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#### **Abstract**

In the world of professional sport, the reliance upon IT systems and associated software is greater than ever, no more so than in the sport of Rugby Union. Such systems are used on a daily basis for a wide variety of tasks, particularly managing the personnel within the organisation, monitoring player progress through testing and recording key characteristics, and in recent years for the analysis of video footage.

This project aims to develop a complete player management system that incorporates a video analysis facility capable of using coded XML files and their associated video, to extract specific sections of video footage from complete match video files. The system aims to use such match footage as a central point for knowledge sharing through the use of annotations that are specific to user specified time ranges of video.

Through the use of an existing portal framework along with the implementation of two compatible portlets, the project has produced a prototype system suitable to conduct both the managerial and video analysis requirements of the Cardiff Blues Academy team. This system will continue to be developed beyond the scope of this project in order to provide a complete player management and analysis system.

## Acknowledgements

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#### Introduction

#### Project Aim

The aim of the project is to develop an online team management and performance analysis portal, in order to aid team management tasks, simplify communication between personnel involved, and facilitate the process of performance analysis through the use of video footage. Performance footage may consist of individual and team training sessions, used by players and coaches to review past sessions with the aim of improving future performances. The aim of the video analysis facility also includes the reviewing of competitive performances such as matches or events. Under the current system in use within professional rugby environments, match and training footage is coded through the use of video processing software used to add XML metadata in relation to specific time zones within the video. This data, when processed provides an opportunity to produce valuable statistics regarding both individual and team performances, along with simplifying review processes as the person reviewing the footage can select specific events to watch during the match. The video analysis facility aims to provide such facilities on a web-based platform, enabling players and coaches to perform analysis tasks from anywhere, using almost any device.

The project will be based around, but not limited to, the Cardiff Blues Rugby Union team, and will be orientated around the activities the players, coaches and performance analysts. The present review activities take place within the Headquarters of the team, with few personnel having access to video analysis software from outside of the training facilities due to its cost. The aim of the project is to provide a secure web portal for accessing video footage and its relevant XML metadata, for the viewing and accessing statistic reports and other team documentation. Through providing such facilities, there is no requirement for multiple licenses of the video processing software, SportsCode (Sportstec, 2015). Through enabling all players to access such resources and download the footage they require for their own personal

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analysis, the resources on the organisations server are limited to one copy of the video footage and associated XML files for that footage. Through processing this associated metadata of the video analysis facility, the project also aims to utilise this data and provide more information to the person reviewing the footage, integrating user annotations to provide further information. Through providing such facilities via an online application within the portal, the video footage owners can also control who has access to the footage and the video analysis software, aiding security and reducing the risk of competitors accessing such material.

In relation, the project also aims to facilitate the monitoring and analysis of strength and conditioning testing clips and scores which hold vital information for coaches to use when creating individual training programs, or when analysing weightlifting technique during scheduled testing sessions. Individual video clips, statistical testing data and coaching tips can be accessed by players and coaches, allowing comparisons to be made between players in regards to their physical attributes. Administrative tasks such as physical monitoring tests, which are to be completed by players on a daily basis, will also be integrated into the system via the portals managerial facilities. These physical monitoring tests can then be viewed by S&C coaches in order to identify any athletes who may not be fit to play, or may require medial attention.

The project also aims to facilitate managerial tasks involved in athletic communities such as that of the Cardiff Blues. The current communication system is heavily based upon emails and associated attachments, requiring the team manager to send emails on a daily basis providing update to schedules, training sessions and other vital information. The project aims to integrate these tasks into an online portal where all this information can be found, viewed and in some cases downloaded by the person accessing them. Weekly tasks such as sending out schedules, team sheets, playbooks and information sheets can be integrated into the web portal, providing all personnel who are involved with all the information they require, located

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in one central location. Through using this central portal for access to such resources, managerial tasks can be performed in a simple and consistent manner by all individuals associated with the organisation, reducing the risk of miscommunication. Through the use of a shared calendar for each organisation on the portal, all personnel can view scheduled events for each week, being provided with updates if any changes are made, and allowing access to be gained in regards to any information resources associated with each event. The portal also aims to enhance overall communication between team personnel via the use of a messaging facility, connecting all members of the organisation, also enabling management staff to view each portal members contact details if this information is required.

Due to the importance of the resources which will reside on the organisations portal, the underlying aim of the project is to ensure it is as secure as possible through meeting the four key principles of ensuring information security; confidentiality, integrity, availability and authentication (Kim, 2007). Through ensuring these four principles are adhered too and by abiding to the universally recognised standards for information security management outlined in ISO/IEC 27001 (ISO, 2015), this will ensure the resources that reside upon the portal are as secure as possible.

#### Intended Users

The system will have four main categories of users who interact with the system: athletes, managers, performance analysts and coaches. Each user who interacts with the system will have several requirements specific to them, however the majority of requirements will be the same due to generic tasks.

Players will generally use the system for accessing information resources such as viewing video clips, documents, statistic reports and messages. Players will also use the system for communication and review purposes and performing tasks such as creating feedback video

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playlists, annotating video playlists, messaging coaches and analysts, and completing questions lists.

Managers will have full access to all tools available on the system, with additional access to administrative tools such as user account creation and user privilege assignment. Managers will predominantly use the system for organisation orientated tasks such as message creation, calendar event creation and viewing player performance review tasks such as question list responses and review video playlists.

Performance analysts will predominantly use the system for the purpose of video analysis tasks. General tasks will consist of bookmarking video clips and creating review playlists from training sessions and games and providing players with information in regards to their performance through annotating specific clips. Analysts will also use statistical reports and graphical representations to illustrate player performance stats, and to create long term aggregated statistic reports. Analysts will however have access to all tools on the system due to their technical skills, as they will often perform the role of systems administrator when the manager is absent.

Coaches will predominantly use the system for athlete performance reviews and will often complete tasks such as creating video feedback playlists, providing feedback to athletes regarding their recent competitive performances, and will also review athletes review question lists and video feedback playlists. Due to their input into athlete performance reviews, they will require access to all tools with the exception of administrative tools.

#### Scope

The application will be based upon a client-server architecture, where the portal and its portlets will be stored and hosted upon the organisations server, performing the majority of processing tasks which will be required by the system. In the case of the Cardiff Blues, there is

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currently sufficient storage and processing resources available on the organisations server. This server will host the portal website, enabling authorised personnel to access the system from external locations. Minimal processing will be performed upon the client's machine, with the exception of interface modification, and user dependent processes such as form validation, performed by JavaScript. This architecture will enable multiple users to access the system simultaneously, providing they have an Internet connection from their personal device.

The portal will use an existing portal framework, modified and expanded in order to fulfill the requirements of professional sports organisations. These include the development and integration of a video analysis portlet and strength and conditioning monitoring portlet, including the facility to compare and contrast athlete characteristics. The portal will also use existing portlets in order to perform administrative tasks such as document management, event scheduling and user communication. User management and user rights will be managed via a database existing upon the portals server. This database will store user information for personnel who are authorised to access the system and will link the users assigned rights to each user account, ensuring users only have access to the facilities and resources they require for their role, and that no unauthorised personnel are able to access the organisations site and its resources.

The 'Player Portal' is an online web portal for organising, communicating and managing athletes within sporting communities. The system is comprised of three main pillars: management tools, video analysis tools and strength & conditioning tools. These sets of tools provide athletes, managers, coaches and video analysts with facilities to manage athlete schedules, communicate with each other, share resources, track & review individual progress, complete monitoring forms, viewing performance statistics, and analysing videos of performances and training sessions. Each set of tools will have its own interface, ensuring the system is modular, enabling additional portlets to be added or removed in the future.

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The portal framework uses the Java Portlet Specification 286 (Scott Nicklous, 2009) in order to implement its security and permissions scheme, mapping portlet roles to portal roles. This not only ensures the standard portal framework is secure and its user right enforced throughout the entire system, but also ensures any additional portlets which are added to the system also conform to the same standards. This specification is regularly updated to provide sufficient security in order to combat emerging and current threats to the system.

#### Approach

The approach during the development of the project has been based upon a linear-sequential model, more commonly known as the 'Waterfall Model' (Munassar, 2010). This approach was chosen due to its simplicity and my understanding of the process having used it in previous software development projects. This made it simple for me to plan the development process and focus on each phase in the sequence at one given time. The approach uses a sequence of distinct phases, typically one phase acts as the input for the next phase, ensuring information from the previous phase is considered in the next phase. The approach also coincided with the final year project restraints and the availability of stakeholders of the system as my involvement with such personnel changed as the project progressed. This allowed me to carry out an interactive Requirements Gathering and Analysis process with the players, coaches, analysts and managers within the Cardiff Blues organisation, as my presence within the environment was frequent. Once this initial process was complete I was also able to involve the stakeholders in the System Design stage which aided the decision making process when considering libraries, languages and aesthetics I choose during the latter stages of the project.

The approach is also suited to formulating a set time period for deliverables and milestones to be produced and reached, making it ideal for the process of planning tasks and forecasting their durations throughout the project. As the implementation of the project takes place later during the development process, the documentation produced during this stage provides a

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clear outline for methods and approaches when implementing the system. This high volume of documentation would not exist for the whole system at the same timescale if an iterative development process were chosen. This approach addresses software development in a modular approach, encapsulating the sequential approach but in smaller, more distinct sections of an overall system. Through using the waterfall model I was able to form a detailed set of well-documented requirements for the entire system, making the possibility of arising ambiguous requirements as low as possible. This methodology did however cause some minor problems during each stage, as it was difficult to track progress within each phase, particularly in the implementation stage where modularity was difficult to maintain as a result of the design specification developed in the second phase of the development cycle.

#### **Assumptions**

One of the main assumptions during the development of the project is that of the methodology and schemas used in order to 'code' video footage. As several different organisations use different schemas and structures when adding metadata to video files, I have chosen the most common methodology used within the Cardiff Blues Video Analysts department.

Development has been undertaken on the underlying assumption that the schema and structure of such XML files will not vary in regards to both naming conventions and the nesting structures which exists.

Another assumption made in relation to this is that of the file type used by the analysts in order to record the video footage. In the coded video footage collection I have obtained from the Cardiff Blues, video footage is stored as the QuickTime file format - .mov. Therefore, I have based my implementation around this file type and the video and audio codecs it uses. Although the system is able to accommodate various file types, testing will be carried out upon this particular video format due to its availability.

#### Important Outcomes

#### **Product Perspective**

The system will consist of a multi-platform web portal suitable for viewing on both mobile and desktop devices, ensuring the tools and services are available for use on any device. The web portal will be hosted from a server on which the portal services, databases and resources will be stored upon, where the client can make requests and queries when required, all of which will be transmitted via an internet connection, using common protocols. As the video analysis software will be developed independently and integrated into the portal framework as a portlet, this facility will fully incorporate into the main portal itself, including a consistent user interface.

#### **Product Functions**

The system will consist of a web portal with three separate sections for performing various tasks, with each section containing tools and services related to that section. In addition to these outlined sections available to all users of the system, there will also be an administrative section only accessible to manager/s of each configured organisation. This administrative section will enable the user assigned with the role to edit the layout of pages, include additional portlets into the configuration, manage user accounts and rights, and enable them to control all resources added to each specific organisations portal.

The web portals managerial tools will enable the general users to create events to add to the community calendar, create messages to send to other users within the community, answer question lists, view and edit personal profile information, viewing files and performing file management tasks such as uploading/downloading files. In addition to this, administrative users will be able to create/edit/delete calendar events, create/view question lists, create player profiles, and perform all file management tasks.

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The web portals video analysis tools will enable general users to view individual athlete clips and team clips from the most recent performances. This facility will also allow general users to view individual athlete strength testing clips, and will be able to bookmark and annotate specific sections of clips in order to create short feedback videos to be supplied to athlete/coaches for review processes. Within this section, users will also be able to view match statistic reports and aggregated totals of performance statistics created by the system.

The web portals strength and conditioning tools will allow users to view athlete strength testing scores and produce comparison graphs of testing scores with other athletes and against their own targets using manipulative graphical displays. Athletes will also be able to undertake physical monitoring questionnaires set by the administrating strength and conditioning coach who will also be able to insert player-testing scores and assign future testing targets.

## Background

#### Anticipated Benefits to Stakeholders

As the current methodology of multiple recipient emails can cause miscommunication problems, through the use an organisation wide portal the sender can ensure information is broadcast to all individuals it is required to reach. The system will allow the user to individual and groups of users who are to receive messages and information, using pre-set and customisable user groups, ensuring no individual is missed out or overlooked. This comes as a result of the portals user management facilities that will enable managers and coaches particularly, to view complete sets of contact details. Alongside being able to use such collections of contact details to communicate with other users within the organisation, the system will also enable the users to communicate via a private messaging facility. This portlet will allow users to communicate on a 1-to-1 basis with other users, notifying each user of any messages they have received through the private messaging portlet. In addition to these private messaging facilities the system will also allow the user to participate in group conversations through the use of message boards. This will allow users to communicate in a collaborative space, sharing ideas, contributing to questions and sharing resources with other members of the organisation. These message boards will organise and collaborate user input, enabling users to search for information in the future and quickly locate any messages through the use of its category or tags.

As the majority of communication is performed via email at present, document and media management is difficult as multiple versions of timetables; daily schedules and forms can exist at even given time with no information existing as to what version is the most up-to-date. Through the use of the portals content management facility, these resources can be managed more effectively, being updated and replaced as and when required, with additional information easily added to them. Such resources can also be viewed through the use of the

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portal; enabling all users to view such resources regardless of the device they are being viewed on, also providing download links to particular resources if necessary. As these resources may change, it is important to notify the user of any changes that have taken place. This is done via the portals notification portlet which tracks changes that relate to each specific user and presents a summary of such activities to the user on their home page for viewing when they log in. Such changes are also communicated to each user via an email notification, providing a link to the user for simple viewing.

In regards to the management of personnel within the organisation, this is facilitated by the portal through providing a simple interface to view what users have access to the organisations portal, providing facilities to add, remove or suspend users depending on their involvement with the organisation. Aside from this, administrative users will also have the ability to add new portlets to meet new requirements as and when they arise.

In regards to the anticipated benefits the video analysis portlet will provide the greatest functionality to organisations such as the Cardiff Blues as it will provide the users with a web interface to conduct previously restricted tasks required when conduction video performance analysis. Due to the time period between playing a game and the recorded video footage being coded, many athletes do not have access to the coded footage until 2-3 days after the match has taken place. Through the use of a web based video analysis system, users will be able to access the footage immediately after it has been coded an uploaded to the organisations server. All video analysis tasks can then be completed from within one website, from viewing and downloading specific sections of matches, adding annotations to match video, and completing match review forms. Previously this process would have had to be undertaken from within the training facilities at the Cardiff Blues where a limited number of devices are available to completing such tasks due to the required software. Through enabling access to coded footage via a web application, users can access the footage from anywhere they have Internet access,

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using almost any device. This will not only make it more convenient for players and coaches to conduct analysis but will also enable them organisation to save sufficient sums of money if a reduced number of video analysis software licenses have to be purchased.

As users of the system will have unrestricted access to the video analysis software, players and coaches will be able to conduct their analysis activities from outside of the training environment, allowing greater time to be spent analysing their own and opposition footage. In regards to the performance analysis procedures, which currently take place coaches, will be able to provide greater feedback to athletes through the use of video annotations and comments on performance footage. This will allow greater athlete development as reviews can be conducted and the video footage used to provide visual feedback to each athlete. Greater collaboration will also be encourage between athletes and coaches as each user can create their own annotations on each match, increasing the sharing of knowledge taking place within the organisation. Experienced players and coaches can aid the development of other players by adding their own annotations that may contain valuable information or advice.

In relation to the benefits the video analysis portlet will provide to the strength and conditioning team at the Cardiff Blues, its use as a method of providing visual feedback to athletes completing technical weightlifting sessions and tests. Through the use of recorded footage of athletes lifts, strength and conditioning coaches will be able to highlight key points and emphasis technical aspects of lifts in order to aid the athletes development. The annotation of this video can also provide further knowledge sharing by other athletes and coaches providing their input and identifying any good or bad examples of technique.

Alongside the benefits of having video footage the portal will also enable managers, coaches, analysts and athletes to use testing and physical statistics to compare and contrast athletes.

Through the use of graphical representations of these statistics, a visual representation will

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allows decision makers to make quick but detailed comparisons of athletes in similar positions, identifying areas where specific athletes require improvement. These statistics will also be used to form ranking tables, using athlete competitive performance statistics and physical testing statistics to monitor each athlete's position in comparison with other athletes. This will encourage competition between athletes to be at the 'top of the table', recording performance statistics on both a weekly and monthly basis.

The system will also allow strength and conditioning coaches to monitor athlete physical conditions through the physical monitoring portlet. This process is currently difficult to administer and is therefore not conducted. Through the use of the portal, athletes can complete their monitoring forms at set times throughout training weeks which will allow coaches to monitor athlete fatigue and identify any athletes who may require medical attention.

#### **Anticipated Challenges**

One of the anticipated challenges of the system will initially be that of learning how the system functions and what functions the system actually contains. This is a challenge with any new system particularly were functionality is new to the user as new methods and interface will inevitably cause delays in users completing tasks. In order to reduce this factor the system has been designed to be as simple as possible, maintaining modularity by only incorporating the required portlets on each page, reducing confusion of what elements to interact with, and providing sufficient whitespace.

As the system will require a system administrator to upload new videos and XML files to the systems server, this may incur additional costs. At present this task is completed by video analysts at the organisation, however if the system were to be used on a larger scale, a system administrator to ensure these videos and data files are added and removed, as and where necessary. This system administration role would inevitably incur additional costs.

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One of the greatest challenges is ensuring match footage and XML files are synchronised with events occurring in the video at the corresponding time values in the XML file. As the footage and XML files are provided by analysts who have completed this process, this factor is not an issue, however if the system were to rely on third party coding methodologies issues such as these could indeed occur.

#### Relevant Existing Software

#### **MyTPE**

Currently used by the Cardiff Blues Academy and numerous other professional sports teams, MyTPE (MyTPE, 2015) is an online team management tool. The website enables team manager to communicate with players, share files, plan meetings, distribute questionnaires and track changes in their team environment. The system allows uploaded files to be viewed and downloaded using the file management system, with access right and storage space being purchased from the web hosting company through a monthly subscription. Although the software is able to store and display video files, it is currently incapable of using coded video footage from training sessions and matches, preventing users from viewing or downloading specific collections of video. The system also prevents any customisation from taking place, preventing administrators from removing features, which are not used, and enforcing heavy restrictions on the volume of content that can be added to the team's site. My Team Performance Exchange (MyTPE) is one of the leading team management facilities in the sport of rugby union throughout the United Kingdom. The company is closely followed by Teamer (Teamer, 2015) who accommodate a range of clients from various sports teams competing at a variety of levels of competition, both offer similar facilities in regards to their team management tools. One of the major problems with these systems is the financial investment they require due to their usage being based on a monthly subscription fee. As a result, many teams purchase the least expensive package the company offers, leading to only basic services

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and minimal storage capacity being available to them as a result. This costing and the lack of video analysis services, customisation options and limited storage capacity make this system very limited.

