The employment of such an online certification service provides benefits for both parties: archives obtain a quality assurance instrument for the recording of their media. In the past, sound carrier owners had to implement quality control by means of a cost-intensive strategy: multiple recording of a single sound medium and time-consuming comparative analysis. The availability of objective measurement results allows for a drastically simplified quality monitoring.

For companies or organisations dealing with the process of mass migration of analogue media, long-term evaluation is an important tool for supporting the continuous internal improvement process. For example, slow deterioration over time can be made visible. Besides the cost savings due to precise situation assessment, there is another advantage for service providers: when using playback devices of different quality, it may have been difficult to argue the higher costs for recording with high-quality machines to their clients. With the help of the automatic, reference-based analysis, quality differences between average and high-class playback devices become easily measurable. By documenting the measurement results, the client can easily see the quality difference between different machines. The SLA guidelines can therefore offer different service levels, thus enabling a quality based pricing system. The adherence to the agreed service level can be proven to the client with the online service. For quality-conscious service providers this opens up new opportunities to set themselves apart from competitors that operate with a less than convincing quality management system.

Summary

The use of a system for the automatic and reference-based quality surveillance of analogue playback devices represents an efficient means of quality assurance when digitising audio media. The method therefore contributes to the preservation of our acoustical heritage.

The quality of digitisation can be markedly improved by this newly obtained control option, provided that a sufficient homogeneity of archive material is given. With extensive automation of the measurement procedure, the ratio of achievable quality to cost or duration of the migration project is improved significantly.

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VIDEO DIGITIZATION AT THE AUSTRIAN MEDIATHEK

Herman Lewetz, Austian Mediathek[9]

In September 2009 the Austrian Mediathek started a project called "Österreich am Wort". Its goal is to digitize and publish via the web about 10,000 full-length recordings within three years. The misfortune for me personally was that in the proposal for this project someone had claimed 2,000 of these to be video recordings. This meant I had to start what we so far successfully had postponed: Video digitization.

Requirements

As a first step, we outlined the requirements we thought important for a digitization schema that best supported long-term preservation. Unlike audio digitization there is still no widely accepted archive format for video.

- **Lossless format**
  The most important requirement for the archive format is that it is absolutely lossless. It is clear that if the content is expected to last forever, it must undergo endless instances of conversion into future formats. Therefore each loss in quality, even if it is minimal, would lead to a total loss of content at the end of the migration chain.

- **Non-proprietary codec**
  The codec must not be proprietary. It must be capable of being used by any programmer for implementation in any program that is intended to deal with it.

- **Hardware independency**
  Video playback shouldn't depend on dedicated hardware. This would limit the use of programs to those that can deal with the dedicated hardware, which in many cases would be proprietary software.

- **Reduced data**
  Calculations have shown that video digitization produces a huge amount of data. Although the prices for storage decrease steadily, the costs are still very high. Calculating in these dimensions, the chance to cut them in half it becomes an important argument.

- **Metadata**
  Documenting the whole process of digitization including metadata of all tools used and their configuration is important for later research.

- **Affordable system**
  Only a small portion of the budget could be spent on video digitization at the Austrian Mediathek. There was only a limited funding for the project "Österreich am Wort". Therefore, the system to be installed for the video digitization had to be cost-effective.

As a last requirement we tried to follow the basic strategy that simplicity makes life easier.

Known alternatives

When you remove all lossy and proprietary codecs from the list of known available video formats there seem to be only two alternatives remaining:

- **Uncompressed**

    Uncompressed formats require a huge amount of storage space, which eventually means limiting the overall digitizing efforts.

- **Jpeg2k**

    This codec wrapped in an mxf container was considered to be an excellent solution for a video archive format in many discussion circles and was, therefore, our favorite solution until we made tests to deal with those files. Many of the few existing applications, which claim to deal with this format, only are able to decode the file. Others cannot handle the mxf container. It also seems difficult to play back a lossless jpeg2k file properly without dedicated hardware. This dependency on hardware makes jpeg2k (a primary open source format) partially proprietary.

Both known alternatives are at least viable possibilities for storing video content without facing a loss in quality through successive migrations. But none of them fulfills all of the requirements as stated previously. Although they seem to represent a serious solution for a long sought reliable format for long term video archiving, many technicians do not seem to be completely satisfied with them.

