Interactive Television News

DAN R. OLSEN, DEREK BUNN, TRENT BOULTER, and ROBERT WALZ, Brigham Young University

A new interactive television experience has been created for watching television news. The goal is to create a news experience that is similar to the way people watch television in their living rooms while giving viewers the power to make choices about what they see. We partnered with existing news organizations to create tools consistent with current news production practices. The viewer experience allows selection of the order of news content, skipping unwanted content and exploring stories in more depth. These tools were used to produce seven days of interactive commercial news that were viewed in ten homes.

Categories and Subject Descriptors: H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces

General Terms: Human Factors

Additional Key Words and Phrases: Interactive television, interactive news

ACM Reference Format:

Olsen, D. R., Bunn, D., Boulter, T., and Walz, R. 2012. Interactive television news. ACM Trans. Multimedia Comput. Commun. Appl. 8, 2, Article 19 (May 2012), 20 pages.
DOI = 10.1145/2168996.2168999 http://doi.acm.org/10.1145/2168996.2168999

1. INTRODUCTION

Television news is one of the most influential media in the developed world today. It shapes the politics of power, controls the national conversation and pervades homes. The nature of the broadcast medium as we now know it concentrates power in many ways. When there are a limited number of broadcast channels, the owners of those channels have tremendous control over what will appear and when it will be shown. The news consumer must select from a limited number of choices (typically fewer than 10). Having made their initial selection they must watch the stories in the order decided by a producer and to the length and depth the producer decides.

The advent of internet television will radically change the control relationship between news producers and consumers. Internet television need not conform to a broadcast schedule because such things are meaningless on the Internet. Most importantly, however, the individual viewer will have the interactive power to choose what they watch and when they watch it. This paper details our prototype of an interactive version of television news that offers viewers the ability to 1) watch the news on their own schedule, 2) exert individual control over the stories they watch and the order in which they watch them, and 3) get more information about the stories they care about than is possible in broadcast news.

Author's address: D. R. Olsen; email: olsen@cs.byu.edu.

DOI 10.1145/2168996.2168999 http://doi.acm.org/10.1145/2168996.2168999

Our work in interactive news is built around four key principles.

(1) Internet video can now deliver HD quality video streams that can move from one video point to another in 2 seconds or less without buffering waits.
(2) The interactive news experience is fundamentally driven by the tools provided in the news room. The end experience cannot be studied independently.
(3) Television news is consumed in the family room couch or chair, not at a desk. The task oriented behavior of the Web is enlightening but not at all the same.
(4) To evaluate a news experience the content must be real, fresh news from a real news source. Laboratory-produced news or archival footage is not sufficient.

In thinking about interactive television news our starting point was existing television news rather than web-based news. This is not to downplay the value of the Web as a news source but rather a desire to enrich and expand upon the currently dominant news experience. We surveyed a number of local and national news station Web sites. These sites varied somewhat in the amount of video provided but they all were more like a newspaper than a television experience. Each site is structured around a set of textual stories. The assumption of these pages is that the viewer will read their news. Video clips are then associated with some (rarely all) of the stories. In most such sites the video is placed like an image figure to supplement the textual story. Navigation of such sites is done by clicking small textual links in a standard web style. This approach provides an important news source but this interactive style will not translate well to the family room television. Anyone who has tried to web-browse on a television across the room has experienced the frustration of trying to hit very small targets when viewing from a recliner. The Web offers excellent transport mechanisms but a very poor interactive experience on the television.

To address these issues we have adopted television news rather than Web news as our starting point. This television-based approach dictates that video rather than text will be the primary medium and the recliner rather than the desk represents the viewer's posture. Based on these assumptions we have created an experience where the viewer can remain completely passive or can exert as much control as they like. Currently television news is an infotainment experience rather than a task-based retrieval experience. Our interactive features are of the form "approve" and "reject" rather than "search" and "organize." Our interactive device is a one-handed remote with no keyboard for entering search queries.

Our viewing experience offers four new styles of interaction:

(1) the ability to reorder the newscast by voting on a series of headline stories;
(2) the ability to skip stories that are no longer interesting;
(3) the ability to select stories from a playlist; and
(4) the ability to access additional material on certain news stories.

This work was greatly facilitated by two partnerships. We first approached the university's communications department which produces the BYU Daily News over public television. This allowed us to learn the nature of the news production process and to insert our tools into their process. This gave us experience on what does or does not work in news production. Students in this process are not under the same pressures as professional news organizations and thus are more adaptable to production changes.

The downside of student-produced news is that it has almost no viewers except the family and friends of the anchors and reporters. The goal of the newscast is education rather than development of a viewing audience. For a valid trial we needed fresh news that people are interested in watching. For this reason we partnered with KSL-TV which is the largest news organization in Utah. Based on

this partnership we delivered interactive news from a real, operating news room into 10 homes over the course of seven days.

Evaluating a home information/entertainment experience is much more difficult than evaluating performance on a work-related task. With a work-related task one can pose a challenge to the user in a laboratory and measure task time and error rate. Such tests can easily compare multiple solutions. In the less intense family room environment, performance times and error rates are irrelevant. Nobody sits down in their recliner at night hoping to maximize their viewing efficiency. The key questions are: can people use the technology and will they use the technology as part of their personal lives.

Because of the difficulties in evaluating home experiments, many researchers have only done simplistic lab experiments or showed their system at conferences to get responses from people. Others have relied on interviews about what people want. What people say they want and will use is every different from what they do. In this work we deploy our tools into actual production and viewing environments and then observe how those tools are actually used. The results are not as tidy as a set of controlled experiments but we believe they are more ecologically valid.

In this work we have addressed preliminary solutions to two key problems: (1) development of news creation tools that are easily understood and deployed by producers and (2) creating an interactive news experience that is effective in the family room environment.

2. RELATED WORK

Interactive news is built around video streaming technologies on the Internet. The common technique of initiating a file download and then starting playback of WMV or Quicktime movies is not appropriate for our purpose. The buffering time of these approaches is unacceptably slow. Interactive movement to a different point in the video or to a different stream incurs these same buffering effects making interactivity unacceptable.

