User- Centred Design of a Mobile Football Video Database

Alyson Evans[1]
Motorola Research Lab

Abstract

The amount of multimedia content that is available to the general population has steadily increased in recent years and this brings with it the challenge of managing large quantities of content, for both creators and consumers. The MPEG-7 standard is aimed at facilitating the management of multimedia content by providing a set of standardized tools for describing audio-visual information to support a wide range of applications. This paper describes the development of one specific application that allows consumers to access a large video database of football video footage using a mobile device. Development has followed a user-centred methodology to ensure that the application development is driven by user needs rather than by the MPEG-7 technology alone.

The process began with scenario-based design to create a broad use scenario from which initial user requirements and functional requirements were derived. Functional requirements were grouped to correspond with particular user goals and the system was modelled according to Beyer and Holtzblatt's 'user environment model' which creates a system view from the user's perspective. This model was then used as the basis for the user interface design for a mobile device. The design process is not yet complete so the paper presents the first phase of work to meet the needs of a specific group to search for sports footage using MPEG-7.

Keywords: MPEG-7, user-centred design, mobile video.

1 Introduction

In recent years large amounts of audio-visual material have become available and access to this material is becoming increasingly feasible for the general population. Numerous tools for content creation, digitization and distribution have led to this growth in the amount of audio-visual content and powerful multimedia compression standards have reduced the complexity of multimedia information. The exchange of general information also increased greatly during the 1990's due to the World Wide Web and the growth of broadband will play a further part in facilitating access for the general population to multimedia content. The development of devices that provide access for users across a range of networks is also broadening the type and amount of information content that will be available. This has brought about a critical need for tools and systems to index, search, filter and manage audio-visual content. The MPEG-7 standard for describing multimedia data is intended to promote maximum interoperability among such systems and to facilitate the creation of innovative applications in this area [1].

In the context of this need the BUSMAN[1] project (Bringing User Satisfaction to Media Access Networks) aims to design, implement, validate and trial an efficient and secure system for delivery and querying of video from large databases. This will facilitate access to large video databases for both professionals and members of the public. Although the project is considering delivery and querying across fast fixed networks and the Internet, as well as mobile environments based on GPRS and UMTS packet data communications, this paper will illustrate the development of a mobile client to provide access to video material for use by the general consumer.

The new technology that provides the key to organising and managing video on very large video databases is MPEG-7. The MPEG-7 standard, ISO 15938 [2,3,4] provides the tools to describe multimedia content. Descriptors (Ds), Description Schemes (DSs) and the Description Definition Language (DDL) enable audio-visual content to be described in a structured and detailed manner at different levels of granularity: region, image, video segment and collection. This provides support for content description, management, organization, navigation and user interaction for a wide range of applications including provision of the means for users to search and retrieve video data from very large databases.

The main research challenge in this work was to establish how to utilise the technology offered by MPEG-7 in direct response to the user needs associated with searching for and managing football video footage on a mobile device. In addition there was the challenge of converting the user's needs into a system design and a user interface design that would suit a mobile device.

There were two main areas of enquiry at the start of the project: the first associated with searching for video footage and the second related to the design challenge of designing the application for a mobile device. The research questions that were asked were:

- How will users want to search for football video material – in particular how will they initiate a search when they are mobile?
- How can the search requirements can be translated into a design for a mobile device.
- How will users want to manage the results of their searches and the collection of video footage that they will build up on a mobile device?

[1] email: alyson.evans@motorola.com

[1] The BUSMAN project is partly funded by the European Commission within the 5th Framework Programme (IST-2001-35152).

Answering these questions has been central in the work to define the system functionality and design of the user interface.

2 User- Centred Design

In its objectives the BUSMAN project emphasised the importance of a user-centred iterative design process based on ISO13407, the European standard outlining 'Human Centred Design Processes for Interactive Systems'[5]. One of the main principles of user-centred design advocated in ISO 13407 is the active involvement of users in the design process and a clear understanding of the users and task requirements.

This process acknowledges that straightforward engineering of the technology itself is not enough - the development of a new product must be set within the context of the activity that it will eventually support and related to the people who will use it. A usable system is one that is easy to learn (for novice and casual users), one that supports the user in the task or activities they are trying to achieve and does so with a level of performance that meets or exceeds a user's goals in terms of efficiency and flexibility [6].

The stages of the user-centred design process have been outlined by many authors, reflecting slight variations on the same theme, as well as in ISO 13407 itself. The key stages, outlined in Figure 1. illustrate the user-centred lifecycle adopted for BUSMAN.