#### **Sportstec**

Currently the leading company in sports video analysis software in the world, Sportstec (Sportstec, 2015) provide multiple solutions to sports teams in order to conduct live and post competition video analysis. Two existing product relevant to this project are that of Sportstec's SportsCode and Sportstec Steam. SportsCode allows performance analysts to capture live footage, add metadata using preconfigured coding sheets. This process provides coaches and players with live statistics and enables vital decision making processes to be undertaken during competition. The software can also be used post-competition in order to create individual and team collections of clips, tagging important events to create valuable collections of statistics for patterns and tactics to be identified and evaluated.

Sportstec Stream is a recently developed web based video sharing platform, enabling teams to share video through an online interface using coded video footage to provide a complete online solution to the viewing of SportsCode video packages. The system enables uses to use the 'matrix' feature embedded into the SportsCode software in order to create and share playlists to other users through the built in user management facility. This software due to its complexity and functionality is extremely expensive to purchase with licensing fees ranging upwards of £1,000 for basic versions of the SportsCode software and varying subscription fees for use of the online service of Sportstec Stream, currently standing at between £20,000-£25,000 annually.



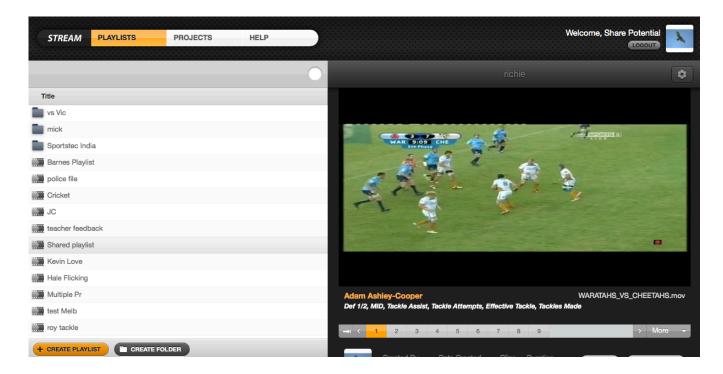


Figure 1 - Sportstec Stream Application Interface

#### Existing Software Used

#### **Liferay Portal Framework**

The Liferay Portal Framework is a lightweight complete portal framework composed in Java that has a high degree of flexibility and openness due to its being open source. In this project the use of the Liferay Community Portal Framework will be used as this package includes sufficient tools and utilities in order to provide the features and functionalities desired by the end users of the system. The framework includes a built in content management system which is accessible to developers in order to expand upon its functionality and add new features through the configuration of compatible portlets and integrated features. Due to the framework being open-source a large volume of documentation and support exists within its community to allow developers to integrate additional portlets into the existing framework.

The basic portal framework is configured with a range of core portlets that communicate with the main portal in order to provide various interfaces and functions to the end users. Portlets

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can also be create through the use of the Liferay Portals Plugins SDK, enabling developers to create new portlets by providing three components that enable a portlet to interact with the core system and the end user; Java source files, configuration files and client-side files. Each newly configured portlet uses the Model View Controller software architectural pattern that enables the software to be divided into three connected sub-sections, with the users view being completely separated from the controlling framework.

The framework also enables the developer to integrate a wide range of other software and data structures, allowing the leveraging of third part applications in order to improve upon its existing system. Through the transparency of the framework it is possible to use a variety of database structures to store data within, enabling the framework to be integrated into pre-existing systems if necessary. Although this is not necessary in the scope of the project, it is possible that the proposals of future development would require this characteristic. This also allows the system to run on a range of operating system as it allows the Liferay Portal to be run on any platform able to run the Java Runtime Environment and the appropriate server.

Although the platform does require configuration of additional portlets and changes from its basic setup, it is however well document with a wide range of resources available for guidance of advanced configuration such as that proposed within this project. Such changes to its basic configurations allow the integration of several applications within one user interface with a consistent appearance.

#### **VideoJS**

VideoJS (Brightcove, 2015) is an open source CSS and JavaScript library that facilitates and improves the usage of the HTML5 video player, allowing for improved cross-browser compatibility and enabling additional features to be implemented through the use of its API. The usage of HTML5 video can improve performance of the web page it is being used within

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due to there being no reliance on secondary applications in order to run. This factor and the opportunity to use the libraries JavaScript API in order to interact with the video, makes it ideal for the purpose of displaying match and training video footage in this project. Through enabling interactions to take place between the video and other elements within the page, the VideoJS library has enabled various plugins to be developed leading to the creation of a range of features and options, both for developers and users.

#### RangeSlider

VideoJS offers one particular plugin library that enable sections of video to be marked in relation to specific start and end time ranges. Through the use of these time range values, the plugin allows such sections of video to be quickly selected by the user for viewing of the video footage that resides between the two-timestamp values. The RangeSlider (Cebrian, Rangeslider-VideoJS, 2014) plugin also allows developers to use its API to interact and control the range slider, using JavaScript event instances to retrieve video player values and initiate other events. This plugin is ideal from the perspective of coaches and analysts, as it allows the highlighting of specific sections of video for other users such as players to view. This highlighting of video sections would allow other users to immediately locate interesting or important sections of video, preventing the tedious process of locating sections of video that coaches may have referenced. In relation to this, coaches and players who complete match reviews often use examples of video footage to provide a visual example of good or bad technique. Through the use of the RangeSlider plugin, users are able to highlight such examples making them evident on the viewer's video timeline.

Although the RangeSlider plugin is useful for highlighting specific section of video footage such as the video footage of a whole rugby match, it does not allow users such as coaches, analysts and players to add information or context to the highlighted video sections. This limits the plugin in its present form in relation to aiding the performance analysis feedback

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process. In order to improve upon the RangeSlider plugin's capabilities and aid the review process user input must be recorded and associated with a specific time range the user has specified. Through the use of the RangeSlider's API it is possible to retrieve the time stamp values the range represents and associate these values with the users input.

#### Annotator

Annotator (Open Annotation, 2015) is an open-source JavaScript library designed in order to add the capability of adding annotations to any webpage, using specific elements and text within such web pages as anchor points to which annotations are attached and indicated to viewers of the web page. The library also has an API, enabling its usage to be expanded, accommodating other content forms such as PDF's, images, sound and other forms of static web content. The Annotator library enables web page viewers to annotate elements on the web page through adding comments and associated tags that enable other users to search for and select other users comments. Alongside adding annotations, the annotator library also allows the user to configure the access and amending of their annotations by selecting pre-set options when the annotation is created. In order to add more information and enable greater sharing of knowledge, the library also offers access to several other plugins that enable additional options such as sharing, geographical information insertion and a rich text editor.

The RichText (Cebrian, 2014) Annotator plugin enables the user to provide a greater range of information within the annotations they add, alongside offering greater customisation of how the annotation is presented to other users. This plugin enables users to add multiple formats of material such as photos, videos and sounds, alongside the insertion of links and other rich text within the users annotation. This plugin allows greater knowledge sharing between users as they are able to link other material outside of the current website, creating a web of information and knowledge within such annotations. This is particularly important in the perspective of the project, as it will enable experienced players and coaches to share their

knowledge and information resources with other users, increasing the learning potential of the organisations members.

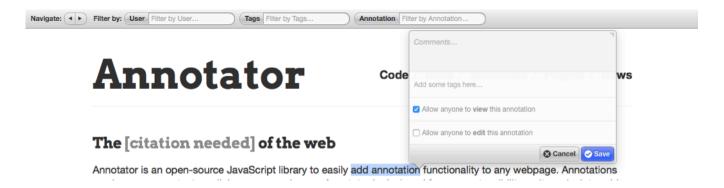


Figure 2 - Annotator JavaScript Library

#### **OpenVideoAnnotation**

As discussed previously both the RangeSlider and the Annotator JavaScript libraries have API's that allow interaction with the libraries and their associated methods. It is therefore possible to take advantage of both libraries and combine them to produce a library that is able to combine both, producing a plugin for the VideoJS library that is able to create and manage range markers with associated annotations. This library has been created by developers and exists in the form of the Open Video Annotation Project (Cebrian, The Center for Hellenic Studies of Harvard University, 2014). The library developed in the project enables users to interact with video elements, allowing annotations to be made based upon the content each user is viewing, with the opinion they express being based upon their past experiences.

Through the use of such annotations, personnel from within the organisation can create media rich annotations on the sections of video they observe. This facility is ideal for the process of performance reviews and where coaches and other players can evaluate and critique personal and team performances, allowing such critiques to be recorded and available for future

reference, using the Annotator's search and tagging facilities. The Open Video Annotation Project also allows the use of the Annotator libraries plugins to allow the sharing of annotations via social networks and private email's, including the inclusion of geo-location tags to be included. This freedom of users being able to add information allows video content to become even richer through linking its content to other resources and the inclusion of user knowledge. The plugin is also compliant with the Open Annotation data format, making its content compatible with many other Open Annotation compliant projects.

#### **Bootstrap**

Bootstrap (Bootstrap, 2015) is an open-source front-end framework consisting of HTML, CSS and JavaScript libraries designed for implementing responsive projects. The use of Bootstrap in this project has been chosen due to its suitability in scenarios of rapid developments, where the main focus on such projects is to enable prototypes such as this project to have simple but complete designs to their interfaces. As Bootstrap also enables user configuration and customisation through its varying elements and classes embedded within its CSS and JavaScript files, it also offers a wide range of features, through the use of responsive classes and the range of JQuery (JQuery, 2015) plugins. Alongside being suitable for the rapid development method required in this project, the Bootstrap front-end framework is also used by the Liferay Portal Framework, enabling the video analysis portlet to be seamlessly incorporated into the portals user interface.

#### **FFmpeg**

In order to use the XML data created by analysts when coding match footage using software packages such as SportsCode to extract and combine specific types of clips, the free video software project FFmpeg (Bellard, 2015) provides sufficient libraries to use such data to extract and collate video sections of multiple codecs. The FFmpeg library consists of many tools, for

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the implementation of this project I have used the *ffmpeg*, a command line tool that enables video and audio file conversion, video and audio frame extraction, and video and audio concatenation. These three features make the library ideal in regards to using the timestamp values provided in the match XML document, combining them with other metadata values, to provide the user with a collection of clips that conform to the users specified clip type they would like to view.

As FFmpeg is also a command line tool it will be accessible and executable through using the command-line facilities of the local server the website is being hosted upon. These shell-executed commands will allow all of the necessary FFmpeg commands to be executed, and the resulting outputs of these commands will produce the required footage specified by the user. In order to extract such timestamp values residing in the XML document, the project uses Php's XML Parser functionality (The PHP Group, 2015). This enables the timestamp values associated with each event recorded in the match video footage to be retrieved and used in order to extract the specific clips specified by the user.

## Requirements Specification

#### Approach

In order to gather requirements for this project I have conducted interview will all four types of users of the system in order to create a complete set of both functional and non-functional user requirements. These interviews were conducted using a semi-structured methodology consisting of several set questions regarding each users own desirable functionalities and interfaces the system should offer, followed by an open ended question of any ideas each user may have regarding the system and the possibility of the idea being implemented.

In addition to these requirement-gathering interviews, I have also conducted a focus group session with a sample of players from the team in order to gather their opinions on how the current system they use could be improved, asking them to highlight any problems they encounter during its use. Having researched numerous existing systems, I also questioned the group on their views towards several functions such existing systems offered, asking them to highlight whether they would be useful in regards to their activities as players.

Through both the interviews and focus group sessions I conduct I was able to form the following list of functional and non-functional requirements that have been sub-sectioned into their relevant categories. The key points from the user interviews and the player focus group can be found in Appendix A and B.

#### **Functional Requirements**

#### **System Credentials**

#### 1.0

The system will only permit users access to the web portal if they provide valid user credentials at the system authentication screen. Any users who do not provide authorised credentials will be denied access to the system.

#### Acceptance Criteria

- 1. User cannot submit a login form without completion of all required fields.
- 2. System must validate the username and password fields of the login form to ensure they are formatted correctly and containing the correct characters to abide by both the username and password policy.
- 3. System will verify if the user login is successful by directing them to their home screen.
- 4. System will notify the user if the username or password is incorrect, not disclosing which field was correct or incorrect.
- 5. System will enable users who have forgotten their password to request a password reminder and reset though the use of a memorable term.

1.1

The system will provide the administrative user with an interface and the functionality to create user profiles in order for the created user to have access to the system, using their email as the unique identification key.

### Acceptance Criteria

- 1. System will not allow administrator to submit a new user form without completing all required fields.
- 2. System will validate the users input to ensure fields abide by any policies associated with them.
- 3. System will allow administrator to assign site the new user can access.

1.2

The system will provide the user with an interface to view each user profile, displaying their associated information and their user account type.

#### Acceptance Criteria

1. Full user profile information will be displayed along with user profile image if present.

#### 1.3

The system will provide the administrative user with an interface to remove user accounts from the system, denying them access to the system and its resources.

## Acceptance Criteria

- 1. Administrator can temporarily deny a user access by deactivating the users account.
- 2. Administrator can permanently deny user access by removing the users account from the system permanently.

1.4

The system will provide each specific user and the administrative user with an interface and the functionality to insert and edit the user profile information, which is displayed to other users of the system.

#### Acceptance Criteria

- 1. User cannot save changes if all compulsory fields are not complete.
- 2. System will notify user if fields do not meet validation requirements of specific fields.
- 3. System will notify the user that the changes have been saves to the system.

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#### Calendar

#### 2.0

The system will allow users to create, edit and remove calendar events to the communities shared calendar, which will be visible to all personnel registered to that specific team or community. Calendar events will consist of several fields of information related to the event, which will be displayed to the user viewing the calendar.

#### Acceptance Criteria

- 1. User cannot create a new event without completing all compulsory fields.
- 2. User must complete all compulsory fields when editing calendar events before the event can be saved.
- 3. Deleted events must be removed from the calendar facility.
- 4. Events must only be viewable by users who are members of the group calendar the event has been added too.
- 5. All events that are set to appear for the logged in user will be present on the users calendar.

#### 2.1

The system will allow users to export the calendar to external applications, by providing a specific URL for the calendar, allowing the calendar to be viewed in both web and mobile applications.

## Acceptance Criteria

- 1. User will be presented with a specific URL to be used for the calendar selected.
- 2. Calendar URL will be specific to the logged in user and will contain all of the users scheduled events.
- 3. Calendars, which do not have permission to be shared, will not provide a URL to the user.

#### Messaging

#### 2.2

The system will provide users with an interface and the functionality to create new messages to send to other active users within their community.

#### Acceptance Criteria

- 1. All active users within the logged in users community will be present in the users message window.
- 2. Non-active users will not be present in the users message window.
- 3. Users will be notified if the option is selected, of any messages they have received from other users.
- 4. Users will be able to select whether they will appear online or offline in the users message window.

#### 2.3

The system will provide users with an interface and the functionality to view received messages sent to them from other users within their community.

#### Acceptance Criteria

- 1. Users will be presented with a notification for each message they have received.
- 2. Users will not be able to receive any messages from other users outside of their community.
- 3. All messages the user has received will be displayed in the users messaging interface.
- 4. The number of messages the user has received will be displayed in the messaging interface.

#### 2.4

The system will provide users with an interface and the functionality to hide messages they have received from other users within their community by closing the messaging interface.

#### Acceptance Criteria

1. Closed messaging windows will no longer appear in the users messaging interface.

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## 2.5

The system will provide users with the option to receive desktop notification of any messages they receive through the messaging facility.

## Acceptance Criteria

- 1. Users will only receive notification if they receive messages.
- 2. Users will not receive repeated notifications of messages they have received.

### **Question List**

### 2.6

The system will provide an interface and the functionality for the user to create a question list, consisting of a maximum number of 20 questions, and will allow the user to send this list to specific users within their community.

### Acceptance Criteria

- 1. Users will be able to specific where completed question lists will be stored.
- 2. Users will be able to specific where completed question lists will be sent to via specifying an email address.
- 3. Users will be able to specify the question to be asked and specify any pre-set answer if multiple choice.
- 4. Users will be able to add or remove questions.
- 5. Non-administrative users will be unable to change the questions contained within the question list.

### 2.7

The system will provide an interface and the functionality for the user who receives a question list to answer each question and send the answered questions back to the sender.

### Acceptance Criteria

- 1. Users will be presented with options to answer all questions specified questions.
- 2. Required fields must be complete before the user is able to submit their question list.
- 3. Users will be notified when the question list has been sent successfully.

### 2.8

The system will provide the user with an interface and the functionality to edit a specific question list or to remove the question list from the system completely.

### Acceptance Criteria

1. Users will be notified if changes have been made successfully.

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- 2. Users will be notified if changes are not made successfully due to incompleteness of the configuration form.
- 3. Users will be notified if the question list is removed successfully.
- 4. Removed question lists will no longer appear on associated users portal interfaces.

2.9

The system will provide the user who has sent the question list with an interface and the functionality to view question list responses from users who have received the question list.

### Acceptance Criteria

- 1. Only administrative users will have access to the viewing and download facilities of the question list.
- 2. All answered question lists will appear on the administrators interface.
- 3. Answered question lists will be downloadable as a CSV file.
- 4. Administrators will be able to reset the question list in order to remove all previous answers.

## File Management

### 2.10

The system will provide the user with an interface and the functionality to upload PDF, Microsoft Office and image files to the system, which will be stored on the systems server.

## Acceptance Criteria

- 1. Users must be able to enter details such as a title and description for the file being uploaded.
- 2. Users must complete required fields in the upload form interface before initiating the file upload.
- 3. User uploading the file must have to option to specify who can view the file.
- 4. System must notify user of successful or unsuccessful file upload.
- 5. Files will be uploaded with the same file name and extension as specified during the file browse form option.

### 2.11

The system will provide the user with an interface and the functionality to download files uploaded to their community file management facility for viewing on their own device.

# Acceptance Criteria

- 1. Each file will provide the user with the option to download it, displaying the file size.
- 2. On selection, the file download option will navigate the user to a new window with the option to download the selected file.
- 3. Downloaded file will have the same file name as which was used to store it on the system server.

### 2.12

The system will provide the user with an interface and the functionality to remove files that have been uploaded to the system.

### Acceptance Criteria

1. Deleted files will be removed from the system file management facility.

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2. Users will be provided with a conformation if the file removal was successful.

## Performance Video Clip Streaming

3.0

The system will allow users to select individual athletes who have competed in recent competitive performances, allowing them to view all associated video clips the athlete was tagged in from that performance.

## Acceptance Criteria

- 1. Users will be presented with the option to select multiple individual athlete clips if present.
- 2. The system will only concatenate clips of the individuals the user has selected.
- 3. Athletes who have not competed in the selected performance will not be displayed to the user as options for selection.

3.1

The system will allow users to select specific clip collections from recent competitive performances, allowing them to view all associated video clips from each collection from that performance.