Our prototype is built on the adaptive streaming technology provided by Move Networks [Move 2009]. The details of how the protocol functions are unimportant to this discussion. The key feature is that it is possible to seek to a new location in a video or in a new video in 1–2 seconds. This provides the underlying functionality required for our interactive behaviors. Similar capability is found in Microsoft's Smooth Streaming [Microsoft 2009]. We believe that Adobe either has or will soon have a similar capability in Flash. All of these protocols are based on HTTP or other Internet transport mechanisms.

Historically, computer-based television news has been concerned with retrieval of archival news clips. The Informedia project [Hauptmann and Witbrock 1997] is one of the early examples of this work. Their speech-based interface provides a nice mechanism for people to retrieve news stories and is a potential alternative interaction mechanism in the family-room environment. The Informedia work, and others like it, assumes that the viewer has adopted a task-oriented approach to retrieving news video from a data base. Rather than the casual viewing, infotainment approach to the evening news, this work assumes that viewers are actively searching for specific news items. Their evaluation methodologies were focused on speech recognition accuracy rather than viewer satisfaction. The use of archival rather than fresh news is also problematic.

Work like Informedia relies upon the association of words and tags with media clips to support the retrieval process. Informedia draws much of it semantic information from the closed-captioning. In addition, Dowman et al. [2005] and Haas et al. [2002] have similarly tried to associate tags and text with video for the purposes of retrieval or for the purpose of automatically personalizing news by topic. Much of this work involves extracting information after it has been produced. The focus of our work is on integrating with the news production process to obtain needed information. Avid's iNews [Avid Technology 2009] product automatically associates the script information used when then news was

produced. This is potentially a valuable source of tagging information that is drawn directly from the news creation process.

The association of tags and script information with news clips lays a foundation for a search-oriented user interface. This is not consistent with the way people view television. Television generally involves more of a content surfing strategy where decisions are made while viewing material. Studies have shown that television viewing is frequently a social experience [Oehlberg et al. 2006] rather than a solitary search experience. Television also fits into the daily routine of home life rather than as part of a specific task [O'Brien et al. 1999; Hughes et al. 2000]. Others studies have indicated that too much television research assumes that home viewer interaction is similar to work when in fact it is very different [Barkhuus and Brown 2009].

Our interactive news is in line with Jensen's vision of interactive television [Jensen 2005]. We want viewers to be involved in selecting the news that they want to watch. A good starting point is MyNews&SportsMyWay [Larsson et al. 2008], from the New Millennium New Media project [Williams et al. 2007]. MyNews viewers provide a profile of their interests. However, our experience indicates that viewers dislike configuration tasks. There is also the problem of interests changing over time. MyNews does allow viewers to increase or decrease the time of the newscast allowing more or fewer stories to be shown. There is also the option of skipping stories and jumping to related stories. The SAVANT [Bywater et al. 2004] system also works from a user profile to adapt the stories.

We see several problems in these efforts. The first is that they ignore the news production process, bringing their technology in after the fact. No information/entertainment experience can succeed without an effective production mechanism. Television news will be produced by news people not programmers. The tools must fit the talent. Secondly, their user interfaces are very web-like rather than mirroring the television experience. There are lots of menus and small text to be selected. Lastly, there has been little evaluation of these systems and in particular evaluation in actual homes. This lack is primarily driven by not having the ability to produce fresh news in a timely way and by not having good Internet delivery technology on which to base an in-home trial.

A notable exception to these laboratory-based efforts is the BBC's Red Button [BBC 2009]. This is a fully deployed professional news service that provides the viewer with an interactive choice of what they will watch. Unfortunately it is limited by the distribution technology. Text headlines overlaid on the screen are possible and a choice of several topics can be interactively selected. However, each of the choices is in reality a separate cable or satellite channel running a continuous loop of the same material. The result is simply a more focused version of channel surfing.

In creating home television technologies we must be cognizant of the social and human aspects of television viewing [Barkhuus et al. 2009; Hughes et al. 2000; O'Brien et al. 1999; Oehlberg et al. 2006]. These are important, complex and highly varied. These studies contribute a lot to our understanding of the social aspect of television viewing but they tell us almost nothing about how new viewing technology will interact with home life. It has been shown that injecting an observer into the home will not be an effective approach [O'Brien et al. 1999]. However, there is some light offered by Zaletekj et al. [2009]. They demonstrated a system where viewer behavior can be logged. They used this information to inform directors of live-television shows. We have chosen to deploy our technology into homes and then track their interactive behavior via the Internet. This is much more cost effective and less prone to biases from people being observed. This observation of actual behavior gives us data on what viewers actually do rather than what they say they do.

It is also important to point out the difficulties in getting user data from large viewer populations. The HomeNet trial [Kraut et al. 1996] is the kind of data we would really like where 48 families and 157 households were observed over a period of months. HomeNet, however, had the luxury that the content they were trying to observe already existed and was available for observation. In interactive

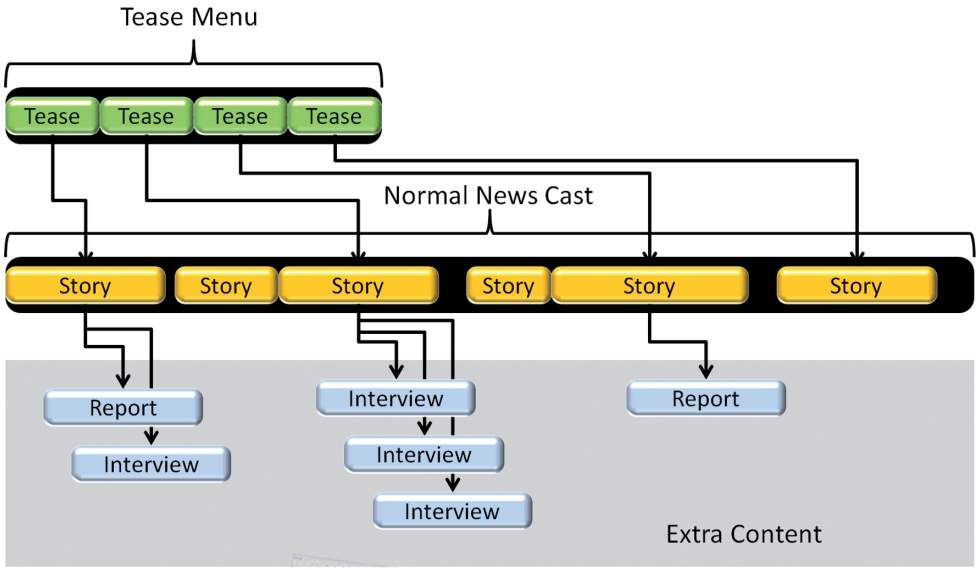

Fig. 1. Newscast Architecture.

television we are creating new content. Because our content must be fresh and rely on professional news organizations, we do not have the luxury of extended trials. Because of these complexities many technologies report no user trials at all [Hauptmann et al. 1997; Haas 2002; Jensen 2005] or laboratory trials [Oehlberg et al. 2006; Williams et al. 2007]. Others have limited themselves to ethonographic interviews of small populations: [Barkhuus et al. 2009] two projects with 10 and 11 subjects respectively, or [O'Brien et al. 1999] 11 households.

