Collaborative and Automatic Annotations to Improve the Utility of Recorded

Meetings


by


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BA, Rice University, 1995




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MASTER OF SCIENCE


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University of Victoria

# Supervisory Committee

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# Abstract

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  In this thesis I present a collaborative annotation strategy to improve the usability of audio/visual meeting recordings. Meeting records are inherently difficult to navigate without structure, and even full transcripts do not always address this problem. Through the use of collaborative annotations some structure can be provided. The current study examines the use of a scalable classroom response system to allow groups to conveniently and easily provide these annotations during a class or meeting and presents a web-based video browser that uses these annotations to greatly improve the efficiency and satisfaction in a later information retrieval task. The applicability of this annotation strategy is discussed in a range of situations across formal meetings, classroom situations, and online audio and video.

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# INTRODUCTION

## Overview

This thesis focuses on improving the usability and usefulness of meeting records through the addition of non-intrusive collaborative annotations. In the current system, participants in a meeting use a five button radio frequency classroom response system to provide annotations on the meeting while it is going on. Five choices, depending on the type of meeting, would allow participants to code a particular point in the meeting as "good point" or "external reference" or "I agree" or "I disagree" or perhaps "action item." The set of choices may vary by the meeting, but having a small set of buttons that can be identified and pressed without having to look at them seems to be a much less cognitively demanding task than taking a full set of notes. These collaborative annotations, combined with some automatic annotations such as who is speaking and which slide is showing, act as an index into the audio/visual recording of the meeting for users who were not able to attend and thus allow more efficient navigation and interpretation of meeting events without having to listen to the entire meeting. The web-based meeting browser presented in this thesis offers an efficient method of overcoming some of the problems and insufficiencies of current meeting recordkeeping strategies.

## Research Questions

The core research question is whether a collaborative annotation system can function as well as manual note-taking or full transcripts in a later information retrieval task, simulating how people who had missed a class or a meeting could take advantage of recorded audio and video. Although the note-takers themselves can certainly use such a

system to review the meeting, the focus of this work is on whether people who were not at the meeting see advantage from collaborative notes taken by those who were there.

Aside from the core question, this research also focuses on usability and satisfaction with a specific implementation of a collaborative note taking system. It also proposes a novel use of classroom response systems that form the input device for these collaborative notes.

### Thesis Structure

This thesis presents a literature review of other work addressing related questions, a design for a meeting browser and annotation system, an implementation of that system, and a pair of user studies evaluating the performance of the system. The discussion section positions the work with respect to future directions in the field and other forms of recorded material that fall outside of the standard conception of a meeting.

### Overview of Results and Limitations

Although the meeting annotation system and browser presented here is a working system, it is important to note that it is still rather preliminary and both engineering and design work would be required to turn it into a robust and general purpose tool for ordinary classroom or meeting use. In rather controlled circumstances, though, this approach has shown itself to be effective in allowing people who were not at an initial meeting to quickly find specific information from recordings. The collaborative annotations were on par with manually taken notes and even transcripts in their ability to allow users to find information and users showed a preference advantage for an integrated annotation system such as this as compared to relying on paper notes.

This thesis presents a unique use of classroom response systems and custom developed software to form a meeting recording tool that allows the creation of well-annotated meeting records without imposing an undue cognitive load on meeting attendees or requiring a dedicated note-taker. This reduction in cognitive load is achieved by the use of a system of simple annotations rather than requiring full notes to be taken.

# LITERATURE REVIEW

The current work is focused on methods of improving the utility of meeting recordings. To this end, the literature can be broken down into 3 main areas. First, some analysis of meetings and existing tools to make them more effective. Next, a discussion of note taking and annotation strategies. These strategies still either fall short of effectively annotating meeting records or they require an inordinate amount of time and effort to produce, so the final section will focus on collaborative annotation strategies. Until the technology reaches the point where automatic annotations are feasible and effective, these crowd sourced annotation techniques seem to offer the most potential to improving the utility of meeting records.

This review is primarily focused on the computer science literature so as to focus on computerized tools for improving meetings. Some alternate strategies would be to look at the psychology and education literatures to return to first principles in identifying what support the toolsets should provide. Even within the computer science literature, there is more than this review can cover. Each of the automatic annotation strategies - speech recognition, speaker identification, topic identification, etc. - have spawned active research communities to improve the field. It is beyond the scope of this review to do more than briefly summarize the current state of the art of these areas and conclude that they are still not ready to supplant human beings in their annotation capabilities.

## Meetings and Meeting Recordings

Meetings are central to many parts of our lives. They are an important vehicle to conduct business, education, and generate new ideas. But meetings are also associated

with challenges. They are often difficult to schedule, they are not self-documenting, and they are not uniformly interesting (Romano01.) For over twenty years, these problems have been discussed and worked on as researchers build ever more useful collaboration tools (Stefik87.) Today videoconferencing is displacing some aspects of in-person meetings - this is good, and an opportunity to make the toolset better. These remote meeting tools are becoming quite sophisticated and provide interaction tools that make remote interaction almost as effective as being there (Garcia07.)

But maybe the gold standard of "as good as being there" ought not be the goal. By-and-large, these tools still don't adequately solve the asynchrony problem. They allow for attendees to be in different places, but are less effective at serving the needs of attendees displaced in time. For all of the complex telepresence, after a meeting is finished the primary record of the meeting is still an audio or video recording. And this alone is not good enough to effectively and efficiently extract the information needed from the meeting (Degen92)(Geyer05)(Jaimes04)(Whittaker94.) Without any structure to guide a user to important or interesting parts, the user must review the entire recording.

### Note Taking, Artefacts, and Annotations

Notes are not good enough either. Moran et al. found that a user was unable to create detailed reports from notes alone (Moran97.) An earlier lab study by Whittaker et al. similarly found that important details are lost when summarization takes place from notes alone as compared to audio. Whittaker also revealed that 70% of people surveyed reported problems with their note taking practices (Whittaker94.) In a 2006 study, Whittaker et al. suggested that notes alone are generally insufficient to accurately

summarize the content of a meeting and that the recorded audio must often be used (Whittaker06.)

This discussion of notes also presupposes that there is no cost to note taking. In fact, there is a cost. Particularly in very interactive meetings, the cost of note taking is inattention to the meeting (Whittaker94)(Whittaker06) because note taking itself is a high cognitive load activity (Piolat05.)

Given the described challenges associated with taking notes and the insufficiency of audio/video recordings by themselves, how can we improve information retrieval about past meetings? There are a number of types of indexing information available to help make sense of a meeting record. Perhaps the most interesting are what Tucker and Whittaker refer to as artefacts (Tucker05.) Notes are included in the list of artefacts, as are presented slides, agenda items, whiteboard annotations, and documents. Timestamps of artefact creation or modification can serve as index points into an audio or video record.

Also interesting are automatically generated annotations regarding the semantics of the meeting. At the extreme end, this could refer to a complete transcription, automatically generated and parsed into an effective summary through a knowledge-based reasoning engine. This is still an unsolved research problem (Foote99)(Hsueh09.) At some point in the future when we have speech recognition that effectively captures group meetings with multiple speakers, and we have the text classification techniques to derive meaning from this, then this might become the preferred way of summarizing and navigating meeting data.

At this point though, a more tractable approach is to leave the full transcript aside and focus on aspects of the meeting that can be more reliably captured. Speakers can now be identified with a high degree of accuracy based on audio recordings (Shu-Chang07.) This information of who is speaking has proven useful as an index into the meeting details (Cutler02.) More recent work has been done regarding visualizations of conversational data (Bergstrom09.) Interestingly, this work includes not only speaker identification, but also a "conversational back-channel" button that users press to mark something as interesting - this is a limited form of a collaborative annotation.

### Collaborative Annotations

In fact, users use a wide range of cues to remember which parts of a meeting they want to access (Jaimes04.) But the aspect that our current work focuses on is the realization that meeting attendees themselves know at the time they see them which parts of a meeting will be interesting to come back to. This is not an entirely new realization; Degen et al. made it back in 1992 (Degen92.) Hayes et al. used a related technique in a study of autistic kids - their caretakers pressed a button to remind themselves which parts of a tape loop would be interesting to come back to in order to look at why certain behavior problems developed (Hayes05.) Meeting annotation is similar, but requires more than just a time marker. Ideally, meeting attendees would be provided with a small amount of leeway in what they were annotating, but not so much that the process of annotation becomes a burdensome cognitive load barrier, always keeping the high cognitive load of full notes as the reference bar to stay under (Piolat05.)

The current design proposes such a minimal annotation system, the details of which are described in the next section.

# DESIGN AND IMPLEMENTATION

A block diagram of the MeetingSurfer system is presented in Figure 1. During a meeting, participants create annotations using iClickers, and the presenter creates annotations by means of a PowerPoint plugin that records slide titles and transition times into a database. The audio/video recordings are synchronized with these annotations. After the meeting, people who were not able to attend (or attendees who wish to review the meeting) are able to view the content by means of the web-based MeetingSurfer browser. This browser is also capable of generating new annotations which will be stored in the database for the use of future viewers.
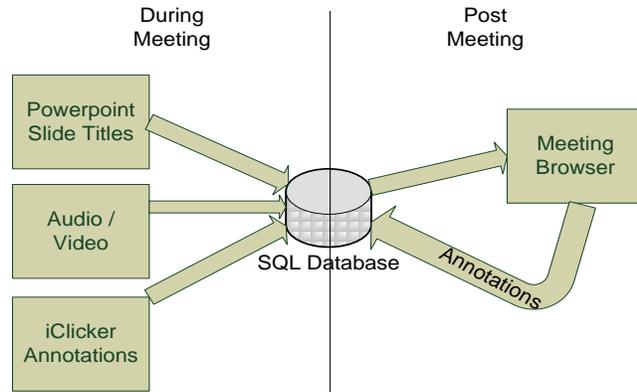
**Figure 1: A block diagram of the system components of the "MeetingSurfer" system**

**Figure 2: the "MeetingSurfer" browser, showing a timeline of speakers and the annotations made by previous listeners**

A timeline, shown in Figure 2, is the core of the meeting browser. The timeline represents speakers, derived from manual annotation or an automated algorithm, and annotations from prior listeners of the meeting. The full meeting browser, shown in Figure 4, incorporates 4 different sources of annotations. First, is a table of contents of topics. On the bottom left is a timeline button, which brings up the timeline. On the bottom right is a button to allow the current listener to add to the annotation database as they are watching a recorded meeting. And finally, in the upper right is a button that brings up a meeting transcript, if one is available. The center section is entirely reserved for meeting video and in the default view even the buttons are semi-transparent. This emphasis on simplicity in MeetingSurfer is a response to earlier systems whose primary usability failing was being too complex (Whittaker08.)

The ability to provide and use annotations to navigate a meeting record is central to the success of this system. To this end, I wanted to provide an easy means of

annotation in real time during the meeting. In classroom situations many students have a computer open to take notes, but this is not universal and as discussed previously it is not even certain that this is desirable due to the cognitive load issues. In more interactive meeting situations this divided attention is even less desirable. My solution is to provide two options: input via the meeting browser software on a computer, for annotations after the meeting, or input via a 5 button remote control (iClicker) to provide annotations during the meeting. The use of these units, albeit in a somewhat different context, has been shown to increase student engagement and attention (Fies06.)