# Acceptance Criteria

- 1. Users will be presented with a selection list of all collection options.
- 2. Only clip collections that exist within the users selected performance will be displayed.
- 3. System will only stream any clips tagged by the specified collection tag and will not stream clips that are not tagged using the specified collection tag.

## **Testing Video Clip Streaming**

3.2

The system will allow users to view athlete testing video clips, displaying all associated information regarding each test clip and the athlete completing it on the users viewing screen.

## Acceptance Criteria

- 1. The system will display the selected video clip in the users window.
- 2. The system will only display the video clip the user selected and not any other video clips.
- 3. Information associated with the video such as the video title and description will be displayed beneath the video player.

# **Video Clip Annotating**

3.3

The system will allow users to annotate clips though the use of comments, which will be associated with a specific time stamp on the video, displaying the annotation when the time stamps coincide.

## Acceptance Criteria

- 1. Users will be unable to submit annotations if all required fields are not complete.
- 2. Annotations will only be displayed at the specific timestamp they are issued.
- 3. Annotations will display the user who created it and its text content.

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### **Performance Statistics**

### 3.4

The system will provide a user interface and functionality to display competitive performance statistic reports, along with associated graphs of these statistics.

## Acceptance Criteria

- 1. System will only display statistics for the select competitive performance.
- 2. Graphs will provide an accurate representation of the selected competitive performance match statistics.

## **Testing Statistics**

### 4.0

The system will provide an interface and functionality for the user to enter player-testing statistics, which will be linked, to the users specific profile they apply to. These statistics will be stored on the system each time they are entered, providing a history of testing scores for each user who has completed testing procedures.

### Acceptance Criteria

- 1. Users will be unable to enter statistics without completing all required fields.
- 2. Statistics will be linked to the athlete they are entered for, and will only be displayed for the selected athlete.
- 3. Non-existing users on the system will be unable to have testing statistics entered for them.
- 4. The system will notify the user if statistics are stored successfully.

### 4.1

The system will allow users to view their history of testing scores entered into the system, providing a graphical representation of key tests in order to provide a visual comparison of athlete physical performance.

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## Acceptance Criteria

- 1. Only statistics linked to the specified user will be displayed.
- 2. One the key test selected by the user will be displayed for the selected athlete.
- 3. Graphical representations will accurately display the athletes testing scores.
- 4. Graphical representations will only display statistics for key tests.

4.2

The system will provide the user with a ranking table of athlete key physical performance test scores.

## Acceptance Criteria

- 1. The system will provide the user with the option to select various tests to base the ranking table upon.
- 2. The system will sort the data in order of best performance to worst performance.
- 3. Ranking tables will be based upon the statistics entered for each specific individual, using the most recent entries to be displayed in the table.

# **Physical Monitoring**

4.4

The system will provide an interface and the functionality for users to create physical monitoring surveys, allowing the user to host these surveys within the community to other users.

# Acceptance Criteria

- 1. User will be unable to submit the monitoring form questions without completing all required fields.
- 2. System will notify user of successful monitoring test submission.
- 3. User will be restricted to a maximum of 20 questions per monitoring test.

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### 4.5

The system will allow the user who has created the physical monitoring survey to view users answers and will identify any concerning answers by monitoring user answers.

### Acceptance Criteria

- 1. User will be able to view all completed physical monitoring surveys.
- 2. System will notify user of the number of physical monitoring survey which have been complete and by who they have been completed.
- 3. Survey creator will be notified of any concerning answers using extreme values as bookends.

#### 4.6

The system will provide an interface and the functionality to allow users from the community to answer a physical monitoring test and allow them to submit their answers, saving them to the systems storage resource.

# Acceptance Criteria

- 1. User will be unable to submit monitoring form without completing all required fields.
- 2. System will notify user of successful monitoring survey submission.
- 3. User will be restricted to answering one physical monitoring test per day.

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### Non-Functional Requirements

### **Performance**

5.0

Response time for video clip dissection and video clip concatenation should be no greater than 5 minutes.

5.1

The system should be able to host a minimum of 5 video packages upon its server's storage facilities for access to the web portals users.

## **Usability**

6.0

Technical elements of the system should be easy to understand and the overall purpose of the system should be clear in regards to the functions it provides, aiding the overall task completion rate.

6.1

Technical elements of the system should be outlined in the system user manuals, which should be complete and up-to-date, and help guides should be present where applicable.

6.2

The system will be easy to learn and remember; leading to a reduction in task completion time, until a reasonable task completion time plateau is attained.

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6.3

The system shall provide appropriate error messages for technical aspects where validation, verification or run-time problems may be encountered. Error messages shall be informative, and aid the resolving of user problems.

6.4

The system shall provide an aesthetically attractive layout and colour scheme, which should aid the users learning of the system, making common tasks intuitive as a result of consistent layouts and colouring.

## Security

7.0

The website portal should be inaccessible to unauthorised external personnel who do not have an account on the system.

7.1

The website portals sub-sites should be inaccessible to both existing users and external personnel who do not have permission to access the system.

7.2

The web portals user access rights should restrict unauthorised personnel accessing facilities which are not required for them to complete there required tasks.

# Reliability

8.0

The system should be recoverable in the result of failure without corruptions, within 24 hours of the system failure incident being reported.

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8.1

The system should require minimal maintenance, with the exception of essential scheduled updates, no substantial maintenance should occur in addition to the scheduled uptime to downtime ratio.

## **Availability**

9.0

The system should be accessible to any user who has access to update versions of the four most popular web browser facilities (Internet Explorer, Safari, Google Chrome and Mozilla Firefox).

9.1

The system should be available 24 hours a day during system uptime periods.

9.2

The system should have an uptime to downtime unit ratio of 99:1, making the system available on an annual basis for at least 361.35 days, with a downtime of 3.65 days.

9.3

The system should be backed up on an incremental basis every 24 hours, using a separate server located in a different geographical location to the system server.

# Maintainability

10.0

The system should have a mean time to repair of no greater than 4 hours in the event of a minor failure to the system occurring.

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10.1

The system will enable system administrators to clear cached content and free up memory resources without being detrimental to the systems performance, or affecting the systems availability.

10.2

The systems modularity will ensure that failure of one module does not cause the failure of other modules, which do not use that module as a source of resources.

## **Manageability**

11.0

The systems performance statistics should be displayed within the web portals system performance monitoring facility to view a graphical representation of key system metrics.

11.1

The systems logs should be available to the administrator through the use of the system performance monitoring facility.

11.2

The system will share key roles between multiple users to aid recoverability in case of system administrators being unable to access the system at a particular time.

# Scalability

12.0

The systems storage capacity should be scalable to increase the number of video packages and other resources, which are made available to the systems user, through the purchasing of additional hardware.

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12.1

The systems processor and associated process memory should be scalable to increase the number concurrent processes the system is able to execute successfully at any given time.

12.2

The system should be scalable in regards to using additional servers in order to create a cluster of servers for coping with additional user capacity demand.

12.3

The systems shall offer a technical development resource to enable extension of core functionalities to be developed by others through the sharing of entity models.

12.4

The system information processing, storage and usage shall be documented logic model, which should be available for the creation of new rules.

12.5

Technical functionalities of the system shall be structured in a modular manner, where separated modules/functions can be mixed and assembled to meet each organisations requirement specification.

12.6

The system will use a Service Orientated Architecture (SOA), clearly outlining the various layers of the module in regards to the framework, and its interface, process, service and data layers.

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# Capacity

13.0

The system should support a maximum of 50 concurrent users, without performance degradation.

13.1

The system should handle cases of reaching maximum user capacity by reducing performance, in order to manage multiple user requests.

# System Design

# Interface Design

In order to make the system accessible to all types of users, the system will implement the Bootstrap User Interface framework. The framework is the most widely used of its kind in regards to providing a readymade solution to User Interface design, providing an effective solution to responsive design. The frameworks ability to accommodate a multitude of devices is vital in providing the same level of functionality to all Internet devices. With the proportion of smartphone owners Internet usage currently standing at 80% (Bosomworth, 2015) and increasing annually, the system must provide the same level of service to all devices able to access it. As the Bootstrap framework is pre-configured enabling development to use its existing classes and options, the time saved during the implementation stage in regards to addressing the usability and aesthetic qualities of the system provides more time for development of functional backend development.

In addition to the consistency the framework offers throughout the interfaces of the system, it also provides a uniform platform in regards to the video analysis and strength & conditioning portlets developed to integrate into the Liferay Portal Framework. The Portal Framework also uses the Bootstrap frontend framework as a result of its responsiveness and compatibility for future web development with its integration of both HTML5 and CSS3. The front-end framework is also customisable in regards to its colour scheme, elements and layout, enabling developers to tailor the system to their own requirements. In regards to aiding the development of this system, the Bootstrap framework is also well documented, providing convenient access to specific information that the developer requires, enabling less time to be wasted when learning the system. The framework has also been developed using a modular approach using an effective architecture to combine libraries to create a library that effectively facilitates rapid web-development.

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The User Interface design prototypes are present in Appendix C, illustrating the integration of the Bootstrap User Interface Framework in the proposed system and its current integration into the Liferay Portal Framework. The Portal Framework also provides an additional portlet known as AlloyUI (Liferay, 2014), enabling the full customisation of the User Interface theme and layout of the Portal's sites and their subsequent pages.

# System Overview

# High Level System Architecture

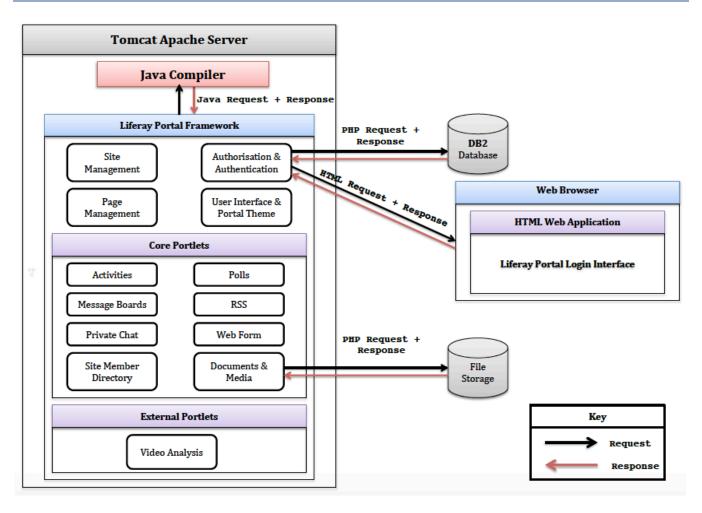


Figure 3 - High Level System Architecture

### **External Portlet Architecture**

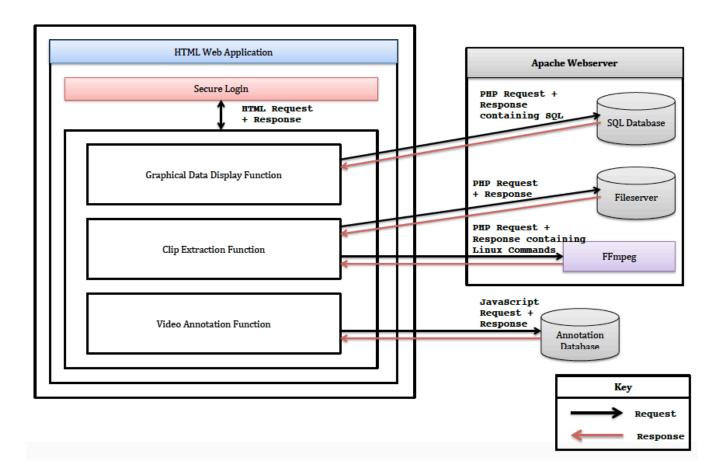


Figure 4 - External Portlet Architecture

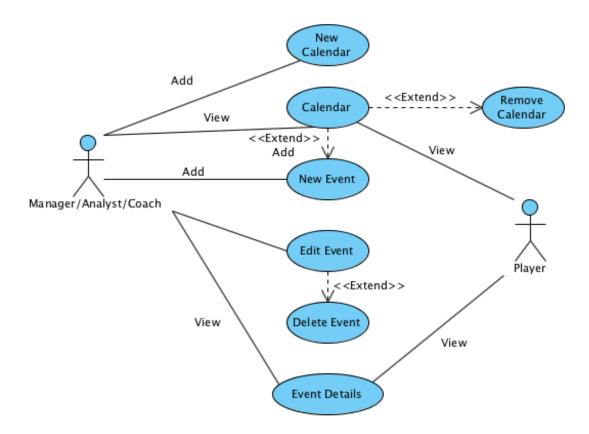
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## **Use Cases**

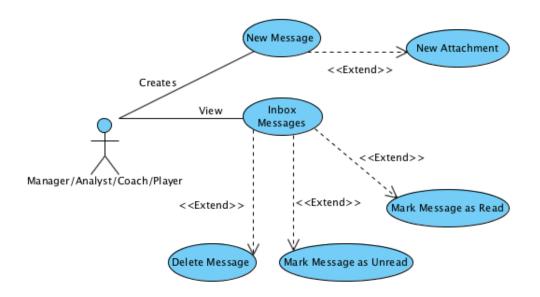
The project systems Use Case diagrams below outline the main success scenario's for each of the systems proposed functionalities, illustrating the varying alternative flows that may occur based upon the option selected by the user. As a result of the role permission system enforced by the Liferay Portal Framework, the options available to each user is also demonstrated in the Use Case diagrams, providing a visual representation of such user permissions.

The common precondition for all use cases illustrated for this system is the requirement of each user completing a successful login procedure prior to being able to interact with the system and its components. In addition to this, video analysis and strength & conditioning portlets will require additional authentication procedures due to the confidentiality of data which is vital to organisations such as the Cardiff Blues competitiveness in their business environment.

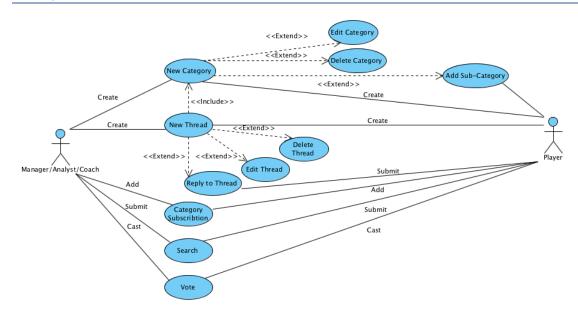
# Calendar



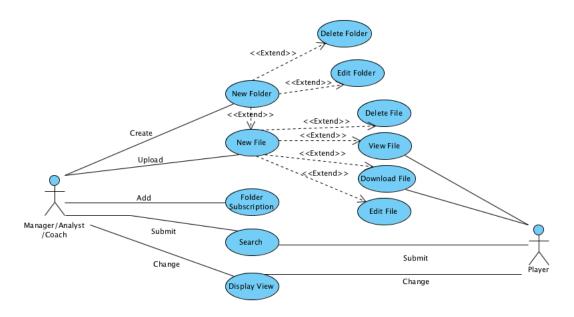
# Private Messaging



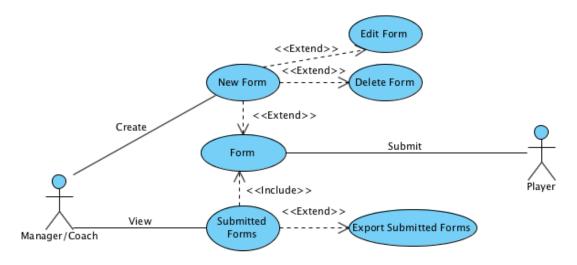
## Group Chat



# File Manager

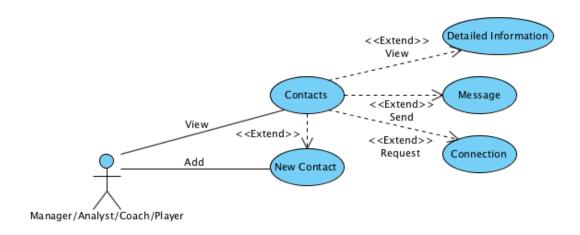


### Review Form

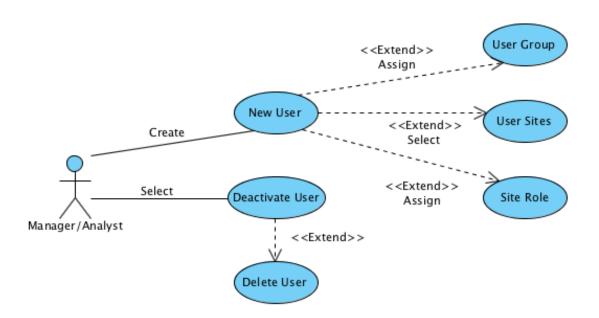


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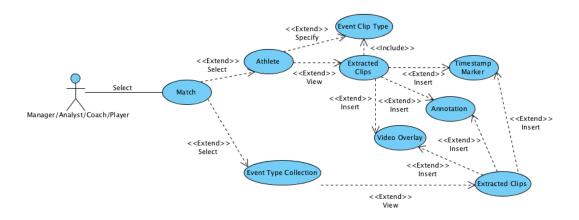
### Contacts



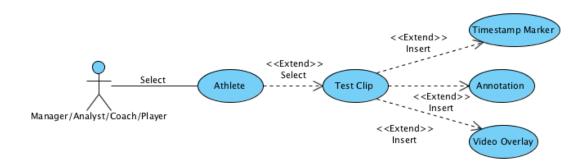
### User Management



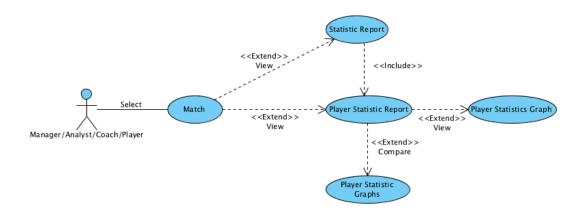
### Match Clips



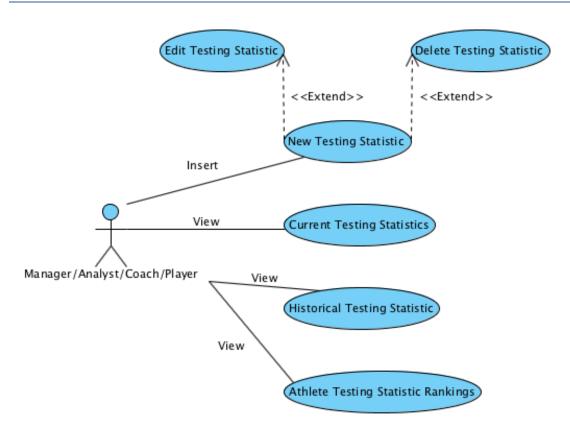
## Physical Testing Clips



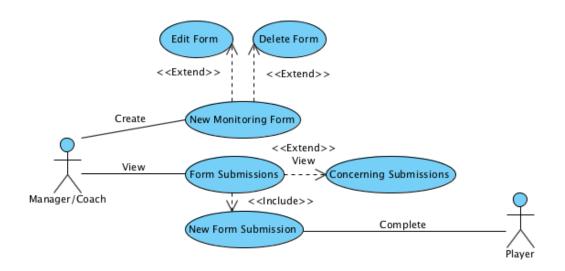
### Performance Statistics



# Physical Testing Statistics



# Physical Monitoring Test



## **Databases**

### **HSQL** Database

HyperSQL (The HSQL Development Group, 2014) is the pre-configured SQL relational database software written in Java that is provided within the Liferay Portal Framework package. The software provides a small, multithreaded database engine suitable for small-scale development within the Liferay Portal Framework. As this project is a prototype system I will not implement a compatible SQL database due to the time restrictions enforced in the project, however if the system were to be released for public use, a change in database software would be required due to HSQL's scalability as it uses execute operations within system memory.