There are a number of video deployments over the internet that have appeared over the last few years such as YouTube, Google TV, Yahoo, Hulu, etc. All of these empower viewers to select the show that they want to view. Our work focuses on embedding interaction deeper into the story to provide a more flexible experience than simple clip selection.

3. INTERACTIVE NEWS ARCHITECTURE

One of our goals was to integrate tightly with existing news production. We did this for two reasons. (1) We wanted a transitional experience for news viewers that feels like a traditional news broadcast yet adds additional functionality. (2) We wanted to simplify the process of news production so that we could use a live, professional news team to produce the needed content without extensively adding to their current routines.

Figure 1 shows the architecture of our interactive newscasts. In the center is the normal newscast that would be produced for the nightly news. Out of this newscast we segment the actual stories. Each story has a title, a type (sports, local, national, weather, etc.) and start/stop times to identify where the story is in the newscast video clip. The newscast forms the backbone of our content. We leave out promotions for other programs or news segments, and advertisements. The promotions for other news segments are called "teases" by the production staff and are used to encourage viewers to watch. We address the tease function differently.

Either just before or just after a news broadcast over traditional television, we record a *tease menu*. This is a video clip that contains headlines for the major stories in the newscast. Only one clip is recorded but it is then segmented into individual tease segments. Each segment is then associated with one of the stories in the newscast. When the newscast is viewed, these tease headlines are shown

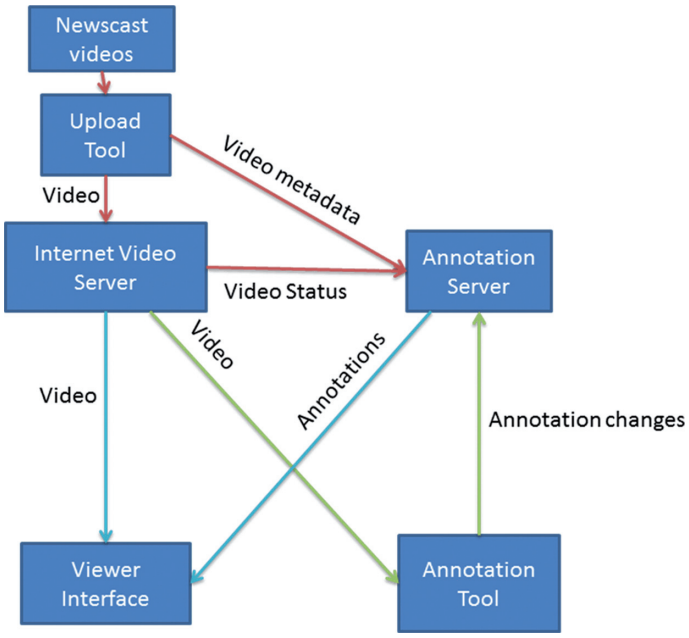

Fig. 2. Interactive News Architecture.

first and viewers have the opportunity to express their opinion on each story. The news production team picks the stories to feature in these headlines, using the accepted guidelines for news production.

When preparing a newscast story, interviews are recorded, special reports written and taped, footage of the scene may also be recorded. The resulting material is then edited down into a story that is generally 90 seconds or less. This video, along with scripted commentary by the news anchors or reporters, becomes the story that appears in the newscast. The remainder of the material is discarded. Some discarded material is not very good. The interviewee was very dull or rambled on. The material is not interesting. Perhaps the camera is dropped, the wind was too high or a jack hammer fired up during the interview. However, some of this material is valuable to people interested in the story.

To conform to the 30-minute time slot dictated by standard television, all stories must be cut down so that many stories can be told. The idea is to tell a little bit about everything to keep the attention of as many people as possible. Focusing on one thing carries the risk that uninterested viewers might leave the newscast. For compatibility and to accommodate user interests we leave the main newscast intact but we allow reporters and producers to add clips of additional interesting video to augment some of the stories. This allows viewers who are interested in a particular story to get more information. For example, if the state legislature is meeting to consider the budget, a reporter may record interviews with the governor and several legislative leaders. For the main story these must be cut down to sound bites or discarded altogether. In our interactive news system, edited versions of these interviews can be attached to the main story for viewers interested in the state budget. These kinds of clips form the extra content in Figure 1.

4. CREATING AN INTERACTIVE NEWSCAST

To create an interactive newscast the reporters generate their stories and scripts just as they do for the traditional television newscast. In addition, reporters will edit or record additional content clips for

Fig. 3. Newscast annotation.

some of their stories. The editing work is additional labor beyond the standard newscast. In addition to scripting the stories, the producers must also script each of the segments for the tease menu clip. Prior to the newscast, or immediately after the newscast the anchors record the tease menu. This also is additional labor. Generally all of these video assets are in place at the end of the traditional newscast. At that point we create the interactive newscast.

Figure 2 shows the interactive newscast architecture. First the video assets (tease menu, main newscast, extra content) are uploaded to a video server where they are ingested into a form suitable for high-speed streaming. They are then placed on an Internet Video Server (HTTP). The HTTP protocol is sufficient for the Move video player to get the information that it needs.

The Annotation Server is the repository for all of the information required to make the newscast interactive. The Upload Tool not only uploads the video but also requests information about the kind of video (tease menu, main newscast, extra content) and which newscast the video belongs to. The Internet Video Server notifies the Annotation Server when the video conversion process is complete so annotation can begin.