### iClickers

The iClicker, shown in Figure 3, is a radio frequency classroom response system. It is made for answering in-class multiple-choice questions and is scalable up to classes of several hundred people. The software, as provided by iClicker, is a Visual Basic 6.0 application that displays the results of these multiple choice questions as graphs and records them for later analysis. Since the current use of the iClicker required more complex manipulations, including timestamps, the software was modified to log all responses into an SQL database along with the time the response was made.

**Figure 3: an iClicker classroom response unit, which communicates via radio signals to a base station**

### PowerPoint Plugin

I also developed a plugin to automatically retrieve annotations from a Microsoft PowerPoint presentation. This plugin was developed with Microsoft Visual Studio 2008 Tools for Office to work with PowerPoint 2007. When PowerPoint is started it connects to the same SQL database that the iClickers communicate with. This logs the slide title and time of each slide transition to the database. The end result is a set of slide transition annotations that can be used in MeetingSurfer to navigate the recording.
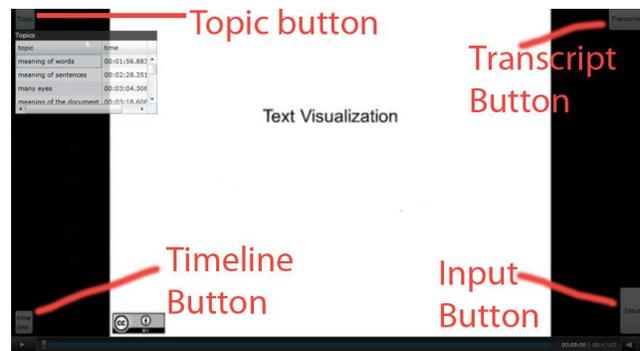
**Figure 4: A view of MeetingSurfer with the slide title window open as it appeared on the recording for the student lecture in the classroom feasibility study**

## Meeting Browser Application

MeetingSurfer was written as a web application based on Microsoft Silverlight version 3.0. This enables it to be accessed from any computer with a compatible web browser. The video is displayed using a smooth streaming control that enables it to play and fast forward without a distracting buffering period. The timeline is a variation of the open source Silverlight Timeline Control (http://timeline.codeplex.com/) and displays both the iClicker data and data about which speaker was talking at any particular time. For our study, this speaker data was manually annotated to ensure there were no errors, but automated speaker identification is becoming practical and is considered as an area ripe for automatic annotations to the meeting record (Cutler02.)

In addition, as shown in Figure 4, there are buttons for a transcript and annotation responses on MeetingSurfer, but these were not much used in either study reported here.

All of the elements mentioned in this section are either stored in an SQL database, or are files (video with audio or audio alone) that share the same time markings through the Silverlight video player. This allows tight synchronization of the annotations and the video.

## Design Process and Decisions

The design has gone through several iterations, the initial focus of the thesis was on automatic annotations; specifically speaker identification techniques and presenting those automatically derived speakers on a timeline. Some initial work was done on the algorithmic techniques of speaker identification, but the approach did not look to push the state of the art and the user interface advantages of doing had been partially explored in a system from Microsoft Research called "Ringcam" (Cutler02).
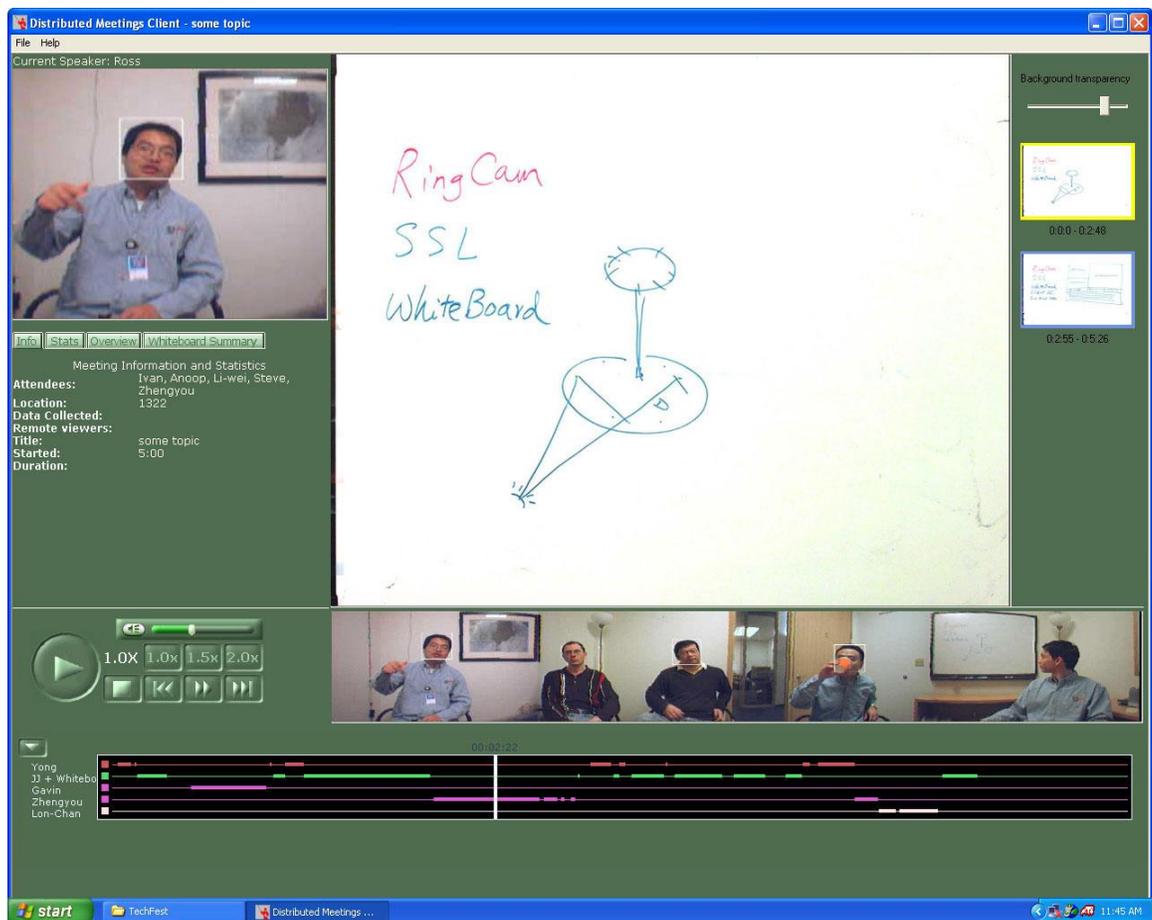


**Figure 5: Ringcam as presented by Cutler et al. (Cutler02)**

While the technique appeared useful, just speaker identification alone did not seem to provide enough annotation to be a complete solution. Other more complete annotations browsers include transcripts and other information, but at a cost of increased complexity. One such browser, Ferret, exemplifies this approach (Wellner05.)
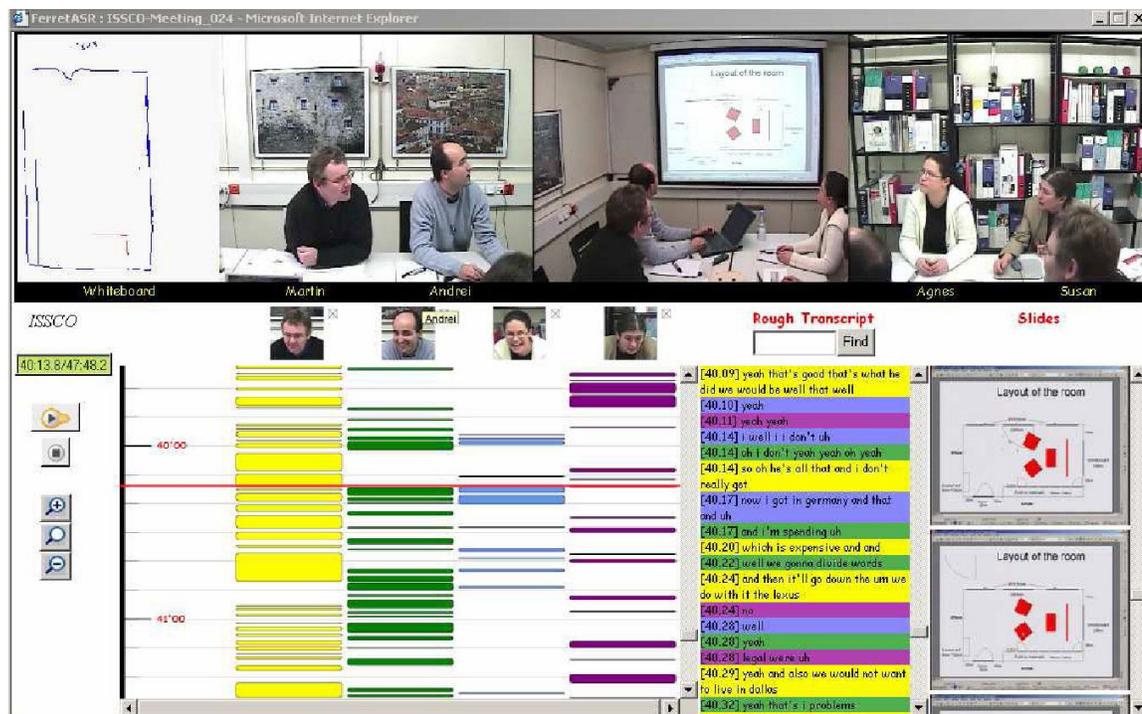


**Figure 6: The Ferret meeting browser, as presented in Wellner, 2005.**

As mentioned previously, this type of display seemed overly complex for an application where the user is primarily interested in viewing the content of the meeting or presentation (Whittaker08.) As a result, the design tenets followed in MeetingSurfer were to present a minimal user interface that is as simple as possible. In the default view, The annotations are not seen and aside from some semi-transparent buttons in the corners there is no indication that this is anything except a normal media player.

The transparency, of both the buttons and the overlaying panels, was informally tested with several users before the current settings of 80% transparency on buttons and 60% transparency on overlay panels was arrived at. This provides the ability to see some amount of the video playback behind the panels, but still have it be opaque enough to interact with the annotation information on the panel.

The design decisions on the table of contents panel, the transcription panel, and the user input panel were not terribly relevant in the user studies reported in this thesis since they were removed for the main study. Only informal responses during the preliminary study provided feedback on the appropriateness of those designs, although they do all generally follow standard design practices for Windows software.

The specific interactions with the timeline panel were arrived at largely through what was available in the underlying Silverlight control, but decisions had to be made regarding the colours and size of marks on the timeline, as well as the scale and position of the timeline onscreen.

The initial feasibility study revealed some usability problems with these initial decisions. The speaker identification information was spread vertically across the timeline in an effort to allow the name labels to be legible. This proved confusing, as people assumed that the vertical position had some meaning. In addition, the quantity of annotations appeared to be somewhat overwhelming. It was also not clear to users of MeetingSurfer how to scroll to see the entire meeting. As a result of this feedback from informal users of MeetingSurfer, changes were made to the user interface - all speaker identification information was contained in a single row of the timeline, closely spaced annotations were collapsed into a single timeline marker, and the timeline was shown

zoomed to the same length as the meeting so no scrolling would be necessary. Figure 2

shows the final version of the timeline, following the implementation of these changes,

while the version used in the initial feasibility study is shown below in Figure 7. (Details

of this study are provided following the implementation discussion in a section entitled

"initial feasibility study".)



