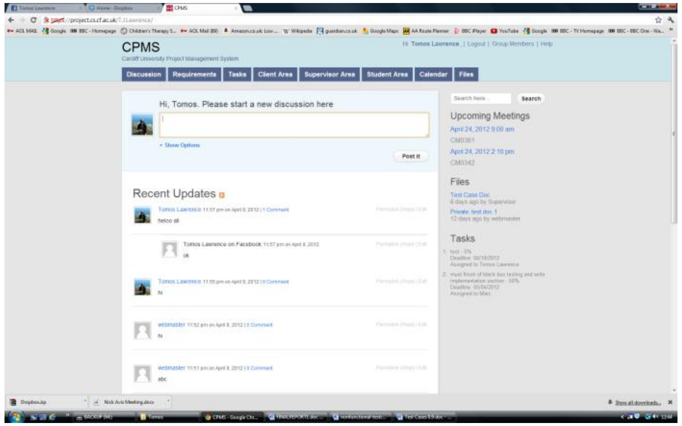
Tasks
1. test - 5%
Deadline: 04/10/2012
Assigned to Tomos Lawrence
2. must finish of black box testing and write implementation section - 50%
</td>
<td>Pass</td>
</tr>
</table>

COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
04	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Windows Vista – Mozilla Firefox **Prerequisites**	Check the system works on Microsoft Windows Vista using the browser Firefox	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

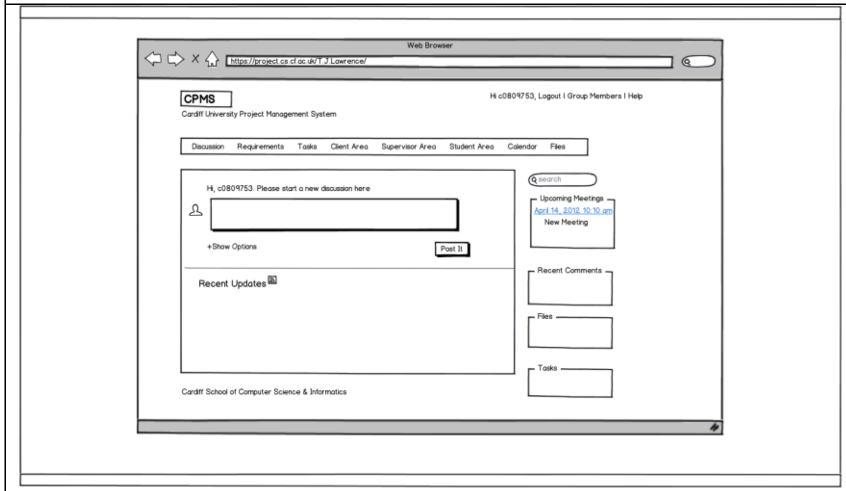
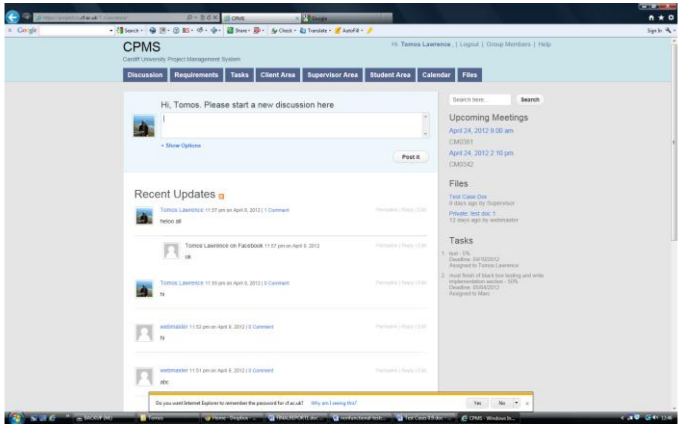
Expected Result	Actual Result	Pass/Fail
 Web Browser https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi c0809753, Logout I Group Members I Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, c0809753. Please start a new discussion here +Show Options Post It Recent Updates search Upcoming Meetings April 14, 2012 10:10 am New Meeting Recent Comments Files Tasks Cardiff School of Computer Science & Informatics	 CPMS - Mozilla Firefox File Edit View History Bookmarks Tools Help CPMS https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi c0809753 , | Logout | Group Members | Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, c0809753. Please start a new discussion here + Show Options Post it Recent Updates No posts yet! Search here... Search Upcoming Meetings Recent Comments Files Private: test doc 1 3 hours ago by webmaster Tasks No items to do. Cardiff School of Computer Science & Informatics	Pass

COMPATABILITY TESTING					
Test Case ID	**Purpose**	**Tester**	**Test Environment**	**Test Procedure**	**Test Data**
05	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Windows Vista – Google Chrome **Prerequisites**	Check the system works on Microsoft Windows Vista using the browser Chrome	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	**Actual Result**	**Pass/Fail**
 Web Browser https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi c0809753, Logout I Group Members I Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, c0809753. Please start a new discussion here +Show Options Post It Recent Updates search Upcoming Meetings April 14, 2012 10:10 am New Meeting Recent Comments Files Tasks Cardiff School of Computer Science & Informatics	 CPMS Cardiff University Project Management System Hi Tomos Lawrence , | Logout | Group Members | Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files + Show Options Post It Search here... Search Hi, Tomos. Please start a new discussion here Recent Updates Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment heloo all Tomos Lawrence on Facebook 11:57 pm on April 9, 2012 ok Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment hi webmaster 11:52 pm on April 9, 2012 | 0 Comment hi webmaster 11:51 pm on April 9, 2012 | 0 Comment abc Upcoming Meetings April 24, 2012 9:00 am CM0381 April 24, 2012 2:10 pm CM0342 Files Test Case Doc 6 days ago by Supervisor Private: test doc 1 12 days ago by webmaster Tasks 1. test - 5% Deadline: 04/18/2012 Assigned to Tomos Lawrence 2. must finish of black box testing and write implementation section - 50% Deadline: 05/04/2012 Assigned to Marc	Pass

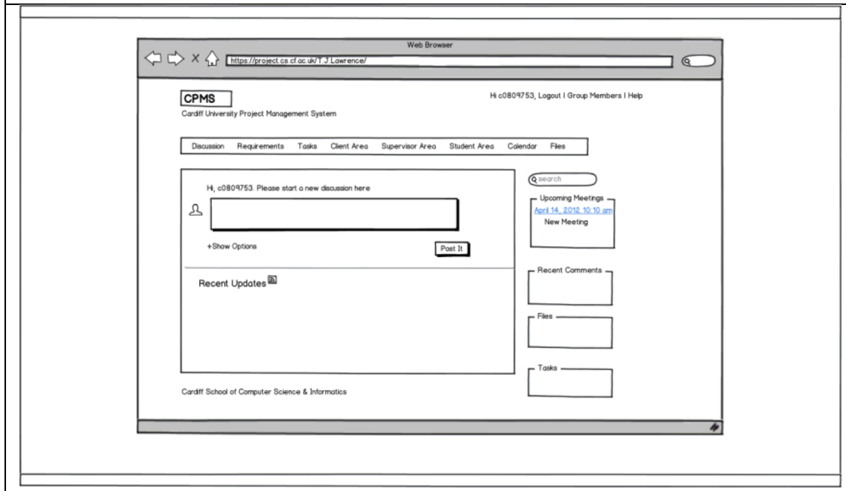
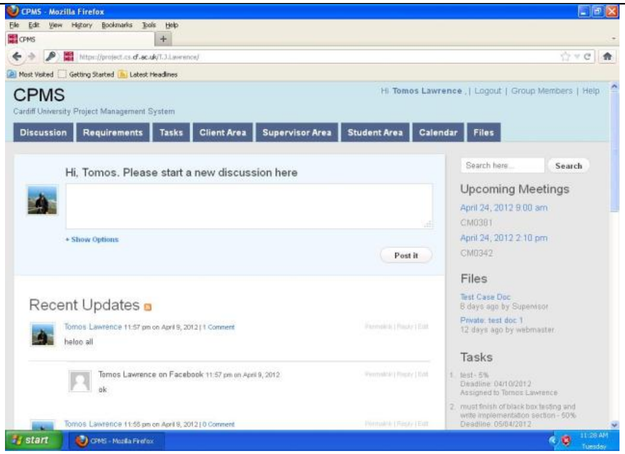
COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
06	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Windows Vista – Internet Explorer **Prerequisites**	Check the system works on Microsoft Windows Vista using the browser IE	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
 Web Browser https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi c0809753, Logout I Group Members I Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, c0809753. Please start a new discussion here +Show Options Post It Recent Updates search Upcoming Meetings April 14, 2012 10:10 am New Meeting Recent Comments Files Tasks Cardiff School of Computer Science & Informatics	 CPMS Cardiff University Project Management System Hi, Tomos Lawrence | Logout | Group Members | Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, Tomos. Please start a new discussion here + Show Options Post it Search Upcoming Meetings April 24, 2012 9:00 am April 24, 2012 2:10 pm Files Tasks Recent Updates	Pass

COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment		Test Procedure	Test Data
07	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Windows XP – Mozilla Firefox		Check the system works on Microsoft Windows XP using Firefox	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.
			Prerequisites			

