**Project Proposal**

**Motivation and rationale – 10%**

Newcastle University possesses a CAVE virtual reality suite, which is both a highly valuable and massively useful piece of equipment. However, its use is presently being disadvantaged by certain features of the current system.

The main problem at the moment is that most users of the suite find it very difficult to operate. This can often lead to problems, rendering the hardware unusable until a technician is available to attempt to resolve these difficulties. In the event of this, it can be particularly awkward to determine the fault given that there are simply so many possible features or elements that could have malfunctioned and consequently this can be a very time-consuming job.

Many of these issues are caused by the proprietary tracking system that is currently used, as there is the potential for the license files to be lost, at which point they must be retrieved from the server before the system can proceed.

Likewise, the current system is somewhat complex to develop for as well. This is because it requires stereotypically ‘hardcore’ programming languages to function, meaning that any users with just a general knowledge of programming may not be able to understand their use.

In the same way testing programs for the system can be particularly tricky as it generally isn’t possible to run the CAVE version of a program elsewhere, meaning that the CAVE itself must be used for testing.

Taking all of this into consideration I believe that the solution is to develop a new system for the suite. Amongst other features, I intend on using an open source tracking system, which will remove the risk of license files being lost, thus ensuring a more reliable system. I also intend on simplifying the development pipeline in use so that it will be more user-friendly. Therefore, by completing this project I will be allowing the suite to be used to its fullest potential and maximising the investment that the University has made in acquiring it.

The overall need that is being addressed by this proposal is the necessity for a single, unified and easy-to-use system. By implementing this it will not only be the commonplace users that will benefit, but also the technicians that overlook its use, as well as developers creating content for the suite. This is because an easier to use system will lead to fewer problems arising and thus fewer cases where a technician is required to restore use of the system. Similarly, a streamlined development pipeline will, in turn, make it easier to develop models and environments for use within the CAVE.

Another motivation for this project is that it will give me the opportunity to develop a system with certain capabilities that are beyond those of the existing one. If it is conceivable for my system to work through a web browser then that will simplify the pipeline even further; developers will require no knowledge of memory allocation or C/C++ in order to create content for the suite.

This is desirable as it will make the technology much more accessible for those who may wish to create something for the suite but simply don’t have the knowledge, resources or time with which to do so. By creating a system capable of working through a web browser I would be giving these users a simpler alternative with which to create their desired content.

This particular project is attractive to me as it will give me a substantial insight into the sector of virtual reality, allow me to develop my understanding of graphics and also give me knowledge and use of several technologies that are paramount for a career related to video games.

**Aim – 20%**

Through this project I aim to develop a toolset for the CAVE virtual reality suite, in order to run projects and studies easily

**Objectives**

* Create 3D architectural visualizations that can be navigated and explored using the VR suite
* Increase the share-ability of the CAVE through the use of the web and open source technologies, and develop my toolset as open source so that there is the potential for other users to modify or add to the toolset at a later date
* Integrate head-tracking and collision detection when available in order to provide an immersive experience
* Support the loading of 3D models of various types to ensure that the toolset is widely useable
* Ensure that the system is capable of displaying stereoscopic images so that motion parallax and depth can be achieved
* Provide logging of user interaction so that the suite can be a suitable location for psych studies and demos