**Figure 7: The initial version of the timeline control used in the feasibility study**

### Code and Implementation Details

The architecture of the system is based around a central SQL server which is normally

accessed through a web server to allow remoting. The exception to this is in the Visual

Basic connector which speaks to the SQL database directly, thus the iClicker base station

must have a direct connection to the SQL server through remote procedure calls (RPC

calls) RPC calls are very efficient, but if there is a firewall in between the two machines

then special ports must be opened. All meeting playback and the PowerPoint connector

use a SOAP (Simple Object Access Interface) interface mediated by the web server, so

they can be remoted without any special firewall ports being opened. Figure 8 shows

some of the main structure of the communication.
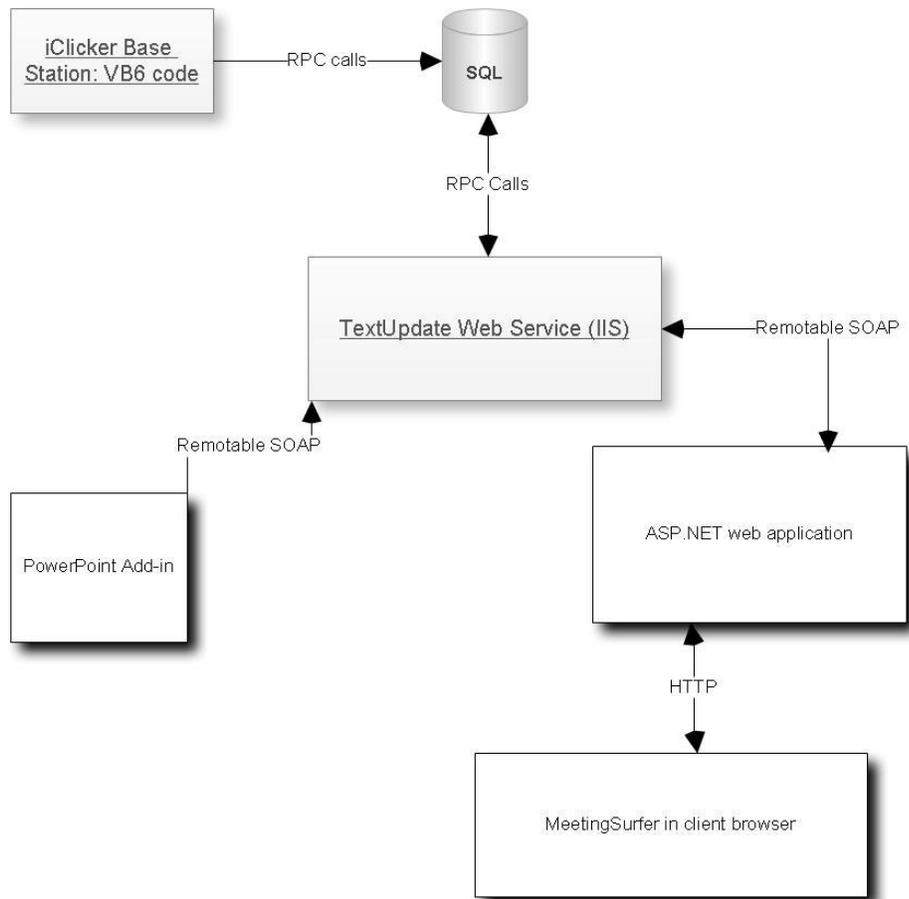
**Figure 8: Architectural details of the MeetingSurfer system**

The lower level details of the code are potentially interesting in three main areas: the iClicker to SQL connector, the PowerPoint to SQL connector, and the Silverlight browser code. Each of these will be discussed below.

### iClicker to SQL Connector

The code to interface to the iClicker base station has evolved over the past several years. When this project was begun, the code was based on Visual Basic version 6.0. This is not a current development environment. The decision was reached to make as few changes as possible in the code, and have most of the intelligence reside on the SQL and data output side. If later versions of the iClicker software had been available then perhaps this decision would have been different.

The primary difficulty was in connecting properly to the SQL database. The existing user interface for the iClicker was disabled and in its place a message stating that data was being logged to SQL was shown onscreen on the SQL computer. The total number of responses was shown on the LCD panel of the base station.

### PowerPoint to SQL Connector

In theory, the existence of modern scripting languages inside of the Microsoft Office suite should have made connecting to SQL trivial. In fact it probably would have been if I hadn't taken a design decision to use a web service in the middle. The idea of this architectural decision was to enable local clients to talk to a common SQL database over a simple text http connection. The database connectors that talk to SQL directly require either special firewall ports be opened or use remote procedure calls.

The PowerPoint add-in was created using Visual Studio Tools for Office. It is about as basic as an add-in gets. It registers itself and then subscribes to updates for slideshow.begin and slideshow.nextslide. When it receives these events, it calls the Textupdate web service interface to pass it the relevant information (slideshow start or slide title.)

The web service is implemented as a SOAP interface and receives the text call from the PowerPoint plugin, adds timeofday information, and opens a connection to the SQL database. Thus it is assumed that the web service is running on a machine that is on the same network as the SQL server, or that has firewall connections appropriately opened.

### Silverlight Meeting Browser

As mentioned previously, the timeline is based on the Silverlight Timeline Control (http://timeline.codeplex.com/.) This control provides a nice basis for interaction, but was not entirely suitable for this usage. The main changes that I had to make were in allowing the text labels to be optional (a label per timeline item was just overwhelmingly crowded visually) and to allow more control over the spacing of the lines so that, for instance, all speaker identification items could be placed on the same row. Because the codebase is rather large, and my changes were scattered throughout sections of it that I did not initially write, this timeline control code does not appear in the appendix.

Beyond this, the application uses the Silverlight Media Framework as a media player. The iClicker annotations are read from an XML file (statically produced for this study, but could as easily be dynamically produced through an SQL to XML connector) and are read into a TimelineMarkerCollection. This allows two things. First, when a marker is reached it throws a MediaElement_MarkerReached event which allows the system to

update the display. Second, when a timeline item is clicked on, or a slide title is selected,

it allows the player to navigate to the appropriate time using the titles as a table of

contents.

# INITIAL FEASIBILITY STUDY

## Research Objectives

The variety of applications of iClicker annotations is broad enough that some focus was needed to evaluate the system. The two areas chosen to focus on were classroom recordings and meeting recordings. This first feasibility study focused on the classroom. The goals of the study were to examine the tool from the annotator perspective, primarily, and to test the performance of the system as a whole. Some informal evaluation of the meeting browser took place, but the main focus was really on the input side of the application for this initial study.

## Participants

The participants in this initial feasibility study were members of a graduate level visualization class. During this study I was presenting a class on text visualization. Eight of the students were asked to annotate the lecture.

## Apparatus

Participants were given iClickers to annotate the lecture. I attached an iClicker base station to the presentation laptop. The presentation was given on Microsoft PowerPoint 2007 and the plugin mentioned in the previous section was used to record slide titles and transition times. This information was used to populate the MeetingSurfer browser, which was then distributed to the class for comments.

**Procedure**

The participants were asked to annotate a lecture. These annotations were for the following items: "A - good point", "B - Topic Shift", "C - Quotable moment", "D - External reference", and "E - I'm bored", using the five input buttons on the iClicker. The meanings of the buttons were written on the blackboard at the front of the class to remind annotators of the meaning of the buttons.

Although use of the annotations (as compared to their creation) was not a formal part of this first study, a link to the application was sent out to all students in the class and some feedback was received on the MeetingSurfer browser itself. I also watched several students navigating the lecture annotations.

**Results**

Over the course of the 47 minute classroom presentation, the 8 students with iClickers made a total of 350 annotations. The PowerPoint plugin also behaved as it was supposed to, properly logging all slides. Students reported that use of the iClickers was not burdensome, although they did have a tendency to click more frequently in sections of the lecture that were less engaging. This is precisely the opposite of the behaviour that you would want in that the more engaging sections would seem to warrant more complete annotation, although this pattern could change if students were annotating for their own use rather than as part of a study.

Since the focus of this study was on the input side, there was insufficient data generated to warrant deeper statistical analysis, but the informal usability feedback led to changes in the application which led to the timeline annotations study described next.

# TIMELINE ANNOTATIONS STUDY

## Research Objectives

Next I conducted a study of annotations on the timeline. The goal of this study was to investigate whether timeline annotations made by other users could be an effective aid to information retrieval. Rather than using a recorded classroom lecture, I decided to use a podcast for this study. This removed the potentially distracting element of video and allowed the study to be based on an audio recording that had a panel of speakers so that the speaker identification information would be more relevant. I focused on the timeline because it is the most complicated element of MeetingSurfer and I felt that this would be where most usability issues would be found. Consequently, the topics window, the transcript window, and the responses window were removed from the version of MeetingSurfer used for this study so that the timeline could be the primary focus.

## Changes from the application used in the initial study

The initial feasibility study, and pilot subjects for this second study, revealed several aspects of the program that needed to be changed.

First, as previously mentioned, the interface was simplified to put focus on the timeline. This was also because there was to be no further annotation by users of the meeting browser, and without powerpoint slides the slide title annotations didn't exist. So simplifying to focus on the timeline was an obvious decision.

Next, the timeline design itself was modified. This was described in detail on page 15, but will be briefly re-iterated here. Figure 2 shows the final timeline design whereas

Figure 7 shows the design used in the feasibility study. The initial version of the timeline attempted to ensure that labels on the annotations were always visible and so stacked them into rows. The row position had no meaning other than improving label visibility, though. Participants did not understand this and expected the row position to have some meaning. In the final version of the timeline speaker information and annotation information were placed on separate rows. This obscured some speaker labels until they were clicked on, but was in general easier to understand.

An additional aspect of the timeline is the relation to the seek bar. Since these are different controls, and the timeline can be zoomed in, there is not always an exact relationship to the seek bar. The initial presentation of the timeline was zoomed to as closely as possible align to the seek bar so that users could use either the seek bar or the timeline to navigate and would generally not see any misalignment between the two. This was only partially successful, as described in the results section. This change in the position of the timeline vis-a-vis the seek bar was made after the pilot subject.

**Participants**

Participants were university students who responded to an email solicitation to participate in a user study. Students were compensated in the amount of ten dollars for their time. Participant ages ranged from 18 to 38 and were equally split between male and female. Seven of the twelve participants described themselves as visual learners, while the remainder described themselves as either mixed or auditory learners. This visual/auditory learner distinction is not well supported in the literature and should at best be considered an indication of preference for a particular modality on the part of the participants. Only four students reported using audio recorded lecture material to study

from, and ten of the twelve reported relying primarily on handwritten notes on paper to study.

## Apparatus

To collect annotations for the study, 6 graduate students not involved in authoring the study used iClickers to annotate each of two panel discussion podcasts on the topic of openness in government. These annotations were combined with speaker identification information to produce the timeline shown in Figure 2. The instructions to the annotators were to press button A when the moderator speaks, button B when a panelist speaks (or when a change in panelist speakers occurs), button C when a pro-openness point is made, button D when a caution about openness is made, and button E when the discussion goes off-topic.

In addition, a set of notes was created (with time markers) and a full transcript was made (see appendix D.) The notes consisted of time markings and a brief description of the topic, but generally not enough information to completely answer questions from. For instance, notes entries consisted of statements such as "8:00 openness as destructive anarchy" "8:20 mod - does it have inherent value?" "8:40 has meaning for a lot of people" whereas the transcript was a full record of the podcast.