Expected Result	Actual Result	Pass/Fail
		Pass

Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
CPMS
Cardiff University Project Management System
Hi c0809753, Logout I Group Members I Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
search
Hi, c0809753. Please start a new discussion here
+Show Options
Post It
Recent Updates
Upcoming Meetings
April 14, 2012 10:10 am
New Meeting
Recent Comments
Files
Tasks
Cardiff School of Computer Science & Informatics

Hi, Tomos. Please start a new discussion here

Recent Updates

Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment
heloo all

Tomos Lawrence on Facebook 11:57 pm on April 9, 2012
ok

Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment

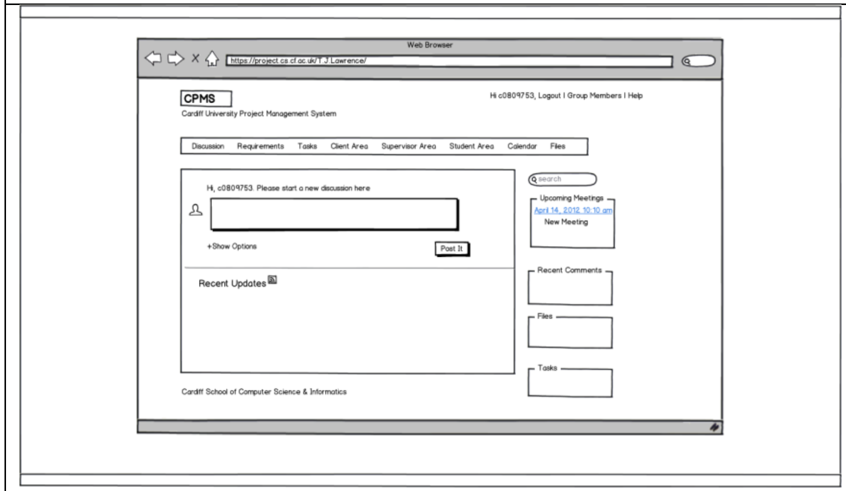
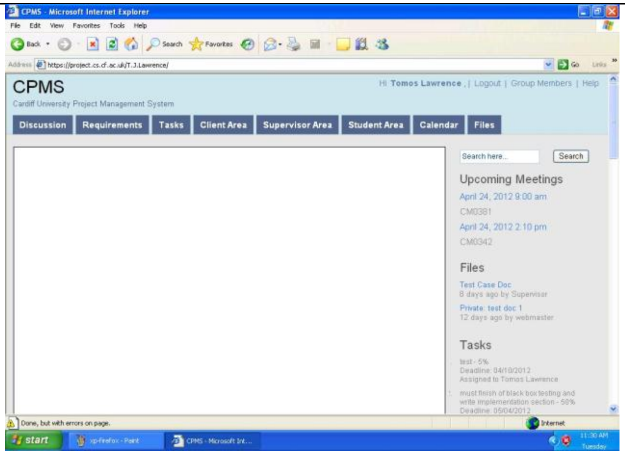
Upcoming Meetings
April 24, 2012 9:00 am
CM0301
April 24, 2012 2:10 pm
CM0342

Files
Test Case Doc
8 days ago by Supervisor
Private: test doc 1
12 days ago by webmaster

Tasks
1. test - 5%
Deadline: 04/10/2012
Assigned to Tomos Lawrence
2. must finish of black box testing and write implementation section - 50%
Deadline: 05/04/2012

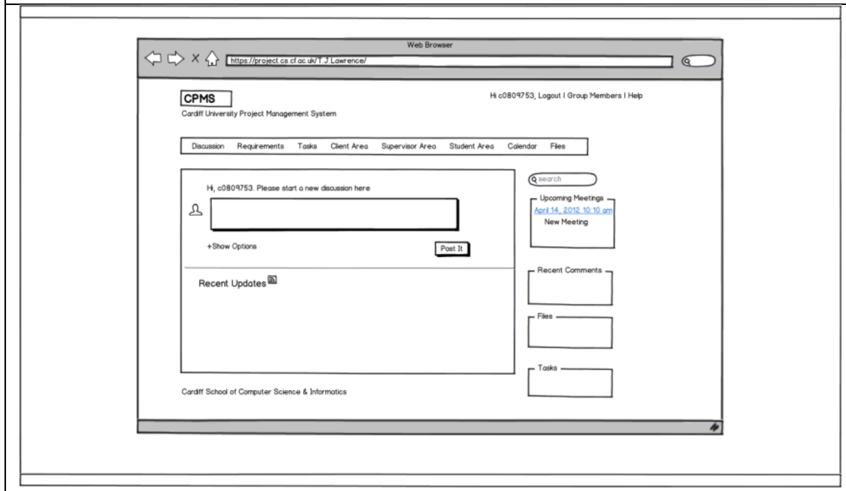
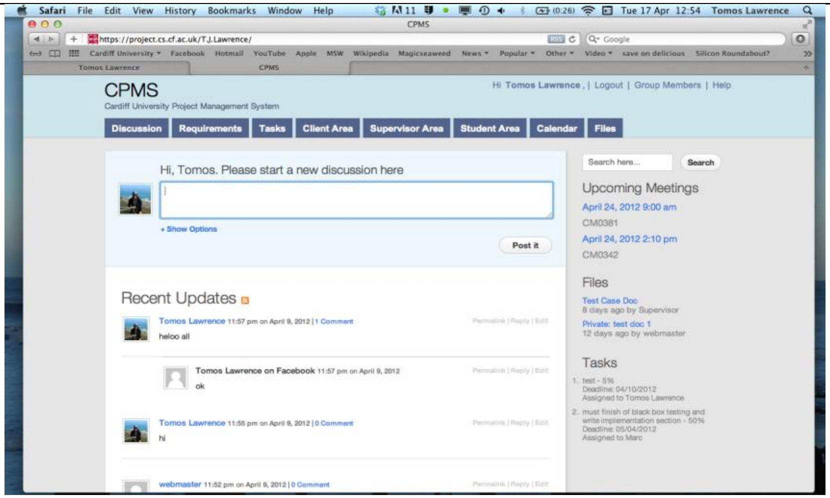
COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
08	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Windows XP – Internet Explorer **Prerequisites**	Check the system works on Microsoft Windows XP using IE	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
 Web Browser https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi c0809753, Logout I Group Members I Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, c0809753. Please start a new discussion here +Show Options Post It Recent Updates search Upcoming Meetings April 14, 2012 10:10 am New Meeting Recent Comments Files Tasks Cardiff School of Computer Science & Informatics	 CPMS - Microsoft Internet Explorer File Edit View Favorites Tools Help Back Search Favorites Address https://project.cs.cf.ac.uk/T.J.Lawrence/ Go Links CPMS Cardiff University Project Management System Hi Tomos Lawrence , | Logout | Group Members | Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Search here... Search Upcoming Meetings April 24, 2012 9:00 am CM0381 April 24, 2012 2:10 pm CM0342 Files Test Case Doc 8 days ago by Supervisor Private: test doc 1 12 days ago by webmaster Tasks test - 5% Deadline: 04/10/2012 Assigned to Tomos Lawrence must finish of black box testing and write implementation section - 50% Deadline: 05/04/2012 Internet start xp-Firefox - Paint CPMS - Microsoft Int... 11:30 AM Tuesday Done, but with errors on page.	Fail

COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
09	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Mac OS X 10.6/10.5 Lion/Snow Leopard - Safari **Prerequisites**	Check the system works on Mac OS X 10.6/10.5 Lion/Snow Leopard using Safari	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
		Pass
COMPATABILITY TESTING		

Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
CPMS
Cardiff University Project Management System
Hi c0809753, Logout I Group Members I Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
Hi, c0809753. Please start a new discussion here
+Show Options
Post It
Recent Updates
search
Upcoming Meetings
April 14, 2012 10:10 am
New Meeting
Recent Comments
Files
Tasks
Cardiff School of Computer Science & Informatics

Safari File Edit View History Bookmarks Window Help
Tue 17 Apr 12:54 Tomos Lawrence
CPMS
https://project.cs.cf.ac.uk/T.J.Lawrence/
Google
Cardiff University Facebook Hotmail YouTube Apple MSW Wikipedia Magicseaweed News Popular Other Video save on delicious Silicon Roundabout?
Tomos Lawrence
CPMS
CPMS
Cardiff University Project Management System
Hi Tomos Lawrence , | Logout | Group Members | Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
Hi, Tomos. Please start a new discussion here
+ Show Options
Post it
Search here...
Search
Upcoming Meetings
Recent Updates
Files
Tasks
Permalink | Reply | Edit

Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment
heloo all

Tomos Lawrence on Facebook 11:57 pm on April 9, 2012
ok

Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment
hi

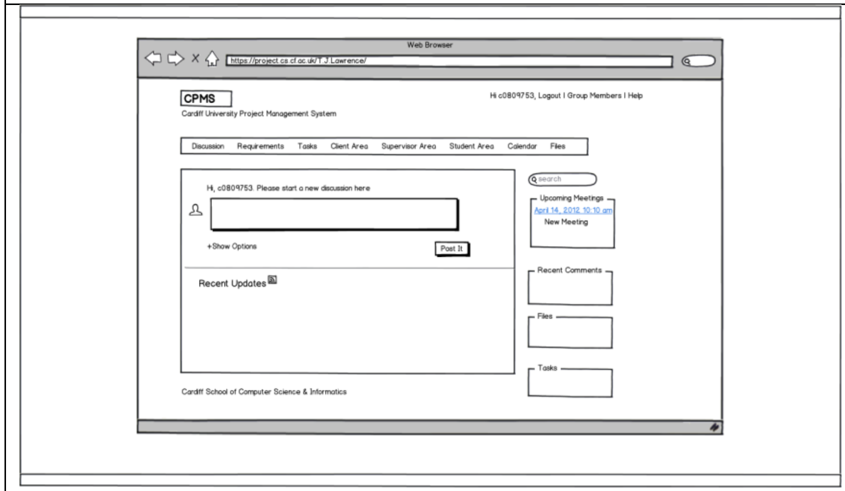
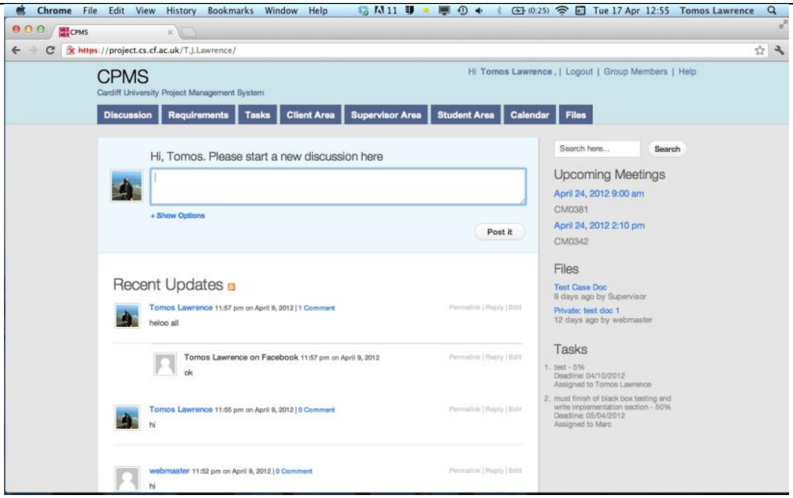
webmaster 11:52 pm on April 9, 2012 | 0 Comment

April 24, 2012 9:00 am
CM0381
April 24, 2012 2:10 pm
CM0342

Test Case Doc
8 days ago by Supervisor
Private: test doc 1
12 days ago by webmaster

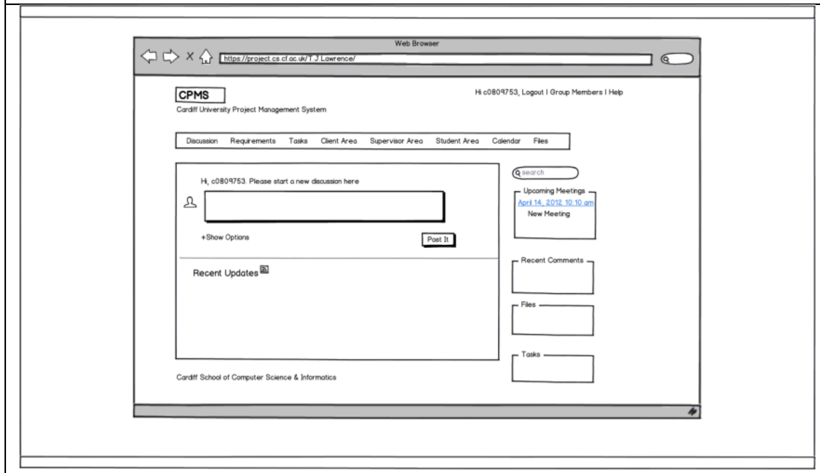
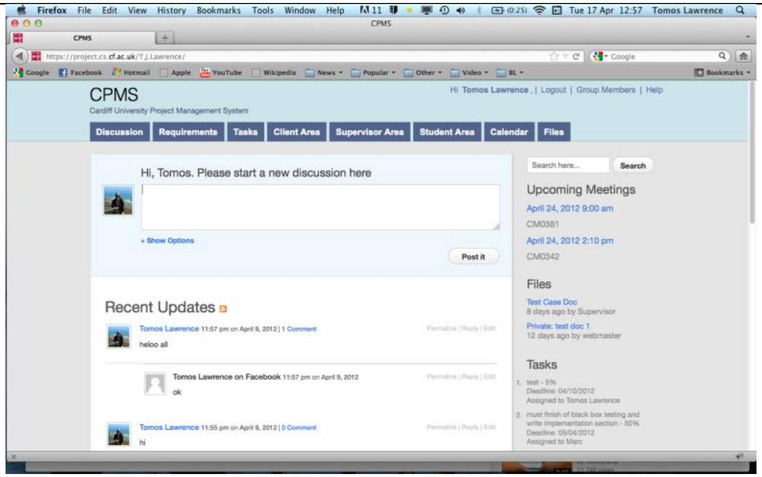
1. test - 5%
Deadline: 04/10/2012
Assigned to Tomos Lawrence
2. must finish of black box testing and write implementation section - 50%
Deadline: 05/04/2012
Assigned to Marc

Test Case ID	Purpose	Tester	Test Environment		Test Procedure	Test Data
10	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Mac OS X 10.6/10.5 Lion/Snow Leopard – Google Chrome		Check the system works on Mac OS X 10.6/10.5 Lion/Snow Leopard using Google Chrome	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.
			Prerequisites			

Expected Result	Actual Result	Pass/Fail
 Web Browser https://project.cs.cf.ac.uk/T.J.Lawrence/ CPMS Cardiff University Project Management System Hi c0809753, Logout I Group Members I Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files Hi, c0809753. Please start a new discussion here +Show Options Post It Recent Updates search Upcoming Meetings April 14, 2012 10:10 am New Meeting Recent Comments Files Tasks Cardiff School of Computer Science & Informatics	 Chrome File Edit View History Bookmarks Window Help (0:25) Tue 17 Apr 12:55 Tomos Lawrence CPMS https://project.cs.cf.ac.uk/T.J.Lawrence/ Hi Tomos Lawrence , | Logout | Group Members | Help Discussion Requirements Tasks Client Area Supervisor Area Student Area Calendar Files + Show Options Post it Search here... Search Permalink | Reply | Edit CPMS Cardiff University Project Management System Hi, Tomos. Please start a new discussion here Recent Updates Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment heloo all Tomos Lawrence on Facebook 11:57 pm on April 9, 2012 ok Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment hi webmaster 11:52 pm on April 9, 2012 | 0 Comment hi Upcoming Meetings April 24, 2012 9:00 am CM0381 April 24, 2012 2:10 pm CM0342 Files Test Case Doc 8 days ago by Supervisor Private: test doc 1 12 days ago by webmaster Tasks 1. test - 5% Deadline: 04/10/2012 Assigned to Tomos Lawrence 2. must finish of black box testing and write implementation section - 50% Deadline: 05/04/2012 Assigned to Marc	Pass

COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
11	To test the functionality of software against non functional requirement 15 [Section 3.1.2]	Tomos Lawrence	Mac OS X 10.6/10.5 Lion/Snow Leopard – Mozilla Firefox **Prerequisites**	Check the system works on Mac OS X 10.6/10.5 Lion/Snow Leopard using Mozilla Firefox	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
		Pass

Hi, c0809753. Please start a new discussion here

Hi, Tomos. Please start a new discussion here

Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment

heloo all

Tomos Lawrence on Facebook 11:57 pm on April 9, 2012

ok

Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment

hi

April 24, 2012 9:00 am

CM0381

April 24, 2012 2:10 pm

CM0342

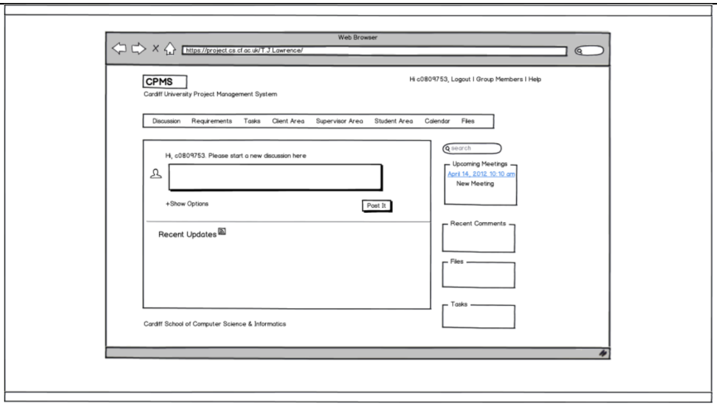
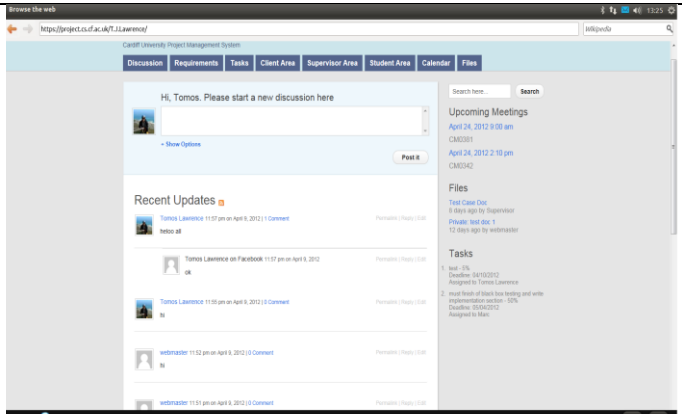
Test Case Doc
8 days ago by Supervisor

