Interaction Design and User Needs for TV Broadcasts Enriched with Linked Open Data

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ABSTRACT
Increasingly, people are consuming television content on devices connected to the Internet that allow them to look up related information. In parallel, Europe is publishing growing amounts of Linked Open Data, including rich metadata about its cultural heritage. The goal of the LinkedTV project is to seamlessly interlink TV and Web content to enrich the user's experience of both. Linked Data and semantic technologies enable broadcasters to achieve added value for their content at low cost through the re-use of existing metadata. We present two user studies related to different user scenarios: Interactive News and Hyperlinked Documentary). These studies reveal the different user requirements and information needs for these different scenarios, and resulted in the development of two types of interfaces.

Categories and Subject Descriptors
H.1.2 [**Information Systems**]: User/Machine Systems---*Human factors*; H.5.1 [**Information Interfaces And Presentation**]: Multimedia Information Systems---*Video;* H.5.2 [**User interfaces**]: *Prototyping, Interaction styles, Graphical user interfaces*; H.5.4 [**Hypertext/Hypermedia**]: *Architectures, User issues*

General Terms
Measurement, Design, Experimentation, Human Factors.

Keywords
SmartTV, interactive television, Connected TV, semantic multimedia, media annotation, content analysis, second screens, automated linking, interaction design, user studies.

1. INTRODUCTION
More and more consumers will have SmartTVs at home [2], complemented by laptops or tablets which can function as "second screens", e.g. to explore related objects (from broadcaster's archives and other online resources) alongside a TV programme. Multitasking while watching TV is a significant

consumer trend, with 88% of TV viewers online in parallel, and 40% using their second screen to get more information on what they are watching [1]. Broadcast companies want to provide their viewers with richer interactive television experiences, and are becoming increasingly interested in enriching television content with hyperlinks to data sources that could enhance the attractiveness of their content and keep viewers from switching to other content sources online. The European project LinkedTV[1] believes that a "true TV ecosystem must functionally integrate the apps with the television programming" [4]. Thus it develops an end-to-end workflow that automates the process of enriching TV programmes with Web content, which significantly enhances the user experience. For this, semantic technologies and Linked Open Data (LOD) datasets are used to lower the cost of annotation, which is not scalable in a completely human curated enrichment. In order to understand what potential end-users of enriched television content want to see and do, we conducted two user studies. Based on these, two second screen applications were developed that provide viewers with extra information on the topics of their favourite TV programmes, which they can bookmark and share. In this paper we discuss 1) the technical workflow behind LinkedTV's project goals, 2) the user studies we conducted based on the use cases (Interactive News, Hyperlinked Documentary) and 3) the design rationale of the user interfaces.

2. LINKEDTV PROJECT GOALS
The end-to-end platform chain of LinkedTV starts with automatic analysis of the audiovisual material and its metadata, applying shot and scene segmentation, visual analysis for concept detection [6], and entity extraction from subtitles [3]. Media Fragments[2] are generated which refer to specific temporal and spatial parts within the analysed television show that present a particular topic or object. For example: an art expert mentions the Greek goddess Hebe, and a Media Fragment corresponding to the utterance is created, e.g. using subtitle information. These Media Fragments are annotated with *named entities* extracted from the text or visual classifiers. For this, LinkedTV has developed a dedicated ontology[3] and re-uses Linked Data URIs for the entity identifiers. For example, the concept Hebe (ancient Greek goddess) can be found in DBpedia with the URI http://dbpedia.org/resource/Hebe_(mythology). LinkedTV uses

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[1] http://www.linkedtv.eu/

[2] Using the W3C media fragment URI specification http://www.w3.org/TR/**media**-frags/

[3] http://linkedtv.eu/ontology reusing parts of the W3C media ontology and the Open Annotation Model

"white lists" of Web content sources trusted by the media owner to contain high-quality links that can be used for enrichments. Distinct Web services provide link matches in these "white list" sources for entities, e.g. recent media shared via social Web channels, structured databases of media resources such as the European digital library Europeana[4], and HTML-based Web sites via a dedicated crawler for embedded media items. A programme editor has access to a dedicated Editor Tool to curate which of these links they want to show to their end users, since usually many more potential targets are found than are reasonable to show. Finally, the LinkedTV Player displays the curated results using HTML5 technology on the second screen.