Before analysing the initial annotations, questions were created for each of the podcasts (see appendix E.) These questions could be answered only with reference to the podcasts. The information was obscure enough, or related enough to specific things the panelists in the podcast said to be unlikely to be answered merely through background knowledge. These questions were randomized so that the questions did not appear in the same order as the answers in the podcast, but they were given to all subjects in the same

order since individual question times were not recorded (only the time to answer the entire set of questions was recorded.)

**Procedure**

After signing consent forms, participants were given a pre-test demographic questionnaire (consent forms and questionnaires are found in appendix A and appendix C, respectively) and then placed into a condition for the first podcast. Each participant was in one of four conditions - A - the timeline condition, B - a no aid control condition where the podcast was simply played in Microsoft Media Player, C - a notes condition where the podcast was played in Media Player but a set of timestamped notes were made available on paper, and D - a full transcript condition where a timestamped transcript was available on paper as well as the audio in Media Player. Participants were then given the questions and instructed to answer them as quickly as possible, making sure that each question was answered correctly and that they marked the time of the podcast where the answer was given. This was done to ensure that it was primarily an information search task rather than depending on background knowledge. The time it took to answer the full set of questions was recorded. Participants were then placed in a different condition for the second half of the study and the process repeated, using the second podcast and the set of questions relevant to that podcast.

After finishing the second half, participants were asked to complete a post-test questionnaire (see appendix F) where they directly compared the two interfaces they had used, as well as answering questions about each one. A short post-test interview was also carried out to elaborate on any usability problems identified, but this interview was user-directed rather than formally structured.

Since there were four conditions, and each pairwise comparison was desired, there were a total of six condition combinations. These were also counterbalanced for order of presentation, so a total of 12 participants were tested.

## Results

All participants completed each set of questions. Since the instructions were to continue working until they had correctly answered each question, the error rates were not expected to be different in the particular conditions and emphasis was instead placed on response times and the questionnaire responses.

The clearest preference data comes from the pairwise comparison numbers. These were asked as a seven-point scale under the question "Which of the two versions did you prefer?" Each of the timeline conditions resulted in a very clear preference for the timeline over other versions, as shown in Figure 9.
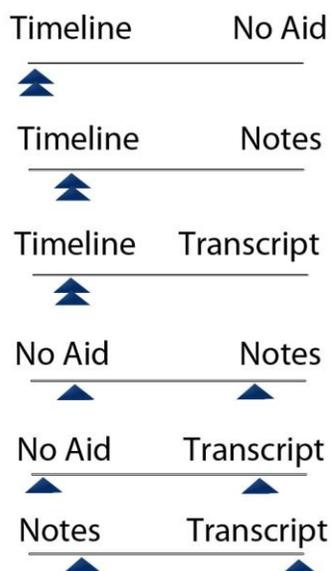


**Figure 9: Participant ratings, one arrow is a rating from one participant in a paired comparison on the post-test questionnaire**

The individual satisfaction ratings seem to lead to this same conclusion (see Table 1), but due to the small sample size in the study only the notes condition can be reported as significantly different than the timeline condition. *P* values in the table are the result of a two-tailed student's *t* test run as independent samples since the respondents were generally different individuals. Part of the variability of the no aid condition can be attributed to different understandings of the question - two participants volunteered that although they understood that the efficiency of finding information would have been improved in other conditions that they would still prefer to study from the original recording since it has the most information. Most other participants interpreted the question as referring to satisfaction for this specific purpose of answering given questions.

|           | Timeline | No aid | Notes | Transcript |
|-----------|----------|--------|-------|------------|
| Average   | 5.8      | 3.7    | 3.5   | 5          |
| Variance  | .57      | 5.5    | 1.1   | 2.8        |
| *p* value | N/A      | .074   | .001  | .303       |
| Cohen's *d* | N/A    | 1.37   | 2.8   | 1.83       |

**Table 1: Average satisfaction ratings for each condition, P and d values compare timeline condition to each other condition**

High variability makes it difficult to interpret the task times reported in Table 2; this variability prevented any of the time differences from reaching statistical significance. The part one task times seem to imply that the timeline and full transcript conditions were the fastest, but the part 2 data is less clear. The part 2 podcast was both shorter (16 minutes vs. 19 minutes for part 1) as well as containing somewhat simpler material than part 1, so differences would have been harder to observe. Some subjects also commented that the notes were easier for part 2 because many of the questions could

be answered directly from the notes, meaning that they did not have to go back to the audio. This was not perfectly controlled for because in part 1 the notes were not as complete with respect to the questions. However, this contrast does highlight that when good notes are available they are more efficient than any other condition, but when notes are incomplete or not present the timeline is a good alternative.

| Part one | | | | |
|---|---|---|---|---|
| | Timeline | No aid | Notes | Transcript |
| Average | 17:30 | 21:45 | 26:05 | 19:00 |
| stdev | 2:30 | 7:48 | 5:15 | 9:06 |
| Part two | | | | |
| Average | 12:50 | 13:50 | 10:07 | 13:57 |
| stdev | 1:36 | 5:00 | 0:50 | 0:55 |

**Table 2: Task times and standard deviations for answering questions related to part 1 and part 2 podcasts.**

In addition to the quantitative evaluations, this study was designed to assess usability issues. A number of subjects indicated that they would like to use the interface just as it is, but there were some remaining issues. The timeline did not align perfectly with the seek bar beneath it; this could be improved. Also, when the original annotations were made, they tended to be a few seconds after the audio of interest as the annotators determined which button to press. In order to account for this a decision was made to arbitrarily go to a point 20 seconds before the annotation when clicked to ensure that no relevant audio was missed. This turned out to be too long in some cases. Unfortunately, the optimal time seems to depend on the specifics of the annotation. Where participants were making a simple judgment, such as "is a panelist talking or is the moderator", then times were very short. Where a more semantic judgment was being made, such as "is this

point pro-openness" then it took much longer for the annotater to press an annotation button.

Although this study did not quantitatively distinguish which annotations were most useful, this did come up in the post-study interview. All participants used both the annotations and the speaker identification information to navigate. Some participants commented on the particular utility of the "off topic" annotation in that then they knew instantly that they could skip that section. Specific questions were clearly asking about pro-openness points, or cautions against openness, so those annotations were helpful in a few cases. The moderator versus panelist annotations were generally not useful because they duplicated information in the speaker identification area of the timeline, however no participant actually filtered the display so that these would not show.

In general, the design objectives of simplicity and clarity of interaction were successful in creating a usable meeting browser and the data in this study clearly show that users were able to take annotations created by other people and use them to improve their search efficiency and satisfaction.

# DISCUSSION

The possibility of meeting capture exists in a number of different forms. On the high end are dedicated meeting rooms that can ensure high quality audio and video, and analysis tools to make best use of the resultant data. On the low end, work has been done on ubiquitous audio capture, and many of the current generation of crowdsourced content providers like YouTube provide essentially a captured video conversation. The classroom and casual meeting situations lie somewhere in between. The solutions for meeting audio (and video) analysis will differ substantially in each situation, but the common denominator is that some analysis must occur because without structure the audio is of limited use besides archival purposes (Hindus92.)

In the dedicated meeting room, technology is maturing fast enough that we can consider the creation of automated transcripts and videos that track individual speakers. These meeting corpora are provided as sets to advance the technology. The AMI meeting corpus is one such set (Carletta07), it contains over a hundred hours of meetings all recorded under the same exacting conditions with transcripts and annotations in a specified format. In controlled conditions, state of the art systems can transcribe with some accuracy, identify speakers, and classify topics to some degree of accuracy so that links between different meetings covering similar topics can be made (Popescu-Belis09.) These fully instrumented meeting room situations are unrealistic for the vast majority of people who would like to make use of the techniques for browsing structured audio data, though.

In the classroom, some other options exist, particularly if the need for interactivity is low (i.e. interactivity consists of only the occasional question from a student rather than ongoing discussions). In these situations, there is even an epistemological argument to be made for divided attention. This argument is in terms of meaning making, that if a student is actively engaged in translating the lecturer's words into their own personal format that they will retain more of that knowledge (Suthers06.) Part of this approach leads into discussions of shared note taking. For at least the past decade, shared note taking systems have been deployed (Davis99) and with last year's release of Google Wave, many classes have recently tried the collaborative note taking experiment, though it has not been an unqualified success (Reiners10.) Some of the problems stem from unequal responsibilities - the person who can type the fastest and who can multi-task the best enters most of the notes, while other students can simply ride for free. It also requires that the note taking take place on the computer, whereas many students still prefer to take notes on paper. An exciting approach is the use of handwritten notes as an index into the meeting record timeline. This was first attempted in 1994 (Whittaker94) and then later in a hardware device that may have been somewhat before its time (Stifelman01.) The approach appears to be ready to bear fruit in a recent study of the LiveScribe pen where the handwritten notes are tied to an audio record as an index (Steimle09.) This approach, which provides indexing of a meeting record without altering the normal note taking behaviors, seems to offer great potential.

This approach is not suitable in all cases, though. Returning to the cognitive load argument (Piolat05) even short handwritten notes threaten to decrease the level of interactivity in a gathering. In the case of a discussion class, a research interview, or a

business meeting, this could be an unacceptable shortcoming. In these cases the approach presented in this paper has an advantage. The realization that it does not take complex annotations to provide a useful index into a meeting record could preserve much of the interactivity in meetings while still providing useful structure to the audio/video record.

As we get down to truly ubiquitous audio a different set of constraints arise. Ubiquitous audio can be in the form of personal recording devices like the SenseCam popularized by Gemmell and Bell in the MyLifeBits project (Gemmel06). It can also be in the form of online video sharing. YouTube has a model of video responses that are really a distributed video conversation (Cha07); it is currently missing some useful annotation elements that would make it a structured data source. Rather than positing full transcription as the holy grail of meeting capture (Hindus92), it should perhaps be structured summaries or annotations that are most desired. Our own study indicates that it may be faster and easier to extract meaningful information from these summarizations. Fortunately, these can also be easier to provide than a full transcript. If the SenseCam (in an audio-recording version) had a set of buttons on it for pre-configured annotations, then this could be easily delivered. Even easier would be a small set of annotation buttons on the YouTube video player. Social annotations have proven effective in other domains of information gathering (Nelson09) and would seem to be a useful addition to distributed audio and video conversations. Of course, one can leave comments on videos on YouTube, but with the exception of times, which are automatically turned into links, these comments are not structured in such a way as to be usable for navigation or sensemaking purposes. The use of simple annotations on a timeline in the current study

would seem to offer a compelling example to follow in other forms of audio and video conversations.

The collaborative annotations suggested in this paper can be considered a form of crowd sourcing, reducing the need for complex computational strategies. Anywhere that human intelligence can produce a judgment that machine intelligence finds challenging, this strategy has potential utility. In this study, this is one reason why the annotations about who was speaking were so much less useful as a navigation strategy than were the semantic judgement annotations.

This thesis offers several contributions - a technical demonstration of a minimal annotation system, an example of the utility of annotations made by other users, and a demonstration of an annotations timeline with a media browser. The main theoretical contribution is evidence toward the idea that annotations improve the efficiency and utility of meeting recordings if presented in a well-integrated browser. This is certainly true in recorded classroom situations and listening to recorded meetings, but can likely generalize to the other situations discussed in this section - community-generated content, ubiquitous audio, and even the recordings in high-end instrumented meeting rooms. Until the day that automated systems can understand the semantics of a multi-person conversation, a day that is even further in the future than the ability to produce an accurate transcript, crowd sourced annotation techniques such as those described in this thesis may have a place in making recordings more useful.