Private: test doc 1
12 days ago by webmaster

1. test - 5%
Deadline: 04/10/2012
Assigned to Tomos Lawrence
2. must finish of black box testing and write implementation section - 50%
Deadline: 05/04/2012
Assigned to Marc

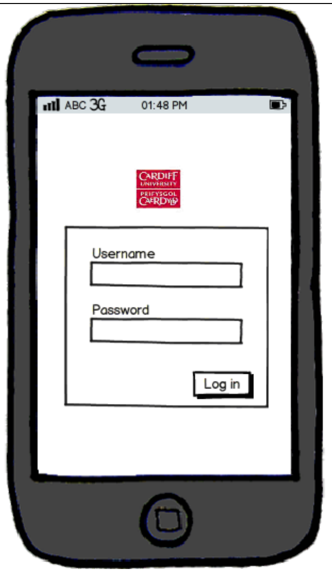
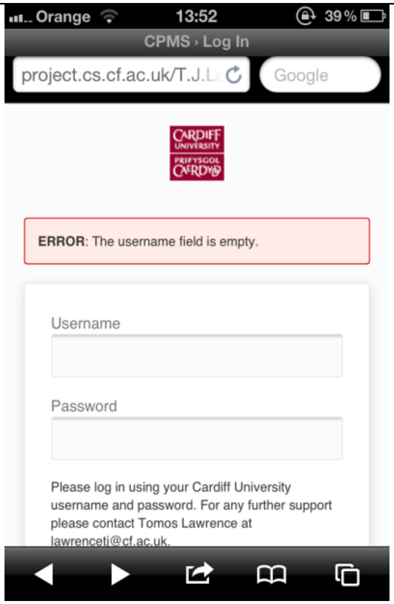
COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
12	To test the functionality of software against non functional requirement 15.3 [Section 3.1.2]	Tomos Lawrence	Ubuntu 11.10– Mozilla Firefox **Prerequisites**	Check the system works on Ubuntu using Mozilla Firefox	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

<table>
<tr><th>Expected Result</th><th>Actual Result</th><th>Pass/Fail</th></tr>
<tr><td>

Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
CPMS
Cardiff University Project Management System
Hi c0809753, Logout I Group Members I Help
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
Hi, c0809753. Please start a new discussion here
+Show Options
Post It
Recent Updates
search
Upcoming Meetings
April 14, 2012 10:10 am
New Meeting
Recent Comments
Files
Tasks
Cardiff School of Computer Science &amp; Informatics
</td><td>

Browse the web
13:25
https://project.cs.cf.ac.uk/T.J.Lawrence/
Wikipedia
Cardiff University Project Management System
Discussion
Requirements
Tasks
Client Area
Supervisor Area
Student Area
Calendar
Files
Hi, Tomos. Please start a new discussion here
+ Show Options
Post it
Recent Updates
Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment
heloo all
Tomos Lawrence on Facebook 11:57 pm on April 9, 2012
ok
Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment
hi
webmaster 11:52 pm on April 9, 2012 | 0 Comment
hi
webmaster 11:51 pm on April 9, 2012 | 0 Comment
Permalink | Reply | Edit
Search here...
Search
Upcoming Meetings
April 24, 2012 9:00 am
CM0381
April 24, 2012 2:10 pm
CM0342
Files
Test Case Doc
8 days ago by Supervisor
Private: test doc 1
12 days ago by webmaster
Tasks
1. test - 5%
Deadline: 04/10/2012
Assigned to Tomos Lawrence
2. must finish of black box testing and write implementation section - 50%
Deadline: 05/04/2012
Assigned to Marc
</td><td>Pass</td></tr>
<tr><td colspan="3"></td></tr>
</table>

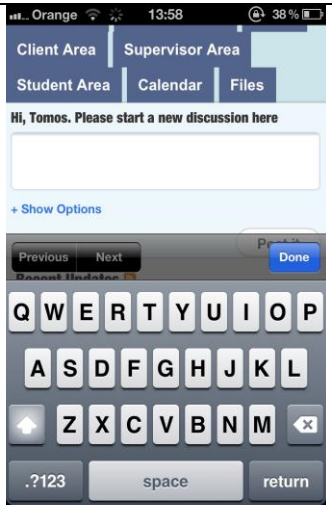
COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
13	To test the functionality of software against non functional requirement 15.4 [Section 3.1.2]	Tomos Lawrence	iOS 5 – Safari **Prerequisites**	Check the system works on iPhone running iOS using Safari	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
 ABC 3G 01:48 PM CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD Username Password Log in	 CPMS › Log In project.cs.cf.ac.uk/T.J.L **ERROR**: The username field is empty. Username Password Please log in using your Cardiff University username and password. For any further support please contact Tomos Lawrence at lawrenceti@cf.ac.uk.	Pass

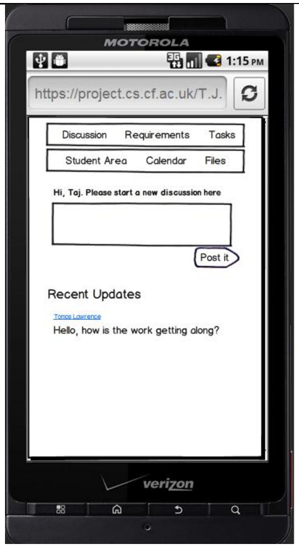
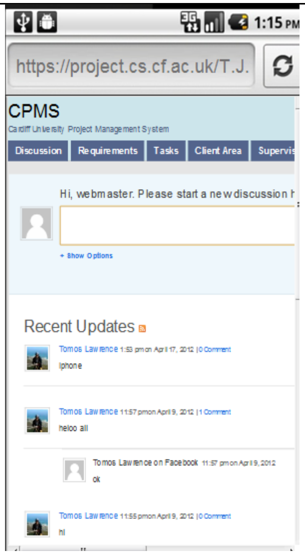
COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
14	To test the functionality of software against non functional requirement 15.4 [Section 3.1.2]	Tomos Lawrence	iOS 5 – Safari **Prerequisites**	Check the system works on iPhone running iOS using Safari	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser. Then click on the new discussion screen.

Expected Result	Actual Result	Pass/Fail
ABC 3G 01:57 PM Discussion Requirements Tasks Student Area Calendar Files Hi, Taj. Please start a new discussion here Q W E R T Y U I O P A S D F G H J K L Z X C V B N M .?123 space @ . return The iOS on-screen keyboard should appear then the discussion box is selected	 Orange 13:58 38 % Client Area Supervisor Area Student Area Calendar Files + Show Options Previous Next Done Q W E R T Y U I O P A S D F G H J K L Z X C V B N M .?123 space return Hi, Tomos. Please start a new discussion here The iOS on-screen keyboard was shown.	Pass

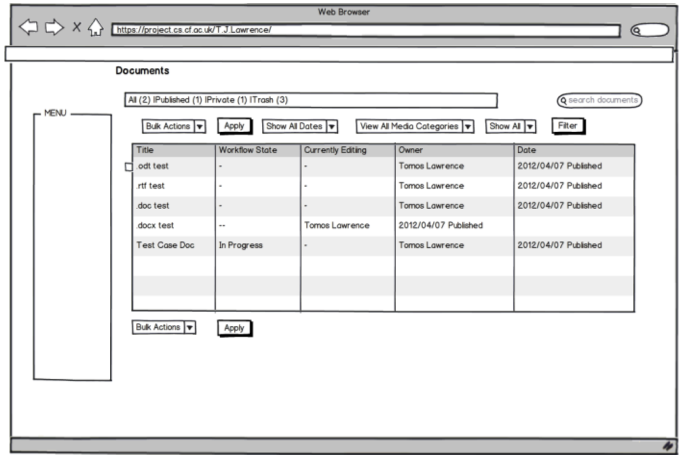
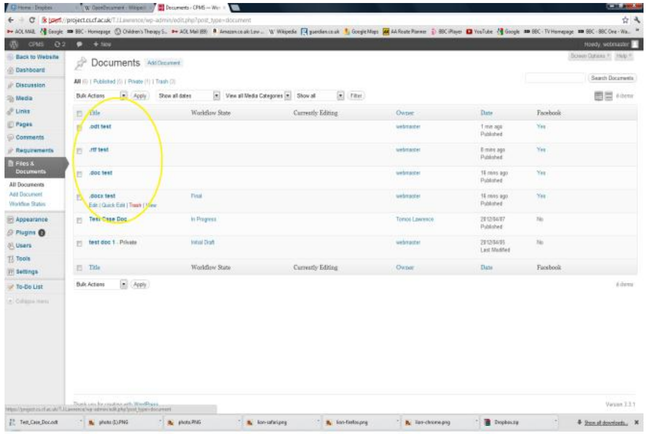
COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure	Test Data
15	To test the functionality of software against non functional requirement 15.4 [Section 3.1.2]	Tomos Lawrence	Android 4 - **Prerequisites**	Check the system works on Android 4 – Default Browser	Input the web address https://project.cs.cf.ac.uk/T.J.Lawrence in a web browser.