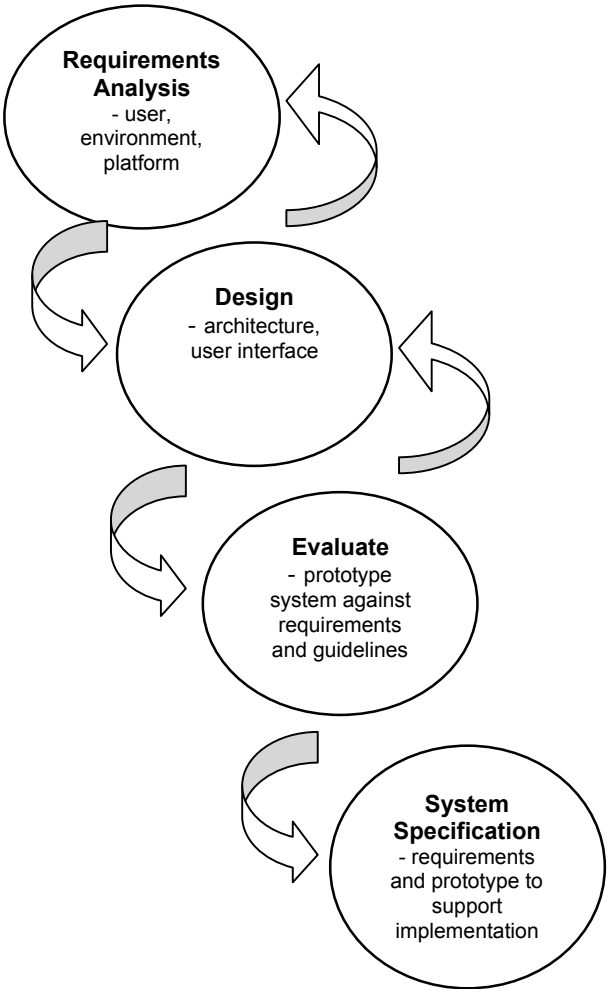

Figure 1: User-Centred Lifecycle Adopted for BUSMAN

This paper focuses on the work that has been done in the first two phases of the lifecycle - requirements analysis and how the requirements have been translated into an initial user interface design.

3 User Requirements

The first phase of the work aimed to identify an initial set of user requirements that could be used to shape the application of the MPEG-7 technology and the systems engineering that would come later in the project. The approach taken was to build up an understanding of how people currently make use of video and then to move from this starting point towards an understanding of how the new technology could be utilized to extend, make easier, make more exiting or even make entirely new ways for people to interact with video material. The aim of this phase of work was to understand the current goals and skills that potential users have in current circumstances and to combine this with what they could imagine doing in the future to make a creative leap towards new system possibilities.

This work was done by interviewing a total of 8 people (all football fans) about how they currently watch football and their use of football video footage. Interviews were a combination of 1:1 and groups interviews. The areas covered by the questions were:

- How do people currently watch football?
- How do people search for particular footage currently?
- What do people remember about a football match?
- What devices are used to watch football?
- How would people want to search for football video footage in a mobile situation if they had access to a very large database of football video footage?
- How would people decide what to watch?

It was particularly important to establish what people remember about video in order to understand what would come to mind when someone is mobile and has no reference material as a starting point for their search. Questions were also asked about mobility in general and the kind of situations in which people envisaged accessing a video database using a mobile device.

A wealth of information was gathered during these interviews. There was a significant consensus between those interviewed on what they remembered about football matches and how they would want to search for football videos from a large database. A surprising number of details were remembered about football matches, especially for the team or teams that each person supported. Football team names were remembered as were player names. People also had knowledge of which teams were playing in which leagues. More surprising was that people remembered scores for many matches, as well as controversial incidents or interesting player actions that occurred during a game. These findings provided input to the user requirements for the search criteria for the new application and helped define the annotation categories that were required within the MPEG-7 standard. The focus of users was on searching with semantic terms, so it was concluded that many of the lower level features of MPEG-7 e.g searching using colour, shape or texture, would

not apply to this specific application for the general consumer. This information was used to construct the metadata model required by the project – one that was closely related to the needs of the users in the context of searching for sports footage.