# CONCLUSION

As the act of capturing high quality audio and video becomes easier, adding structure to these records (ie. through easy to provide annotations) becomes ever more important. The current study suggests that the level of detail in these annotations need not be excessive in order to provide a very significant benefit for information retrieval.

In addition, this work suggests that annotations created by one set of users will have applicability to other users. This may seem obvious, for years students who miss class have asked a classmate if they can borrow their notes. This work suggests that even if a high quality audio recording of the class existed that it would still make sense to borrow the notes if those notes were aligned on a timeline of the original recording.

The continuous use of the iClicker throughout the class as an annotation device, in addition to its function as a periodically used question response device, offers a convenient and inexpensive means of delivering these collaborative annotations. Future work in classroom and in meeting situations is needed to determine which specific annotations are most relevant and useful in each context. Of course, this will vary somewhat by the content of the discussion, but if there is a core set of annotations that are globally useful then it would make learning to use the timelines that much easier.

This is a fairly limited set of initial studies, of course, so future work will have to address meeting situations and more classroom situations. Particularly interesting are situations involving multiple uses for the iClicker - interactive games combined with standard multiple choice questions along with using the iClickers for annotation purposes. Future work can also look at whether the fairly arbitrary choice of 5 respnse

buttons is the appropriate balance between annotation load and utility. Some other

hardware devices, and classroom response systems that depend on cell phones and

browsers, would allow one to study these interactions without the 5 button limit imposed

by the iClicker hardware.

As even more hardware form factors become available - collaborative computer-

based notetaking, Livescribe-style recording of handwritten notes, partial automatic

transcriptions from the audio data - the key finding of this work should remain relevant.

That is that annotations on a timeline form a rewarding and efficient means of

information retrieval that significantly increases the utility of recorded meeting records.

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# Appendix A - Subject consent form

Human Factors in Visualization

You are being invited to participate in a study entitled collaborative annotations that is being conducted by Melanie Tory and Derek Jacoby.

Melanie Tory is a faculty member in the department of Computer Science at the University of Victoria and you may contact her if you have further questions by email at mtory@cs.uvic.ca or by phone at (250) 472-5798.

This research is being funded by NSERC.

The purpose of this research project is to investigate how people use information, and how different visual representations of data affect how people perform tasks such as data analysis and decision making. Research of this type is important because it allows us to design better data displays to allow more effective, efficient, and enjoyable analysis of data in a variety of applications.

If you agree to voluntarily participate in this research, your participation will include

- Filling out a background questionnaire that asks about your experience with computer technology and data analysis applications, as well as personal characteristics such as age and gender.

- Completing computer-based tasks.

- Participating in a verbal interview.

- Filling out a questionnaire about the computer-based tasks and tools you experienced.

- Being watched by live observers.

The research session is expected to take approximately one hour.

There are no known or anticipated risks to you by participating in this research.

Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw, we will ask whether we may use your data for data analysis. If you decline, your data will be destroyed.

Your confidentiality and the confidentiality of the data will be protected by identifying data only with a participant number rather than your name, password-protecting computer files, and storing video and audio tapes in a locked office. Confidentiality may not be guaranteed because the nature or size of the sample from which participants are drawn may make it possible to identify individual participants.

It is anticipated that the results of this study will be shared with others in the following ways:

- Published articles

- Conference presentations

- Video publications

- Theses

- Internet project descriptions

Data from this study will be disposed of within 5 years. Electronic data will be erased, paper copies will be shredded, and video/audio tapes will be recorded over or physically destroyed.

In addition to being able to contact the researcher at the above phone numbers, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Associate Vice-President, Research at the University of Victoria (250-472-4545).

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

| *Name of Participant* | *Signature* | *Date* |

*A copy of this consent will be left with you, and a copy will be taken by the researcher.*

# Appendix B - Test Script

Thank you for participating in a study of information extraction from recorded meetings. There will be two phases to today's study, each involving a short podcast and answering questions about the content contained therein. As you answer these questions, please ensure that you have found the section of the podcast where the answer was given - even if you know the answer from your own background knowledge it is important to reference the information in the podcast itself. To this end, each question will have a field for time, you should write down the approximate time in the podcast where the answer was given.

Do you have any questions?

Before we begin we must fill out some subject consent forms. This data is to be used for a master's thesis at the University of Victoria. The data will be retained, but personally identifiable information about you will not be included in the thesis.

[fill out consent form]

Next, I'd like to ask you fill out a pre-test questionnaire. This is just a bit of background so that I can compile demographics of the participants in this study. If there are any questions that you would prefer to leave blank, please do so.

[fill out pre-test questionnaire]

Now we're going to start the first half of the study. Do you have any questions before we begin?

[4 variations - for each test condition. part 1 and part 2 use the same instructions, just modified for the condition they are in]

[no aid]

On the screen in front of you is a media player. You may play, pause, and seek to any point in the podcast that you like as you answer the questions on the paper in front of you. Notice that there is a time indication in the corner of the media player, this is the number to write down next to the question when you have found the answer. Please try to be as fast as possible, and if you can find the answers without listening to the entire podcast please do so, but ensure that you do correctly answer each of the questions.

Do you have any questions? Please begin.

[experimenter with stopwatch, records the entire question answering time, not per question]

[notes]

On the screen in front of you is a media player. You may play, pause, and seek to any point in the podcast that you like as you answer the questions on the paper in front of you. Notice that there is a time indication in the corner of the media player, this is the number to write down next to the question when you have found the answer. You also

have a page with notes from the podcast, you may use this as an indication of where in the podcast to find the answers you are looking for. Please try to be as fast as possible, and if you can find the answers without listening to the entire podcast please do so, but ensure that you do correctly answer each of the questions.

Do you have any questions? Please begin.

[experimenter with stopwatch, records the entire question answering time, not per question]

[collaborative annotations]

On the screen in front of you is a media player. You may play, pause, and seek to any point in the podcast that you like as you answer the questions on the paper in front of you. Notice that there is a time indication in the corner of the media player, this is the number to write down next to the question when you have found the answer. The timeline above the seek bar has coloured balls on it indicating the responses that previous meeting viewers made about the content of the meeting. The legend to these colours is on the left of the screen, and includes speaker changes, moderator versus panelist comments, and whether the points made were in support of openness or cautions against openness. You may click on the timeline balls, or drag the seek bar to the location of interest. Please try to be as fast as possible, and if you can find the answers without listening to the entire podcast please do so, but ensure that you do correctly answer each of the questions.

Do you have any questions? Please begin.

[experimenter with stopwatch, records the entire question answering time, not per question]

[full transcript]

On the screen in front of you is a media player. You may play, pause, and seek to any point in the podcast that you like as you answer the questions on the paper in front of you. Notice that there is a time indication in the corner of the media player, this is the number to write down next to the question when you have found the answer. You may also use the printed transcript, it also has time markings. You are free to use either the written form, the audio recording, or both as you prefer. Please try to be as fast as possible, and if you can find the answers without listening to the entire podcast please do so, but ensure that you do correctly answer each of the questions.

Do you have any questions? Please begin.

[experimenter with stopwatch, records the entire question answering time, not per question]

Great, thanks for getting through the first half. Would you like to roll right into the second half, or take a short break first?

[read instructions from above for the appropriate test block]

Excellent, all done with the main part of the study! I've got one more questionnaire for you before we're done. Please feel free to elaborate verbally on any of your answers, but I would appreciate if you could make your core points in writing before we discuss it.

[hand them the post-test questionnaire]

Great, thanks for participating! Do you have any other comments or thoughts on the study for me? Or any questions about the work we did here today or the use of these results?

# Appendix C - Pre-test Questionnaire

**Please answer this background questionnaire. If there are any questions that you find uncomfortable or intrusive, please feel free to leave them blank.**

1. How old are you?

2. Are you male or female?

3. What is the highest level of education you have completed?

4. How recently was that?

5. Do you consider yourself a visual learner or an auditory learner?

6. Do you (or did you) record your lectures in school?

7. If you did make recordings, did you go back and use them to study from?

8. Do you (or did you) take detailed notes in lectures? Handwritten or on a computer?

# Appendix D - Transcripts and Notes

**Part 1**

00:00:00

[Music]

[Clapping]

Male Speaker:  Good afternoon, and thanks all for coming here today to the Albert at Bay Hotel in Ottawa.  Hello to everybody here with us live and hello to everybody watching via our live web stream and hello to my podcast since we'll be checking out soon.  We are here today to discuss openness, which is a very trendy word.  We hear it more and more, we hear about open governments that anyone can participate in, open networks that anyone can join, open source software and hardware that anyone can build upon, open access to information to news, to research, open it just feels good to say it, isn't it.  Who would want to be against that?  Nobody, everybody wants to be associated with it.  Just, last summer here in Canada our government wanted very much to be thought of as open and they held an incredibly open national public consultation on the topic of copyright reform.  There were town hall meetings throughout the country, you could come live, you could submit your comments, your thoughts through the internet and not only was this held on the open but it was web streamed and everything was transcribed and shared openly, anybody who wanted to have a say to express their

opinion of what this important piece of legislation should be was encouraged to do so openly.

Well, I just learned today, thanks to actually one of our panelist that the results of this

00:02:00

Open consultation will in all likelihood be completely ignored and the future of Canadian corporate law will be whatever our Prime Minister thinks it should be, or perhaps more accurately whatever he has told it should be. Speaking of the United States, Secretary of State Hillary Clinton not long ago delivered this incredible landmark address, this historic speech on internet freedom around the world. And again and again we heard this trendy word open. She spoke of open networks and freedom and she, she pledged United States government support for technologies that will allow citizens of repressive countries like Iran to not only circumvent censorship but to do so anonymously. Some weeks later a United States Federal Court of Appeals sided with the Recording Industry of America Association and sanctioned the unmasking of the identities of thousands of citizens who had been sharing files online anonymously. We talk of this trendy term open in terms of open access to technology and we regard it as a human rights *[Inaudible] [00:03:19]* when the news comes that almost half of the population of India has a cell phone, over 500 million cell phones in India, just remarkable. We learn through a United Nations piece of research in Hamilton Ontario,

and somewhat less enthusiastically we regard the news that only 366 million people in India have access to toilets. We talk of openness synonymously with transparency and sunlight and we repeat the [Inaudible] [00:03:51] sunlight, the best is infected. And it really can be

00:04:00

Exposing to public scrutiny, making open those things that happened privately where important decisions were made, it can hold decision makers to account and elected officials to account. It can do that, it can expose corruption, it can do that, but openness perhaps can dazzle us and distract us, maybe the sunlight can blind us. Maybe it can distract us from discussing less trendy subjects, the pesky details along the way, poverty, intellectual property, privacy, surveillance, those pesky subjects are what we are here today to discuss. We are going to delve into this and discuss whether openness is an end unto itself or whether it is a tool for achieving some measurable good, and to do so *[Inaudible] [00:04:49]* has assembled just an incredible panel of thinkers, who I'd like to walk into the stage now. Sunil Abraham is the executive director of the center for internet and society. He is a social entrepreneur and free software advocate based in Bangalore. Please come up. One round of applause please. Professor Ron Deibert is the director of the citizen lab at Monk Center for International Studies, the University of Toronto. I have been reading about Ron in the New York Times, on masking Cyber *[Inaudible] [00:05:23]* Networks. One round of applause for Ron Deibert. Professor Michael Guice is a Law professor at the University of Ottawa, where he holds the Canada

research share in internet and e-commerce law. He is also favorite source of leaks. Here comes the Canadian tech policy and Anita Goramurthy is a founding member and executive director of IT for change an India based NGO engaged in policy research and advocacy

00:06:00

On information and communications technology for development ITC. Welcome everyone one more time, one round of applause. Professor Yochai Benkler a law professor at Howard University and co-director of Howard's Brook land Center for internet society author of Wealth of Networks who is joining us through the miracles of technology I believe on one of these screens any moment now. Professor Benkler, hello.