As a result of the extensibility of the Liferay Portal Framework, the schema, which exists within the system, can be extensive as a result of the vast number of components that can be integrated into the system in the form of portlets. The core schema used within all systems comes in the form of user and permission management database that manages the users, groups, organisations, roles and permissions used within the system. The default database schema implemented by the Liferay Portal Framework is illustrated below:

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### Liferay Portal Users HSQL Entity-Relationship Diagram

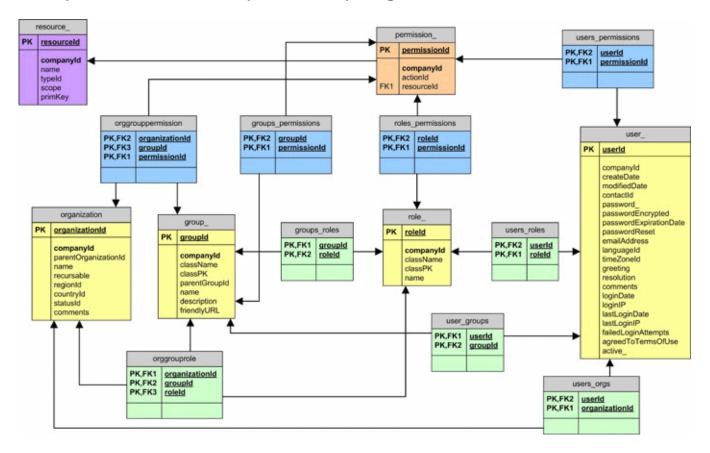


Figure 5 - Liferay Portal User Management ER Diagram

(Joseph Shum, 2006)

### **SQL** Database

In addition to the Liferay Portal Framework's user management database schema, the video analysis and strength conditioning portlets will use an additional isolated database in order to provide an added layer of security. As a result of the video analysis portlet and the strength & conditioning containing information and resources that are vital to the competitiveness of organisations such as the Cardiff Blues, there is an additional requirement to ensure that such resources are only accessible to authorised and authenticated personnel. Through the use of an additional login facility within the portlets themselves, this will provide greater security and

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will also enable the portlet itself to assign access permissions based on each user. This will ensure unauthorised personnel are unable to access, manipulate and use the system to perform tasks and obtain information they are not authorised to access.

As this database will only be required to store user information and associated testing and physical statistics, its schema will be static as the information which is stored will be consistent and will follow a general pattern. Therefore the system will incorporate an SQL relational database in order to control user access and store related data that will predominantly consist of integer and string data types, both suitable for storage within the database. Although the query time for relational databases such as SQL does increase in correlation with the volume of data stored in the systems database, the anticipated volume of data in the database is not expected to be vast as it will consist of only the necessary fields required to perform both the login and display athlete statistics. In order to ensure database efficiency and eliminate data redundancy, the database will be designed and implemented in third normal form.

#### Users Table Schema

Users							
#	Name	Туре	Length	Attributes	Null	Extra	
1	user_id	Int	11	Primary	NOT	AUTO_INCREMENT	
				Key	NULL		
2	user_name	Varchar	64	N/A	NOT	UNIQUE	
					NULL		
3	user_password_hash	Varchar	255	Unique	NOT		
					NULL		
4	user_email	Varchar	64	N/A	NOT		
					NULL		
5	user_role	Varchar	32	N/A	NOT		
					NULL		

6	user_weight	Float	11	N/A	NOT
					NULL
7	user_height	Float	11	N/A	NOT
					NULL

The user\_role field will enable the external portlets to check this value in order form a method of authorisation in regards to adding new content to the video analysis and strength & conditioning portlets. Through checking this value, the system will only allow logged in users with the required role to access such specific pages within the portlet.

# **Testing Exercises Table Schema**

Exercise Tests							
#	Name	Туре	Length	Attributes	Null	Extra	
1	exercise_id	Int	11	Primary	NOT	AUTO_INCREMENT	
				Key	NULL		
2	exercise_name	Varchar	128	N/A	NOT	UNIQUE	
					NULL		
3	exercise_details	Varchar	128	N/A	NOT		
					NULL		

# **Testing Statistics Table Schema**

Test Record								
#	Name	Туре	Length	Attributes	Null	Extra		
1	test_id	Int	11	Primary	NOT	AUTO_INCREMENT		
				Кеу	NULL			
2	user_id	Int	11	Foreign	NOT			
				Кеу	NULL			
3	exercise_id	Int	11	Foreign	NOT			
				Key	NULL			

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4	test_score	Varchar	64	N/A	NOT	
					NULL	

## **Security**

### Isolated Servers

In order to provide an added layer of security to the overall system, the Portal Framework and the external portlets will be hosted on separate servers. Through implementing the portlets that will host and provide access to vital information and video footage, any possible attacker will be required to access the portlets via the Portal Frameworks user authorisation and authentication, and in addition to this will be required to repeat a separate version of this process via the external portlets interfaces in order to gain access.

Through hosting the portlets on a separate server, the data contained within their associated databases will be stored in a different database to the Portal Frameworks database, which as described previously is currently implemented in Java based software, HyperSQL. Although this database is secure and the Portal manages the access to this database and the data stored within it, as the current servers at the Cardiff Blues use file storage facilities as opposed storing such video files in a traditional database. This project will therefore use a similar architecture in relation to the storage of such video footage due to the regular exchange of material within this file storage facility as new matches will be added on a weekly basis, and as a result old matches will be removed.

### Maintaining Servers

As new threats arise in relation to access protected systems, the Portal Framework server and the external portlet server will need to be maintained, and kept up-to-date by technical staff in order to ensure it is protected from emerging threats. Due to the Portal Framework being maintained by a third-party organisation that provide one of the largest open-source

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organisation Portal Frameworks, the maintenance and updates will be performed by Liferay and their developers. In regards to the updates required on the external portlets server, such updates will be required to be carried out by a system administrator who will need to ensure the Php login and access scripts, and the hosting software is kept up-to-date and is capable of restricting all possible threats, notably by ensuring non-used ports are blocked to restrict access to hackers through this medium.

### **SQL** Injection Protection

As the system requires user input for specific pages such as those that require information or file uploads, the system must assume user supplied data is not safe. If malicious users were to send potentially dangerous information or commands via a form input into the systems user input fields, this data must be checked for HTML tags, removing them in order to ensure any script commands are not longer valid syntax. Any user input must also be encoded to ensure in the event of such malicious script being provided by the user, such script will be reformatted, forcing it to abide by the chosen encoding standard that is not harmful when displayed by the system. All user-entered data must also be validated prior to being stored into the systems database, ensuring the format and syntax of the users input meets prespecified requirements, prior to being transmitted.

### Safe Error Messages

As the system may produce error messages through users manually entering URL's and keystroke errors occurring, in the case of malicious attacks where all pathways into the system are probed, and in cases where the system is not able to process the users requests, the message displayed to the user must only contain relevant information to the user. These error messages should be configured to only make the user aware that an error has occurred and short instructions on how to recover from the error. Such error messages particularly in the

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case of database communication should not echo out such details to users who may use such details to conduct malicious attacks.

### Sensitive Information

As the external portlet will implement its own user authentication functionality, user confidential fields such as the users password must be transmitted and stored securely. In order to communicate the users password to the database were it is saved; the users entered characters will be processed using the PHP-5.5 password hashing and salting functions. Through the use of such libraries, the users password is never stored but instead is stored in a salted and hashed format. The salt is automatically generated through the use of the Php hashing function, consisting of a 60-character hash created through the use of the Php BCRYPT algorithm (Php, 2015), its pseudo code is present in Appendix D.

Through combining the users entered string and the randomly generated salt, once the necessary hashing of the string and the salt has taken place the produced outcome is stored within the database in its hashed and salted format. This value is then retrievable and verifiable through the reuse of the algorithm, its cost and the hash value, all the necessary information required to verify the users entered password match the specific details that are stored within the database.

# Pseudo Code

### External Portlet Login

```
Connect to host server

Select database

Select User table

if(submit button selected) {
    username = Entered username in login form;
    password = Entered password in login form;
    if (username or password are empty){
        return "Username and Password field must not be empty.";

}else{

password = encrypt_password(password);

query = query_database("SELECT user id, username FROM user table WHERE username='username' AND password='password'");

num = retrieve number of matched rows (query);
    if (num === 1){
        assign user id and start the logged on session;
        redirect to next web page
        exit();

}else{
        return nothing;
    }

}

Password = next veb page
    exit();

}else{
        return nothing;
    }

}
```

Figure 6 - Login Pseudo Code

### Video Clip Extraction - FFmpeg

```
match_xml = Selected match file from user form with .xml extension;
   match_vid = Selected match file from user form with .mov extension;
   event = Selected event from user form;
   time_array = ();
clip_array = ();
   Select match_xml from XML file directory;
   for each (element in match_xml){
11
12
       if (element === event){
           start = element.start_time;
13
14
           end = element.end_time;
           append time_array with (start,end);
15
16
17
  3
18
19
   for x in times{
20
       append clip_array with subclip(start, end);
21
23
   videos = [clip_array[i +1] for i in clip_array];
  all_clips = concatenate_videoclips(videos);
   all_clips.write_videofile("file/location/here.mp4");
```

Figure 7 - Video Clip Extraction Pseudo Code

# Limitations of Design

### Liferay Portal Framework

The Liferay Portal Framework enables the customisation of the layout of each developed portals pages, enabling the administrator specific how many columns the page should contain and the portlets that should be implemented within it. As these options are pre-configured there is a great deal of limitation in regards to the customisation of such pages in regards to both their layout and the structure of which its content is displayed. Portlets configured for the page appear in sub-divided elements, making them visibly separate from the page itself. Although this visual property does not affect the functionality of the page, it does however create a seemingly divided web page. As the framework is maintained and updated by third party developers, the display properties of the portlets cannot be altered.

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This is also the case with other User Interface attributes such as the CSS properties and JQuery plugins the framework uses. Despite these attributes being easily implemented in standard web-applications, as they are stored in separate files and linked to each page, in the case of the portal framework these attributes cannot be edited, making only preset colour schemes available for usage. This make the portal limited in its use as a multi-organisation wide web site as there is constrained differentiation levels between different sites, prohibiting the organisations colour schemes from being incorporated into the system.

In addition to this the Portal Framework also prohibits the customisation of portlet layouts, further eliminating the possibility of customisation to such entities. Although in the scope of this project this is not a problem as the functionality and interface is substantial for the systems purpose, if the system were to be expanded and greater functionality needed to be added to the system this could cause problems as the portlet would need to be redeveloped.

Another limitation of the use of a preconfigured Portal Framework in this project is the volume of unused classes and portlets that are included in the portals library. As the framework is designed to accommodate a wide variety of business environments, many of the features are present in the system but are not implemented or configured. As the design of the system is implemented using a modular, object-orientated approach, it is simple to follow API documentation in order to add new portlets for added functionality. In the case of removing core portlets it is difficult to determine the dependencies of such portlets as they are integrated in order to form the core portal system.

As is the case in this project, the implementation of a separate database to manage the external portlets content is necessary due to the complexity and compatibility of the portal in regards to database integration. As the portal is preconfigured with a database within its library it is difficult to integrate external databases without large volumes of reconfiguration occurring

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within the portlets and core functionalities that the portal provides. This is also the case when developing web applications within portlets, as they must abide by the communication restrictions enforced by the portal framework, limiting the functionality and methods such web application portlets are able to implement.

### **FFmpeg**

Although FFmpeg offers a wide range of multimedia handling tools, the library is unable to concatenate video clips that have different codecs. As a result of the varying video recording procedures and methodologies that exist in the world of sport, this could cause major issues if the system were to be scaled to a wider scope than this project. Additional video codec conversion procedures, provided by FFmpeg, would need to be carried out in order to make such footage compatible for the concatenation process.

One additional limitation to the FFmpeg libraries approach to extracting specific sections from a video input file is that the default commands do not accommodate multiple arguments for extraction. Due to this factor only single clips can be extracted from the input file at any on time without complex filters being implemented, even in the case of such filters being use these clips need to be concatenated. As each clip will be stored as a separate file they will need to be recorded once they have been created in order for them to be gathered and concatenated to form the final video file specified by the user. In order to overcome this, the implementation will require the use of a loop in order to iterate through all clips and then concatenate them at the end of the loop.

### **HSQL**

As a result of the Liferay Portal Framework library being preconfigured with a HyperSQL database, this form of data storage is only suitable for small-scale stand-alone applications. As this project is a demonstration of software, this database is sufficient as there will only be one

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user at any specific given time. Despite the HSQL software being capable of supporting concurrent streams of communication, its structure and design is only sufficient of supporting a small volume of read-write operations at any one time. In the scope of this project the number of operations is sufficient, however in the case of this software system being used organisation wide, this database would be completely insufficient as it is not scalable. If the system was required to support a multi-user distributed client system, the database software would need to be reconfigured in order to use software such as SQL. This software would support such a client-server architecture, enabling the database to be scaled using such methods as clustering (Guay, 2015), which would allow a high number of user requests to be distributed over multiple servers connected to the same database.

# Implementation

## **External Portlet Architecture**

## Video Analysis Portlet Architecture

In the initial system architecture in the design phase the proposed implementation of the system used the methodology of directly executing FFmpeg operations through the Apache Server's shell facility. Through the use of this methodology FFmpeg commands were directly executed using its preconfigured syntax, referencing each file from options selected in user interfaces such a web form. During the implementation phase, despite this approach being successful in regards to successfully executing the necessary command, in order to extract a specific section of video, this methodology increased the complexity and duration of time required in execute this command for each event. As the number of video extractions required for a match could be extensive, the time taken for each set of events to be extracted became a lengthy process as each clips video and audio footage needed to be extracted separately, and then combined upon successful completion to form each specific clip. This process was also repeated when concatenating the separate clips that had been extracted, using a FOR loop in order to iterate through the array of the successfully extracted clips.

In order to avoid this extensive process and speed up the extraction and concatenation process the approach to extracting and concatenating the video clips was changed, opting for the use of a Python library that served as a wrapper for the FFmpeg library. This Python library enables the same commands to be executed in a more effective manner, through concatenating the specific clips as they are extracted from the original video file. This is possible through storing the Python scripts on the same system server that the match video files are stored on, enabling these files to be accessed when required. This approach also allows the user selected

form values to be passed to the script as arguments, allowing them to be used as refinements during the extraction process. The new architecture is illustrated below in Figure 8 below.

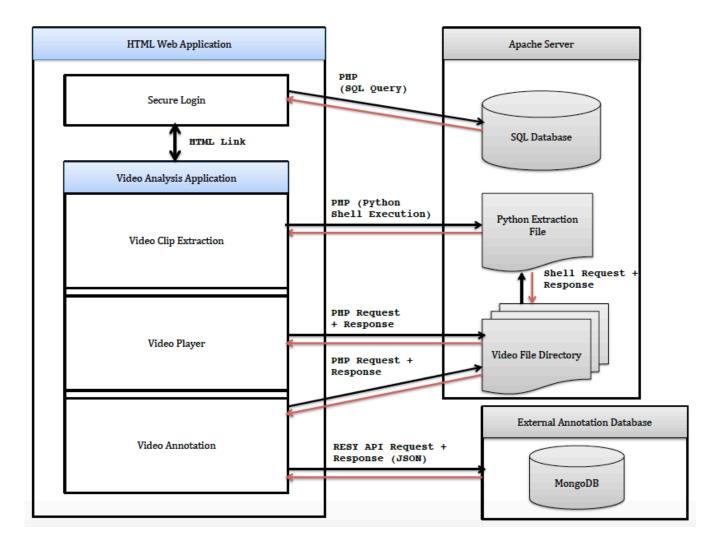


Figure 8 - Video Analysis Portlet Architecture

### S & C Portlet Architecture

The Strength & Conditioning portlet architecture has also changed in comparison with the original proposed architecture that combined both the Video Analysis portlet and Strength & Conditioning portlet. In order to allow for future expansion to each of the portlets and providing greater modularity, these portlets have been separated, as they will use different tools and libraries to perform their tasks. Alongside providing two distinct sets of tools,

through using a modular approach to the development of these portlets it will enable the system administrator to add or remove each portlet to a page within the portal. This may be necessary if the system administrator is performing maintenance or updates on the portlet, allowing it to be removed whilst such procedures are being carried out. The amended architecture is illustrated below in Figure 9 below.

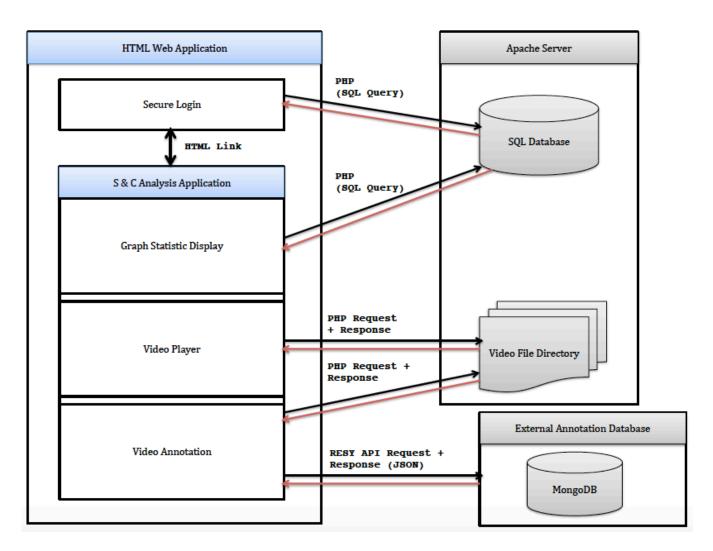


Figure 9 - S&C Portlet Architecture

## Login System

### **Purpose**

The independent login system for the video analysis and strength & conditioning portlets will provide a method of controlling access to the external portlets, preventing unauthorised users from accessing the functionality that the portlets offer. Through providing a secondary authentication process this also prevents unauthorised users from accessing the portlet directly, by passing the portals authentication process completely. As both the video analysis and strength & conditioning portlet will contain valuable information regarding both individual players and the team as a whole, along with enabling access to important video footage, such resources must be protected to ensure unauthorised access does not occur. In order to register new users to both external portlets, the system will only allow users with sufficient permissions such as 'Managers' and Analysts', to register new users. This will ensure no unauthorised users are able to register an account and access the external portlets facilities and resources.