Once video assets have been ingested by the Video Server the annotation process can begin. The annotation step that must be done manually by production crew to provide the information needed for the interaction. Figure 3 shows the tool for annotating the newscast. The newscast is segmented into stories and each story is given a title and a category. The most important information about each story is the start and end time of each segment in the newscast. There is also dead time (black) on the timeline that is not used in the interactive newscast. This contains commercials or promotions for other programming.

The annotation tool also has a similar user interface for marking the segments of the tease menu and associating each segment with a story in the main newscast clip. The "Stories" tab of the tool allows producers to select individual stories and associate additional content with the story. The producer selects a story from the list of annotated stories and a timeline for that story is shown. The producer then selects segments out of that story's timeline for association with additional content. For example when a particular crime witness is speaking in the main story we want to offer the full interview to the viewer. This part of the tool allows the producer to attach the full interview clip to the segment of time where the witness is speaking. The extra content is thus offered in the context of the main story.

5. THE VIEWING EXPERIENCE

The easiest improvement to the viewing experience is the ability to watch the news any time that you want. Modern DVRs will provide this facility. Then the next enrichment is to select what you want to watch. This is more problematic because the way people select video is different from the way people select links on a Web page. Barkuus et al. [2009] shows that many viewers select what to watch by surfing through what is available and actually watching segments to see if they are interested. Other viewers used program listings to select. We have provided our viewers with multiple possibilities and then logged their behavior to see which they actually use.

The interaction behaviors that we offered were the following.

(1) Present headlines of key stories and allow the viewers to specify their preferences. (This was used to control story order.);
(2) Offer a playlist menu from which they could select stories and additional materials;
(3) Skip ahead to avoid a story that has become uninteresting; and
(4) Select more information while watching a story to get a deeper view.

To facilitate interaction we provide the viewer with a one-handed remote control. For our prototype we used the wireless mouse shown in Figure 4. Although this is a gyroscopic mouse we did not use any of the mouse functionality. All we wanted was the buttons and a clean software interface to our viewer code. This mouse fit the bill. However, it should be thought of as a remote control and not as a mouse. We never used any pointing functionality in the viewer interface.

A big challenge that we faced in providing an interactive television experience is to provide a rich set of controls in an easy to learn package. The complexity of television remotes has become a cultural joke. We did not want to exacerbate that problem by adding even more buttons. The controller that we used has a trigger under the index finger. When the user pulls that trigger an image of the controller appears on the screen with the current meaning of the controls clearly labeled (Figure 5). The labels on the controls vary based on where the user is in their viewing experience. There are more controls than can fit on this small number of buttons. The viewer can operate these controls without pulling the trigger. The trigger simply provides instant help on what the controls currently do. In other projects we have used game controllers in a similar way.

We used this style of remote for several reasons. The first was that the current universal remote that comes with most televisions is way too complicated. Creating a remote that has a button for each interactive behavior would be physically cumbersome and could not scale. The Apple Remote has the kind of minimalist style that we are looking for, but its 5 basic functions were not sufficient. The style we are exploring is a simple remote with relatively few general purpose buttons whose functionality can be exposed on the screen. The only instruction that we gave our subjects was to "pull the trigger if you do not know what to do." We wanted to test whether showing the physical control on the screen

Fig. 4. Handheld controller.

Fig. 5. Control prompt overlay.

with button labels would be sufficient for viewers to learn a set of commands. We assume that the ultimate physical style of remote will be different from ours.

5.1 News Headlines

We wanted to explore creating a menulike experience that was not textual and list-oriented but rather video-oriented in style. We did this with our tease menu. When the viewer begins their newscast they are shown the tease menu clip first. For each item in the clip the title of the associated story appears on the screen with an image of the controller (Figure 6). This controller shows that the left button is "thumbs up" and the right button is "thumbs down". The viewer can use these buttons to express an opinion on the story whose tease clip they are currently viewing.

Fig. 6. Tease menu user prompt.

Fig. 7. Additional content offering.

Any story that the viewer gives a "thumbs up" will be moved to the beginning of the newscast. Any story that the viewer gives a "thumbs down" will be moved to the end of the newscast. If the viewer does nothing then the story stays in its original order. This is our first interactive technique. It is a simple vote on headlines that will then reorder the stories. Because of the viewing time required for the headlines we did not include all stories. Stories not included were left at their original positions in the newscast.

5.2 Simple Viewing

Once the headlines have been shown the main newscast begins. The viewer can passively view this newscast with no additional input. The stories are ordered according to their original production order, modified by the viewer's headlines choices. We have augmented this simple linear viewing by adding two interactive controls: "next story" and "previous story." The next story button allows the viewer to skip a story that has not proved interesting. The previous story button allows the viewer to recover from mistakes made with the next story button. The two buttons together allow for a semilinear browsing of the sequence of available stories.

We also augmented the simple viewing mechanism with the extra content that the reporters provided. As the viewer is watching a story that has extra content, the title of that content appears in the upper right of the screen with the central button highlighted for selection (Figure 7). This offering of additional content is controlled by the timeline information that was provided when the producer attached the content to the story. When the additional content is complete or the viewer selects to terminate the additional content, control returns to the main story where it was previously.

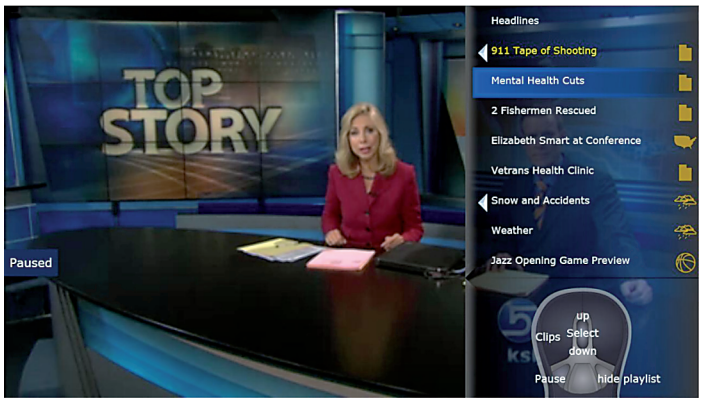

Fig. 8. Playlist controls.