The interviews also yielded data that was used to construct a scenario of use for the new application. Scenario-based design is particularly useful when there is no pre-existing system that user's can relate to when they try to envisage how to use new technology. Creating potential use scenarios is part of a user-centred design process outlined in [7] that can be used to scope, bound and focus the requirements analysis process and to provide a connection between abstract ideas generated by potential users during interviews and a more tangible representation of a new system. The creation of a scenario provides a means of capturing, structuring and organising the ideas that people generate in a random fashion during an interview. Scenarios can also help to establish and maintain a connection between team members from different disciplines, in particular between those responsible for advocating the case of the user and those responsible for the engineering [8].Within the BUSMAN project the scenario provided a clear view of what the users thought they wanted from a mobile football video database application. The engineers in the project were able to debate the implications for the use of MPEG-7 and start to shape the use of that technology by constructing a metadata model (that outlined which parts of MPEG-7 were to be used) that was related directly to the user needs. An extract from the scenario 'Football Fans' that was generated from the initial user research is shown in Figure 2.

From this scenario and the user interviews it was possible to define an initial set of 50 user requirements. Each activity the users imagined carrying out with the new application would require specific capabilities in the new system. Hence, it was possible to identify a number of functional requirements needed to support the envisaged user activities.

4 Modelling User Activity and the New Application

The entire 'football fans' scenario contained seven individual use cases and through examination of each individual case it was possible to identify the details of exactly what the user would have to do to complete each activity, e.g. the first use case shown in Figure 2 is about finding a full length video of a football match. The user would need to carry out a number of activities to achieve this. They would need to switch on their mobile device, select the application and carry out a search of the database using a set of search criteria. Once the footage was identified the user would then need to pay for it and to watch it on their device. The user might also want to retain a link to a piece of footage for future use. This kind of analysis revealed the detailed actions required to achieve each use case and indicated further functional requirements.

To ensure that the user–centred focus was retained at this stage, before the system architecture was developed, a user–centred model of the new application functionality was developed from the use cases and the activities associated with them. The model was based on the idea of the 'user environment design' [9] and created the underlying application structure as envisaged from the user's perspective of the activities they would carry out with the application. The most logical grouping of functions, according to the different types of activities were identified and defined as activity 'focus areas'.

The 'user environment design' model has been compared with an architect's plan for a house – the architects plan shows key distinctions to support living, the 'user environment design' model shows key distinctions for supporting work practice or activity with a software system. The model is useful and powerful in the design process as it permits debate about the system structure before the design process becomes loaded with the details of the user interface design or software implementation. It is easily understood by users, human factors specialists and engineers alike. The model is used to show all the parts of a system (required for specific activities) that the user knows about and it also shows how the different parts relate to each other.

Football Fans

'Mike is traveling by train on the way to visit friends for the weekend when he decides he'd like to watch one of the more memorable games by the team he supports – Manchester United. He remembers a time when they beat Ipswich 9-0 and decides that he'd like to watch that game. He enters the team name, the opponent team's name and the match score into the BUSMAN system and it retrieves the video of that match. Mike pays for one viewing and settles down to watch the match.

Later that afternoon at his friend's house Mike watches a live football match. Manchester United beat Liverpool 3-2, with one particularly good goal by Roy Keane. Liverpool have one goal disallowed following an offside decision.

Later that evening, at a bar with a large group of friends, there is discussion about the game they watched earlier that day and they decide to watch the highlights. Using BUSMAN Mike enters the team names and chooses to see the goal highlights video. The group repeatedly watch the goal by Keane and discuss the skill it involved.

Conversation about the goal by Keane reminds Mike of a goal that Keane scored when he was playing for Nottingham Forest in the early '90s. He uses BUSMAN to search for goals scored by Keane around 8 years ago. BUSMAN returns a list of goals scored at that time. When Mike finds the one he was looking for he plays it and shows it to his friends so that they can appreciate its similarity to the one he scored earlier that day'.

Figure 2: Extract from the Use Scenario 'Football Fans'

For the mobile football video database four 'focus areas' were identified from the scenario and user requirements. One contained searching type activities like choosing search criteria, entering them into the application and submitting a search. Another focus area was concerned with viewing video and the play, stop, rewind and fast forward functions associated with that. The third focus area related to the management of a collection of footage that a user might build up over time. The final focus area related to payment for the footage.

The mobile application to search retrieve and view sports footage was modelled as shown in Figure 3 below, based on the 'football fans' scenario and the analysis of more detailed activities. The model provides a structure of user activity that formed the basis of user interface design and also influenced the development of the software architecture.