In addition to deny access to unauthorised users, this login system will also ensure the organisations abides by any legal obligations such as the Data Protection Act (1998), which may be enforceable if the systems was to be expanded to store additional personal information. If such data stored on the system was obtained by unauthorised personnel and used for purposes other than for which it was obtained for, this would inevitable contradict the Data Protection Act and could lead to serious legal consequences being enforced upon responsible entities.

#### **Functionality**

The login system consists of 3 main functionalities in order to complete all processes required for registering, logging in and logging out a user. Each section of the login systems

functionality uses different methods and techniques in order to process, store and retrieve data, enabling the system to use the users information throughout its interfaces.

### Registration

The registration process uses a HTML form in order to gather the users required information, using a PHP class in order to perform tasks such as checking form fields are present, validating the format of user input and verifying the user has entered the correct information they intended to enter. This class uses multiple if statements in order to ensure such conditions are met, if the necessary conditions are not met by the users then a PHP error message is generated, informing the users of any conditions which were not satisfied and providing additional information on how to ensure their input satisfies the preset conditions. Through using such methods, no data is sent to the systems database prior to all conditions being met.

It is also necessary to ensure users have not used SQL or JavaScript code injection methods to conduct malicious attacks on the system, such as inserting SQL or JavaScript commands into form fields. In order to ensure entered fields do not contain any forbidden characters, the PHP tag stripping functions is used to remove such characters and ensuring all input is plain text. Once this input has been cleansed and processed, the users entered username and email form values are crosschecked with existing records in the systems user database to see if they already exist. If these values are original and do not already exist then they are added to the database. The users password and password verification field however are processed prior to being stored in the systems database. These form values are first verified in order to ensure they match and the user has entered the same intended characters for both fields. Once the verification process has successfully been passed, the users password is hashed using the PHP 5.5 password\_hash function that uses the BCRYPT algorithm to create a 60 character string through the use of salt and cost values which can be either automatically assigned or manually specified. Once the password has been be encrypted it is stored in this encrypted form in order

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to ensure if anyone were to gain access to the systems database, the original password value would not be retrievable as it will be stored in its encrypted form. This value will then be compared with the users entered value each time they attempt to login in the future, comparing the entered value with the stored value after performing the same operations on the users input.

The registration process also allows the system administrator to assign a role within the system for each user in order to outline the rights the user has in relation to what pages and functions they are able to access and use. This role field will be added to the session variables for the user when their session is successfully created during the login process. Users who have a manager role within the system can perform this role assignment when registering new users to the system.

### Login

Similarly to the user registration process, the login process also uses a simple form to gather user input and process the form field contents. The fields are processed using the relevant validation checks in order to ensure they meet the required format and have not been left blank. As both the users username and email address must be unique within the user database, the user is able to login using either of these values along with the their specific password. The username form value is also cleansed using the same process as in the registration form before it is compared with the values within the database in order to locate the specific password hash for that user. The users password entered into the login form is then verified with the password stored within the user database using the PHP 5.5 password\_verify function. On the occurrence of a successful match, the users data is written to the PHP session in order to be used within the users session. The user is notified of any errors that may occur due to the wrong username or password being used but is not informed which value is incorrect. Upon successful login the user is redirected to the systems

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home page and is assigned a user login status, which is used in order to monitor throughout the system if the user is logged in or not, redirecting the user to the login page if they are not logged in.

### Logout

The logout function uses the assigned sessions variables created in the login process and destroys these variables in order to end the users sessions using the PHP session\_destroy function. The user session variable is then set to 0, making the user unable to access any web pages that require the user to be logged in to the system.

### Justification of Implementation

PHP is a widely used and tested languages for implementing login methods such handling user input through web forms in order to perform operations such as login, logout and registration procedures. The language provides a variety of tools and methods for the handling of login information such as emails, passwords and other content, in order to provide a secure login interface to a web application. Due to the variety of versions of PHP the system also needs to have a fallback methodology of handling such login processes as the password encryption process carried out in this system. The fallback methodology used within this implementation is created to ensure the registration and password clarification processes carried out during the registration and login procedures are still able to take place if the PHP version used on the server does not support the functions used within the registration and login classes.

## Video Annotation

### **Purpose**

The video annotation function allows users within the organisations community to access recent match video footage in order to interact with the video through adding their own comments about the content of the video they are viewing. This functionality allows users to add comments in relation to the videos content, the knowledge and views of each user is reflected within the video through such comments, aiding the leaning process of all users within the organisations. Through adding such metadata to fragments of video, specific sections of match footage is not only easier to locate, and also provides a method of encouragement for all personnel to engage with the footage, highlighting points of strength, weakness or interest within individual and team performance. This feature also enables other viewers to view all annotations made on specific sections of the video, enabling users to quickly locate the most popular sections of video in regards to user comments for their own viewing.

#### **Functionality**

The system will provide three main functionalities in relation to the video annotation process, combining together to enable to creation, viewing, and statistical comparison of video annotations.

### **New Annotations**

The system enables the creation of new annotations through the use of several open-source JavaScript libraries that have open API's, enabling them to integrate with one and other to form new library capable of adding annotation to video. The Annotator JavaScript library enables the annotation of elements within web pages, providing a small pop-up form upon the selection of an element in order for users to add their annotations to that specific element. The

OpenVideoAnnotation project captures the annotator's functionality through using its methods and construct on video footage. The video annotator is initiated through creating instances of the annotator object in relation to a specific element on the web page, in the case of this project it was the HTML5 video element configured using the VideoJS JavaScript library. As the user select the 'New Annotation' button that is integrated into the VideoJS video player, an instance on an annotation is created as shown below in Figure 10 below.

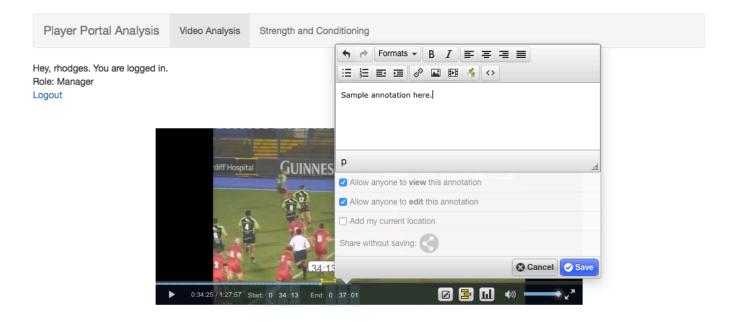


Figure 10 - Video Annotation Interface

The annotation instance also combines with the RichText, Geolocation and Share plugins in order to allow the user to add variety of different forms of content, add their current location, and share the annotation with other users through communication mediums such as email or via a social network. These plugins add additional data to the annotation that is stored using a unique ID field. This ID is then used to retrieve annotation which correspond to the specific web page and element they were created upon, enabling multiple videos on the same web page to have individual annotation databases stored on the annotation server. As the purpose of this project is to demonstrate the functionality of the video annotation plugin, the feature

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will use the library developer's demonstration storage facility in order to provide a full range of the video annotators methods of functionality. The multiple libraries are initiated through the creation of an instance of the Open Video Annotation library show below in **Figure 11**, loading the annotator plugin in addition to the preconfigured options for storing, retrieving and displaying the annotations within the specified element.

```
//Load the plugin Open Video Annotation
var ova = new OpenVideoAnnotation.Annotator($('#match_video'),options);
```

Figure 11 - Initialising Open Video Annotation Plugin

### **View Annotations**

The system implements an additional plugin in order to load and display the annotations which exist for the specific video on the web page, and the exact locations of which the user annotations have been inserted are outlined. The VideoJS RangeSlider plugin, implements a function to enable the retrieved annotations obtained from the annotation database, and their relevant timestamp values, to be displayed to the user. The plugin highlights specific sections of the video timeline where annotations have been inserted and upon being selected by the user, the start and end times of the annotations time range are loaded within the video player. The system allows the user to view all of the annotations that have been specified as being 'viewable' by their creator, displaying a visualisation of all annotations made to the video as shown below in Figure 12.

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Figure 12 - Annotation View Interface

Each highlighted range can then be selected, with the video range loaded by the video player and the users comments viewable in the popup display as shown below in Figure 13. These comments can be edited or deleted by the user who created them at any time, allowing comments to be amended if necessary.



Figure 13 - Annotation Interaction

#### **Annotation Statistics**

The feature also allows the functionality to view where on a particular match annotations have taken place, the number of annotations that have been created, and any trends in the creation of annotation through using the annotation data to create a graphical representation of such statistics. Through this functions users are able to locate particularly interesting sections of videos in order to view other users comments, or add their own as show below in Figure 14.

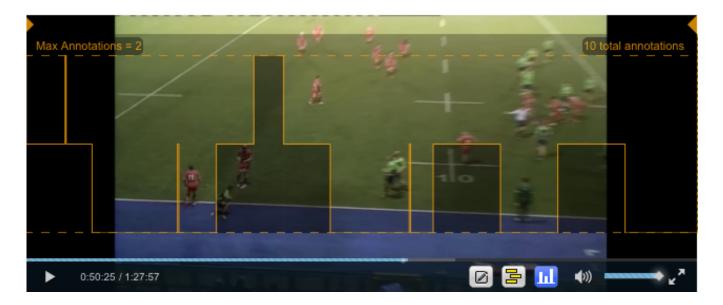


Figure 14 - Annotation Statistics View

### Justification of Implementation

The VideoJS video player is a simple HTML5 media player capable of displaying multiple format of video, this is vital for this project as the video footage used can be inconsistent and be recorded in a number of formats. Alongside building upon the HTML5 video player, the library offers an open API in order to allow customisation of the video player and its control panel, allowing other libraries to interact with the video player, as is the case with the Open Video Annotation library.

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As the VideoJS library is one of the most widely used HTML5 video players there is also a vast amount of documentation and libraries developed in order to allow additional functionality and features to be added to the basic video player. The library also allows interaction with other elements on the same web page, enabling developers to create new methods of interactions such as in the annotator library.

The Open Video Annotation library is used in order to combine multiple JavaScript libraries that interact with the VideoJS library, enabling these additional features to interact with each other to create an improved user experience. As the majority of configuration is pre-implemented in this library, this saved valuable time during the implementation of this feature as it only require configuration within the page and the storage facility, and not the full implementation of the functionality. The library has also been vastly tested and used by multiple academic organisations for use within high traffic scenarios such as that of student-lecture video annotation, to identify where key information resides within lecture videos. As the Player Portal traffic will comprise of a similar traffic flow to that of an academic institution, with multiple clients accessing the system at any given time, the library will be sufficient in supporting such user interaction.

The Annotator library is also fully compliant with the Open Annotation standard, providing the opportunity for these annotations to be integrated and used in the future with other applications which implement the standard.

## XML Data Extraction

### **Purpose**

In order to extract the required data from the SportsCode generated XML files, containing the specific events that occurred during each match video, the use of Python XML library is required. The Python module ElementTree is an XML API that creates a tree representation of the XML document, enabling the querying of the elements within the tree, that represent the nodes within an XML document. The elements can then be queried to see if they correspond to the selected events the user has chosen, if so they are then queried at element level in order to retrieve data specific to the node itself such as the start and end time of the specified event, known as child nodes.

### **Functionality**

In the scope of this project the ElementTree module was used in order to read the selected events specified by the user to create the desired collection of clips. In order to perform this task, the Python script reads the specified XML file using the ElementTree parse method, creating the tree structure of the XML file. This structure is then queried from its root element using the findall method in the ElementTree library. This method locates only elements with the specified tag/s within the tree structure that are direct children of the selected element. As the XML file created by the analysts uses the syntax 'instance' in order to specify an event, each of these child nodes are queried in order to find the 'code' node that specifies the event type. Within this 'instance' there are several corresponding values, one being the 'code' node, the 'start' node, and the 'end' node. Through the use of these two nodes the start and end time for the element can be retrieved in order to use these values as arguments when completing the clip extraction process. This process of retrieving and storing each matching 'code' nodes 'start' and 'end' values is carried out on all nodes within the specified XML file as

shown in Figure 15 below. An example of the structure of the XML nodes and attributes can be found in Appendix E.

```
#!/usr/bin/env python
from moviepy.editor import *
import xml.etree.cElementTree as ET
video_file = "../media/video/141126_(U18)_Blues_22-3_Scarlets.mov"
xml_file = "../media/xml/141126_(U18)_Blues_22-3_Scarlets.xml"
instance = ":SCRUM"
tree = ET.parse(xml_file)
root = tree.getroot()
allInst = root.findall('ALL_INSTANCES/instance')
clips = {}
count = 0
for event in allInst:
    if event.find('code').text in instance:
        count = count + 1
        id = event.find('ID').text
       start = event.find('start').text
        end = event.find('end').text
```

Figure 15 - XML Node Extraction

### Justification of Implementation

Although Python offers a range of available packages in order to handle XML, the ElementTree packages provides a lightweight XML API that provides a more efficient method for parsing and creating XML. The package is available in a C based implementation that is 15-20 times quicker than the Python version of ElementTree (Lundh, 2005), and significantly faster than the DOM package available in Python. In comparison with other options the C based package is also able to parse XML documents without reading the entire document into the systems memory. This reduced memory load is vital in relation to the number of potential

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requests the systems server is processing at any given time as it could result in vast waiting time, or even failure to complete user requests.

The package is also well documented, providing sufficient information on how to load, query and extract XML entities from the XML file. As the script has been designed in order to accommodate the WRU schema of analyst coding methodologies, the script outlined uses the event identifier 'code' in order to obtain information about an event. This has been used as the XML files I have been provided with follow this particular schema as opposed to other schemas that are used by other organisations.

## Video Clip Extraction

### **Purpose**

The video clip extraction is vital in allowing users to select specific type of clips from an entire match and combine them to create a customised collection of video clips. The system will provide an interface for the user to select the desired types of clips available from each match. The values selected within the form in the interface will be used in order to extract the chosen nodes from the XML file and their specific time nodes. In order to extract the video files using the node values acquired from the XML match file, a method of extracting the video and audio frames from the original match footage was required. In order to extract such footage the use of the FFmpeg library has been chosen due to the vast number of tools it offers. However, as opposed to directly executing FFmpeg commands through the server's shell, a Python package that uses the FFmpeg library through the implementation of a wrapper was chosen. This module is known as MoviePy (Zulko, 2015), and allows the basic FFmpeg tools of editing, cutting, concatenating and adding input to video footage. The module is able to handle a wide range of formats due to the integration of the FFmpeg library, and therefore is able to perform the operations required on the original match footage.

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The MoviePy module allows clip extraction through the creating sub-clips of the original footage for each instance of an event. These clips are then listed as the extraction arguments are created before iterating through each of the extraction arguments in the list, and combining them to create a new video file consisting of only the specified video clips the user has selected.

### **Functionality**

### Extraction

The first function used within the Python extraction script is the MoviePy clip extraction method. This method uses the FFmpeg library in order to extract a sub section of a video file using a range of parameters. In order to create the collection of clips specified by the user, each instance of the clip type needs to be located within the original video footage using the corresponding time stamps associated with each instance. Once the required arguments have been supplied to the script from the XML script prior to it, each clip can be added to a list of clips to be extracted from the original video footage.

In order to perform this operation within the Python language, using the MoviePy library, the initial creation of a variable for the event occurs, followed by the argument for the video file that the user has selected. This same variable is then appended with the sub clips start and end time to be used to locate the specific section of video to be copied. These times are extracted by the ElementTree XML module in the Python string format, however due to the requirement of the MoviePy sub clip function requiring the time to be in the Python float format, the start and end time variables must be transformed before the clips can be extracted. Once the extraction arguments are in their complete form within the array, each argument is added to the final array, used in the concatenation argument.

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### Concatenation

The second function used within the Python script is that of the concatenation of the extracted sub clips in order to create one video and audio file containing the users required footage. The MoviePy module provides a wrapper for the FFmpeg concatenation function that allows sub clip arguments to be embedded within the functions list of video to concatenate. Through using the MoviePy wrapper to make use of the FFmpeg libraries range of functions, the concatenation process can be more efficient as the extraction and concatenation process can be completed in one operation, as opposed to two separate operations in the case of issuing executing FFmpeg in the server command line. Upon successful completion of the clip concatenation, the file is saved in the specified location, enabling the quality of output video to be specified here and any additional options required to format all clips in a consistent manner. The resulting code for this process can be viewed below in Figure 16. The system outputs the progress of the resulting extraction and concatenation processes progress whilst the script is being executed. This output can then be used in order to inform the user of the progress of the extraction process using this output to create on screen notifications.

```
clips = {}
count = 0

for event in allInst:
    if event.find('code').text in instance:
        count = count + 1
        id = event.find('ID').text
        start = event.find('start').text
        end = event.find('end').text

        clips[count] = VideoFileClip(video_file)
        clips[count] = clips[count].subclip((float(start)), float(end))

videos = [clips[ i+1] for i in range(count)]
result = concatenate_videoclips(videos)
result.write_videofile('Scrum.mp4')
```

Figure 16 - Video Clip Extraction and Concatenation

### Justification of Implementation

The use of the MoviePy module within Python simplifies the process of extracting video in comparison with executing command line prompt through the server itself. As Python provides greater error feedback to the developer when implementing the script, the debugging process is conducted with greater information than what would be available otherwise. The MoviePy module is also simple in regards to its syntax as it uses the basic format of the command followed by the arguments. In comparison with using FFmpeg through the command line interface, this is a less complicated approach to executing such commands. This simplicity has also made it more efficient for in regards to only performing one operation that combines both the extraction and concatenation of the video clips within one process. This also aids the end user, as they will not have to wait for two separate processes to be completed before the end footage is produced. Although the time taken to conduct the process will heavily depend on the end systems hardware and software, the command line execution should in theory be faster. Due to the script requiring integration with an XML parser, as

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Python accommodates this requirement, the option to use the MoviePy wrapper to use FFmpeg tools provides an all in one solution to the problem.

In addition to this, Python and the available modules also have a vast collection of detailed documentation regarding their use and examples of how such modules can be used. This also aided the development of the extraction and concatenations scripts, as although there were no existing examples for solutions to the problem, there was however several examples of the functions the script would require. As I had also developed using the Python language prior to this project, I also had experience in solving some of the problems I encountered such as resolving list indexing problems that arose when configuring the listing procedure for clip concatenation.

Pythons popularity as a web platform and as the provider of services to web applications is increasing rapidly in recent times. This is due to Python being simple and minimal in comparison with other languages, requiring a small quantity of lines of code, leading to the likelihood of issues occurring being reduced and as a result making debugging processes simpler. Python is also relatively easy to lean, as mentioned previously, due to Python having a wide variety of wrappers for other complex packages, the usability of the language is simple and intuitive, making development and release of software faster.

# Liferay Portal Framework

### Purpose

The Liferay Portal Framework provides the architecture and core functionalities for the managerial column of the Player Portal system. As the frameworks core portlets consists of several functionalities that aid the management of personnel, resources and information, its use as a web platform tis unrivalled by any other open-source portal framework. The framework enables the use of developed portlets for facilities such as; calendars,

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announcements, document and image management, message boards, polls, user directories and web forms. These functionalities are part of the core framework provided by the Liferay Community Portal and require basic configuration in order for them to be integrated with the user management system. The Portal also provides a consistent user interface through the use of the Bootstrap CSS and JavaScript libraries, creating an immersive and dynamic user experience through the implementation of further capabilities such as dynamic page loading through the use of AJAX.