Our decision

During several months of testing and research we also looked into open source solutions. There, we found a huge range of formats and codecs including some unknown to us, but seemingly suitable. The fact that almost all programs in the open source community dealing with audio and video rely on the libavcodec library, which is part of the ffmpeg project, makes all the codecs and containers, which are implemented in that library, well distributed among available open source tools. This library is so open, free and well-known that some commercial vendors have even decided to implement it in their products. Thanks to wrapper applications for several different operating systems, the library's multimedia codecs can be used by any application that support the use of external codecs. On the Microsoft Windows platform, for example, one can use "ffdshow-tryouts", which makes the libavcodec available as VfW (Video for Windows) and DirectShow codec. After a successful installation, all applications, which are able to deal with system codecs — whether they are free, open source or commercial, now also can handle all formats and codecs inside this library.

One of these codecs, which is part of the ffmpeg library, is the so-called "FFV1". It is a codec with a mathematically lossless compression. It decreases the amount of data down to almost 30 %, which is comparable to jpeg2000. It is capable of dealing with all current color spaces like YUV, YV12 and RGB including subsampling (4.4.4, 4.2.2 and so on). Even the resolution was independent. We tried PAL 4:3 and 16:9 as well as HD 1980 x 1080. However, we made no tests with NTSC. As the Austrian Mediathek is located in Europe and is a national AV archive, we have only video with the PAL standard in our collections. Tests with NTSC would be part of future investigations.

The great advantage of the FFV1 codec is its comparatively low demand on processing power. We managed to achieve proper recordings without adding or dropping frames using a standard PC. Even the playback was performed properly without breaks buffering.

The choice of the video archive format was the first step. The few available video digitization systems at this time are not able to deal with the ffmpeg library. Therefore we decided to use existing open source software and develop our own idea of a video digitization system.

The system

Video-Cube (ingest machine):	Ferry (automation server):
Standard PCs, Dual-Core, 2.3 GHz, Intel I5, Decklink SDI card	Standard PCs, Dual Core, 2.6 GHz, Intel I5
Windows 7	Debian Lenny (5.0.4)
ffdshow-tryout	encoding: Mencoder, FFMPEG
VirtualDub (Open Source capture software)	analysing: Shotdetect
	script: PHP

Besides the Decklink card we used only standard hardware. At the moment we have in use three machines for capturing the video and two ferries, which perform all automated tasks in the background. Both sides can be altered by additional machines.

- **Script language**

The code is written in PHP. In order to only have one programming language across the whole project and because it is easy to learn and is in widespread, PHP was chosen for implementing the browser-based GUI and the workflow processing applications running in the background. The script itself is the source code.

- **File-based solution**

Following the concept to introduce the simplest possible solution, we decided not to use any database. Instead, all the needed information and created data is just stored as files in an organized system of folders. For example, the metadata describing the workflow is an XML file enriched with additional information by every successive task in the row. This file gets passed from task to task. The Ids, you see in the frames of the HTML page (GUI), are actually the names of listed XML files situated in the dedicated folders. Thus, at every stage it is possible to check the actual status of the recording. (Figure 1)
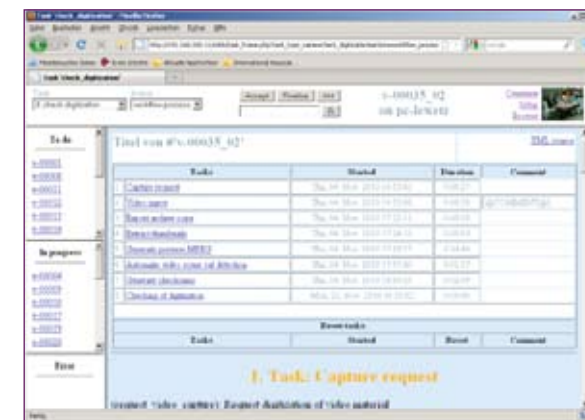

Figure 1. This view gives reference of the performed tasks, their parameters and their individual periods.

- **Simplified architecture**

The other simplification is represented by the fact that each of the PC machines is dealing with just one task at a time, although they technically would be able to perform more than just one

process. Thus, maintaining an overview of which task is performed by which machine can be achieved with less complex scripting. On the other hand, this concept increases the number of PCs in use. However, the included hard drives also alter the available data space, which makes any need of extra storage obsolete.