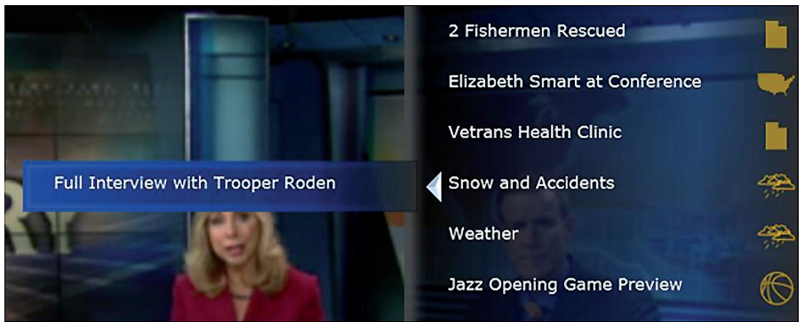

Fig. 9. Additional content.

5.3 Playlist Interaction

In addition to the simple viewing controls we also provide the viewer with a playlist that can be brought up at any time (Figure 8). This example shows the playlist with the prompt trigger pulled so that the prompt is visible. A transparent list of all of the stories in the newscast appears on the right. Viewers can use the thumb-wheel in the center to scroll through the playlist and directly select the next story that they will watch.

In addition to selecting a story to watch, the playlist also shows which stories have additional content and allows that content to be selected directly from the playlist, as shown in Figure 9.

5.4 Summary of the Interactive Experience

Interactive news provides a standard television experience where viewers can simply start at the beginning and watch to the end, seeing exactly what viewers see on their traditional televisions. We then augment this experience with four interactive capabilities. Viewers can express their opinions of the headlines to reorder the stories they will be shown. They can skip forward and backward in the story sequence. They can select stories from a menu-like play list and they can choose to watch extra content with some stories.

6. EVALUATION

A full evaluation with a high degree of statistical confidence would require deployment into thousands of homes over several months. This would provide good strong numbers indicating how the technology is used over time after the novelty wears off and how a broad demographic of viewers would respond to it. The technology of interactive television is just barely reaching the level where in-home deployments are even possible. Such an ambitious study is not yet possible.

In contrast with this full public trial there are the evaluations done with prior work. Because of technology limitations, prior researchers have been forced to use archival material rather than actual fresh news. Their evaluations have been limited to lab demonstrations because until recently there was no Internet video protocol that could deliver interactive behavior into actual homes.

Our evaluation approach is a compromise between the in-lab experiment and the full public deployment. After prototyping our tools using the newsroom of the student-produced BYU Daily News, we introduced our tools into the KSL-TV newsroom and produced an interactive news deployment over the course of seven days. This gave us fresh, real news to use in evaluating the viewing experience. Additional days were not possible because of upcoming demands on the newsroom. In addition, we gained insight into the impact of these techniques on the news production process. Seven days gave us enough time to get past the initial novelty of the system but not really enough time to evaluate how this would be used over time. We think this gives us much more information than was available before but far less than we would like.

In preparation for our seven-day production with KSL-TV we recruited ten families in a local suburban neighborhood to install our technology in their homes. The locale for selecting families was chosen for convenience in installation and support. We were unsure of how much effort would be required and whether failures would need immediate in-home attention. We screened about 20 homes and selected 10 that had the necessary Internet facility, TV connections compatible with our equipment and reported that they were regular watchers of television news. We made no attempt at demographic diversity or profiling. Our questions largely revolved around “Will it work in the wild?” and “Will anybody actually be able to use it without our careful tending?” Our evaluation is much more formative than summative.

6.1 Evaluation of Newsroom Production

To produce an interactive newscast there are four additional tasks beyond a normal television broadcast.

(1) Reporter editing of extra content material

(2) Recording the tease menu clip

(3) Uploading video assets to the video server

(4) Annotating the newscast

We observed production during the BYU Daily News and through the seven days of the KSL-TV trials. In addition, we conducted post interviews with each group. The responses were very similar for both groups.

The provision of extra content was very uneven depending upon individual reporters. Some saw this as an interesting new alternative. Some saw it as something they were willing to cooperate with. Some saw it as an intrusion. Most of this variability is due to the fact that the production of interactive content had no bearing on their job performance. We did not get any antagonism to the approach, only occasional apathy.

The uneven level of reporter motivation did produce two effects. The first is that only 21.5% of the stories in the KSL trial had any extra content. This may be the cause of some of the effects we noticed in the viewing experience. The second issue is that much of the extra content was not well edited. Reporters and producers are very careful about condensing a news story to its most interesting essentials. Much less care was taken with the extra content because it was perceived as an extra rather than as part of their real job. The result was that much of the extra content was more boring than necessary. We believe that better content could have been produced if it was an actual job priority. In hind sight we may have gotten better results by offering incentives to reporters. However, our partners were primarily focused on "getting out the evening news." Adding incentives may have been perceived as being at cross purposes with their existing goals.

In both newsrooms, the recording of the tease menu caused some consternation at first. Newsrooms have a very distinct rhythm with pieces falling into place at predictable times and in predictable ways. Introducing the tease menu recording disturbed that rhythm. However, after some initial confusion around "What are we doing here?" and "Why are we doing this?" everyone caught on and it flowed into the normal news process.

The uploading of video assets to the video server raised the most complaints as part of the production process. There were complaints that it tied up key equipment to do the video encoding and it slowed down the process of getting out the interactive version of the news. The interactive version generally did not appear in less than an hour after the television broadcast (30 minutes in length). We see various ways to resolve this problem. The good news is that it is a technology problem that can be addressed and not a serious barrier to actual news production. More and less-expensive hardware will simplify this process as well as changes to production practice to allow content to be generated in parallel.

Annotating of the newscast was in all cases done by a student working for our lab. This student is majoring in broadcasting and not a programmer. The result was that we were able to successfully annotate a newscast in about the time required to record the newscast. This demonstrates feasibility of the annotation process but not much more. We do believe that if the annotation process were integrated into the professional tools used in the news room [Avid 2009] that this effort would be minimal.

6.2 Evaluating the Viewing Experience

For each of the ten families in our trial we deployed a computer attached to their own broadband network. We found that many of the families did not have network connections near their televisions. However, they were surprisingly willing to assist us in stringing cable through their home to make the connection. We suspect that they would be less cooperative if our trial had lasted for months rather than 8 days. We used two different computers depending on the connections that they had to their television. For those with only NTSC connections we used a Mac Mini. For televisions that supported HDMI we used a Dell Studio Hybrid. Both machines cost about $ 500 and are about the size of other television components. Each was preloaded with our software and was setup so that powering on the device would automatically display our software. To the viewers it appeared to be a dedicated television device.