3. USE CASES AND SCENARIOS

Two scenarios were used to inspire the second screen development: Interactive News and Hyperlinked Documentary. We used a cultural heritage program called "Tussen Kunst en Kitsch" (similar to the BBC's Antiques Roadshow[5], henceforth TKK) of Dutch public broadcaster AVRO[6] as a representative of the cultural heritage genre. In this program, professionals evaluate the authenticity and value of items brought to them by local people. The experts give information about the historical and artistic context of the antiques.

In order to represent a news broadcast in a synthesized form suitable for user testing, participants were shown reports from BBC's One Minute Online World News[7] that were chosen to emulate the diversity of news categories included in popular news broadcasts. Both programmes contain distinct chapters about specific topics, e.g. Obama's June 2013 visit to Berlin or a 19th century gold watch by famous watchmaker Breguet.

4. USER STUDIES

Two focus groups were held; one with news viewers (11 participants, age 20-58) and one with TKK viewers (8 participants, age 54-67, 4 men, 4 women). Face-to-face interviews were held with nine additional news viewers. [5] The main criterion for recruiting participants was to include people who were frequent viewers of either TKK or news broadcasts and representative of those program's target audiences. For the TKK focus group, participants were recruited through an online call among current viewers. For the news use case, the recruiting took place at a university and a research centre. To ensure a range of participants representative of potential users, participants that were neither students nor researchers were included.

We focussed on current habits regarding television watching and mobile multitasking, information needs, and requirements on how viewers want to access this desired information.

It should be noted that the focus groups serve as a general view on people's current habits while watching the video news broadcasts and a cultural heritage program. They also give an indication about what kind of additional information people would like to see while watching these programs. However, there are some aspects that warrant attention for the interpretation of the results. The first one is the language. The news broadcast focus group was held in English, and the news program shown was also in English.

Although most Dutch people are fluent speaking it, some participants were not completely comfortable watching British television without subtitles. Furthermore, international news, used in the study, is not interesting for all audiences. Some of the members of the focus group had strong preference for national and local newscasts. Regarding the TKK focus group, a better spread in the ages of the participants is desirable. Although most viewers of TKK are indeed 50+, cultural heritage shows in general also have a younger audience, which should be represented in the next series of user trials. In general, further studies should and will be conducted with bigger groups in order to have quantitative as well as qualitative results.

4.1 Current habits

In both cases, more than 50% of the focus group participants declared that they already use the Internet to look up additional information about the television shows more or less regularly. In the case of TKK they mostly do so right after the show. Of the news viewers 35% tend to look for information multitasking during the show and the rest do so whenever they have time.

Both TKK and news viewers indicate their first source to find information is Google, followed by Wikipedia. Furthermore, TKK viewers also look on specific museum websites, the Internet Movie Database and Europeana. Unsurprisingly, the other sources that news viewers use are online newspapers and specialized news websites from agencies or broadcasters such as the BBC News and Associated Press. Often broadcast news consumers are also habitual online newspapers readers inasmuch as watching news on television and reading newspapers are perceived as complementary but distinct activities: watching news is perceived as a social activity while reading the newspaper is perceived as a solitary one. Furthermore, viewers perceive the news as a source that delivers a general overview, while they see newspapers as a source of more focused in-depth information.

4.2 Information needs and user requirements

In journalism, there are a few basic questions that should be answered in order for a story to be considered complete, namely, "who", "what", "when", "where", "why", and "how"[8]. Because of the large overlaps between this model and the types of information that users declared they would like to have, we use it in order to divide the user information needs into categories. Specifically we provide support for:

- **WHAT**. Hyperlinked Documentary: object type (e.g. painting), material type (e.g. silver), art style (e.g. Jugendstil). Interactive News: in-depth specific information about the event itself, the thing that happened and is narrated.