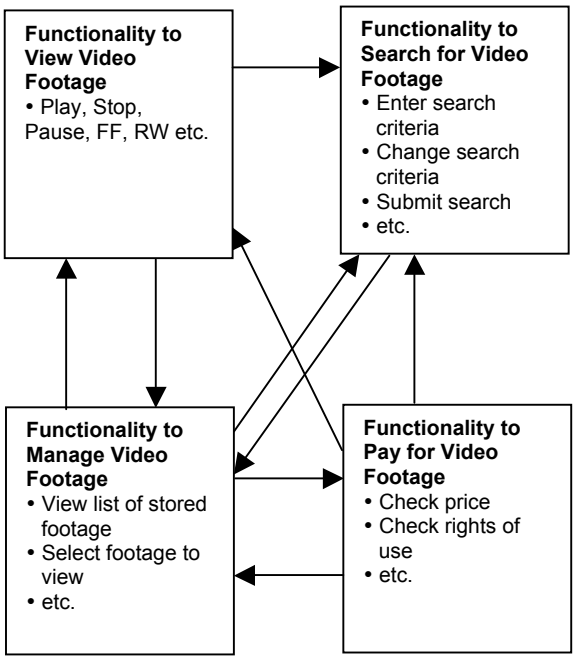

Figure 3: Conceptual Model for system to search, retrieve and view video footage

The BUSMAN conceptual model was used by engineers in the project to plan the structure of the system architecture. It provided the engineers with an early insight into what users wanted from the system and how the system functionality needed to connect. The conceptual model provided a vital connection between user needs and the system architecture at a stage in the lifecycle prior to implementation. This modelling allowed useful debate to occur before a commitment was finally made to the architecture to be implemented. The conceptual model also supports design by providing the underlying structure of an application before detailed ideas about input and outputs and information display are conceived.

5 Designing the User Interface from the Conceptual Model

Once the detailed functionality was meaningfully grouped into the focus areas defined by the conceptual model the user interface was designed with direct reference to it. Four main interface areas were defined – each corresponding to one of the focus areas. One area focused on searching activity – inputting search criteria, submitting the search as well as display of search results. Another area of the UI was devoted to playing the video – this required maximum display area for viewing plus the usual controls associated with playing and reviewing video. The third distinct area of the UI was for paying for video footage – this requires activities like inputting user identification information and bank account details – similar to the UI requirements for Internet shopping. The fourth area of the UI was devoted to management of the video footage. It is likely that a user will have access to a variety of footage at one time and they will need to be able to access it directly, without having to run a search each time. So an area was dedicated to contain the links to 'accessible footage', to 'favourite footage' and to footage identified as 'possibilities' to potentially be watched at a later date.

Figure 4 shows the screen of the user interface through which the user enters search criteria. Each search criterion was suggested by users in the interviews at the start of the project. Each criterion is a button which links to another page that presents the user with a range of possible criterion choices. The aim is to allow the user to enter a set of criteria for their search using the smallest number of key presses. The video footage that will be accessed using the mobile device will be annotated using the new MPEG-7 standard to correspond with this set of criteria

The links between the different areas of the UI shown in the conceptual model are implemented through the use of the buttons contained in the application navigation bar, which remains on display at the foot of almost every screen of the UI. From the search page the user can connect to the collection of videos that they have built up. No link is present here to 'play video' because there are no videos to choose.

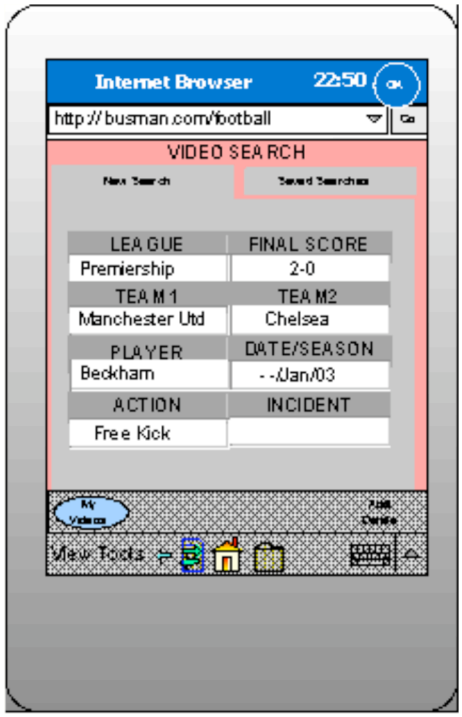

Figure 4: User Interface to enter search criteria

The UI area dedicated to managing video footage is shown in Figure 5. This is distinct in style from the UI used to enter

search criteria and provides the means for the user to manage links to different pieces of footage. Footage has been categorised into that which is already accessible as it has been paid for, other footage has been identified by the user as 'possibly' being of interest. A third category allows the user to keep a list of their favourite footage.