■ **Capture**
For the ingest of an SDI video stream, we use the application called "VirtualDub". It runs on MS Windows. Having the ffmpeg library installed, it enables the application to capture natively with the ffv1 codec wrapped in an AVI container. Thus, we avoid the time and resources normally used for conversion into the archive format. VirtualDub also gives us the ability to segment the files in accurate length.

■ **Segmented archive file**
Our system is designed to accept each recording as a bundle of segmented files. We decided to split the video into 1-minute file segments. Using the PAL system in Europe, this translates to accurate 1500 frames per file.

The main reason for dealing with segmented files lies in the attempt to reduce the load of the intranet and the storage environment and achieve a more fault tolerant procedure. In case of failures, having smaller files reduces the amount of data that has to be restored. For example, creating individual checksums for each minute makes it possible to identify and replace a smaller piece of faulty data.

■ **Metadata**
All Metadata are written in an XML file, which is defined using the METS schemas. To achieve this was one of the most time consuming efforts.

It is our aim to register our system with the official METS page. Following the METS standards enables many other institutions that have also implemented METS schemas in their systems, to interpret our metadata without complicated matching procedures and vice versa.

■ **Web browser GUI**
The GUI, which shows all tasks, statuses and actions, is a simple HTML page. In order to support as many browsers as possible, the HTML code was kept straight-forward and simple, using only well-known and established HTML elements. The use of Javascript was kept to a minimum and is not required for essential functions of the GUI.

Watching and navigation of the complete workflow is organized in this one page. It is designed to make only those items available, which are needed at the actual stage of the workflow.
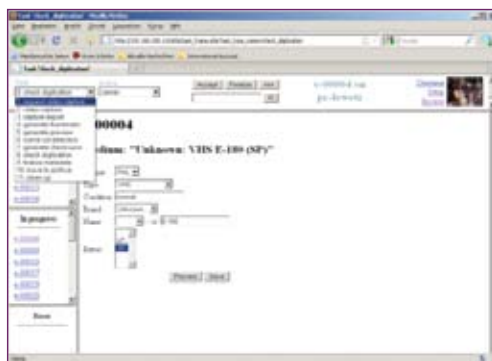
The page is divided into 5 frames. (Figure 2)

Figure 2. This dropdown shows the actual installed tasks. When a task is selected, the frame changes to a view of the dedicated task.

The upper frame of the window shows the navigation menus and action buttons for accessing, finalizing and eventually resetting tasks. Buttons are only active when the tasks are in the appropriate context.

The left menu shows all installed tasks, which can be chosen by clicking. The content of all frames then relies on this dedicated task.

The second menu offers a selection of different actions depending on whether they are available in the chosen task.

The left column is divided into 3 parts:

■ **"to do":**
    The text file of all recordings, which are ready for the actual task, wait inside the frame called "to do" until accepted.

■ **"in progress":**
    When accepted for processing, the text file gets moved into the frame called "in progress". Then the dedicated task starts.

    When finished, the button "finalize" starts the finalizing procedure. All relevant files created in this task get moved into the task folder „finalized" and the text file gets moved into the "to do" folder of the next task.

    Depending on the character of the task, activating the "accept" as well as the "finalize" button can happen automatically or can be done manually.

■ **"error":**
    Any errors occurring during processing move the file to the "error" folder modified with the appropriate error message. It appears in the frame called "error". It will stay there until it is manually reset. It then jumps back to "to do", where it waits until being accepted again.

In fact, the visible recordings are nothing else than the names of metafiles in dedicated folders. This means the information illustrated on the page is generated by simply summarizing the content of the dedicated folders "to do", "in progress" and "error".

These metafiles start with the metadata coming from the catalogue and become modified with additional processing information from task to task. After a task is finished and the button "finalize" has been activated, this file will move to the next task.

The middle frame shows the content of files, which have been created during former tasks of the selected recording. It varies with the selected action.