**Background – 30%**

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| Source | Summary | Explanation |
| Phil Heslop [1] | * Senior technician * Oversees use of Newcastle University’s CAVE virtual reality suite | As it is Phil who is in contact with the CAVE suite most of the time, I intend on consulting with him at regular intervals throughout my project in order to ensure that my solution is meeting the requirements for the system. I also anticipate discussing the success of my solution with Phil with regards to him giving his opinion on the share-ability and usability of the system, as they are relatively subjective characteristics and so the impression from someone with a detailed knowledge of the current system will be highly valuable. |
| CQ3A (Cave Quake III Arena) [2] | * Quake3 renderer * Developed specifically for the CAVE | Commonly known as the “Hello World” of virtual reality, this is the engine currently in use within the University’s CAVE. It is sufficient for producing 3D models, however it is also commercial software that is now relatively dated and restricted. |
| CAVELib™ [3] | * Virtual reality software API * Provides a platform for creating interactive three-dimensional environments for use within a CAVE | This is proprietary software that is currently used within the CAVE. It governs the task of ensuring that all of the images rendered are stereoscopic and also that these graphics are displayed correctly across each of the CAVE’s screens. My project will essentially involve me re-writing this API for a modern system. |
| WebGL [4] | * JavaScript API * Can be used to render both two and three-dimensional graphics within a web browser | This is the web equivalent of OpenGL that makes it possible to render graphics on the web without the requirement for any plug-ins. Also, like OpenGL, it is open source meaning that it is highly accessible and documented. It is relevant to my project as it’s likely that I will be using WebGL in order to implement my solution, due to the fact that it contains the features that will allow me to create a toolset meeting the requirements for this project. |
| three.js [5] | * JavaScript library * Can be used to create and display three-dimensional graphics within a web browser. | This library is important as I intend on using it in conjunction with WebGL as it is lightweight and also open source. Again, this means it is extensively documented and supported, ensuring that it is both future proof and can be understood by those without any advanced programming or graphical knowledge. |
| [6] | * Describes how the use of virtual reality can be beneficial in locomotive design | This paper is relevant to my project as it describes one possible application of a CAVE system that is similar to one of the intended features of my toolset, providing 3D architectural designs. It outlines using the 3D visualisation technology and stereoscopic immersion that can be achieved using a CAVE in order to design and model trains. This highlights the importance that my toolset meets the two objectives relating to these two features, as this will ensure that it can be used for a variety of purposes, such as the one outlined in this paper. |
| [7] | * Outlines a research use-case for a CAVE system * Explains the possible benefits of using virtual reality for research | The paper describes the bespoke use of a CAVE system in order to provide physical rehabilitation exercises for patients with rheumatoid arthritis. This is relevant because one of the main aims of this toolset is to enable the CAVE to be easily used for research, meaning it should be feasible for someone to develop, using this paper as an example, a series of interactive exercises that can be displayed within the CAVE for participants to complete. |

**Diagrammatic work plan – 15%**

Start  
Tue 08/10/13

Finish  
Wed 14/05/14

01 November

01 December

01 January

01 February

01 March

01 April

01 May

**Ethics approval form**  
Tue 08/10/13 - Fri 01/11/13

**Presentation**  
Tue 08/10/13 - Fri 01/11/13

**Proposal**  
Fri 01/11/13 - Fri 13/12/13

**Planning & estimation**  
Fri 01/11/13 - Sun 01/12/13

**Development**  
Fri 13/12/13 - Tue 15/04/14

**Dissertation**  
Wed 01/01/14 - Wed 14/05/14

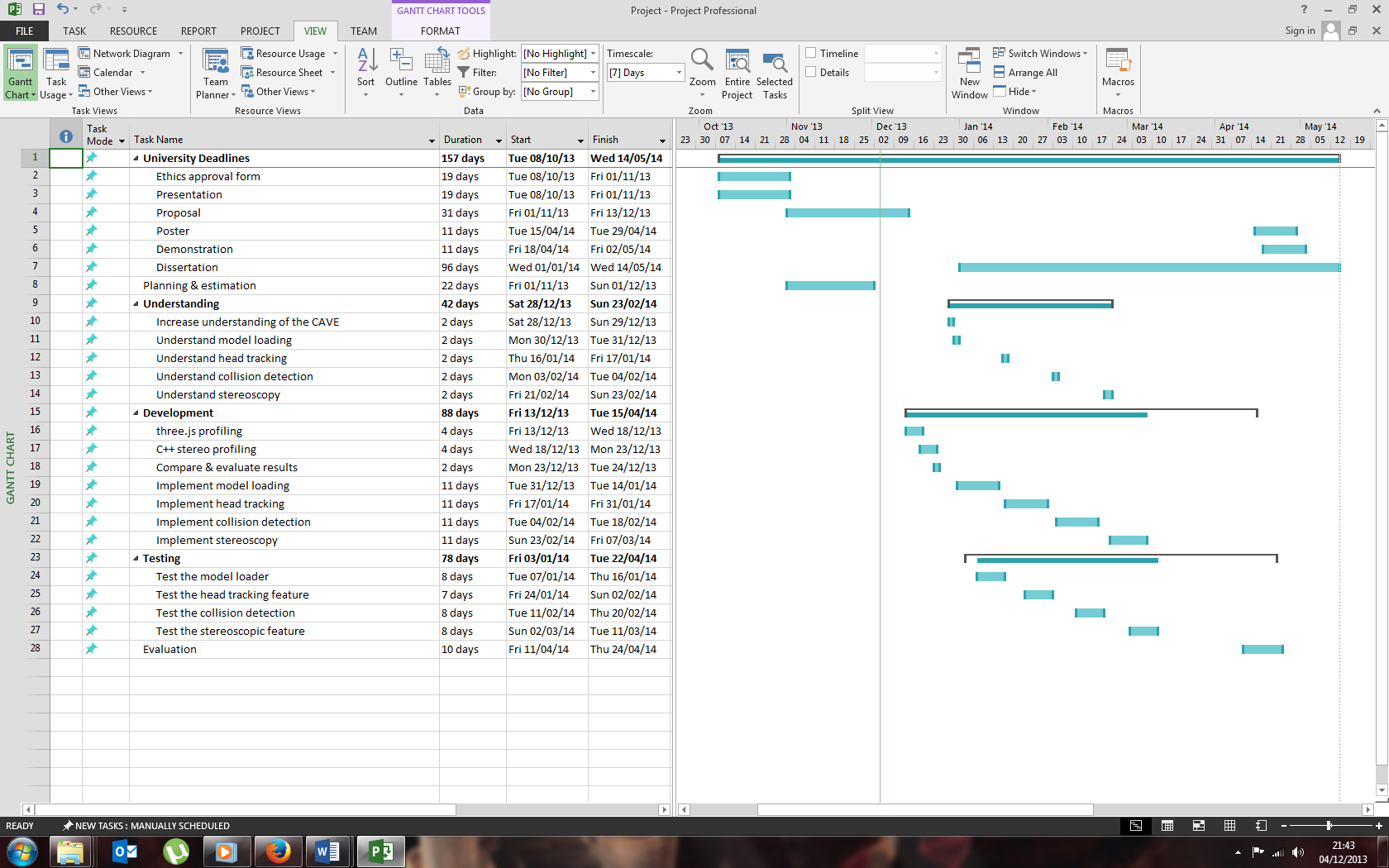
**Testing**  
Fri 03/01/14 - Tue 22/04/14