Expected Result	Actual Result	Pass/Fail
 MOTOROLA 1:15 PM https://project.cs.cf.ac.uk/T.J. Discussion Requirements Tasks Student Area Calendar Files Post it verizon Hi, Taj. Please start a new discussion here Recent Updates Tomos Lawrence Hello, how is the work getting along?	 1:15 PM https://project.cs.cf.ac.uk/T.J. Discussion Requirements Tasks Client Area Supervis + Show Options CPMS Cardiff University Project Management System Hi, webmaster. Please start a new discussion h Recent Updates Tomos Lawrence 1:53 pm on April 17, 2012 | 0 Comment iphone Tomos Lawrence 11:57 pm on April 9, 2012 | 1 Comment heloo all Tomos Lawrence on Facebook 11:57 pm on April 9, 2012 ok Tomos Lawrence 11:55 pm on April 9, 2012 | 0 Comment hi	Fail

COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Data
16	To test the functionality of software against non functional requirement 15.5 [Section 3.1.2]	Tomos Lawrence	Windows Vista – Google Chrome	Using the account 'c0809753' the user will log in and click the 'files' tab on the navigation bar. When brought to the files page the user will then click 'add document'. Here the user will enter a document title '[.fileformat test]and click 'upload new document'. Finally the user will click update.
			Test Procedure: Check the system will accept and upload .docx, .doc, .rtf and .odt file formats	

Expected Result	Actual Result	Pass/Fail
 All the file formats were accepted and upload and the documents should appear on the document summary page	 The documents all were successfully uploaded and now appear on the document summary page.	Pass

Web Browser

https://project.cs.cf.ac.uk/T.J.Lawrence/

Documents

All (2) lPublished (1) lPrivate (1) lTrash (3)

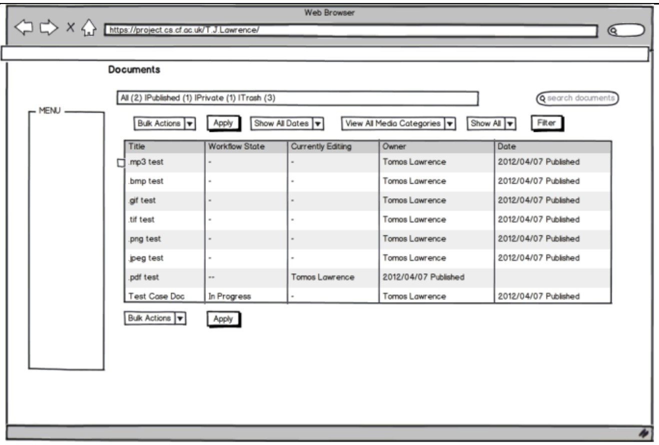
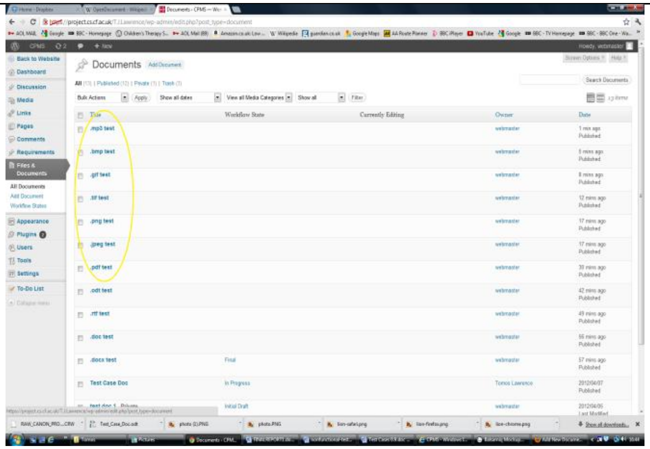
Title	Workflow State	Currently Editing	Owner	Date
.odt test	-	-	Tomos Lawrence	2012/04/07 Published
.rtf test	-	-	Tomos Lawrence	2012/04/07 Published
.doc test	-	-	Tomos Lawrence	2012/04/07 Published
.docx test	--	Tomos Lawrence	2012/04/07 Published	
Test Case Doc	In Progress	-	Tomos Lawrence	2012/04/07 Published

Documents

Title	Workflow State	Currently Editing	Owner	Date	Facebook
.odt test			webmaster	1 min ago Published	Yes
.rtf test			webmaster	8 mins ago Published	Yes
.doc test			webmaster	16 mins ago Published	Yes
.docx test Edit | Quick Edit | Trash | View	Final		webmaster	16 mins ago Published	Yes
Test Case Doc	In Progress		Tomos Lawrence	2012/04/07 Published	No
test doc 1 - Private	Initial Draft		webmaster	2012/04/05 Last Modified	No

COMPATABILITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Data
17	To test the functionality of software against non functional requirement 15.6 [Section 3.1.2]	Tomos Lawrence	Windows Vista – Google Chrome	Using the account ‘c0809753’ the user will log in and click the ‘files’ tab on the navigation bar. When brought to the files page the user will then click ‘add document’. Here the user will enter a document title ‘‘[.fileformat test]’ and click ‘upload new document’. Finally the user will click update.
			Test Procedure: Check the system will accept and upload . PDF, JPEG, PNG, TIF, GIF, BMP, MP3 file formats	

Expected Result	Actual Result	Pass/Fail
 All the file formats were accepted and upload and the documents should appear on the document summary page.	 The documents all were successfully uploaded and now appear on the document summary page.	Pass

Web Browser
https://project.cs.cf.ac.uk/T.J.Lawrence/
Documents
MENU
All (2) lPublished (1) lPrivate (1) lTrash (3)
search documents
Bulk Actions
Apply
Show All Dates
View All Media Categories
Show All
Filter

Title	Workflow State	Currently Editing	Owner	Date
.mp3 test	-	-	Tomos Lawrence	2012/04/07 Published
.bmp test	-	-	Tomos Lawrence	2012/04/07 Published
.gif test	-	-	Tomos Lawrence	2012/04/07 Published
.tif test	-	-	Tomos Lawrence	2012/04/07 Published
.png test	-	-	Tomos Lawrence	2012/04/07 Published
.jpeg test	-	-	Tomos Lawrence	2012/04/07 Published
.pdf test	--	Tomos Lawrence	2012/04/07 Published	
Test Case Doc	In Progress	-	Tomos Lawrence	2012/04/07 Published

Title	Workflow State	Currently Editing	Owner	Date
.mp3 test			webmaster	1 min ago Published
.bmp test			webmaster	5 mins ago Published
.gif test			webmaster	8 mins ago Published
.tif test			webmaster	12 mins ago Published
.png test			webmaster	17 mins ago Published
.jpeg test			webmaster	17 mins ago Published
.pdf test			webmaster	33 mins ago Published
.odt test			webmaster	42 mins ago Published
.rtf test			webmaster	49 mins ago Published
.doc test			webmaster	55 mins ago Published
.docx test	Final		webmaster	57 mins ago Published
Test Case Doc	In Progress		Tomos Lawrence	2012/04/07 Published
test doc 1 - Private	Initial Draft		webmaster	2012/04/05 Last Modified

Appendix F – Security Test Cases

SECURITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure
01	An online WordPress Security Scan to gain an understanding of the server, hosting and security of the site.	Tomos Lawrence	Using the security tool available at http://hackertarget.com/wordpress-security-scan/	I entered the URI https://project.cs.cf.ac.uk/T.J.Lawrence/ into the form

Test Data	Pass/Fail
I entered the URI https://project.cs.cf.ac.uk/T.J.Lawrence/ into the form	Pass

Expected Result	Actual Result
No installation of Wordpress should be found due to the project server requesting authentication protected by 256 bit encryption	No installation found - 401 Authorisation Required
Google Safebrowsing – Safe	Google Safebrowsing – Safe
Mywot trustworthiness – Excellent	Rates 92 (Excellent)

SECURITY TESTING

Test Case ID	Purpose	Tester	Test Environment	Test Procedure
02	To check for port vulnerabilities	Tomos Lawrence	Using the security tool available at NMap 5.51	I entered the URI https://project.cs.cf.ac.uk/T.J.Lawrence/ into the form

Test Data	Pass/Fail
I entered the URI https://project.cs.cf.ac.uk/T.J.Lawrence/ into the form	Pass

Expected Result	Actual Result
No open ports	No open ports or security vulnerabilities

Appendix G – Heuristic Evaluation

Heuristics Used:

1. **Visibility of system status**

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

2. **Match between system and the real world**

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

3. **User control and freedom**

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

4. **Consistency and standards**

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

5. **Error prevention**

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

6. **Recognition rather than recall**

Minimise the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

7. **Flexibility and efficiency of use**

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

8. **Aesthetic and minimalist design**

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

9. **Help users recognise, diagnose, and recover from errors**

   Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

10. **Help and documentation**

    Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

All the above heuristics are definitions are taken exactly from Jakob Nielsens book Usability Inspection Methods (Nielsen 1994).