An overview shows all existing recordings and their individual status. There, they can also be processed as a batch. (Figure 3)
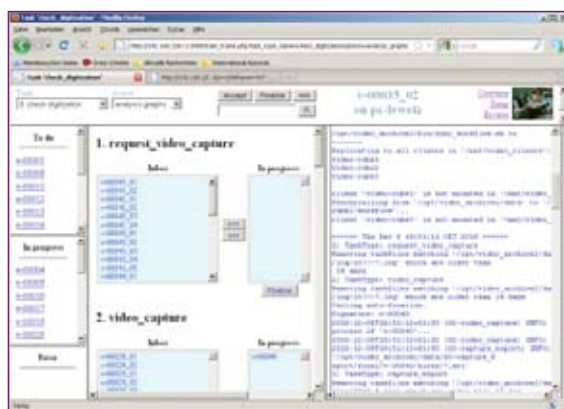
Figure 3. This overview enables monitoring and administration of the tasks in common.

The workflow

For descriptive metadata we use an independent catalogue database. The workflow starts after the cataloguing. An automated export stores a text file with dedicated metadata selected from the record in the catalogue into a specified folder. A script continually looks for text files in this location and eventually parses them.

When such a text file has been acknowledged and parsed, the ID of the recording to be digitized appears in the "to do" frame of the first task called "request". This ID actually is the filename of the text file, which then becomes modified with additional information from task to task.

In the first task called "request", there is a small text box where some technical information about the cassette has to be entered, which might be important for later research. The fields to be filled in vary with the format and its specifications. (Figure 2)

After successful digitization, the next tasks start automatically. The recording is analysed, thumbnails are created, metadata are collected and an mpeg copy is made. This takes some time so the manual check has to wait until the next day. Fortunately we can continue for the day with digitizing additional recordings.

Different views are available for checking to see whether the digitized recording was a success or should be redone for any reason. (Figure 4 and Figure 5)

Figure 4. This is the view of the detected shots. It shows some results of the detected cuts and transitions. The larger picture on the top represents the activated thumbnail below. In addition, the application also detects any extant picture errors, interprets them as cuts and creates thumbnails, as it does with all normally detected cuts. Thus, many failures become visible at a glance.
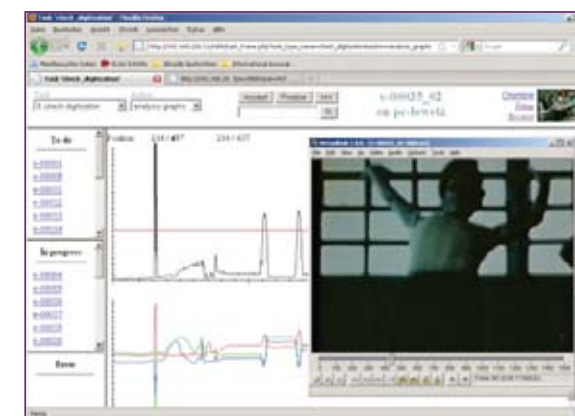

Figure 5. These two graphics are created by the shot-detect application during the analysis. We combined and synchronized them in the browser. Slewing through these traces gives us much information about the condition of the file. Parts in doubt can be viewed in a video player by clicking onto the curve.

When the recording passes all checks successfully, all relevant files get moved automatically into the defined storage folders.

The final task is to clear the system of all remaining files and folders, including involved ferries and the ingest machine. This is important to make space for the next recordings.

All tasks used in our system are installed as individual modules. They can be replaced or altered by other tasks. This enables us to vary the system if needed.

Publishing the system as open source

A description of this system, including this article, is accessible on our website:
http://video-digitalisierung.mediathek.at

The next step, to take place in 2011, will be a systematic publication of the entire project on our website. The scripts, documentation and descriptions will be published under the GNU General Public License (GPL). Our intention is to give back code, which we used for free from the internet, enriched with our input. We took some individual applications and are giving back an entire system. All applications, which we had to modify, did not just become orphaned versions for our own use. Depending on the development structures of external tools, we're not only sending our changes back to the upstream developers, but we are also collaborating with some of them, as well as directly committing into the official source tree. In another case we were successful in getting the developers to take our needs into account during their future development. The original FFV1 codec is not able to deal with more than 1 core. This will be changed in future updates. Triggered by our request, the developers have already started working to modify the FFV1 codec for multithreading. Tests show that the processing will be much faster and that files processed with this codec can run on even less powerful PCs.