Yochai Benkler: Hi, I hope you are hearing me fine.

Male Speaker: How is it going? You all have microphones. Let's start big. Let's risk a definition here. What is openness to you?

Anita: I completely agree with you that it's a very warm and fuzzy word. And it's very hard to say anything critical about openness. But I am going to go back into history because as always history has something to tell all of us. Now, where was that word openness used before in history? Twenty years ago, glasnost do we remember. Well, at that time it meant many things, it meant openness, transparency and even truth.

And it of course went hand in hand with the notion of Pedi striker economically structuring. Of course, the rest as they say is history and now in the erstwhile USSR and many countries of Central Asian and Eastern Europe we see the aftermath of glasnost. And where is it most evident? Well, if any of you here is a feminist this question is a no brainier. Glasnost and *[Inaudible] [00:07:39]* changed the status of women dramatically. In almost a frying pan to the fire kind of way, so there you are. As Zen as it sounds openness does not quite sit pretty as easily with development without complications

00:08:00

It could even be representative of a kind of destructive anarchy that disrupts but it does not know how or what to reconstruct. So for me it seems like it's a rhetoric that means multiple things and we have to be really careful about what we mean and that needs to proceed from our vision of what development is.

Male Speaker: How about, is this a concept under which we can mask any number of campaigns or negative *[Inaudible] [00:08:28]* does it have any inherent value or is it a merely rhetorical device that could be as destructive as some of the things that you just brought out from history? Professor Ron Deibert.

Professor Ron Deibert: I think it's both, yeah. I think it's that and everything it certainly has meaning for a lot of people, it has for me for many years to describe some of the motivations I have and my colleagues have in terms of what it is that we aim to do,

which has been for now nearly a decade to as I describe it lift the lid on things that are going on beneath the surface of the internet and cyber space generally and bring some transparency and accountability to processes that are largely hidden from public scrutiny. So it's a very powerful term to get out some of these motivations, but we shouldn't fool ourselves as Anita eloquently put it here that the term and the concept can have multiple meanings, it can be used as a rhetorical device and it certainly will be co-opted and that's what I think we have to be careful of moving forward is that we look carefully and scrutinize how terms like these can mask the power relations.

Male Speaker:   Sunil lets take this down to earth in a practical [Inaudible] 00:09:36 sense.   Can this concept of openness make an actual impact; can make a difference in the field of development?

Sunil Abraham:   The trouble with openness is that it's increasingly an empty signifier.  People use openness as a new form of green washing whatever

00:10:00

Whatever the standard agenda is, to give you one example from India.  When the government in Karnataka the state Anita and I come from decided to engage with civil society and have residential welfare organizations tell the government what to do, they had these open consultation meetings in Infosys which is a very large multination corporation, and only middle class Indians were able to participate in those meetings,

take holidays from work et cetera, so it meant that those living in slums, 30% of Bangalore's population they had no voice in these so called open consultations, they didn't have the expertise to understand these government documents and then comment upon them in an intelligent fashion, so as Ram points out you cannot apply openness in a blanket fashion, you would have to take into consideration the power dimension and then install a particular avatar of openness in each area of event.

Male Speaker: Michael you've taken a leadership position in popularizing certain policy initiatives in Canada and engaging with the public and it seems like a lot of your work is informed by a base belief that the wider you open up a debate, in fact if you can explode it open as widely as possible and engage as many people as possible it can have an impact, can it?

Michael Geist: Apparently I'm pretty even thinking that it can hopefully, at lease based on some of the stuff that we've seen over the last day or so with respect to a copyright. I guess I'm going to continue to be nice and hope that in fact it can. And I think that openness is really an end to itself, I mean, I think that openness in the context of say open access to research is all about ensuring access to research and open seems to be the best delivery mechanism to ensure that as many people as possible have access to that. Open access in the context of some networks is seen as the best

00:12:00

And in many as insisted try to help facilitate competition, lower prices, increase speeds all of those kinds of things. In the context of policy making, so whether it's been on Canada on issues like copyright or neutrality those are a couple of areas where I think openness in terms of open consultation and open participation at least have the, the affect and I think the ability to ensure that these issues move up the political ladder so to speak so that they get some attention. The public has an opportunity to ensure that their voice is heard and in some ways that alone represents a pubic shift on some of these issues, if you think back say in the telecom space, you know, 10 years ago CRTC hearings were the purview of a small group of broadcast and telecommunications lawyers and no one could ever be bothered to participate much less tune in and you know, last summer we had a traffic management hearing in Canada that hundreds of people were sitting and watching the streams and actively participating and putting in their views and the same is true for copyrighters you mentioned with the consultation. The big challenge though is that that participation isn't an end of itself. I mean, the goal is to ultimately ensure that those views are appropriately reflected in policy and it's clear we still have a little bit of ways to go until we get to that point.

Male Speaker: Following this idea of openness is the possibility that it's a wolf in sheep's clothing. When you open something up, when you open up communications, when you open up peoples private lives and you extol the virtues of this and perhaps it becomes an end unto itself, is there a flip side, is there a danger and I am thinking specifically of the argument that when people are over sharing the possibility for government surveillance, it becomes greater. What happens to our privacy, and who does

it benefit when we open up on the personal.  Professor Ron Deibert I think that you be the right person to kick off this topic having recently exposed.   How many [Inaudible] [00:13:49] networks now is it?

Professor Ron Deibert:  That's closed proprietary information, I can't discuss that.

00:14:00

Well, yes, to get to your basis point here about surveillance there is a problem that we've kind of backed ourselves into I think is a way I would put it socially speaking, with social networking and a great deal of open collaboration and more openness around the way we communicate with each other.   We often don't think about the unintended consequences of technological change in this respect.  One of them has been what I and others have described as a kind of auto surveillance where people willingly put forward information about themselves that assists surveillance.  However, I think that some of the concerns are misplaced, popular concerns anyway, which tend to focus on the big brother of this day and I think the bigger concern frankly are the private companies that own and operate the infrastructure and act as the intermediaries for the communications ecosystem that we live in, so the telecom operators, the internet service providers, many of them really care about our private lives so much unless them make some money in some way or if they are regulated into caring about it because they are a proxy for law enforcement or intelligence and I think that's where again we have to expose what's going on, make people aware of issues like default privacy settings which kind of streamline people into

being more comfortable with a complete erosion of privacy, with respect to privacy as a whole I think it's a basic right that I think is eroding so fast and I think there is as much as privacy commissioners are very active today and are working frantically with colleagues in jurisdictions around the world to push for regulations, the momentum is so far in the other direction because of both technical and institutional changes and changes in everyday social practices. I tag myself in photos and I tag my colleagues and my kids, read about their schools and where they are journeying

00:16:00

Where they eat and what their pets are and everything and this really concerns me at a fundamental social level.

Male Speaker: Professor Benkler our privacy commissioner here in Canada recently led an effort with nine other regulators from different countries chiding Google and Facebook for disclosing an unprecedented and inappropriate amount of personal information. Are these worries warranted, it seems that we are all very concerned about something but we don't exactly know that it is. Do you think these worries are a sort of exaggerated?

Professor Benkler: Well, the issue I think is not necessarily exaggeration or of the concerns. It's precisely the excessive *[Inaudible] [00:16:46]* of the use of the current openness as though it's a target. And I think this came out in the first round of questions

and I definitely want to align myself with the idea that while the concept is broad we need to make it concrete. The basic problem is the problem of power, and the problem of different concentrations of power coming to apply on people through control over one or another resource, whether it's information about whose funded whom in government when you talk about transparency, whether it's information about what particular set of things you bought that then allows somebody to control the flow of information to and from you in a way that's intended to get you to buy one thing or another. You might find yourself in a situation where the concern with power in this case or the particular set of companies to shape the consumption preferences of certain users, says to you openness itself is flipped on its head because the individual is not somebody who is powerful relative to go.

Male Speaker: Okay. So change in listeners that is the end of part one of the recent forum

00:18:00

On open development that I hosted for the International Development Research Center in Ottawa. Tune in next week for part two in which Professor Yochai Benkler and I throw down in freestyle wrap up.

[Music]

Male Speaker:  Search engine is produced by me and a community of listeners who should be getting ready to fight the lousiest copyright bill yet, in about five week's time.  Email me story tips and freelance pictures at Jessie@jessiebrown.ca.  You can follow me at twitter at Jessie Brown, and the blog is tvo.org/search engine.  This show was released for the creative commons license, so feel free to turn into a cake.  The next podcast will be up on **Thursday**.

**Part 1 Notes**

0:20 mod introducing panel

0:40 topic intro - openness, types of openness

1:20 government openness on copyright reform

2:25 hillary clinton address on internet freedom

2:58 RIAA file sharing lawsuit

3:37 half of india population has cellphones

4:15 dazzle of openness - distract from poverty, IP, etc.

5:00 welcome panelists - Sunil Abraham

5:15 prof ron deibert - director of citizen lab, university of toronto

5:30 prof michael Geist

5:50 Anita Guramutry

6:15 prof Yohai Benkler - attending remotely

6:40 what is openness, Anita?

6:45 back into history, where was openness used before?

7:10 glasnost example, perestroika

7:30 aftermath of glasnost - status of women

8:00 openness as destructive anarchy

8:20 mod - does it have inherent value? Ron Deibert

8:40 has meaning for a lot of people - aim for nearly a decade to lift the lid on internet and cyberspace

9:15 shouldn't fool ourselves - term and concept can have multiple meanings

9:30 how terms like these can mask power relations

9:40 Sunil, can opennes make a difference?

9:50 increasingly an empty signifier. Greenwashing

10:00 India open consultation problems

10:30 only middle class indians could participate

10:50 cannot apply openness in a blanket fashion

11:05 ask michael about base belief that wider you open up debate, the better

11:25 apparently I'm pretty naive in believing it can have an impact!

11:40 openness is rarely an end in itself

11:55 open access to networks is seen as the best

12:10 policy making - openness in terms of open participation and consultation gets issues attention

13:00 copyright consultation - openness not the end in itself

13:15 openness as wolf in sheep's clothing

13:30 is there a danger - when people are oversharing the possibility of surveillance arises

13:50 Ron Deibert - yes, to get to basic point. Social networking and open
collaboration raises unintended consequences. Auto-surveillance.

14:40 big brother of state is not necessarily to enemy

14:55 private companies - don't care about private lives unless it makes them money

15:20 default privacy setting streamline into a complete erosion of privacy

15:40 privacy commissioners - momentum is so far the other direction

15:55 tag photos, social media - this really concerns me

16:10 privacy commissioner chided google and facebook, are these worries
exaggerated?