Bos et al (2005) Added Heuristics:

11. **Follow web application conventions.**

    Avoid the use of double clicks. Use roll-overs to display additional data in order to reduce screen clutter, but never hide primary controls or content. Use standard web controls (i.e., radio buttons, check-boxes, etc.) and flows (e.g., the deletion of elements from a list). When using text as a hyper-link, underline it.

12. **Browser controls and navigation.**

    The use of the browser’s controls (e.g., the back button) or (accidentally) closing the browser should not result in data loss (save changes when appropriate). Make a clear distinction between the browsers and the web applications menus and controls. If the browser is not opened full-screen, the browser’s controls should not cause errors or confusion.

13. **Allow easy data entry that minimises the chance of errors.**

    Various types of input should be recognised [...]. Provide easy means for the entry of restricted data (e.g., a calendar view for the input of dates, a colour picker for the selection of colours, etc.).

Heuristic Evaluation:

Number	Heuristic	Summary
1	Visibility of system status	Several features intend to keep the users informed about what is going on. The horizontal navigation bar not only allows users to select pages, but indicates the page they are currently browsing. The selected page is highlighted in yellow (as opposed to blue) to indicate the page currently in use. The right sidebar keeps users informed with the latest information in regards to upcoming meetings, files and tasks. The system provides little feedback relating to information processing and loading of new pages. The user must rely on their browser's page loading progress bar to determine if a new page is being loaded or not. However some feedback of information processing is integrated within the calendar facility and the submission facility. However the system does not allow the user to keep track of their location in terms of where they have navigated from the starting point. Breadcrumbs could be implemented to overcome this.
2	Match between system and the real world	The system is targeted at specifically 2nd year computer science and information systems students; therefore a certain level of complexity is acceptable. The system makes use of user's language as there is no system jargon or project management jargon that students may find difficult to understand. For example instead of using system language such as 'create a new post here' the system says 'start a new discussion here'. It is difficult to compare the system to real world conventions, as no explicit conventions exist. However it can be said that students would organise information into sections and by date order. The system has several clearly defined sections and information is organised in chronological manner.
3	User control and freedom	As this system is web-based system the layout is relatively

		fixed and rigid. On each page a header, footer, right sidebar and main body make up the core structure. Accessibility and display issues arise when low screen resolutions are being used. For example at 800x600 the sidebar, footer and are lost and the main body is not useable. The system does allow make use of 'emergency exits'. For example users can cancel changes to requirements, calendar entries or files with clearly marked buttons.
4	Consistency and standards	The systems consistency is maintained throughout. The header and navigation bar, footer and sidebar remain the same throughout the site. The only changes are made in the content of the body. The uses a consistent colour scheme and makes use of the same fonts throughout the site. With an exception of the 'files page', 'requirements edit page' and the 'profile page' which brings users to the Wordpress backend, which is not consistent with the front-end pages. To overcome this the default Wordpress backend menu has been modified to provide consistent terminology throughout the site.
5	Error prevention	The system appears to be designed to prevent problems occurring. Usability testing returned no obvious errors therefore the system is well designed. If a user does not enter valid login in details appropriate error messages are displayed advising the using on available actions. The layout and design have been carefully constructed to avoid users making accidental errors due to poor design.
6	Recognition rather than recall	The system has a number of useful features. By having the right sidebar present on each page the user can use it as a reference instead of navigating to the specific for example files page. This can be useful for quick references or whilst referring to a for example upcoming meeting on the discussion page. The help page is accessible from all pages in the header, this can provide users with assistance where required.
7	Flexibility and efficiency of use	The system does not provide any direct link to any accelerators that can be used to speed up interaction. However if an 'expert' user is familiar with Wordpress they can make use of the 'posts' facility to create discussions

		fast, duplicate discussions etc.
8	Aesthetic and minimalist design	The system intends to be functional and therefore this heuristic has been compromised. For example each page includes the sidebar which essentially a summary of the page it relates to. But an existing link to the page is available within the navigation bar. This information is relevant to the user though however it does create clutter, but each included is element is relevant so the system complies with this heuristic as far as possible.
9	Help users recognise, diagnose, and recover from errors	Any error messages are provided in a clear format that make sense to the user and does not return php error codes etc. Very few errors can occur anyway.
10	Help and documentation	An online user manual can be found in the help section along with a FAQ page. Any additional help is included alongside elements of the website that may not seem straightforward.
11	Follow web application conventions.	The primary controls remain visible on all sections of the website. Double clicks are not use anywhere on the site, instead single clicks are required for navigation. The system makes good use of radio buttons, check boxes and flow where appropriate. Although most hyperlinks can be clearly identified as a hyperlink, most do not make use of underlining for aesthetic purposes.
12	Browser controls and navigation.	The system does not cause any confusion with the browser's controls, as the navigation system is entirely separate. The system does not cause data loss if the user accidentally navigates off a page with the browser's controls. For example if a user navigates back or forward whilst composing a discussion the data will not be lost, additionally if the user is editing a file and navigates of the page an 'auto save' of the file occurs. However if a user closes a browser accidentally data will more that likely is lost as it might end their session for security reasons are require authentication again.
13	Allow easy data entry that minimises the chance of errors.	The system implements this in almost all areas. For example discussion data entry is limited to the discussion box, any editing of requirements is limited to a onscreen editing facility with limited options, upcoming meetings are limited to entry via the calendar facility, tasks are limited to the task entry forms and submissions are limited to the submission facility. All these features restrict the entry of data to ensure data entered is consistent, valid and contains all necessary elements.

Prioritisation of Problems

To evaluate the findings from the Heuristic Evaluation, we have used a dual rating for each problem found which was used to identify specific problems areas and make recommendations. The tables below define severity and ease of fix ratings used.

Severity Rankings

Rating	Definition
0	Violates a heuristic but doesn't seem to be a usability problem at all
1	Cosmetic problem only: need not be fixed unless extra time is available on project
2	Minor usability problem: fixing this should be given low priority
3	Major usability problem: important to fix, so should be given high priority
4	Usability catastrophe: imperative to fix this before product can be released

(Nielsen 1994)

Ease of Fix Rankings

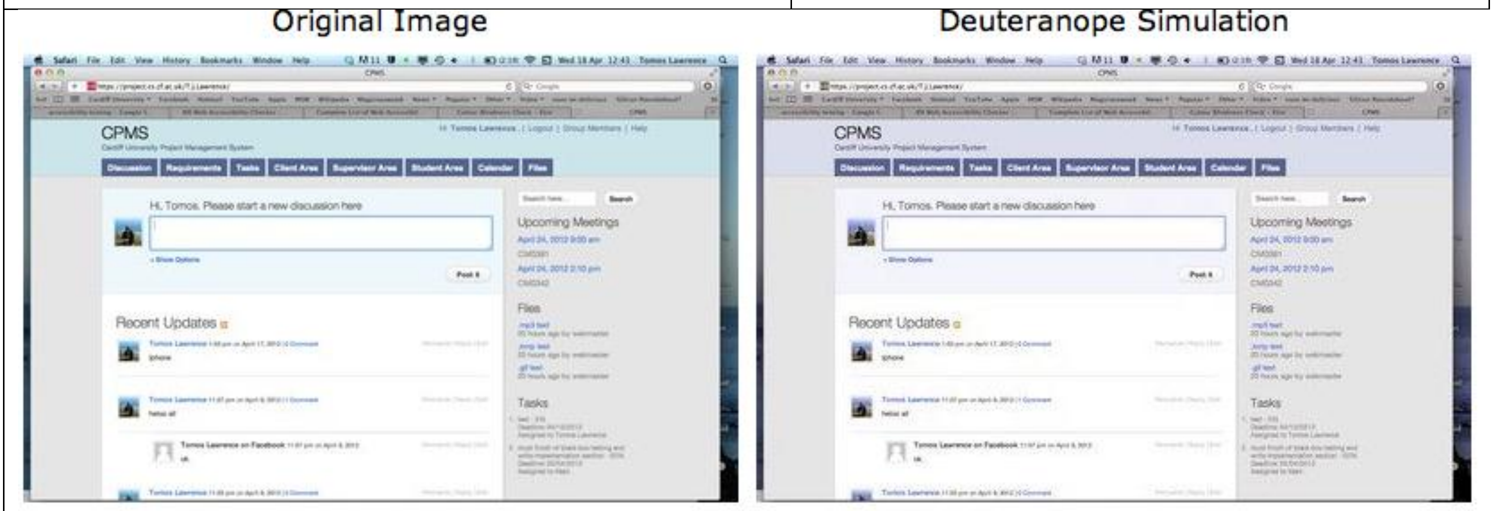
Rating	Definition
0	Problem would be extremely easy to fix. Could be completed by one of the team members before the next release
1	Problem would be easy to fix. Involves specific interface elements and solution is clear
2	Problem would require some effort to fix. Involves multiple aspects of the interface or would require a team of developers to implement changes before next release or solution is not clear
3	Usability problem would be difficult to fix. Requires concentrated developed effort to finish before next release, involves multiple aspects of the interface. Solution may not be immediately obvious or may be disputed.