**Evaluation**  
Fri 11/04/14 - Thu 24/04/14

**Poster**  
Tue 15/04/14 - Tue 29/04/14

**Demonstration**  
Fri 18/04/14 - Fri 02/05/14

**Today**



**Explanation of work plan – 10%**

* **What has been done so far?**

In order to get a more concrete understanding of the features and requirements of the toolset that I will be creating, I have conducted a semi-structured interview with Phil Heslop to determine how the current system functions and also any improvements that could be made. As Phil has a lot of experience with the suite and the technology used he has a detailed knowledge of what the end solution should comprise.

* **Why is the plan structured as it is?**

Throughout my project I intend on using an agile software process model. This is because I will be implementing various features into the toolset one at a time and certain tasks have the potential to take less or more time than initially planned, due to any issues that I may run into during development. A process model such as SCRUM allows change with ease and will ensure that my project can be organised and sufficiently planned.

Another benefit of using an iteration and sprint focussed cycle is that I can constantly have a working prototype available and frequently demonstrate this to Phil in order to receive feedback, like a sprint review meeting. In that sense, I am seeing Phil as the product owner with this toolset. We will also be able to discuss any impediments that may have arisen during the iterations work.

**References – 10%**

1. *Newcastle University VR Lab*. Available at: <<http://www.iri-vr.ncl.ac.uk/>> [Last accessed November 2013]
2. Paul Rajlich, 2001. *CAVE QUAKE III ARENA.* [online] Available at: <<http://www.visbox.com/cq3a/>> [Last accessed December 2013]
3. Mechdyne, 2013. *CAVELib™.* Available at: <<http://www.mechdyne.com/cavelib.aspx>> [Last accessed December 2013]
4. The Khronos Group Inc., 2013. *WebGL – OpenGL ES 2.0 for the Web.* Available at: <<http://www.khronos.org/webgl/>> [Last accessed December 2013]
5. three.js, 2013. *three.js – JavaScript 3D library*. Available at: <<http://threejs.org/>> [Last accessed December 2013]
6. J. Seron, Diego Gutierrez, A. Magallon, J. Sobreviela, and A. Gutierrez., 2004. *A CAVE-like environment as a tool for full-size train design*. Virtual Real. 7, 2 (April 2004), 82-93. Available at: <<http://dx.doi.org/10.1007/s10055-003-0117-6>>
7. Shawn N. Gieser, Eric Becker, and Fillia Makedon, 2013. *Using CAVE in physical rehabilitation exercises for rheumatoid arthritis*. In Proceedings of the 6th International Conference on PErvasive Technologies Related to Assistive Environments (PETRA '13). ACM, New York, NY, USA, Article 30, 4 pages. Available at: <<http://doi.acm.org/10.1145/2504335.2504367>>