The one challenge that we faced was that the computer connections to the television were through a different input than their standard television. This meant that to access our content they would need to use their TV remote to switch inputs. This is the same thing that most of them must do to use their DVD or VHS player, but we were concerned about this barrier to normal passive viewing. As an encouragement to switch to Internet video we created a home page that included our news offering as well as other online video services such a Hulu or the television networks (Figure 10). Other than offering these links we did not change their user interfaces at all. To select the news or to view the other material, they needed to use our controller as a gyroscopic mouse. We got a number of complaints

Fig. 10. Home page for news viewing.

about the usability of this type of mouse. Because this was outside of our news experience we did not measure its usability, but it may have formed a further barrier to watching our news. In the upper left of the home screen we provided a help button. Clicking this button would show a short video on how the controls worked. Our user training consisted of telling them how to select items to view and how to get the help. We also gave them some hands-on experience with a test newscast and explicitly asked them to watch the news daily.

Most of the data that we report comes from logs that we took of viewer behavior. Each interactive input generated a log message that was sent to the server. This allows us to document actual behavior rather than relying upon viewer opinion. We chose this evaluation approach for a number of reasons. First there is already data in the literature providing interview results about people's television viewing habits [Barkhuus et al. 2009; Hughes et al. 2000; O'Brien et al. 1999]. Interview data has some deficiencies. In particular what people say they do and what they actually do are not always the same. Our second consideration was to avoid laboratory studies. Laboratory studies can really hone a particular behavior but their artificial nature does not provide a lot of guidance as to how a technology will fit with home life. The way people use television news has a lot to do with how they live their lives [O'Brien et al. 1999]. For this reason we opted for an in-home deployment. We also wanted to get some longevity from our data. There are obvious problems with first-time use of any technology. There is a positive bias due to the introduction of new technology and a negative bias induced by the learning of new techniques. Ultimately we would like to deploy the technology over months but that was not financially practical for us or our partners. We did want to deploy for a period long enough to get past the first-time use problem.

6.2.1 *Participation.* The average family size of our participants was 4 with every family having two adults heading the home. The average age was 35 and the average adult age was 52. There were an equal number of males and females. Among the total sample, 55% reported watching television news daily or several times a week. Among adults this was 83%. All but two people reported themselves as moderate computer users. The remaining two reported themselves as expert users. There is a DVR-like device in 50% of the homes. They reported that each family averages 15 hours of television watching per week.

We told them that the news would be available any time after 6:30 P.M. Figure 11 shows a histogram of the times that they actually watched the news. Note that two of the sessions were almost 24 hours later. It is clear that viewers are time shifting their news viewing but that most of them are watching near to the normal late news time.

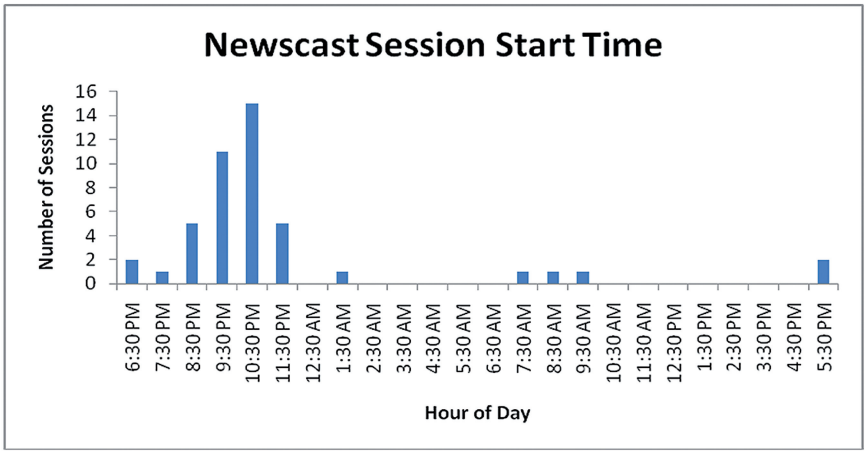

Fig. 11. Counts of when people watched.

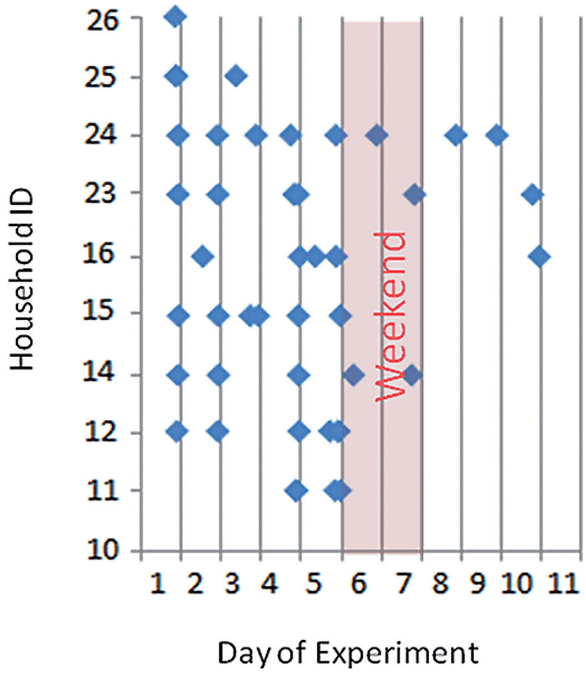

Fig. 12. Viewing patterns by household.

Figure 12 shows the viewing times broken down by household. Each of the marks is at the actual time of viewing even though the scale is laid out in days. There is a distinct pattern of non-participation. Family 10 never used the system even though they agreed to the trial. Family 26 only turned it on once and families 11 and 25 only turned it on twice. Originally KSL said they would only be able to participate for 5 days and then later extended for 2 more days. Only 3 families continued to watch during the extension. This somewhat ragged participation is the product of many factors. Most

Average	Day 1-3	Day 4+
80%	102%	65%

Fig. 13. Percent of each newscast actually watched.