(Tennant et al 2005)

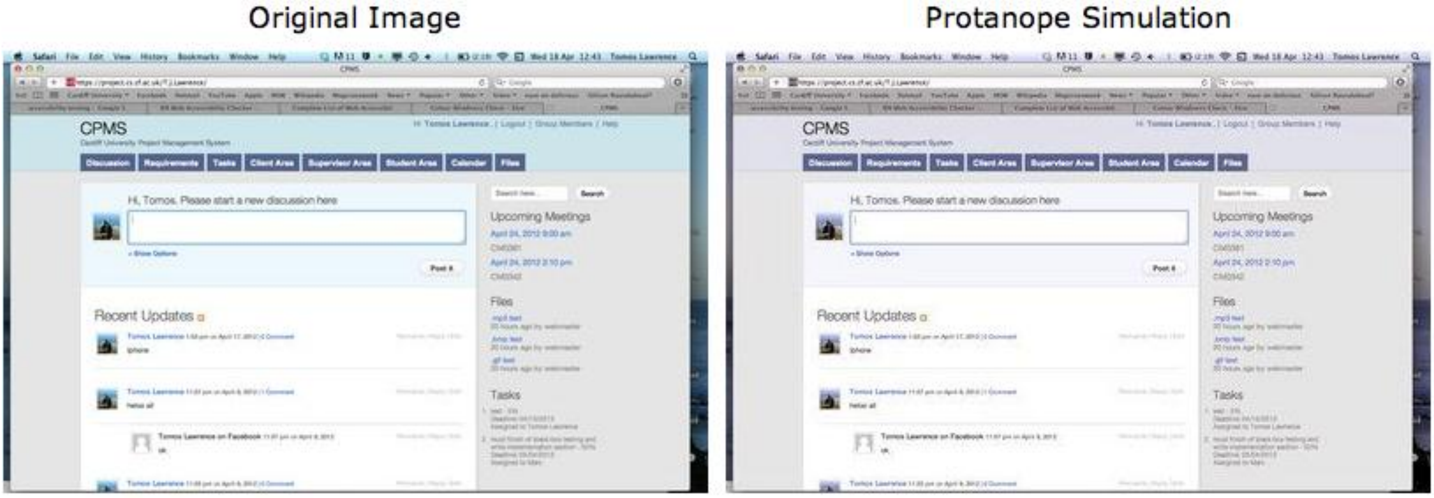
Appendix H – Accessibility Test Cases

ACCESSIBILITY TESTING			
Test Case ID	**Purpose**	**Tester**	**Test Environment**
01	To test the functionality of software against non-functional requirement 16.1 [Section 3.1.2]	Tomos Lawrence	Web Browser – Mozilla Firefox – Windows 7
Test Procedure	**Test Data**	**Pass/Fail**	
To check the system must make use of a suitable colours and font use to ensure people with visual impairments have the same experience. This test case will check for **Deuteranope**	Run the colour blindness check at Vischeck.com	Pass	

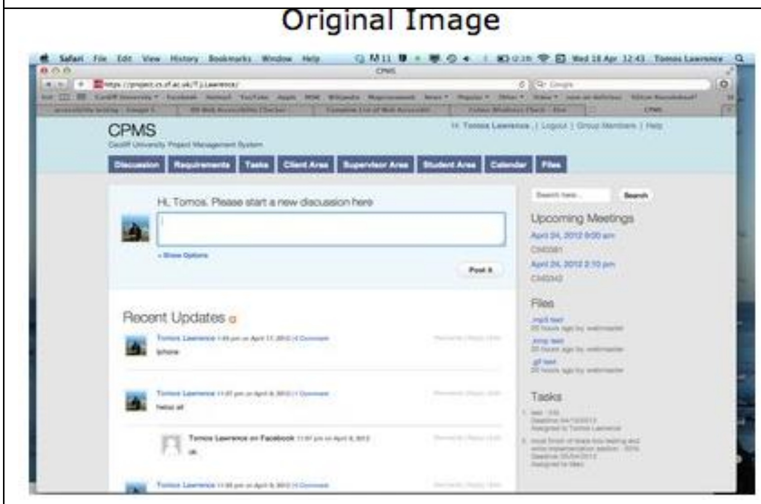
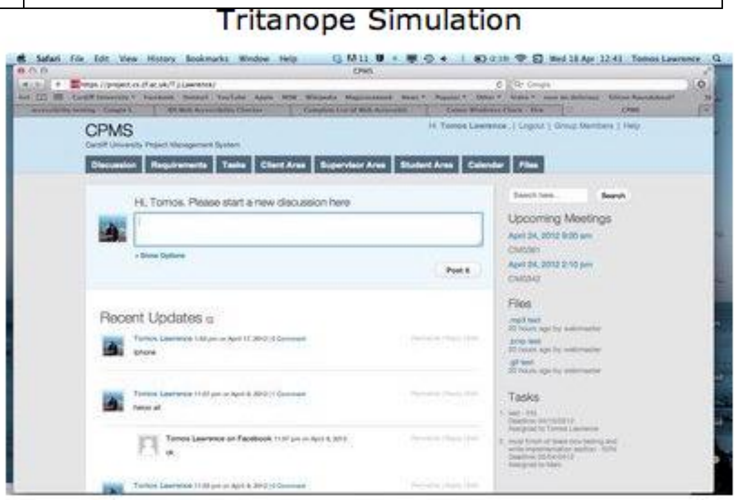
Expected Result	**Actual Result**



Test Case ID	**Purpose**	**Tester**	**Test Environment**
02	To test the functionality of software against non-functional requirement 16.1 [Section 3.1.2]	Tomos Lawrence	Web Browser – Mozilla Firefox – Windows 7
Test Procedure	**Test Data**	**Pass/Fail**	
To check the system must make use of a suitable colours and font use to ensure people with visual impairments have the same experience. This test case will check for **Protanope**	Run the colour blindness check at Vischeck.com	Pass	

Expected Result	**Actual Result**
	

Test Case ID	**Purpose**	**Tester**	**Test Environment**
03	To test the functionality of software against non-functional requirement 16.1 [Section 3.1.2]	Tomos Lawrence	Web Browser – Mozilla Firefox – Windows 7
Test Procedure	**Test Data**	**Pass/Fail**	
To check the system must make use of a suitable colours and font use to ensure people with visual impairments have the same experience. This test case will check for **Tritanope**	Run the colour blindness check at Vischeck.com	Pass	

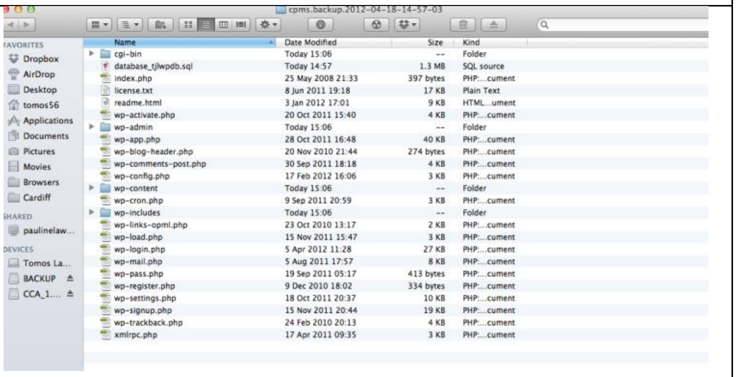
Expected Result	**Actual Result**
	

Test Case ID	Purpose	Tester	Test Environment
04	To test the functionality of software against non-functional requirement 16.2 [Section 3.1.2]	Tomos Lawrence	Web Browser – Mozilla Firefox – Windows 7
Test Procedure	**Test Data**	**Pass/Fail**	
To check the system must make use of a suitable colours and font use to ensure people with visual impairments have the same experience. This test case will check to see if the website meetings the **WCAG 2.0 (Level AA) guidelines.**	Paste the source code of https://project.cs.cf.ac.uk/T.J.Lawrence/ into the web accessibility checker at http://achecker.ca/checker/index.php	Fail	

Expected Result	Actual Result
I do not expect the website to meet all the WCAG 20 guidelines as even Cardiff.ac.uk main pages only partially conform to the W3C's WAI Web Content Accessibility Guidelines at Level AA for example www.cardiff.ac.uk has 7 known accessibility problems	The index page of https://project.cs.cf.ac.uk/T.J.Lawrence/ has 24 known accessibility problems.