- **WHO**. Hyperlinked Documentary: creator, art expert, historical person. Interactive News: more information about a person appearing or being mentioned in the news, the actors of the news.

- **WHERE**. Where the episode is recorded, where the object is from, what's on in the museum / planning museum visit. Interactive News: location information, e.g. geographical localisation and general contextual information about the place where the news happens.

[4] http://europeana.eu/

[5] http://www.bbc.co.uk/programmes/b006mj2y

[6] http://avro.nl/

[7] http://www.bbc.co.uk/news/video_and_audio/

[8] http://en.wikipedia.org/wiki/Five_Ws/

News viewers expressed other specific information needs such as: interest to compare the same news item as it was presented through different media, overview of past related events, local effect of global news, local testimonies about international news, opinions about the news, and the possibility to follow a story through time and be alerted when changes occur.

Both TKK and news viewers would like to see the enrichments presented **per chapter**, i.e. a part of the programme in which a specific art object is discussed. Besides these information needs, all users expressed the need for other requirements, such as being able to **Bookmark** concepts and the related information sources so they can read it back whenever they want. Viewers would like the enriched version of the program to have **social features** that allow them to **share** chapters and enriched concepts with others. Being able to **control the TV and have "à la carte" video features** was a requirement mostly mentioned by news viewers. They want to use a second screen almost as a catch-up device, e.g. to browse through a programme's archive, play and pause, and to select chapters and send them to the TV. Finally, users would like the application provide **personalisation of enrichments**, based e.g. on sources, topics and categories they like.

5. USER INTERFACES

Two user interfaces were developed in order to further investigate the user requirements in terms of information needs and interaction. The first interface was designed in such a way that it can be adapted to both use cases. An alternative interface was designed to accommodate the more specific needs of the news spectators.

5.1 First prototype

Since it was not possible to incorporate all information needs and requirements at once, we chose to focus on the needs of specific 'personas' from both the TKK and news use cases that were representative for real-life second screen users. The focus for development therefore was on the requirements derived from these personas and their related scenarios: bookmarking, sharing, and presenting the various enrichments. High-level WHO, WHAT and WHERE categories became information layers, in the form of browsable thumbnail strips.
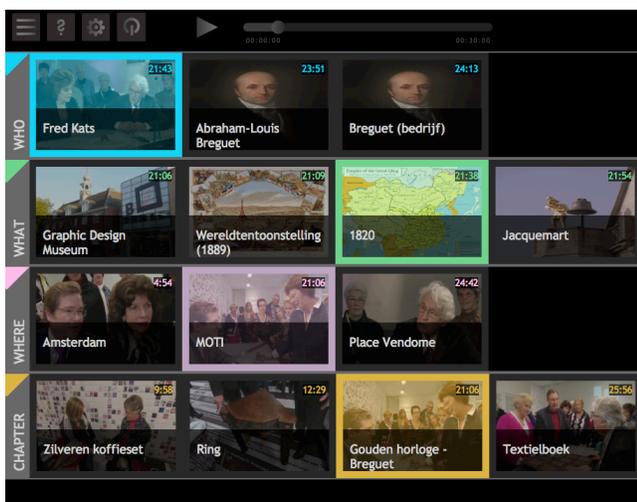

Figure 1: Entities in the thumbnail strips in the second screen interface. Active entities are highlighted.

Furthermore, since users indicated specifically that they want to see the enrichments per chapter, this distribution was incorporated in the interface. The player shows all the available entities in the chapter the viewer sees during the TV playback at that moment, and highlights the active entities relevant at the specific point in time, thus ensuring synchronisation of the viewing experience and the related enrichments (see Figure 1 above). Users can access summarised information about the entities by tapping on the names (e.g. 'MOTI' or '1820' in Figure 1 above). Turning the tablet to a vertical position provides an extended version of this information. Information provided is taken, as explained in the introductory paragraphs, from online open sources such as Wikipedia, Europeana and others in the broadcasters "white list".