View Controls	Seconds Between
Average	53
Day 1-3	63
Day 4+	48
Change	-24%

Fig. 14. Average Time between uses of control help.

of them are due to the challenge of attempting in-home rather than laboratory trials. We still believe, however, that the in-home data is much better than laboratory data despite the difficulties.

The participation rate shown in Figure 12 is not unreasonable for an in-home trial of a technology over the course of a week. The problem with in-home trials is that they must interact with personal lives. The value of in-home trials is that they interact with real life. It is not surprising that 4 families did not use the technology more than twice. In real homes such variability is not unusual. We really do not have any data as to whether the non-participation by 4 families is due to their personal lives or the technology.

6.2.2 *Viewing time.* One of the key questions to answer when people are offered an interactive television experience is whether they will use the interaction to watch for less time. If people watch less news than before then there will be less opportunity to offer advertising and thus less income. For each newscast that someone viewed we recorded the amount of time that they actually watched. We compared this to the total time of actual news available in that session. We also wanted to control for initial behavior. Our hypothesis was that there would be a lot of initial toying with the system and then in later days people would settle into more normal habits. We therefore separately report the behavior of days 1–3 from the behavior in days 4–8 in Figure 13. Because this data is relative to sessions actually watched it is not impacted by the ragged participation shown in Figure 12.

We picked the cutoff of 3 days because by that time almost every family that was going to engage with the technology would have used it multiple times. Thus by day 4 the viewing habits would be those of one moderately familiar with the technology. This is obviously not true for household 11. It is also possible that a different family member who has not used the technology early on and then tried it out on day 4 might skew the data without our knowledge.

Figure 13 shows that in the first three days viewers watched more than the standard newscast. This is due to the additional material that was available. However, after the first three days viewers are watching much less of each newscast. They are getting familiar with the interactive controls and using them to avoid news that does not interest.

6.2.3 *Control Help.* In Section 5 we introduced the idea of a minimal remote control that would use on-screen prompts to expose the full range of the control space. Figure 5 shows the on-screen overlays that we used to prompt users as to what they can do. This overlay was available by pulling the trigger on the control. It was not necessary for the overlay to be used to activate the controls. The controls operate the same whether the trigger is pulled or not. Our idea was that people would initially use the help overlay, then learn the button functions and stop using the overlay. Figure 14 shows the number of seconds between uses of the overlay. Smaller numbers indicate more frequent usage. Notice that the frequency of use increases in the later part of the trial. We have no real explanation for this behavior.

Participants	Comment
88%	Controls easy to use once learned
25%	Highly liked controls
50%	Controls easy to learn
25%	Controls not easy to learn
50%	Gyroscopic pointer or gestures interfered

Fig. 15. Participant responses related to usability of the controls.

It is obvious from the other data that viewers were very successful in using the new controls that we offered, yet as they gained experience they increased rather than decreased their use of the overlay. This is a topic that will require more study.

We did ask a number of qualitative questions after the trial to try to understand how usable the controls actually were. Figure 15 summarizes these results. These questions were asked of one of the parents in each home, depending on who was available when we picked up the equipment. Though there is support for the ease of use, there are also indications of usability problems. The functioning of the controls is highly modal. The controls do different things depending upon what the viewer is currently doing. We believe that this modal behavior may have induced some of the usability concerns and would explain the frequent use of the overlay. It would seem that the viewers are unsure about what each button does and are frequently seeking help. We are gratified by the number of people that considered the controls easy to use once learned. The positive data shown in Figure 15 does not necessarily indicate that this is the best approach. However, the absence of strong negative feedback is important. The negative feedback on gyroscopic pointing and gestures leads us away from such techniques in the future.

6.2.4 *Use of Interactive Controls.* There are three ways that viewers can exert control over the stories that they watch.

—Express an opinion during the headlines tease menu

—Select next/previous story

—Select a story from the playlist.

In our KSL newscasts the number of headline stories varied between 7 and 10 with an average of 8 headlines per newscast. This is less than half of the number of stories that actually occurred in the newscast. To include every story would have made the headlines too long. We logged the number of times that a viewer expressed a positive or negative choice about a headline story. Over the whole experiment this occurred an average of 5.3 times per newscast. This means that the viewers were expressing opinions on 66% of the headlines. During the first three days of the trial an average of 4.3 opinions were expressed per newscast. The median number, however, was 2. In looking at the data we see some viewers pressing the button multiple times as they learned how to use it. In the days 4–8 we find an average of 5.9 opinions expressed per newscast with a median of 6. The learning of the controls effect has disappeared and the viewers are expressing opinions 74% of the time. During free-form viewer comments after the trial, 38% of the viewers reported that they mostly used the headlines menu as their mechanism for selecting news stories with 25% reporting a combination of techniques.

The other interactive paradigm in our system is where viewers actively make story choices while watching. Figure 16 shows the seconds between uses of one of the navigation commands. Over the course of all trials there was an average of 79 seconds between viewers' use of one of the navigation controls. It is obvious that the viewers are very active in their selection of what they want to watch.

Navigation	Seconds between inputs
Average	79
Day 1-3	74
Day 4+	82
Change	11%

Fig. 16. Frequency of use of navigation controls.

	Playlist Selection	Next Story	Previous Story
Day 1-3	26%	38%	36%
Day 4+	26%	41%	33%

Fig. 17. Comparative popularity of navigation controls.

Though interaction was more frequent in the first three days of the trial, it continues strong throughout.

Figure 17 gives us insight into which controls were actually used. The numbers in Figure 17 are the relative usages out of the three forms of navigation. The most popular control was to skip to the next story. This is sort of the minimal level of interaction. The viewer watches and then vetoes stories that do not hold interest. It is also clear that viewers second-guessed their decisions because previous story was also common. Playlist selection is where a user scrolls through a list of stories and picks the next one to watch. This is a more active choice option that is also much slower. However, it did retain strong popularity when compared to the other techniques. This data indicates that interactive story navigation is popular and that there is no clear winning technique. There also does not seem to be a change of usage after day 3.

6.2.5 *Use of Extra Content.* One of our hopes for this technology was that the offering of new content beyond what was available in the standard newscast would make up for the content that the viewers would skip over. However, only 44% of the households ever selected any of the extra content at all. Out of all the newscast views only 16% of those sessions contained a selection of extra content. Among households that actually used the feature, they used it in 37% of the newscasts that they watched.