Conclusion

The primary and most important messages of this project paper can be summarized in two statements:

- There is a third alternative format for long-term video preservation.

- There is a system available as open source software that is able to deal with a huge number of video formats, including this third alternative, and that helps to organize the complete workflow from digitizing through analysis and documentation to archiving. (http://video-digitalisierung.mediathek.at)

Our results might assist other institutions in deciding how to preserve their video content. For the Austrian Mediathek this decision has been made. For us, the FFV1 codec is currently the most complete solution, and practice shows that our system is a professional alternative to commercial solutions. If other reliable codecs become available or the jpeg2k codec fulfills its potential, which it already claims to do but in fact does not, the FFV1 codec would enable us to migrate to these newer codecs at any time and losslessly. The question is: Will there be any need to do so?

THE CNRS — MUSÉE DE L'HOMME AUDIO ARCHIVES: A SHORT INTRODUCTION

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The historical and institutional context

The CREM works on the preservation, documentation and dissimination to a global audience of one of the greatest archives of ethnomusicology in Europe. The *Centre National de la Recherche Scientifique* (National Center for Scientific Research, CNRS) and the *Musée national d'Histoire Naturelle* (National Museum of Natural History, MNHN) share the property of the archives, supported by the *Ministère de la Culture* (Ministry of Culture) and the *Université Paris Ouest* (Paris Ouest University, formerly called Paris 10 University). These audio archives[10] were founded by the french musicologist André Schaeffner in 1932, returning from the Dakar-Djibouti expedition (directed by Marcel Griaule) in 1931 in Africa where he collected both musical instruments and records. The sound archives and the organology department were named *Département d'ethnologie musicale*[11] (Department of Musical Ethnology) of the *Musée d'Ethnographie du Trocadéro* (Museum for Ethnography at Trocadero square, next to the Eiffel Tower), then *Musée de l'Homme* (Museum of Mankind) in 1937. In 1968, under the direction of the French ethnomusicologist Gilbert Rouget, the department became the *Laboratoire d'ethnomusicologie* (Laboratory of Ethnomusicology) of the CNRS. Since 2007, after integrating the *Laboratoire d'Ethnologie et de Sociologie Comparative* (Laboratory for Comparative Ethnology and Sociology, LESC), the team is now called *Centre de Recherche en Ethnomusicologie* (Research Center for Ethnomusicology, CREM). In 2009, the CREM left the museum, under construction, to be hosted at the *Université Paris Ouest* in Nanterre (in western suburbs, next to business center *La Défense*).

The Collections: historical and contemporary records

Since the foundation in 1932, this archive has been closely related to scientific research and a large number of historical records have entered the collections. These include Schaeffner's cylinders recorded during the Dakar-Djibouti expedition, lacquer discs recorded by Gilbert Rouget during the Ogooue-Congo expedition in 1946 with the first records of pygmy music, and our first magnetic tapes recorded in the field by Gilbert Rouget in 1952 in west Africa.

Today, this audio archive constitutes a major human cultural heritage, with more than 6000 collections. It includes about 3700 hours of commercial records; nearly 5000 discs. some very rare; and about 3800 hours of unpublished records (made during fieldwork and other expeditions). The archive, still expanding and supporting contemporary fieldwork, is acquiring more and more audiovisual and digital formats. Most of the collections are of traditional and popular music, but they also feature oral traditions and spoken word from around the world and in numerous languages.

Some of the fieldwork recordings began to be published in the 1940s in the "Musée de l'Homme" then "CNRS-Musée de l'Homme" collections. Now, there are about 150 references published on several types of disc, making up some some very famous series, such as "Voices of the world" or "Musical instruments of the world". All these references are now out of print and are no longer available to the public or libraries.

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10   For more informations on the history of the audio archives, see Pitoeff, Pribislav, 'Histoire des archives sonores du musée de l'Homme', *Annuario degli archivi di etnomusicologia dell' accademia nazionale di Santa Cecilia*, 1.1993, Libreria Musicale Italiana, pp 143-149.
11   For more informations on the history of department, see Rouget, Gilbert, 'Le Département d'ethnomusicologie du Musée de l'Homme. Maison mère de la discipline en France et dispositif en péril', *L'Homme* 2004/3-4, No. 171-172, pp 513-523.