As the framework provides detailed resources for integrating new portlets, the system will also host a private chat portlets that will enable users to communicate through direct messaging. This portlet require initiating within the core framework through adding an instance of the portlet to the frameworks list of enabled portlets. Due to the portlets compatibility within the portal being aided by the SDK, the communication between the core portal and the portlet is performed via the enforced methods.

The portal framework will also be used in order to host a point of access to the video analysis and strength & conditioning applications through the use of an external portlet frame. This feature enables the access to external applications via an integrated portlet interface within the system, creating a consistent and integrated user interface.

### **Functionality**

#### Calendar

The calendar portlet enables users to enter event details such as the event title, date, time, location and additional information, in order to create a schedule for users within the organisation to be able to view. Such events can be specified as to where they should be displayed, within both individual or shared calendars, enabling the user to have their own personal calendar, in addition to the shared organisation wide calendar. Events created within

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these calendars can be edited and deleted by the user who created them, enabling any errors or changes to be undertaken.

Each user can also add additional calendars to the calendar portlet, allowing the user to have a combined calendar displaying all events relevant to them. These additional calendars can be removed and exported from within the portlet, enabling users to use the provided link from the system to sync the calendar to their own devices. In addition to handling the creation, amendment and deletion process of calendar events, the portlet also enables users to add resources to specific events such as additional information for the created event. These resources can also be amended and deleted by the user who created them, and can be viewed and searched for by users within the organisation.

### **Review Forms**

The form portlet enables the facility for players within the organisation to conduct match self-review forms through providing a set of specific questions and in some case pre-defined answer options. Each match review form can be re-configured by an admin user, allowing them to: edit questions, add additional questions or make any other amendments they deem necessary. Once a player has completed the created review form, the administrators can view their answers in order to gain an insight into the player's perception of their performance. An administrative user such as a manager can then use this information in order to aid the players review process during their video analysis sessions.

Player's answers from match review forms can also be saved and downloaded by admin users in order to keep a record of past reviews as a marker to gauge any future progress the player has made. These answers can also be emailed to the specified email addresses that are configured when the review form is created, allowing recipients to view each player's answers as and when they are completed.

### **Polls**

The poll portlet within the portal framework enables admin users to create multiple polls to be viewed and answered by all users within the organisations online community. The facility allows admin users to create polls consisting of several questions with varying user input selections available; allowing the user to select the intended users the poll should be cast to. The poll can also be edited or removed by its creator, enabling any changes to be made to the poll; these changes will also be communicated to users. Upon publishing each poll users are able to select their specified option that the publishing user has specified, presenting the poll creator with a graphical overview of the number of votes each option has received. The poll creator will only allow each user within the organisation to vote once, enabling administrative users to gather information such as player preferences.

## **User Directory**

The user directory portlet enables users to view other members of the organisations site, listing each user and additional information such as contact details, roles and the organisations they belong too. This portlet also allows users to search for other users within their organisation in order to refine the users displayed in the directory and locate specific individuals.

### File and Media Manager

The file and media management portlet within the portal framework conducts the handling and viewing of user-uploaded files. The portlet allows users to create categorised folders in order to store documents and media files within. The user can tag resources added to these folders in order to facilitate searching for them at a later date. These tags can also be used to sort such files into related categories, allowing users to view related files conveniently. Any files or folders the user has created can also be edited, moved or deleted by their owner or the site administrator. As the portlet supports a vast number of file types, the majority of

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documents can be viewed through the user selecting the specific file. The system then processes the file in order to configure the reader and display the files contents to the users. As files may be added to a specific folder on a reoccurring basis, users can also subscribe to folders in order to be alerted when any changes occur to this folder.

### **Message Board**

The message board portlet enables users from within the organisation to communicate in an organisation and collaborative manner, allowing users to share their own input into specific topics. Administrative users are able to create categories for discussion to be organised into, aiding the retrieval of information process. These categories can also have child-categories embedded within them to further aid this process of discussion thread retrieval. Users will be presented with an overview of each category in regards to the number of sub-categories it has and the number of threads each category contains. Users can then view each thread, including specific details such as; who it was started by, how many posts it contains, how many views it has had and when the last post took place. Upon selection of this categories or threads, users can create their own thread or response to a thread in order to publish their input to the rest of the community. This publication can be edited or removed at any time by the user who created it, or an administrative user of the system.

Users are able to conduct several tasks in regards to existing threads and their input into the topic of group conversations. Users are able to reply to threads either directly to the posting user or to the thread in general. Each post within the thread can be voted in regards to its value in relation to the thread, positive votes increasing its values, negative votes being detrimental to its value. If specific threads are of interest to the user they are also able to subscribe to the thread in order to being notified of any new posts that have taken place, creating a productive and aware user community.

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In relation to locating specific posts, users can conduct their enquiries through either filtering or searching the use posts. Through filtering posts users can view threads they have subscribed too, have posted on or are the most popular posts within the users community. User searches can also be conducted in order to refine the posts in relation to the keywords they contain, retrieving only the relevant posts and as a result aiding the retrieval of information.

### **Private Chat**

The private chat portlet enables users from within the same organisational site to communicate on a 1-to-1 basis through an instant messaging facility located within the footer of every page within the site. This portlet enables users to send messages to friends within their community when they are online, notifying the user of any messages they have received from other users of the site. Such received messages can also be configured to alert the user through their desktop notification software, integrating the messaging process and ensuring users are notified of an incoming message as soon as possible. This communication process facility is vital during occasions where users such as player want to ask coaches questions in a private manner; ensuring unintended users are unable to view the messages between the sender and the recipient.

### Justification of Implementation

The Liferay Portal Framework provides a sufficient set of core functionalities in order to implement a dynamic and functional organisational web site. As the portal provides a basic framework in the form of a website with a user management facility, the portal can be used in multiple instances to serve several different organisations. The portal framework is extremely flexible in regards to the customisation that can take place within each organisations site, allowing each instance to be configured using different portlets to satisfy the organisations

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specific requirements. As each site within the portal is connected due to its parent site being the Player Portal framework, users can be added to each site as and when the site administrator from each site chooses to do so. This allows wider organisations to communicate with one and other over a common communication facility. As the basic features of the system are implemented in the portals basic framework sufficient time is also saved during the development process as configuration of the portal is well documented by the Liferay organisation, and a wide range of community support is also available.

As the core portals functionality is limited to a user management system, it is dependent on the compatible portlets in order to conduct any additional functionality. The Liferay organisation provides a wide range of compatible plugins in order to provide other functionalities to the user. As the majority of tasks the users are required to conduct are based around the managerial column of the system, many of the portlets already developed within the Liferay community are sufficient for use in the Player Portal system. These pre-developed portlets only require configuration within the portals source files and additional configuration if any further customisation is required, such as the redirection of users upon completion of tasks and the level of user privilege each portlet is accessible too. These configurations require sufficiently less time and resources to develop, enabling more time to be spent on developing other parts of the system.

The Liferay Portal Framework uses the open-source Bootstrap CSS and JavaScript libraries in order to create a consistent and dynamic Graphical User Interface. This library enables the system to have an attractive and uniform theme throughout the entire site, also allowing externally developed portlet to use the same library and integrate seamlessly with the core system.

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## Results and Evaluation

In order to evaluate the extent of which the system has achieved the intended aims set out at the start of the project I will test each fully developed module using a series of test cases. The outcomes of these test cases will aid my final evaluation of the system as a whole. As many of the modules used within the system such as the core portlets used for the managerial tasks, have been tested by the developing entity, Liferay, these portlets will not be tested in within the testing scope of this report.

## **Testing**

Testing will be separated into white box and black box testing procedures where appropriate throughout the developed system. This will provide a deeper level of testing within critical features and will allow modules that are not fully developed to be tested and enable an indication to be gained as to where any problems may reside.

### External Portlet Login

The following test cases have been developed in order to evaluate the functionality of external portlets login system. As the login system has been implemented in order to add an additional layer of security to the system, its functionality must be tested fully to ensure no resources or functionalities are accessible to unauthorised users. These tests will be undertaken using black box testing procedures, concerning the functionality of the unit within the system.

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## Test Case ID: 1

Test Case ID: 1	Test Purpose:	Sub-System: Login	Preconditions:
	Successful Login	Unit	Successful Portal
			login, Player Analysis
			portlet selected
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	Enter correct	Username input field	Pass
	username.	accepts users input.	
2	Enter correct	Password input field	Pass
	corresponding	accepts users input.	
	password.		
3	Select 'Sign In'	Login class initiated	Pass
	button.	and user presented	
		with 'Menu' screen.	
Comments: Test	Related Tests:	Author: B.Thyer	
successfully			
completed.			

# Test Case ID: 1 – Evidence of Success

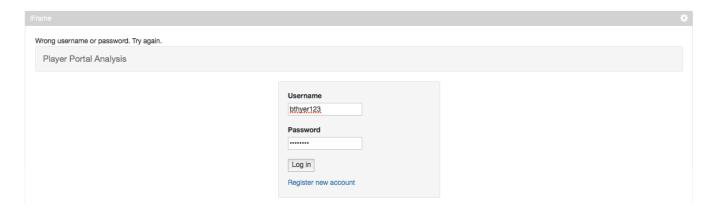


# Test Case ID: 2

Test Case ID: 2	Test Purpose:	Sub-System: Login	Preconditions:
	Unsuccessful login -	Unit	Successful Portal
	Username		login, Player Analysis
			portlet selected
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	Enter incorrect	Username input field	Pass
	username.	accepts users input.	
2	Enter correct	Password input field	Pass
	corresponding	accepts users input.	
	password.		
3	Select 'Sign In'	Login class initiated	Pass
	button.	and user login error	
		detected. User	
		notified of login error.	
Comments: Test	Related Tests:	Author: B.Thyer	
successfully			
completed.			

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## Test Case ID: 2 – Evidence of Success

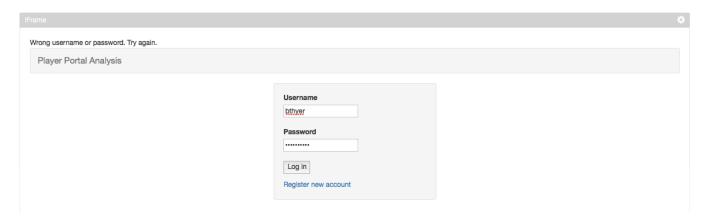


# Test Case ID: 3

Test Case ID: 3	Test Purpose:	Sub-System: Login	Preconditions:
	Unsuccessful login -	Unit	Successful Portal
	Password		login, Player Analysis
			portlet selected
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	Enter correct	Username input field	Pass
	username.	accepts users input.	
2	Enter incorrect	Password input field	Pass
	corresponding	accepts users input.	
	password.		
3	Select 'Sign In'	Login class initiated	Pass
	button.	and user login error	
		detected. User	
		notified of login error.	
Comments: Test	Related Tests:	Author: B.Thyer	
successfully			
completed.			

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## Test Case ID: 3 – Evidence of Success



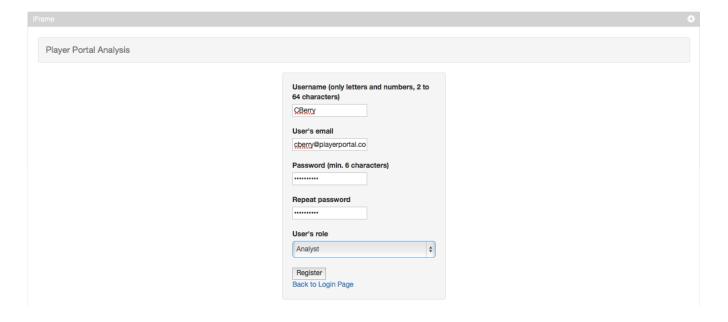
# Test Case ID: 4

Test Case ID: 4	Test Purpose:	Sub-System: Login	Preconditions:
	Successful	Unit	Successful Portal
	registration process		login. Player Analysis
			portlet selected.
			'Register New
			Account' option
			selected.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	Enter valid username.	Username input field	Pass
		accepts users input.	
2	Enter valid Email	User email input field	Pass
	address	accepts users input.	
3	Enter valid password.	Password input field	Pass
		accepts users input.	
4	Enter matching	Password repeat	Pass
	password repeat.	input field accepts	
		users input.	
5	Select user role from	Dropdown box	Pass
	dropdown selection	displays users	
	box.	selected role.	
6	User selects 'Register'	System initiates	Pass
	button.	Registration class and	
		notifies user of	

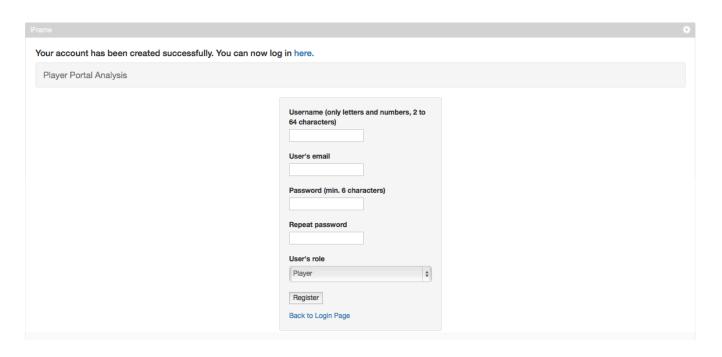
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		successful	
		registration.	
Comments: Test	Related Tests:	Author: B.Thyer	
successfully			
completed.			

## Test Case ID: 4 - Evidence of Success



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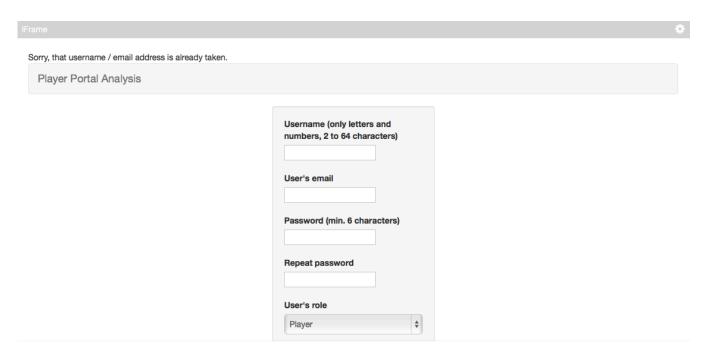


<b>Test Case ID:</b> 5	Test Purpose:	Sub-System: Login	Preconditions:
	Unsuccessful	Unit	Successful Portal
	registration process		login. Player Analysis
			portlet selected.
			'Register New
			Account' option
			selected.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	Enter pre-existing	Username input field	Pass
	username.	accepts users input.	
2	Enter valid Email	User email input field	Pass
	address	accepts users input.	
3	Enter valid password.	Password input field	Pass
		accepts users input.	
4	Enter matching	Password repeat	Pass
	password repeat.	input field accepts	
		users input.	
5	Select user role from	Dropdown box	Pass
	dropdown selection	displays users	
	box.	selected role.	
6	User selects 'Register'	System initiates	Pass
	button.	Registration class and	
		notifies user of	

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		unsuccessful	
		registration, notifying	
		user that the	
		username already	
		exists.	
Comments: Test	Related Tests:	Author: B.Thyer	
successfully			
completed.			

### Test Case ID: 5 – Evidence of Success

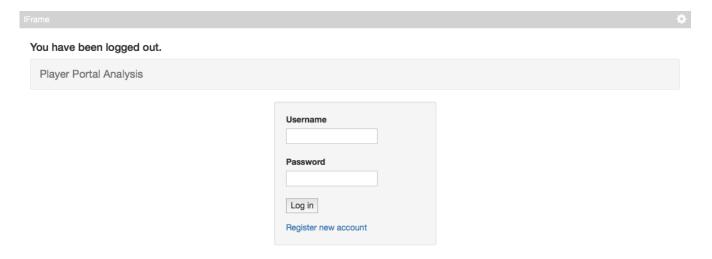


## Test Case ID: 6

Test Case ID: 6	Test Purpose:	Sub-System: Login	Preconditions:
	Successful logout	Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	Users selects 'Logout'	Logout process	Pass
	option in navbar.	initiated, system	
		destroys sessions and	
		deletes user cookies.	
		User is redirected to	
		'Login' page.	
Comments: Test	Related Tests:	Author: B.Thyer	
successfully			
completed.			

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## Test Case ID: 6 – Evidence of Success





# Video Analysis Portlet

## Test Case ID: 7

Test Case ID: 7	Test Purpose: Full	Sub-System: Video	Preconditions:
	Match Viewing	Analysis Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects match	System displays	Pass
	from dropdown	selected match in	
	option list.	dropdown box.	
2	User select 'View Full	Systems loads	Pass
	Match' button.	selected match into	
		HTML5 video player.	
3	User selects play	Video is initiated and	Pass
	option displayed in	then played.	
	video player.		
Comments: Test	Related Tests:	Author: B.Thyer	
successfully			
completed.			

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# Test Case ID: 7 – Evidence of Success

Player Portal Analysis Video Player Strength & Conditioning Signed in as bthyer Logout
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<b>Test Case ID:</b> 8	Test Purpose: New	Sub-System: Video	Preconditions:
	Match Annotation	Analysis Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login,
			Match selected and
			loaded
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects 'New	System displays 'New	Pass
	Annotation' button	Annotation' form.	
	on video player.		
2	User enters 'Start'	System accepts user	Pass
	and 'End' times into	input, loading start	
	video player input	and end times into	
	boxes.	range slider of video.	
3	User enters	System accepts user	Pass
	annotation text into	input.	
	text area input box.		
4	User selects	System accepts users	Pass
	annotation 'View'	checkbox selection.	
	checkbox option.		
5	User selects	System accepts users	Pass
	annotation 'Edit'	checkbox selection.	



	checkbox option.		
6	User selects 'Save'	System stores	Pass
	button.	annotation, loads	
		specified range into	
		range slider of video	
		player and initiate	
		video playback.	
Comments: Test	Related Tests: 7	Author: B.Thyer	
successfully			
completed.			

### Test Case ID: 8 – Evidence of Success

Player Portal Analysis Video Player Strength & Conditioning Signed in as bthyer Logout



Test Case ID: 9	Test Purpose: View	Sub-System: Video	Preconditions:
	Match Annotation	Analysis Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login,
			Match selected and
			loaded
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects 'Show	System displays	Pass
	Annotations' button	existing annotation	
	on video player.	range markers on	
		video player.	
2	User selects an	System loads selected	Pass
	existing annotation	annotation ranges	
	range marker.	into video player,	
		highlighting the	
		selected range and	
		initiates playing	
		video.	
Comments: Test	Related Tests: 7, 8	Author: B.Thyer	
successfully			
completed.			