16:35 Binkler - excessive breadth of use of the term openness is the problem

17:00 basis problem is the concentration of power


**Part 2 Transcript**

00:00:00


[Music]


[Clapping]


Male Speaker:  Today on the show I'm going to bring you part two of the panel
discussion that we began last week.  This was a live event in Ottawa that was presented
by the International Development Research Center.  These guys give out large sums of
money for research into how to improve the developing world and the big talk in the

development community these days is technology and openness, and how the two can be used together to make things better in the second and third world. So they brought together a bunch of thought leaders on the subject, big brains like Michael Guice and Ron Diebert who you've heard on the show before, as well as Sunil Abraham from the Center for Internet and Society in Bangalore, India, Anita Gurumurthy from IT for change also from India and Professor Yohchai Benkler from the Berkman Center for Internet and Society at Howard University. And when we left off I was asking the panel whether all of this talk of putting open technology in laptops and cell phones into the hands of the poor people of the world if all of that isn't kind of missing the point. Anita Gurumurthy was the first to respond.

Anita Gurumurthy: There is a lot of hype and too many myths floating around which are tremendously atheoretical about the connections between openness technology and democracy. It's important to look at the mobile revolution, and when you talk about the masses the billions who in India own mobile phones I think it's time that we stop celebrating this as the totem of you know, the information society in order to pay attention not only to the fact that mobiles are closed architectures, but also I think the assumption that social movements and social protest is actually billed upon web 2.0

00:02:00

Or on social networking I think really needs to be *[Inaudible] [00:02:00]* and here I think I'd really like to borrow from my readings on *[Inaudible] [00:02:08]* and his

critic of twitter.  You know, he points to two things, one is about the flash mob kids in Belarus in 2006 and the assumption that many of us have that you know, you can just get on to you know, this virtual space and organize a community and bring about change, you know, as if you can blog a way a dictatorship.  You can avoid all that you know, dirty bloody politics, you know, which is not true, so development is dirty, development is about the lives of people and it's about aspiration, symbolic issues and material issues.

Male Speaker:  Ron I'm still bruised from my last when I go around with a *[Inaudible] [00:02:44]*.  I've been in a dark mood ever since.  I can hear his voice now in my head telling me that all of this talk of openness is merely a fetish, and somebody who has dedicated himself to providing censorship circumvention tools to revolutionary communities and to the citizens of oppressed countries, *[Inaudible] [00:03:06]* does it matter.  Is this the first step or is this the diversion from where the real revolution is going to come from?

Ron Deibert:  I think he's right to a certain degree.  He's done a good job I think splashing cold water on a lot groundless enthusiasm about social networking technologies and the role they play in many parts of the world, so no doubt about it with him on that I agree, at the same time I think we have to be careful not to swing too far in the other direction and underestimate the extent which today even in places about which *[Inaudible] [00:03:37]* speaks, these technologies are still very important and sometimes in some parts of the world new media, cyberspace, the internet whatever you want to call

it is the only viable alternative for opposition movements to express themselves because the state controls traditional media

00:04:00

And certainly judging by the degree to which authoritarian and non democratic regimes focus on these technologies today it's important to them, because they understand that it's a tool for, a very powerful tool for social mobilization so much so in fact that they're working to insinuate themselves into those very tools. So you have for example, elements of the state, intelligence networks masking themselves as pro-democracy movements using twitter and other social networking tools, monitoring people's Facebook accounts, not only in the countries but abroad and intimidating people through what they find on these platforms.

Male Speaker: Anita.

Anita Gurumurthy: Of course it's desirable I mean, I would want a mobile phone and I presume everyone would want to have a mobile phone, so it's as simple as you know, the human propensity to communicate and so everyone would want to communicate. I also must add that while we examine issues of you know, open knowledge, we will have to take cognizance of the fact that increasingly the battleground is in the blooding lines between the public and the private, so you're having a trend not just in India but in many developing countries where public educational institutions are

getting privatized, so you know, what you see is you know, on the one hand these moves and incentives to adopt let's say you know, creative commons licenses et cetera but on the other hand you know, you really don't have incentives you know, to actually adopt you know, these collaborative processes that push you in the direction of the commons, so for me I think the questions around social justice and equity would be, how can you have you know, access to information which promotes the agency of people, you know, how can you have a participation in these emerging networks that also promotes politics and how can you have collaboration that also promotes appropriation, you know, appropriation of local surpluses.

00:06:00

Male Speaker:  Sunil as an entrepreneur and as somebody who has seen this play out in practical situations I think you know, that Thomas Friedman in the Nicholas nickels parties would have us believe that perhaps you put a cell phone or a $100.00 dollar laptop in a poor child's hands and the world is his or her oyster, have you seen practical benefits, have you seen that connection leading to something tangible.

Sunil Abraham:  When Thomas Friedman comes to Bangalore he gets into a taxi and drives straight into the IT district and the government makes sure, the government in Bangalore that the IT district never faces any power cuts, and so he sees the completely different Bangalore, than the Bangalore I live on the outskirts of the city where we have about four hours of power cut on a daily basis, so you shouldn't go by what Mr.

Friedman says.  With *[Inaudible] [00:06:52]* one laptop a child it's not really a technological innovation, it's the sales target really.  When you say that you want to sell one laptop a child, he claims that it's based on constructivist education, there's nothing really in the sugar operating system that one can connect through the work of BRJ or Montessori, so it's missing what one would call the content, the open educational resources or open content that should be on these devices.  Some Latin American countries are picking up this idea, but in India it still remains purely in pilot format.  Where is the real change?  Again, going back to mobile phones, I was in an auto rickshaw, in Thailand you call them tuck tucks, traveling from office to my home and midway the auto rickshaw driver took a phone call and then he said I'm sorry you now have to get off because I have something else to do.  The maidservant that services several apartments in my flat

00:08:00

Will call us or organize her day in a much more efficient manner because she can now negotiate with several employers using the mobile phone so there is a huge tangible impact and we are definitely seeing the benefit of modern technology and the benefits in my opinion clearly out way the risks but the risks do exist and we have to constantly keep them in mind.  It isn't as if these risks only emerge from really sophisticated technology like Facebook and twitter.  They can emerge from the very simple standardization.  In India we now have a proposal to introduce a unique identity number, so all the government will do if one forgets the biometrics behind the project is assign each citizen

with a unique number, it's a standardization of identity, but what will happen is hospitals and insurance companies will be able to synchronize databases, so you don't really need complicated technology to be a threat to democracy or open societies, a very simple standardization on a number can also be a threat. In Gujarat when the Muslims were targeted people were roaming through the city with census database in one hand, a sword in the other hand, a mobile phone in their pocket, that's how 5000 Muslims were murdered in Gujarat. So, all network technologies can come with huge social costs, but they also come with huge social benefits.

Male Speaker: I would like each of you to answer this briefly if you can and I'm sorry for this question. If you cover as a journalist let's say if you cover politics in Ottawa, everyday you report on what happened today, that's what you're asked happened today. If you covered technology you're asked what's going to happen

00:10:00

In ten years. The iPad came out, is this a game changer, I don't know. So the question is what you want to see happen in 10 years, and you can kind of interpret this question anyway you want whether it be through a focus of development or in terms of policy here in Canada. Michael perhaps you can start.

Michael Geist: So I'll only pick a couple of areas. I'll start with open access and open educational resources. I think in 10 years works that are published by researchers particularly in places like Canada then United States but frankly in many institutions

around the world the ones that are not available under OA are the exception rather than the rule. An intellectual property I sure hope that I'm not sending out yet another blog post for the eighth time a bill is about to be introduced and they really are going to introduce the Canadian DMC this time. I think it's easy to be pessimistic right now but what things look like in 10 years but I'm actually going to be optimistic in all of this. I think there is still in the short-term around intellectual property rules or even around some of the network rules I think that the kind of fading or the public policy ballet that we have seen over the last number of years will continue, but the one thing that I think is on the side of those pushing for better balance with respect to copyright and ensuring better access is frankly time and demographics. It seems to me that we are already at the point that a growing number of people who will vote in the next election whenever that election happens to be can scarcely remember a world without the internet and certainly a sizable number of people can scarcely remember a world without the personal computer. If we fast forward to that 10 years, we're now talking about what almost every Canadian under 45 at least not being able to remember a world without a PC, 35 or so not being able to remember a world without the internet, that's a pretty powerful demographic in terms of the way policies get made and it also becomes an increasingly the demographic from which ministers and leaders themselves are drawn from. On some of these issues that seem so difficult today

00:12:00

I think I know clearly who wins at the end of the day. The issue is whether or not we spend the next five or ten years locked in this continual battle between sometimes demographics, certainly between different industries those that are adapting those that are not and then at the end of the day recognize that this has been a rather foolish fight or can we get there quicker and I think the countries that get there quicker that represent the real benefits that can accrue from that are the ones that will set themselves up longer term to take real advantage.

Male Speaker: Professor Benkler 20/20 what do you say?

Professor Benkler: Thankfully you asked for a hope not a prediction. What would you like to see rather than what you think will happen so I'll use that liberally? I think what I'd like to see is in the political a cultural openness to seeing people as telling their own stories and inquiring for themselves a push in terms of policy to require standardization of government data alongside analysis that will allow people locally to say, here the local person who exercise control over the licenses here has wronged me, and there is a system that will make it such that it is difficult for somebody to be wronged in that way because there are easy metrics and to push that I'd like to see growing practices of people providing their own alternative sources of discourse. I'd like to see not only scientists but also teachers adopt practices of developing their own open education materials and large adoption of the kind of translation efforts that we've seen here and there be at the Ted videos but more impressively global voices. I would like to see broader practices of people saying, we can come to the state of the *[Inaudible]*

*[00:13:54]* software and offer software services over open source platforms because we don't have to pay a licensing fee

00:14:00

To whoever owns it, and I would like to see markets opened to saying, what is the best person writing software, wherever they happen to be whose capable of doing this building on an open software infrastructure, and so on and so forth.  The critical thing to understand in the difference between the hope and the prediction is that none of this is inevitable.  The technology will not make any of this inevitable, and there are distinct pushes both by owners of content and as you say by governments pushing cyber security agenda trying to shut down the relative openness.  You asked about the iPad.  I think the iPad is irrelevant.  But the iPhone isn't, because of the centrality of the mobile foreign factor.  In which of these two trends the relatively controlled platform or the open platform on which people can develop will end up being the primary platform for billions of people will be an absolutely critical decision.

Male Speaker:  Can we have a very warm round of applause for our panelist today.

[Clapping]

[Music]

Male Speaker:  Search engine is made by me and a community of listeners who will have to explain to me what the mobile phone factor is.  Email me with story tips and freelance pictures at Jessie@jessiebrown.ca the blog is at tvo.org/search engine and you can follow me on twitter at Jessie Brown.  This program is released with the creative commons license, so feel free to play it in your took, took.  The next pod cast will be up in two weeks, because I'm getting married next week for real.

**[Music]**

**Part 2 Notes**

0:15 moderator intro

0:35 talk in development community is technology and openness

0:45 introduce participants

1:05 was asking the panel whether all of the technology into the hands of people isn't missing the point

1:20 anita - missing connections between openness, technology, and democracy

1:45 time to stop treating mobile phone as epitome of social progress

2:10 critique of twitter. flashmob kids. you can't blog away a dictatorship.

2:40 ron - still bruised from the last go around

2:55 all talk of openness is merely a fetish?

3:10 is Morasov wrong?

3:20 right to a certain degree. Has done a good job splashing water on new technologies. But these technologies are still very important.

3:45 in some places this new media is the only place for opposition to express itself

4:05 it's important to regimes because they understand that it's a tool for social mobilization

4:25 state masking themselves and monitoring

4:35 anita - of course it's desirable. human propensity to communicate.