Appendix I – Maintenance & Recovery Test Case

MAINTENANCE & RECOVERY TESTING			
Test Case ID	**Purpose**	**Tester**	**Test Environment**
01	To test the functionality of software against non-functional requirement 17.1 [Section 3.1.2]	Tomos Lawrence	MAC OSX Lion - Finder
Test Procedure	**Test Data**	**Pass/Fail**	
To check the system backups database (user) information and web files daily and compress to a zip archive.	On the server navigate to `/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/backups and download the available zip file to verify its contents`	Pass	

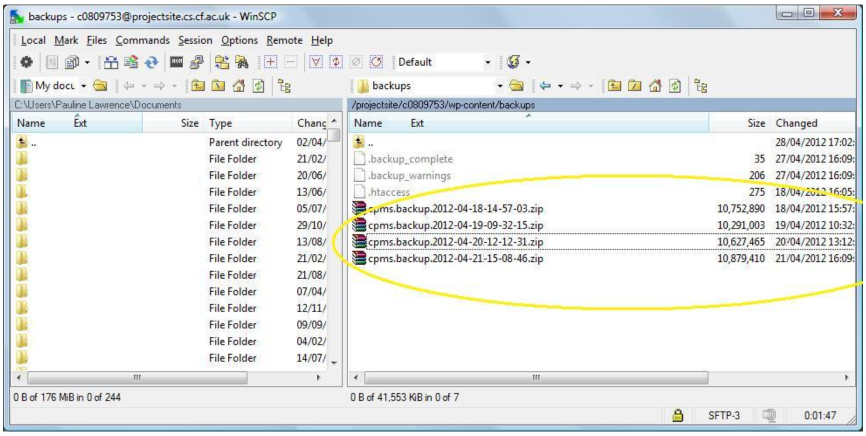
<table>
<tr><th>Expected Result</th><th>Actual Result</th></tr>
<tr><td>The backup should include a mysqldump of the database which includes all the user information and all the web files e.g. wp-content wp-admin etc.</td><td>


cpms.backup.2012-04-18-14-57-03

<table>
<tr><th>Name</th><th>Date Modified</th><th>Size</th><th>Kind</th></tr>
<tr><td>cgi-bin</td><td>Today 15:06</td><td>--</td><td>Folder</td></tr>
<tr><td>database_tjlwpdb.sql</td><td>Today 14:57</td><td>1.3 MB</td><td>SQL source</td></tr>
<tr><td>index.php</td><td>25 May 2008 21:33</td><td>397 bytes</td><td>PHP:...cument</td></tr>
<tr><td>license.txt</td><td>8 Jun 2011 19:18</td><td>17 KB</td><td>Plain Text</td></tr>
<tr><td>readme.html</td><td>3 Jan 2012 17:01</td><td>9 KB</td><td>HTML...ument</td></tr>
<tr><td>wp-activate.php</td><td>20 Oct 2011 15:40</td><td>4 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-admin</td><td>Today 15:06</td><td>--</td><td>Folder</td></tr>
<tr><td>wp-app.php</td><td>28 Oct 2011 16:48</td><td>40 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-blog-header.php</td><td>20 Nov 2010 21:44</td><td>274 bytes</td><td>PHP:...cument</td></tr>
<tr><td>wp-comments-post.php</td><td>30 Sep 2011 18:18</td><td>4 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-config.php</td><td>17 Feb 2012 16:06</td><td>3 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-content</td><td>Today 15:06</td><td>--</td><td>Folder</td></tr>
<tr><td>wp-cron.php</td><td>9 Sep 2011 20:59</td><td>3 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-includes</td><td>Today 15:06</td><td>--</td><td>Folder</td></tr>
<tr><td>wp-links-opml.php</td><td>23 Oct 2010 13:17</td><td>2 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-load.php</td><td>15 Nov 2011 15:47</td><td>3 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-login.php</td><td>5 Apr 2012 11:28</td><td>27 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-mail.php</td><td>5 Aug 2011 17:57</td><td>8 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-pass.php</td><td>19 Sep 2011 05:17</td><td>413 bytes</td><td>PHP:...cument</td></tr>
<tr><td>wp-register.php</td><td>9 Dec 2010 18:02</td><td>334 bytes</td><td>PHP:...cument</td></tr>
<tr><td>wp-settings.php</td><td>18 Oct 2011 20:37</td><td>10 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-signup.php</td><td>15 Nov 2011 20:44</td><td>19 KB</td><td>PHP:...cument</td></tr>
<tr><td>wp-trackback.php</td><td>24 Feb 2010 20:13</td><td>4 KB</td><td>PHP:...cument</td></tr>
<tr><td>xmlrpc.php</td><td>17 Apr 2011 09:35</td><td>3 KB</td><td>PHP:...cument</td></tr>
</table>

The above screenshot shows the extracted contents of the downloaded backup 'cpms.backup2012-04-18-14-15-03.zip' it include the mysqldump file and all the web files contents.</td></tr>
</table>

MAINTENANCE & RECOVERY TESTING			
Test Case ID	**Purpose**	**Tester**	**Test Environment**
02	To test the functionality of software against non-functional requirement 17.1 [Section 3.1.2]	Tomos Lawrence	Windows 7 – WCP SCP
Test Procedure	**Test Data**	**Pass/Fail**	
To check the system backups database (user) information and web files daily	On the server navigate to `/nfs/mntI4/projectsite/T.J.Lawrence/wp-content/backups and verify that daily backups are being produced by checking files & timestamps`	Pass	

Expected Result	**Actual Result**
The system should display 4 backups from 18-21st April in a ZIP file format.	 backups - c0809753@projectsite.cs.cf.ac.uk - WinSCP Local Mark Files Commands Session Options Remote Help Default My docu · backups C:\Users\Pauline Lawrence\Documents Name Ext Size Type Chang .. Parent directory 02/04/ File Folder 21/02/ File Folder 20/06/ File Folder 13/06/ File Folder 05/07/ File Folder 29/10/ File Folder 13/08/ File Folder 21/02/ File Folder 21/08/ File Folder 07/04/ File Folder 12/11/ File Folder 09/09/ File Folder 04/02/ File Folder 14/07/ 0 B of 176 MiB in 0 of 244 /projectsite/c0809753/wp-content/backups Name Ext Size Changed .. 28/04/2012 17:02: .backup_complete 35 27/04/2012 16:09: .backup_warnings 206 27/04/2012 16:09: .htaccess 275 18/04/2012 16:05: cpms.backup.2012-04-18-14-57-03.zip 10,752,890 18/04/2012 15:57: cpms.backup.2012-04-19-09-32-15.zip 10,291,003 19/04/2012 10:32: cpms.backup.2012-04-20-12-12-31.zip 10,627,465 20/04/2012 13:12: cpms.backup.2012-04-21-15-08-46.zip 10,879,410 21/04/2012 16:09: 0 B of 41,553 KiB in 0 of 7 SFTP-3 0:01:47 The system successfully displayed the 4 backups.

Appendix J – Configuration Management

VERSION CONTROL LOG			
Version	**Date**	**Changes Made**	**Changed By**
0.1	01/12/2011	Theme was created – CSS etc	TL
0.2	20/12/2011	Discussion facility work	TL
0.3	30/01/2012	Customised Wordpress	Tl
0.4	20/02/2012	Added Cardiff University authentication & redirects	TL
0.5	19/03/2012	Added 'Files' functionality	TL
0.6	28/03/2012	Added 'Client Area' & 'Supervisor Area'	TL
0.7	03/04/2012	Added 'Calendar Functionality' and created group members page.	TL
0.8	10/04/2012	Added 'Requirements' page & 'Tasks Page'	TL
0.9	14/04/2012	Added 'Students Area' & Sidebar, Customised Profile Page & Created Help Page	TL
1.0	19/04/2012	Added Facebook integration & Email nonfictions	TL
1.1	02/05/2012	**Release Version**	TL

Appendix K– User Accounts

Existing CPMS User Accounts		
Name	**Password**	**Comments**
C0809753	Not Available	This is my personal Cardiff University Account
Client	cpms2	
ModuleLeader	cpms1	
scm9mj	Not Available	This is another students personal Cardiff University Account
Supervisor	cpms3	
tajburrow	cpms4	
webmaster	Not Available	This controls full administrator access and is only available on request.

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DOCUMENT VERSION CONTROL

Version	Date	Status	Details	Changed By
0.1	20/03/2012	Draft		TL
0.2	01/04/2012	Draft v0.1		TL
0.3	11/04/2012	Draft v0.2		Tl
0.4	12/04/2012	Draft v0.3		TL
0.5	14/04/2012	Draft v0.4		TL
0.6	15/04/2012	Draft v0.5		TL
0.7	16/04/2012	Draft v0.6		TL
0.8	17/04/2012	Draft v0.7		TL
0.9	18/04/2012	Draft v0.8		TL
1	20/04/2012	Edit v1		TL
2	22/04/2012	Edit v2		TL
3	24/04/2012	Edit v3		TL
4	25/04/2012	Edit v4		TL
5	26/04/2012	Edit v5		TL
6	24/04/2012	Under Review v1		TL
7	25/04/2012	Under Review v2		TL
8	26/04/2012	Under Review v3		TL
9	27/04/2012	Under Review v4		TL
10	28/04/2012	Under Review v5		TL
11	30/04/2012	Preliminary Copy		TL
RELEASE	**02/05/2012**	**RELEASE COPY**		**TL**