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## Test Case ID: 9 – Evidence of Success

Player Portal Analysis Video Player Strength & Conditioning Signed in as bthyer Logout

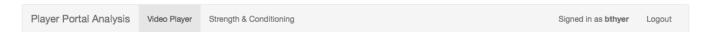


Test Case ID: 10	Test Purpose: Edit	Sub-System: Video	Preconditions:
	Match Annotation	Analysis Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login,
			Match selected and
			loaded
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects 'Show	System displays	Pass
	Annotations' button	existing annotation	
	on video player.	range markers on	
		video player.	
2	User hovers over an	System loads	Pass
	existing annotation	annotation text	
	range marker.	display window.	
3	User selects 'Edit'	System loads	Pass
	icon from annotation	annotation-editing	
	display window.	window, presenting	
		user with previously	
		entered annotation	
		content.	
4	User edits annotation	System stores edited	Pass
	text and selects 'Save'	annotation, loads	

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	button.	selected annotation	
		ranges into video	
		player, highlighting	
		the selected range	
		and initiates playing	
		video.	
Comments: Test	Related Tests: 7, 8, 9	Author: B.Thyer	
successfully			
completed.			

### Test Case ID: 10 - Evidence of Success





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Player Portal Analysis Video Player Strength & Conditioning Signed in as bthyer Logout



Test Case ID: 11	Test Purpose: Delete	Sub-System: Video	Preconditions:
	Match Annotation	Analysis Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login,
			Match selected and
			loaded
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects 'Show	System displays	Pass
	Annotations' button	existing annotation	
	on video player.	range markers on	
		video player.	
2	User hovers over an	System loads	Pass
	existing annotation	annotation text	
	range marker.	display window.	
3	User selects 'Delete'	System delete	Pass
	icon from annotation	annotation and	
	display window.	removes annotation	
		range marker from	
		video display.	
<b>Comments:</b> Test	Related Tests: 7, 8, 9	Author: B.Thyer	
successfully			
completed.			

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### Test Case ID: 11 – Evidence of Success

Player Portal Analysis Video Player Strength & Conditioning Signed in as bthyer Logout



Player Portal Analysis Video Player Strength & Conditioning Signed in as bthyer Logout



## Test Case ID: 12

Test Case ID: 12	Test Purpose: View	Sub-System: Video	Preconditions:
	Match Annotation	Analysis Unit	Successful Portal
	Statistics		login, Player Analysis
			portlet selected and
			successful login,
			Match selected and
			loaded
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects 'Show	System displays	Pass
1	User selects 'Show the Statistics' button	System displays statistics graph	Pass
1			Pass
1	the Statistics' button	statistics graph	Pass
Comments: Test	the Statistics' button	statistics graph overlay on video	Pass
	the Statistics' button on video player.	statistics graph overlay on video player.	Pass

• • •

## Test Case ID: 12 – Evidence of Success

Player Portal Analysis Video Player Strength & Conditioning Signed in as bthyer Logout



Test Case ID: 13	Test Purpose: Team	Sub-System: Video	Preconditions:
	Clips Extraction	Analysis Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects match	System displays	Pass
	from dropdown	selected match in	
	option list.	dropdown box.	
2	User selects 'Extract	Systems redirect user	Pass
	Clips' button.	to clip selection page.	
3	User selects 'Set	System display	Pass
	Piece' clip type from	selected clip type	
	dropdown option list.	option in dropdown	
		box and generates	
		associated event type	
		checkboxes.	
4	User selects 'Own	System indicates	Pass
	Scrum' and	selected checkbox	
	'Opposition Scrum'	options user has	
	event type checkboxs	chosen.	
	options.		
5	User selects 'Extract	System directs user to	Pass

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	C1: /1 II		
	Clips' button.	extraction page,	
		indicating clip	
		extraction progress	
		and presenting user	
		with a viewing link	
		once complete.	
6	User selects 'View	System registers user-	Fail
	Clips' link.	viewing request and	
		redirects user to view	
		the video clips.	
Comments: Video	Related Tests:	Author: B.Thyer	
clip extraction script			
is initiated by			
extraction form, user			
match and clip			
selection variables are			
not passed to			
extraction script.			

<b>Test Case ID:</b> 14	Test Purpose: Team	Sub-System: Video	Preconditions:
	Clips Extraction	Analysis Unit	Successful Portal
			login, Player Analysis
			portlet selected and
			successful login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects match	System displays	Pass
	from dropdown	selected match in	
	option list.	dropdown box.	
2	User selects 'Extract	Systems redirect user	Pass
	Clips' button.	to clip selection page.	
3	User selects	System redirects user	Pass
	'Individual Players'	to individual player	
	clip type from	selection page.	
	dropdown option list.		
4	User selects specific	System indicates	Pass
	player checkbox	selected checkbox	
	options.	options user has	
		chosen.	
5	User selects 'Extract	System directs user to	Pass
	Clips' button.	extraction page,	
		indicating clip	
		extraction progress	

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		and presenting user	
		with a viewing link	
		once complete.	
6	User selects "View	System registers user-	Fail
	Clips' link.	viewing request and	
		redirects user to view	
		the video clips.	
Comments: Video	Related Tests:	Author: B.Thyer	
clip extraction script			
is initiated by			
extraction form; user			
match and clip			
selection variables are			
not passed to			
extraction script.			

### Test Case ID: 13 & 14 – Reason for Failure

Although the extraction script is initiated by the users actions, the Php script does not pass the selected options the user has chosen to the Python extraction script, resulting in a video clip being concatenated using the default values.

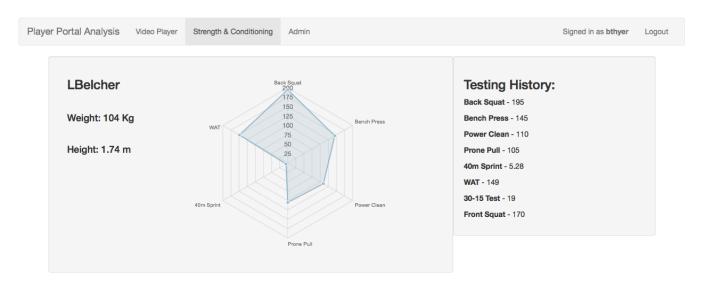


# Strength & Conditioning Portlet

## Test Case ID: 15

<b>Test Case ID:</b> 15	Test Purpose: View	Sub-System: Strength	Preconditions:
	individual testing	& Conditioning Unit	Successful Portal
	statistics graph and		login, Strength &
	history.		Conditioning portlet
			selected and
			successful login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects	System redirect user	Pass
	individual testing	to individual testing	
	records 'View'	profile page.	
	button.		
2	User selects 'Testing	System redirects user	Pass
	Statistics' option for	to selected	
	chosen user.	individuals testing	
		statistics page,	
		presenting user key	
		test radar graph and	
		testing history.	
Comments:	Related Tests:	Author: B.Thyer	

### Test Case ID: 15 – Evidence of Success

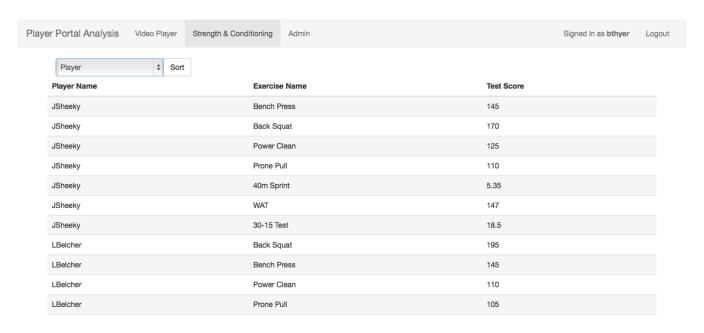


## Test Case ID: 16

Test Case ID: 16	Test Purpose: View	Sub-System: Strength	Preconditions:
	individual testing	& Conditioning Unit	Successful Portal
	statistics graph and		login, Strength &
	history.		Conditioning portlet
			selected and
			successful login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects team	System redirect user	Pass
	testing records 'View'	to team testing	
	button.	ranking page.	
2	User selects 'Player'	System indicates	Pass
	option from sorting	users selected sorting	
	options.	option.	
3	User selects 'Sort'	System reloads	Pass
	button.	testing ranking table,	
		sorting table records	
		by 'Player Name'	
		column.	
Comments:	Related Tests:	Author: B.Thyer	

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### Test Case ID: 16 – Evidence of Success

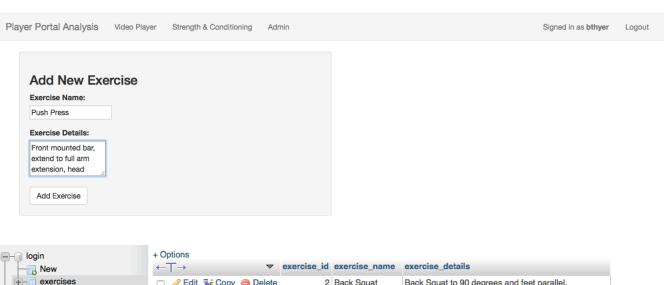


Test Case ID: 17	Test Purpose:	Sub-System: Strength	Preconditions:
	Inserting new	& Conditioning Unit	Successful Portal
	exercise.		login, Strength &
			Conditioning portlet
			selected and
			successful admin
			login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects 'Admin'	System redirects user	Pass
	tab from navigation	to admin page.	
	bar.		
2	User selects 'Add'	System redirects user	Pass
	button for 'New	to new exercise	
	Exercise' option.	creation page.	
3	User enters exercise	System accepts users	Pass
	name into input field.	input.	
4	User enters exercise	System accepts users	Pass
	details into text area	input.	
	input field.		
5	User selects 'Add	System executes SQL	Pass
	Exercise' button.	query, inserting user-	
		entered value into the	
		database and	

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		redirecting the user to	
		the admin page.	
Comments:	Related Tests:	Author: B.Thyer	

#### Test Case ID: 17 – Evidence of Success



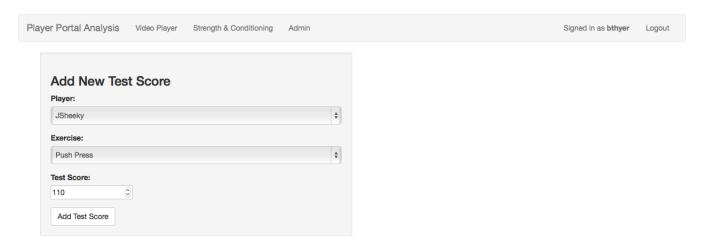


Test Case ID: 18	Test Purpose:	Sub-System: Strength	Preconditions:
	Inserting new player	& Conditioning Unit	Successful Portal
	test score.		login, Strength &
			Conditioning portlet
			selected and
			successful admin
			login.
Test Case Steps:			
Step	User Instructions	System Response	Result (Pass/Fail)
1	User selects 'Admin'	System redirects user	Pass
	tab from navigation	to admin page.	
	bar.		
2	User selects 'Add'	System redirects user	Pass
	button for 'New	to new test record	
	Testing Score' option.	insertion page.	
3	User selects selected	System indicates	Pass
	player from 'Player'	users selected option.	
	option field.		
4	User selects selected	System indicates	Pass
	exercise from	users selected option.	
	'Exercise' option		
	field.		
5	User enters numerical	System accepts user	Pass
	testing score into	input.	

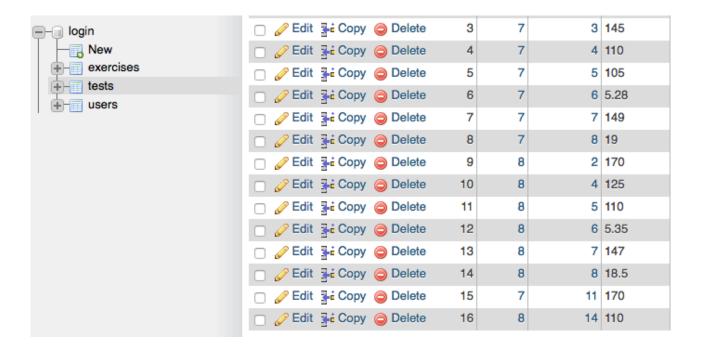
• • •

	'Test Score' input		
	field.		
6	User selects 'Add Test	System executes SQL	Pass
	Score' button.	query, inserting user-	
		entered values into	
		the database and	
		redirecting the user to	
		the admin page.	
Comments:	Related Tests:	Author: B.Thyer	

#### Test Case ID: 18 – Evidence of Success



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#### **Testing Summary**

Although not all aspects of the developed system have been tested, the tests conducted above indicate the majority of the systems originally developed functionalities behave correctly and satisfy a vast number of the original user requirements. As the portal frameworks functionalities are not original to this project, these methods and interfaces have not been tested in the scope of this project, but through my own use and through running tests with individuals from each user group, it is evident that these features and their functionalities behave as intended.

In regards to the extent of which the video analysis portlet satisfies its original user requirements, the test cases above illustrate only the only failures existing within the clip extraction feature. Although this features script functions correctly in its independent form, it is the communication of data between the web servers Php environment, and that of the scripts Python environment that causes this failure. Due to this failure, the video analysis

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portlets functionality is not fully complete, enabling users to view and annotate full match videos, but preventing the extraction specific clips from the video.

In relation to the completeness of the strength & conditioning portlet, the majority of the functionality required within this portlet, as proposed during the requirements section, has been implemented. The portlet enables users to view individual and team testing scores, allowing comparisons to be made between players. Administrative users are able to add new exercises and associated testing scores for each player. The only exception to this portlets development is that of the physical monitoring feature which has not been developed fully and will be developed further in the future due to its complexity.

In order to gain further confidence of the systems functionality, additional tests should be completed on the validation methods imposed in regards to the data entry processes that take place within the system. Although the user input is cleansed in regards to preventing SQL injection, the data is not validated in regards to its length, pattern or its contents format. This is important, as the system will be used by a wide variety of users, with varying understandings of how to use the system. Additional validation methods must be developed, integrated into the current system and tested against possible user inputs in order to guarantee the users input is valid.

#### Critical Evaluation

The managerial aims of the project have successfully been met through implementing the Liferay Portal Framework and its associated portlets that enable the users requirements to be attained. Communication between the different users of the system within the organisation is facilitated through the use of the private and public messaging facilities within the portal. These portlets enable users to communicate on both a one-to-one, and one-to-many basis, recording transcripts of each type of conversation. These features will reduce the use of emails

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as a form of communication to multiple individuals, providing a centralised point for communication and any relevant resources. The portals document management facility further provides a more secure and reliable access point to vital information resources, as it addresses the aim of enabling greater version control and more efficient sharing of resources. The implemented web form portlet also addresses the problem of players manually filling out review forms, instead providing a centralised access point to a pre-defined web form, allowing managers to view each players answer immediately after their submission.

In relation to the aims of the video analysis portlet, the portlet enables all users of the system to contribute to each player review process through the video annotation facility. The portlet address the aim of allowing coaches and player to conduct player review processes through highlighting specific section of videos and providing information in relation to the highlighted clips. The feature also allows use to mark specific ranges of a match in order to highlight its content to other users, increasing the knowledge sharing within the organisation. Users are able to view statistical reports of each match in order to view their own, other players and general team statistics of each performance. One aim that has not been achieved in the project at present is the extraction of specific clips from the original match day footage, using the XML nodes that exist in the generated event files. The system currently executes the script, however the communication of user selected values into the script is not currently functioning correctly, leading to video clips being extracted using the default script values. As the methods used within the script are functioning successfully, the one additional configuration required is correctly executing the script from Php, whilst also passing the users form variables to the script to be used to configure the video file, XML file and the selected events the user has chosen to extract. Although this feature is not functioning correctly at present, its functionality will continue to be worked up in the future, leading to the production of a complete video analysts portlet.

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When evaluating the original aims of the strength & conditioning portlet, the portlet enables users of the system to view individual testing statistics in order to gain an insight into each player's physical attributes and testing history. Coaches are then able to view associated testing video in order examine and analyse each players technique in the specific benchmark lifts. The portal also enables users to view ranking tables of the players, in regards to both the testing scores and each key lift. One feature that originally existed within the aims of the portlet is that of a physical monitoring test that would enables athletes to input answers to key questions, and the system would process these inputs and provide instructions for the user to follow if any answers were of concern, highlighting such answers to the strength & conditioning coaches. As the feature is more complex than I originally anticipated its implementation will be carried out in the future of this project in order to ensure it meets the required user specifications.

In regards to the development methodology chosen, this has been a problematic choice in regards to its uncompromising structure, particularly during the later stages of the project. As a result of the design of the whole system being carried out so early in the project, it was difficult to incorporate the proposed design choices throughout the whole system. This was particularly evident in during the implementation of the video analysis extraction feature, where the proposed implementation of using the FFmpeg library directly did not function as efficiently and as effectively as possible. Despite spending a large duration of time developing this functionality through the use of command line execution scripts, the decision to change methodology and implement the functionality in the Python language was the best for the development of the portlet. As the development model in reality is not flexible in allowing these changes to be made in the latter stages of project, particularly during testing stages where often errors and malfunctioning code is discovered. The development methodology is also not as well suited to a modular development approach that would have best suited the

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development of this system in reflection. This has lead to one of the weaknesses of this system being that not all features within the original portlets have been developed, producing incomplete portlets in comparison with the original aims of each portlet.

In hindsight the original aims of the project, although accurate, were optimistic in relation to the time scale and the degree of functionality the system required to be implemented. As the original functionality of the system exists in the original portlets being developed, encompassing the video analysis and strength & conditioning functionality, these portlets should have been prioritised during the implementation stage. As the portal framework required considerable implementation and configuration in order to not only function but also to enable the external portlets to be integrated into the system, a considerable amount of time was spent in this area of the project before the unique functionality of the system began development. This decision to develop the managerial functionality was a positive one in regards to the overall completeness of the project system as a large proportion of the users requirements are met within these functions. In regards to the video analysis portlet however, this decision to focus upon the managerial functionality did reduce the amount of time available for its own development, and for the development of the strength & conditioning portlet.

# **Future Work**

### Dynamic Clip Extraction

At present the video clip extraction process is a static process, requiring a user to select specified options and then initiate the extraction process through submitting the extraction form, before being presented with the extracted video clips. These extracted clips are present within a new file, however in order to make this extraction process more efficient and allow the user to chose specific clips from the video to be viewed in the video element the use of dynamic script that would use the values from the XML file to load only specific sections of the video could be implemented. This implementation could use the JavaScript library such as Popcorn.js in order to use to video player timeline API in order to only play time ranges that exist within the users required clips XML start and end values. As this implementation would result in a heavy process load on the client's device, an implementation of this functionality on the server side of the system would be the most efficient solution.

## Multiple XML Schemas

As the system has been designed in order to accommodate XML schemas produced using the Welsh Rugby Union's coding conventions, XML schemas produced by other organisations such as SportsCode or OPTA that use other coding schemas will not be processed correctly by the script. In order to accommodate multiple coding conventions, the script should use a conditional statement in order to identify what nodes exist within the XML structure, before using these nodes to intelligently choose what nodes to locate in order to extract the specified values.