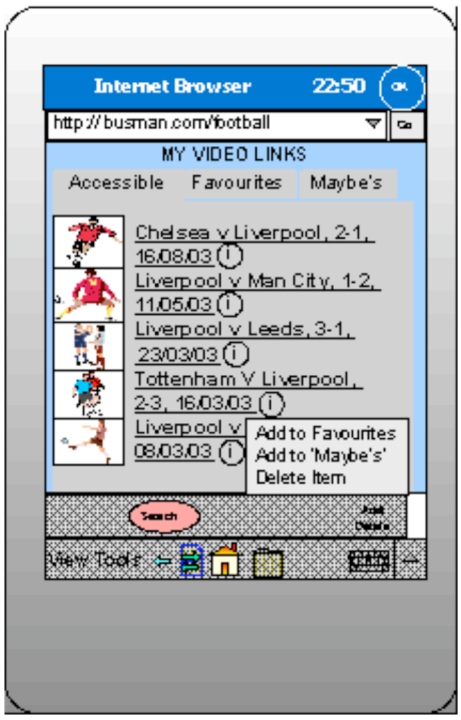

Figure 5: User Interface to Manage Video Footage

These pages are shown to illustrate how the conceptual model can provide a logical basis for structuring the user interface. Understanding the structure of the UI before individual pages of the UI are designed saves valuable time in what can be a somewhat confusing process if a strictly top down approach is taken.

The BUSMAN project has progressed as far as designing the first iteration of the user interface. The next stage in the user-centred process is to evaluate the prototype system in terms of its functionality, the structure of the functionality and the user interface itself. The first stage will be an 'expert evaluation' that will utilise guidelines on user interface design from ISO standards and other sources. The user interface will be re-designed following this evaluation and will then be subjected to at least 2 rounds of user testing with real users. The feedback gained from these evaluations will be used for further re-design of the user interface as well as development of the user requirements – these will be added to and refined and the evaluation phase progresses.

Hence, the entire user-centred design process illustrated in Figure 1 will be followed, and at the end of the project the aim is to have a comprehensive and relevant set of user requirements plus a prototype system that can be used to demonstrate the concept of searching for football videos in a large video database when the user is mobile.

6 Conclusion

The BUSMAN project set out to make best use of MPEG-7 technology on behalf of general consumers who, in the future, will be able to access video footage when they are on the move. By adopting a user-centred focus from the outset user needs were captured and used as a reference point as each step in the development lifecycle took place. By making use of two user-centred techniques – scenario development and the conceptual model the user needs were not simply noted at the start of the project but were integrated into the design of the system architecture and user interface. The user-centred techniques were new to many of the engineers on the project but their value has been appreciated as its output provided tangible reference points that were used to develop technology and system architectures. Although it is possible to argue that great leaps in the development of new technology could be constrained by paying too much heed to the conservative needs of its potential users, the methods outlined here illustrate how the user needs can be presented and understood by the whole project team in a way that permits informed debate between the technologists and those representing user needs in a way that allows intelligent decisions to be made about utilisation of new technology.

References

[1] Chang, Shih-Fu., Sikora, Thomas., and Puri, Atul. Overview of the MPEG-7 Standard. IEEE Transactions on Circuits and Systems for Video Technology, Vol 11, No 6, June 2001.

[2] Martinez, J.M (Ed). Overview of the MPEG-& Standard. ISO/IEC JTC1/ SC29/WG11 N4509, Dec 2001.

[3] ISO/IEC, 15938-3/FDIS, Information technology – Multimedia content description interface – Part 3 Visual, ISO/IEC, Oct. 2001.

[4] ISO/IEC, 15938-5/FDIS, Information technology – Multimedia content description interface – Part 5 Multimedia Description Schemes, ISO/IEC, Oct. 2001.

[5] ISO 13407. Human Centred Design Processes for Interactive Systems.

[6] Mayhew, D.J. The Usability Engineering Lifecycle. Academic Press, Morgan Kaufmann, 1999.

[7] Carroll, John.M., Making Use; Scenario Based Design of Human Computer Interactions. MIT Press 2000.

[8] McGraw, K. and Harbison, K. User Centred Requirements: The Scenario Based Engineering Process. Lawrence Erlbaum Associates Inc. 1997.

[9] Beyer, H. and Hottzblatt, K. Contextual Design: Defining Customer Centred Systems. Morgan Kaufmann. 1998.