5.1.1 Implementation

To support viewer access to LinkedTV enrichments, project partner Noterik developed the Springfield Multiscreen Toolkit (SMT)[9]. The toolkit supports application developers by abstracting away the low-level details of the synchronization and distribution of content between screens. Developers can create a single application that is independent of how many screens are involved, which can dynamically react to changes in the amount and types of screens attached to it. Another feature of the SMT is an online version managing system that simplifies the deployment of applications and allows the application developer to switch between different versions of the application. Applications are developed using standard technologies, such as HTML5 and Javascript for the front-end and Java for the back-end services. Using these technologies the applications can offer support for a broad range of devices. The first prototype allows companion screens to control video playback on the main screen and synchronise the associated LinkedTV enrichments to the main screen video. Besides touchscreens, the system also allows main screens to be controlled by gesture and remote control.

5.2 Alternative design for the News use case

In order to assess the news viewers specific information needs, a separate interface was designed using a three-column layout with roll-down menu tabs.

Figure 2: Timeline view and browsing routes in the LinkedTV alternative interface for the news. Photo of Edward Snowden by: Laura Poitras / Praxis Films (CC BY-SA)

[9] http://www.noterik.nl/products/webtv_framework/

This design incorporates content distributed in five browsing routes:

- Follow a news story throughout time ("timeline");
- Follow news throughout sources ("in other media");
- Access various opinions on a news topic ("opinions");
- Tweets, based on country of origin ("global to local");
- In depth curated information about a subject ("in depth").

5.2.1 Implementation

A hi- fi prototype was implemented based on the design described above (see Figure 2). Five short news videos were selected and edited to form an eight and a half minutes long newscast. An HTML5 functional website was created according to the design specifications. This website was adapted so that it could seamlessly pass for a native mobile device application seen in full screen. Contents were curated and added through JSON and HTML coding to each of the news stories and each of the browsing routes. The look and feel of the application obtained was very realistic. The experience of feeding the interface with real content helped to adjust some of its characteristics such as space in the diverse text fields. Overall, the interface adapted well to the information of diverse sources.

Due to time and technology constrains, not all the functionalities intended for a final application were implemented. However, the core functionalities were all included.

5.2.2 Evaluation

This user interface was evaluated in a task-based study in order to estimate to what extent the mentioned browsing routes constitute a suitable way to organize and communicate information so that it satisfies the requirements of the news broadcasts consumers.

Participants in the study were generally enthusiastic to have different types of information related to the news concentrated in one application and considered that, in this sense, the interface would be timesaving with respect to their current equivalent practices (e.g. consulting several independent sources). The proposed interface sections were described as very thorough in covering possible users' information needs. In particular, the most valued sections were:

- the chronological overview of the news delivered through a timeline;
- the opportunity to read the same news headline as it was presented in different media sources.

The possibility of accessing geo-localized information through tweets was, unexpectedly, the functionality that participants liked the least. The evaluation of the LinkedTV News interface was useful in further exploring and understanding users information needs and experimenting with possible ways of dealing with complex information needs.

6. CONCLUSIONS AND FUTURE WORK

The development of the first second screen interfaces for TV broadcasts enriched with LOD provided many insights into user's information needs and requirements. We found that different types of TV formats and various user scenarios require different approaches. For instance, news viewers users are much more interested in following a story through time, and seeing various opinions on a topic, whereas the TKK viewers are specifically focused on information about artists and art styles. The work described in this paper provides us with a solid basis for on-going development. LinkedTV will continue in 2014 to refine the workflow for annotation and hyperlinking, expanding the LOD sources it uses and how the available metadata from those sources can be increasingly used in guiding the system to select more relevant links. A new cycle of larger user trials using improved versions the two second screen application prototypes will help us validate further the usefulness of the selected enrichments for viewers, acceptance of personalisation functionality when it requires modelling of user preferences or tracking of viewer behaviour, as well as the intuitiveness of the user interface. Furthermore, the cognitive load for end users that a dual screen set-up demands will be explored. The results of the evaluations will be used to improve the added value of using Linked Open Data in the enrichment process for our broadcast partners, namely: greater automation leading to lower costs for providing added value services around their content, which in turn helps keep viewers connected.

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