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### Multiple Video File Concatenation

The implemented script uses one instance of a video file and one of an XML file in order to extract the specified clips from the original match footage. However, in order to extract specific events from multiple match footage files the system could implement a multiple thread configuration that would enables the users specified events to be extract from multiple video files by accessing each files associated XML file. Each individual extraction thread could then be concatenated at the end of the script in order to provide a complete set of all event instances from multiple selected matches. Although this process would consume a large volume of processing and would take a considerable amount of time to complete, this functionality would allow users to analyse events across multiple matches, enabling the identification of any trends or patterns within each match.

### **Physical Monitoring Tests**

In relation to the future development of the strength & conditioning portlet, the implementation of a physical monitoring test facility is one of the key future developments as it is a feature coaches are monitoring manually increasingly more as new tests are evolved. Although a simple question and answer facility would suffice for the original user requirements, allowing a record to be kept of the athletes test answers and enabling coaches to view and analyse these answers. Development of this feature in the future could incorporate an element artificial intelligence in the form of a case-based reasoning script that would analyse the athletes answers and highlight concerning answers to coaches for further analysis. These cases could also incorporate the feedback of information to the athletes if their answers indicate specific signs, reducing the manual workload of coaches as they will be notified of any concerning results, but non-severe results can be managed by the system itself.

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As the data collected from such tests will also be personal information, there is an added requirement of data confidentiality that needs to be addressed. This could be addressed across the whole of the system through the encryption of the database that will store this information, as was used in the case of the password storage field where the users input was salted and hashed.

### Annotation of Individual Video Clips

As in the case of the full match video annotation facility, the possibility of implementing the same facility for individual video footage clips is also a future development I would like to implement. The feature would use the same functionality and methods as the full match video footage, however there would be a problem in relation to the number of individual's clips that would exist on the server, taking up a large volume of storage capacity in the long-term scope of the system. In order to overcome this issue, individual clips could be stored temporarily from 1-2 weeks before being removed and replaced by new footage, enabling the analysis process to be conducted on an individual basis in addition to the team focus of the full match analysis facility.

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### Conclusions

The main aims of the project have been met when evaluating the developed functionality, and proposed future development the system requires in order to fully satisfy the original user requirements. With the exception of the non-complete video extraction function, the remainder of the system has been tested and functions correctly, satisfying the majority of the system requirements and address the main aims of the project. The system in its current state completely supports all managerial tasks required by its end users, along with providing all necessary facilities, with the exception of the physical monitoring tests module that will be implemented in the future, for the strength & conditioning portlet. In regards to the video analysis portlet, the facility to provide an interface to undertake video annotation is a large proportion of this portlets functionality, enabling users such as players and coaches to be able to undertake analysis sessions from a completely new perspective, and with a greater proportion of possible inputs from other users.

As the system is not presently complete, only specific portlets have been tested on the end user in order to gain an insight into any changes that will be required in the future to fully meet the users needs. Through testing the video analysis portlets annotation functionality with video analysts at the Cardiff Blues, the general feedback was that the feature was a step forward in the review process currently in place, with great enthusiasm being placed on it for enabling experience players and coaches to also view highlighted video sections, in order to gain their input. This was highlighted as being particularly important for developing players who are not always able to gather this knowledge as the review process normally consists of only the player and the coach.

In regards to the user feedback on the strength & conditioning portlet, the coaches highlighted the importance of have a visual representation of testing data, making positive remarks

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regarding the radar graph that represents the key tests for each player. The coaches also commented on the integration of video testing clips into the portlet, as these clips are currently not available to players to review, adding a further opportunity for future development to be available to the players.

In conclusion, although the system is not fully complete and does not presently meet all the users requirements, I believe great progress has been made to developing an unique team management system that will become increasingly more important in the professional sports environment as more teams make use of this service.

# Reflection on Learning

In relation to my own learning throughout this project, perhaps the greatest learning I have encountered is the importance choosing the best-suited development approach. Although the chosen approach for this project suited the generation of the relevant documentation of this report, it perhaps was not the best choice in regards to the implementation style that best suits my own development and that of a system such as the Player Portal. Due to the system being modular is design and in development, an iterative approach for each of the columns of functionality may in hindsight have allowed the development and improvement of such functions to be considerably more effective. As this approach involves less documentation being produced as the development of the system often takes place first, documentation produced would have been regarding the final developments. This approach also enables greater user feedback to be gathered throughout the process as functioning features are produced earlier in the process, enabling user preferences to be integrated into the system earlier, and allowing the user to learn the system as it is being developed.

Another key learning of the development of this project is that of prioritising features to develop first and the features to be developed if there is time available within the scope of the project. Due to my goal of producing a whole system being ambitious, this list of prioritised developments would have aided my decision making in regards to what to develop at what stage of the project. This could have lead to a more complete system being produced and would have enabled future development to be centralised around a specific module of the system.

As my experience in both these areas in past projects had not negative, I have had no reason to question these underlying assumptions when developing software. However, as a result of this project, my experiences have changed in both these areas of software development as I

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now have an understanding of how different development approaches best suit different software projects. Learning how to chose such development models is something I am eager to gain more information on in my near future.



## **Appendices**

#### Appendix A – User Interviews Summary

#### **Video Analyst**

- Combination of team management and video analysis web application.
- Easily access video footage to replace with new video footage on a weekly basis.
- Permanently store team playbooks on the system and allow players to view these resources on the system itself.
- Allow review process to encapsulate actual video clips, with the ability of coaches and players to add comments to these video clips.
- Bookmarking video clips in order to share with other users.
- Method of announcing to users of any changes made to resources, schedules or other important information.

#### **Strength & Conditioning Coach**

- Ability to store athlete testing results on the system and view each player's results history.
- Allow comparisons between athletes testing scores to be made in order to rank athletes in relation to each exercise they test in.
- View video testing clips with possible integration of commenting on these clips.
- Physical monitoring questionnaires to ask each player a series of questions on a daily basis and monitor their physical condition. Possibly highlight to the coach of any concerning answers through email or notification on system.

## Manager

- Ability to create a central calendar consisting of events on the weekly schedule.
- Facility for players to complete self-review forms and for staff to be able to access this forms once it has been submitted.
- Integrate both the video analysis features and the strength & conditioning features within once team management system.
- Allow players to communicate through the system to share ideas and documents with one and other.
- Allow management to communicate with multiple users of the system at one time to reduce the reliance on group emails and text messages.

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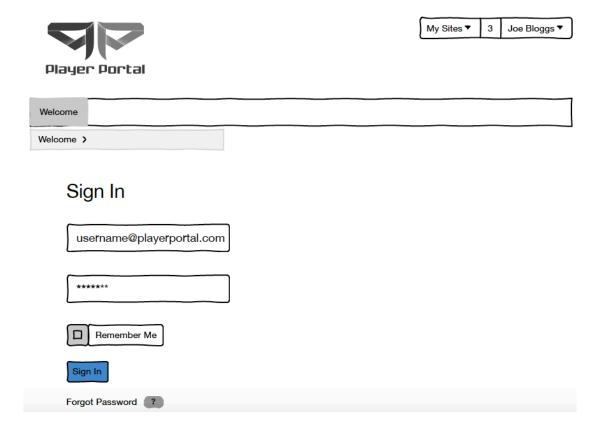
### Appendix B - Player Focus Group

- Ability to view individual clips from matches at home.
- Completing video reviews from home to save time when only playing short periods of a game, as the current process require meeting with the coach regardless of how long you have played.
- Enable more people to be involved in the analysis review process, as some coaches who may have valuable knowledge are not able to provide their input.
- Get regular updates of changes to the schedule by email or notification.

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# Appendix C - User Interface Prototypes

# **Public Homepage**



#### **Dashboard Homepage**



# Player Portal Cardiff Blues

My Sites ▼ 3 Joe Bloggs ▼

New Post

Dashboard \*

Video Analysis

Strength & Conditioning

Cardiff Blues > Dashboard

#### Activities

#### Collapsible Group Item #1

Anim pariatur cliche reprehenderit, enim eiusmod high life accusamus terry richardson ad squid. 3 wolf moon officia aute, non cupidatat skateboard dolor brunch. Food truck quinoa nesciunt laborum eiusmod. Brunch 3 wolf moon tempor, sunt aliqua put a bird on it squid single-origin coffee nulla assumenda shoreditch et. Nihil anim keffiyeh helvetica, craft beer labore wes anderson cred nesciunt sapiente ea proident. Ad vegan excepteur butcher vice lomo. Leggings occaecat craft beer farm-to-table, raw denim aesthetic synth nesciunt you probably haven't heard of them accusamus labore sustainable VHS.

Collapsible Group Item #2

Collapsible Group Item #3

#### Activities

Social

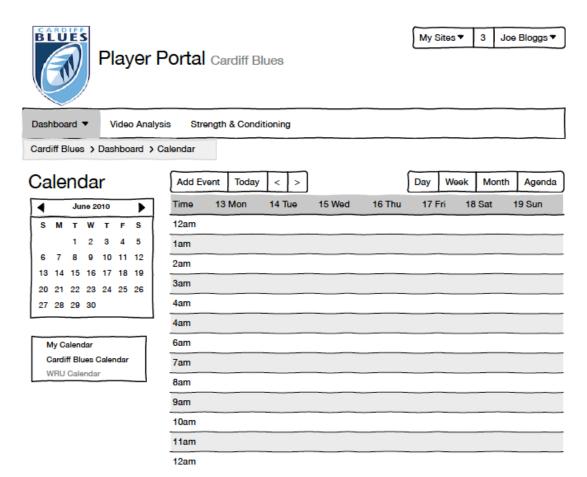
Cars

Home	Recent Posts	My Posts	My Subscriptions		Search		Submit
Post New Thread							
Category		Categories		Threads		Posts	
Training		0		1		7	New Post

Settings Online Friends (0)

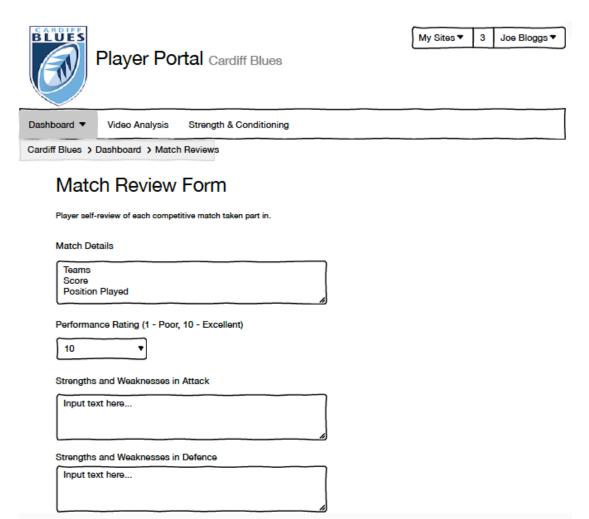


### Calendar



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#### **Review**



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# **User Directory**



# Site Members Directory

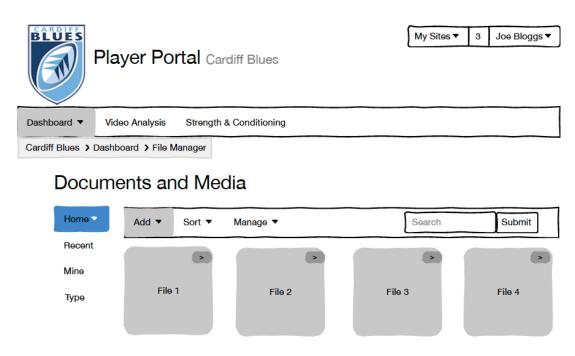
Users Organis	sations User Gro	ups				
Search Submit						
First Name	Last Name	Screen Name	Job Title	Organisation		
Liam	Belcher	Ibelcher	Player	Cardiff Blues		
Chris	Berry	cberry	Analyst	Cardiff Blues		
Richard	Hodges	rhodges	Manager	Cardiff Blues		
Lee	Jarvis	ljarvis	Coach	Cardiff Blues		

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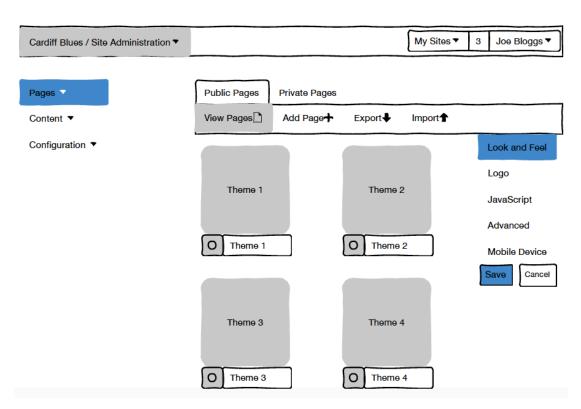
### **Polls**



## File and Media Manager



#### **Administration**



# **Video Analysis**

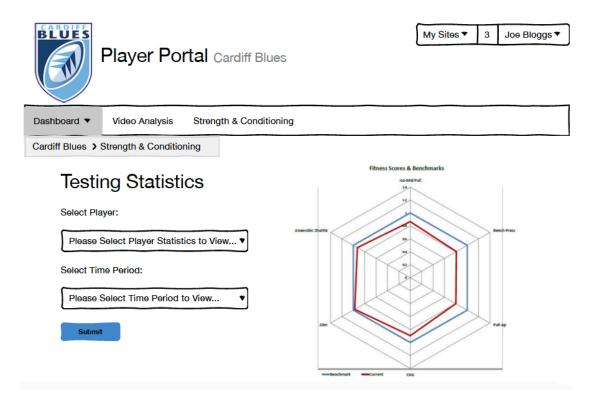


# **Match Statistics**



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# **Testing Statistics**



### **Player Comparison**



# Player Comparison

Select Position:

Please Select Position to Compare...

Submit

Position	First Name	Last Name	Age	Weight	Height	
Prop	Mark	Otto	20	112	1.9	
Prop	Jacob	Thornton	19	115	1.83	
Prop	Larry	the Bird	21	109	1.86	

#### Appendix D - BCRYPT Algorithm Pseudo Code

```
bcrypt(cost, salt, input)
    state ← EksBlowfishSetup(cost, salt, input)
    ctext ← "OrpheanBeholderScryDoubt" //three 64-bit blocks
    repeat (64)
        ctext ← EncryptECB(state, ctext) //encrypt using standard Blowfish in ECB mode
    return Concatenate(cost, salt, ctext)
```

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#### Appendix E – Match XML Schema

```
<instance>
<ID>307</ID>
<start>852.5559381927</start>
<end>862.1616666667</end>
<code>Morgan Sieniawski (000068793)</code>
<label>
<text>Tackles 0</text>
</label>
<label>
<text>Tackles - Total </text>
</label>
<label>
<text>Tackles - Total </text>
</label>
<label>
<label>
</label>
```

## Bibliography

Bellard, F. (2015, 04 13). *About FFmpeg*. Retrieved 04 14, 2015, from FFmpeg: https://www.ffmpeg.org/about.html

Bootstrap. (2015, 04 13). *Bootstrap*. Retrieved 04 13, 2015, from Twitter Bootsrap: http://getbootstrap.com

Bosomworth, D. (2015, 01 15). *Mobile Marketing Statistics 2015*. Retrieved 04 17, 2015, from Smart Insights: http://www.smartinsights.com/mobile-marketing/mobile-marketing-analytics/mobile-marketing-statistics/

Brightcove. (2015, 04 04). *HTML5 Video Player*. Retrieved 04 13, 2015, from VideoJS: http://www.videojs.com

Cebrian, D. (2014, 09 30). *Rangeslider-VideoJS*. Retrieved 04 13, 2015, from GitHub: https://github.com/danielcebrian/rangeslider-videojs

Cebrian, D. (2014, 10 07). *RichText Annotator Plugin*. Retrieved 04 13, 2015, from GitHub: https://github.com/danielcebrian/richText-annotator

Cebrian, D. (2014, 01 27). *The Center for Hellenic Studies of Harvard University*. Retrieved 04 13, 2015, from GitHub: https://github.com/CtrHellenicStudies/OpenVideoAnnotation

Guay, P. (2015, 03 23). *Database Server Clustering*. Retrieved 04 21, 2015, from Patrice Guay, eng: http://www.patriceguay.com/webhosting/database-server-clustering

ISO. (2015, 04 06). *ISO/IEC 27001 - Information security management*. (ISO/IEC) Retrieved 04 06, 2015, from International Organization for Standardization:

http://www.iso.org/iso/home/standards/management-standards/iso27001.htm

• • •

Joseph Shum, A. C. (2006, 04 18). *Liferay Portal 4.0 - Developers Guide*. Retrieved 04 17, 2015, from Liferay: http://content.liferay.com/4.0.0/docs/developers/ch07s05.html

JQuery. (2015, 04 11). *JQuery Foundation*. Retrieved 04 13, 2015, from GitHub: https://github.com/jquery

Kim, S. F.-h. (2007). IT Security Review: Privacy, Protection, Access Control, Assurance and System Security. *International Journal of Multimedia and Ubiquitous Engineering*, 2 (2), 17-32.

Liferay. (2014, 07 20). *Liferay Portal 6.2 Developers Guide*. Retrieved 04 17, 2015, from Liferay: http://www.liferay.com/en\_GB/documentation/liferay-portal/6.2/development/-/ai/alloyui-2-0-bootstrap-migration-liferay-portal-6-2-dev-guide-02-en

Lundh, F. (2005, 01 30). *The cElementTree Module*. Retrieved 04 23, 2015, from effbot: http://effbot.org/zone/celementtree.htm

Munassar, N. M. (2010). A Comparison Between Five Models Of Software Engineering. *IJCSI International Journal of Computer Science Issues*, 7 (5), 94-101.

MyTPE. (2015, 04 08). *My Team Performance Exchange*. Retrieved 04 08, 2015, from My-TPE: https://my-tpe.com

Open Annotation. (2015, 04 10). *Annotator*. Retrieved 04 13, 2015, from annotatorjs: http://www.annotatorjs.org

Php. (2015, 04 19). *Php Password Hash*. Retrieved 04 19, 2015, from php: http://php.net/manual/en/function.password-hash.php

Scott Nicklous, M. (2009, 02 06). *JSR 286: Portlet Specification 2.0*. Retrieved 04 06, 2015, from Java Community Process: https://jcp.org/en/jsr/detail?id=286

• • •

Sportstec. (2015, 04 06). *Sportscode Version 10*. Retrieved 04 06, 2015, from Sportstec: http://sportstec.com/products/sportscode-version-10

Sportstec. (2015, 04 08). *Sportstec Products*. Retrieved 04 08, 2015, from sportstec.com: http://sportstec.com/products

Teamer. (2015, 04 08). *Teamer*. Retrieved 04 08, 2015, from teamer.net: https://teamer.net

The HSQL Development Group. (2014, 02 14). *HyperSQL*. Retrieved 04 17, 2015, from hsqldb: http://hsqldb.org

The PHP Group. (2015, 04 13). *XML Parser*. Retrieved 04 14, 2015, from php: http://php.net/manual/en/book.xml.php

Zulko. (2015, 04 15). *MoviePy*. Retrieved 04 23, 2015, from MoviePy: http://zulko.github.io/moviepy/index.html