5:00 increasingly the battleground is in the blurring lines between the public and the private

5:30 really don't have incentives that push in the directions of the commons

5:40 how can you have participation in these emerging networks that promotes appropriation of local surpluses

6:00 sunil - you put a cellphone in a poor child's hands and the world is their oyster. Have you seen practical benefits?

6:20 the IT district in bangalore never faces any power cuts. In the outskirts we have 4 hours of power cuts per day.

6:55 one laptop per child isn't technology, it's a sales target

7:15 it's missing the open educational resources

7:25 some latin american countries are picking up on this idea.

7:35 where is the real change? Was in an autorickshaw, driver took a phone call and said sorry now you have to get off. The maid service will organize her day in a more efficient manner. definately seeing benefits

8:20 the risks do exist, but there is benefit

8:35 risks can emerge from simple standardization - ie. unique identity measure

9:20 roaming through city with census database and a sword - all technologies can come with huge cost

9:50 moderator - what do you want to see happen in ten years?

10:15 michael - open access and open educational resources - works that are published by researchers the ones that are not available under open access are the exception, not the rule.

10:50 it's easy to be pessimistic, but I'm going to be optimistic

11:00 the public policy battle will continue

11:15 time and demographics are on the side of greater openness in copyright

11:30 many cannot remember a world without the computer

11:50 powerful demographic in terms of how policy gets made

12:10 question is whether we spend the next 10 years in a foolish fight

12:30 Professor Binkler, 2020, what do you see?

12:45 like to see a cultural openness

13:00 a push for standardization of government data

13:30 people's own discourse. Teachers developing their own educational materials.

13:50 software services over open source platforms

14:00 markets open to best software and building on open infrastructure

14:15 none of this is inevitable - content owners and government are trying to shut this down

14:35 ipad is irrelevant, but the iphone isn't

14:50 controlled platform or open platform will be an absolutely criticial decision

# Appendix E - Questions

**Part 1 Questions**

**Please circle the correct answer and note the time reference from the podcast (to the nearest minute)**

1. The participation of slum residents of bangalore in the India consultation process was primarily restricted by

A - location and timing of polling stations

B - interest of the residents in the slums

C - laws and regulations restricting input to landowners

time reference:


2. According to Michael, in the net neutrality debate what aspects of openness have worked well in Canada?

A - open participation and consultation

B - open access to networks

C - transparent network routing protocols

time reference:


3. According to the US position, anonymous circumvention of firewalls is

A - illegal in all cases

B –encouraged by the US in the case of repressive regimes

C - always legal

Time reference:

4. Professor Benkler believes that the main concern is private companies collecting data about

A - who has funded whom, and what you are purchasing

B- your movements and activities

C - your political preferences

Time reference:

5. According to Anita, the role of women after perestroika

A - changed for the better

B - changed, but not necessarily improved

C - got worse

Time reference:

**Part 2 Questions**

Please circle the correct answer and note the time reference from the podcast (to the nearest minute)

1. In Sunil's view, what is the one laptop per child effort missing to properly found it on a constructivist educational philosophy?

A - staged development

B - progressive disclosure

C - open educational content

time reference:

2. Why is new media often the only place that opposition can express itself?

A - the technological elite are the only ones with a well defined opinion

B - anonymity online limits the risks

C - the state controls all other media outlets

time reference:

3. According to Michael Geist, in ten years the voter demographics will be radically changed by what?

A - nobody under 35 being able to remember a world without a PC

B - nobody under 35 being able to remember a world without the internet

C - nobody under 45 being able to remember a world without the internet

Time reference:

4. In Anita's view, development is dirty and is about

A - aspirations, symbolic issues, and material issues

B - money and control

C - power and politics

Time reference:

5. A concrete and bloody example of the danger of standardized data emerged in the Muslim killings in

A– Bombay

B – Gujarat

C– Mumbai

Time reference:

# Appendix F - Post-Test Questionnaire

Please answer a few questions about your experience. Circle the appropriate value.

Which of the two versions did you prefer?

1   2   3   4   5   6   7

[the first version]        [the second version]

For the first version, please rate the following

Ease of finding information

1   2   3   4   5   6

7

[very hard]

[very easy]

Efficiency of finding information

1   2   3   4   5   6

7

[very hard]          [very easy]

Overall satisfaction

1                2                3                4                5                6

7

[very unsatisfying]                                                [very

satisfying]

For the second version, please rate the following

Ease of finding information

1                2                3                4                5                6

7

[very hard]

[very easy]

Efficiency of finding information

1                2                3                4                5                6

7

[very hard]

[very easy]

Overall satisfaction

1           2           3           4           5           6

7

[very unsatisfying]                                            [very

satisfying]

If you missed a class and needed to learn the material to study for an exam, which

would you prefer?

1           2           3           4           5           6

7

[the first version]                                            [the second

version]

If you missed a 4 person business meeting and needed to know what happened,

which would you prefer?

1           2           3           4           5           6

7

[the first version]                                            [the second

version]

# Appendix G - Raw Study Results

| subject | age | gender | education | when? | visual or auditory | audio record lectures? | use audio to study? | detailed notes? (h=by hand, c= by computer) |
|---|---|---|---|---|---|---|---|---|
| pilot | 27 | f | ba | 2009 | vis | no | no | yes - h |
| 1 | 20 | | 3rd year | 2010 | both | some | no | yes - h |
| 2 | 24 | m | 2nd year | 2009 | vis | yes | yes | no |
| 3 | 38 | m | msc | 2010 | vis | no | no | yes -h |
| 4 | 18 | f | 1st year | 2010 | both | no | no | yes - c |
| 5 | 18 | m | high school | 2009 | vis | no | no | yes -h |
| 6 | 25 | | 2nd year | 2009 | vis | some | yes | yes -h |
| 7 | 23 | f | 3rd year | 2010 | aud | no | no | no |
| 8 | 21 | f | high school | 2007 | visual or auditory | no | no | yes -h |
| 9 | 27 | m | bsc | 2006 | vis | no | no | yes -h |
| 10 | 20 | f | 2nd year | May-10 | vis | yes | yes | yes - h |
| 11 | 18 | m | high school | 2010 | vis | yes | yes | yes - h |
| 12 | 24 | f | ba | 2009 | aud | some | no | yes - h |

**Table 3: Raw results on the pre-test questionnaire**

| subject | condition | Start time | End time | Task time (delta of start time to end time) |
|---|---|---|---|---|
| | | | | |
| 1 | no | 11:36:30 | 12:03:00 | 00:26:30 |
| 2 | timeline | 8:12 | 08:27:00 | 00:15:00 |
| 3 | timeline | 10:15:00 | 10:35:00 | 00:20:00 |
| 4 | notes | 03:01:00 | 03:23:00 | 00:22:00 |
| 5 | full | 03:49:30 | 04:19:00 | 00:29:30 |
| 6 | timeline | 06:20:30 | 06:38:00 | 00:17:30 |
| 7 | full | 11:13:00 | 11:27:00 | 00:14:00 |
| 8 | notes | 12:29:00 | 13:01:00 | 00:32:00 |
| 9 | no | 11:07:00 | 11:33:00 | 00:26:00 |
| 10 | full | 01:00:30 | 01:14:00 | 00:13:30 |
| 11 | no | 02:02:15 | 02:15:00 | 00:12:45 |
| 12 | notes | 02:38:00 | 03:02:15 | 00:24:15 |
| | | | | |
| | avg | | | |
| | timeline | No aid | notes | full |
| avg | 00:17:30 | 00:21:45 | 00:26:05 | 00:19:00 |
| stdev | 00:02:30 | 00:07:48 | 00:05:15 | 00:09:06 |
| | | | | |
| t-test vs timeline (p value) | | 0.449426254 | 0.087295154 | 0.805817613 |

**Table 4: Part 1 raw results and averages**

| subject | cond | Start time | End time | Task time (delta of start time to end time) |
|---|---|---|---|---|
|  |  |  |  |  |
| 1 | timeline | 12:05:00 | 12:19:00 | 00:14:00 |
| 2 | no | 08:29:00 | 08:48:30 | 00:19:30 |
| 3 | notes | 10:37:00 | 10:48:00 | 00:11:00 |
| 4 | timeline | 03:25:00 | 03:36:00 | 00:11:00 |
| 5 | timeline | 04:21:00 | 04:34:30 | 00:13:30 |
| 6 | full | 06:39:00 | 06:53:00 | 00:14:00 |
| 7 | notes | 11:28:00 | 11:38:00 | 00:10:00 |
| 8 | full | 01:02:30 | 01:17:20 | 00:14:50 |
| 9 | full | 11:36:00 | 11:49:00 | 00:13:00 |
| 10 | no | 01:15:00 | 01:27:00 | 00:12:00 |
| 11 | notes | 02:16:00 | 02:25:20 | 00:09:20 |
| 12 | no | 03:03:15 | 03:13:15 | 00:10:00 |
|  |  |  |  |  |
|  | avg |  |  |  |
|  | timeline | no | notes | full |
| avg | 00:12:50 | 00:13:50 | 00:10:07 | 00:13:57 |
| stdev | 00:01:36 | 00:05:00 | 00:00:50 | 00:00:55 |
|  |  |  |  |  |
| t-test vs timeline (p value) |  | 0.768430468 | 0.07993954 | 0.370974936 |

**Table 5: Part 2 raw results and averages**

| subject | timeline | | | No aid | | | notes | | | full | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ease | efficiency | satis | ease | efficiency | satis | ease | efficiency | satis | ease | efficiency | satis |
| 1 | 5 | 5 | 5 | 4 | 2 | 3 | | | | | | |
| 2 | 7 | 7 | 7 | 2 | 5 | 3 | | | | | | |
| 3 | 5 | 5 | 6 | | | | 4 | 5 | 5 | | | |
| 4 | 5 | 7 | 6 | | | | 2 | 2 | 3 | | | |
| 5 | 6 | 6 | 6 | | | | | | | 4 | 4 | 4 |
| 6 | 5 | 6 | 5 | | | | | | | 3 | 3 | 3 |
| 7 | | | | | | | 6 | 7 | 2 | 4 | 3 | 5 |
| 8 | | | | | | | 5 | 5 | 4 | 6 | 6 | 7 |
| 9 | | | | 3 | 3 | 2 | | | | 6 | 7 | 7 |
| 10 | | | | 7 | 7 | 7 | | | | 4 | 4 | 4 |
| 11 | | | | 5 | 7 | 6 | 3 | 2 | 4 | | | |
| 12 | | | | 3 | 2 | 1 | 6 | 7 | 3 | | | |

**Table 6: Ease of use and efficiency ratings on post-test questionnaire, higher numbers represent easier to use, more satisfying, more efficient**

| subject | time vs no | time vs notes | time vs full | no vs notes | no vs full | notes vs full | time vs no |
|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | 1 |
| 2 | 1 | | | | | | 1 |
| 3 | | 2 | | | | | |
| 4 | | 2 | | | | | |
| 5 | | | 2 | | | | |
| 6 | | | 2 | | | | |
| 7 | | | | | | 2 | |
| 8 | | | | | | 7 | |
| 9 | | | | | 6 | | |
| 10 | | | | | 1 | | |
| 11 | | | | 2 | | | |
| 12 | | | | 6 | | | |

**Table 7: Direct comparison numbers on post-test questionnaire. Lower numbers are a preference for the first named condition in each column.**