The average length of an extra content clip was 163 seconds (2.7 minutes). The average viewing time of an extra content clip was 94 seconds. For 75% of the clips that were selected the viewer watched the entire clip. For the rest the viewer skipped out early and in many cases very early.

This is a disappointing level of use for this feature. However, we believe that there are a number of factors that contributed to this. The first is that only 21% of the news stories had any extra content. As viewers were watching the normal news stories, the overlays offering the extra content were only up for 7.1% of the normal newscast time. This means that extra content was relatively rare and thus the default viewer assumption would be that there is nothing more to see. This would be reinforced by their experience with normal television where there is nothing else available. In trying not to interfere with the standard newscast stories, we believe that our prompts for the extra content were too subtle. Many television newscasts today contain segments where the anchors or reporters say "For more information go to our Web site at ...." We believe that more overt invitations would have drawn more viewer attention.

A final problem was the quality of our extra content material. The extra content clips were poorly edited and frequently had no new material. In connection with this 75% of the post interviews reported that much of the extra content offered was not interesting. In contrast 88% of viewers said they liked

the extra content feature. Clearly there is a user interface design problem and a content production problem in this feature.

6.2.6 *Additional Comments.* In addition to the measured numbers we received a number of comments in the post interviews. 100% of all respondents said that they liked the ability to watch what they want. 63% specifically mentioned that they liked skipping stories that did not interest them. 38% mentioned that they liked watching on their own schedule, which is consistent with the data in Figure 11. Other comments of note were:

—Some choppiness between stories as the system interactively moved between stories (we believe we have developed a caching system that will resolve this.)

—Difficulty with textual prompts on NTSC(low resolution) televisions.

7. CONCLUSION

We have created a system for interactive newscasts that can be delivered to viewers over the Internet and into their family rooms. We have created a news production system that fits well with existing news processes and provides the viewers with popular new controls over their news consumption. The usage data supports the effectiveness of on-screen help to support a minimalist remote control style. The new controls involve opinions on story headlines, skipping back and forth over stories and selection of stories from a playlist. These controls were used very frequently and retained their popularity into the latter days of an 8 day trial. We have deployed real, fresh newscasts into actual homes and evaluated that use in the context of real home life. We have also created mechanisms for enriching a newscast with additional content. We have shown that this can be effectively produced and delivered, but we have not yet shown a form for extra content that is attractive to viewers. In sum we offer a new technology that will change the way people consume their evening news. The usage data that we report from actual logs in actual homes provides insights that are not available from mere interviews or laboratory studies.

REFERENCES

AVID. 2009. Avid iNEWS NRCS. http://www.avid.com/products/iNews/index.asp.

BARKHUUS, L. AND BROWN, B. 2009. Unpacking the television: User practices around a changing technology. *ACM Trans. Comput.-Hum. Interact. 16,* 3.

BBC. 2009. BBC-digital-interactive TV. http://www.bbc.co.uk/digital/tv/tv_interactive.shtml.

BYWATER, J., BOURGUET, M., KAZAI, G., LALMAS, M., AND PEARMAIN, A. 2004. Scalable and personalised broadcast service. In *Proceedings of the European Conference on Interactive Television: Enriching the Experience*.

DOWMAN, M., TABLAN, V., URSU, C., CUNNINGHAM, H., AND POBOV, B. 2005. Semantically enhanced television news through web and video integration. In *Proceedings of the Workshop on Multimedia and the Semantic Web at the European Semantic Web Conference*.

HAAS, N., BOLLE, R., DIMITROVA, N., JANEVSKI, A., AND ZIMMERMAN, J., 2002. Personalized news through content augmentation and profiling. In *Proceedings of the International Conference on Image Processing*. 9–12.

HAUPTMANN, A. G. AND WITBROCK, M. J. 1997. Informedia: News-on-demand multimedia information acquisition and retrieval. In *Intelligent Multimedia Information Retrieval*, AAAI Press, Cambridge, MA.

HUGHES, J., O'BRIEN, J., RODDEN, T., ROUNCEFIELD, M., AND VILLER, S. 2000. Patterns of home life: Informing design for domestic environments. *Pers. Ubiq. Comput. 4,* 1, 25–38.

JENSEN, J. F. 2005. Interactive television: new genres, new format, new content. In *Proceedings of the 3nd Australasian Conference on Interactive Entertainment*. Creativity & Cognition Studios Press, Sydney, Australia.

KRAUT, R., SCHERLIS, W., MUKHOPADHYAY, T., MANNING, J., AND KIESLER, S., 1996. The HomeNet field trial of residential internet services. *Comm. ACM 39,* 12, 55–63.

LARSSON, H., LINDSTEDT, I., LOWGREN, J., REIMER, B., AND TOPGAARD, R. 2008. From time-shift to shape-shift: Towards nonlinear production and consumption of news. In *Proceedings of the 6th European Conference on Changing Television Environments (EUROITV'08)*. Springer, 30–39.

MICROSOFT CORPORATION. 2009. Smooth streaming: The official Microsoft IIS site. http://www.iis.net/extensions/SmoothStreaming.

MOVE NETWORKS. 2009. Move Networks >> Move Adaptive Stream. http://www.movenetworks.com/move-media-services/move-adaptive-streaming.

O'BRIEN, J., RODDEN, T., ROUNCEFIELD, M., AND HUGHES, J. 1999. At home with the technology: An ethnographic study of a set-top-box trial. *ACM Trans. Comput.-Hum. Interact. 6,* 3, 282–308.

OEHLBERG, L., DUCHENEAUT, N., THORNTON, J.D., MOORE, R.J., AND NICKELL, E. 2006. Social TV: Designing for distributed, sociable television viewing. In *Proceedings of the European Conference on Changing Television Environments* (*EUROITV '06*).

WILLIAMS, D., KEGEL, I., URSU, M., PALS, N., AND LEURDIJK, A., 2007. Experiments with the production of shape shifting media: Summary findings from the project NM2 (new millennium, new media). In *Proceedings of the 4th International Conference on Virtual Storytelling: Using Virtual Reality Technologies for Storytelling* (*ICVS'07).* M. Cavazza and S. Donikian, Eds., Springer. 153–166.

Received October 2010; accepted January 2011