The Interactive-MUSICNETWORK

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Abstract: The Music Network Accesssibility Working Group aims to address key aspects of the provision of music for the print impaired in the digital age. This report provides an overview of music coding for print impaired people.

Keyword List: music coding, notation, accessibility, Braille

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Executive Summary and Report Scope

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The area of music encoding is moving towards greater unification and co-ordination of effort with the activities and strategies being pursued by the Music Network. For organizations providing support and alternative format materials for print impaired people this offers the exciting challenge of bringing together several disparate activities and building a far stronger future for coding activities in this field.

It is difficult to discuss the needs of print impaired people in direct relation to market terminologies, but it would be fair to say that music in all its forms has particular significance to print impaired people. Interaction with music scores has until now been somewhat limited, and the main provision of music in alternative formats has been through Braille Music, which has been in production in many countries for over a century.

The Accessibility Working Group addresses the main areas in a series of workshops and meetings; disseminates information about new developments and tools; contributes to the adoption of an inclusive Design For All approach in this field: and contributes to ongoing discussions on emerging multimedia standards.

1 Introduction

The Music Network Accesssibility Working Group aims to address key aspects of the provision of music for the print impaired in the digital age. In recent years a number of key initiatives (such as those undertaken by EC funded projects like CANTATE, HARMONICA and WEDELMUSIC) have opened up new opportunities in the field of interactive multimedia music. The area of music encoding is moving towards greater unification and co-ordination of effort with the activities and strategies being pursued by the Music Network. For print impaired people this offers the exciting challenge of bringing together several disparate activities and building a far stronger future for coding activities in this field. The Accessibility Working Group provides a review of the current situation; some explanation of different approaches to describing accessible music; dissemination of the key emergent themes and technologies; and information about the main contributors, events and problematic areas.

The document complements the continuing general work of the Music Network, in particular the work undertaken in the parallel workshops on music notation, notation standards and education, and we seek to keep accessibility issues at the forefront of all work being carried out by the Music Network.

This document provides a brief overview of the current situation: an overview of accessible music formats; emphasises first the need to continually re-define accessibility to ensure that the scope does not become static in any way, ensuring all new technologies are incorporated in this ever changing definition.

In relation to print encoding a description of the current status of research and facilities in music coding are given from an accessibility standpoint. A description and analysis of the current solutions available for print impaired people is then discussed. This includes both fully implemented solutions in use, and also research work in progress. The report also contains an overview of emerging multimedia standards and their relationship to accessible music.

2 Background

2.1 Print impairment

The term *print impaired* refers to anyone who has a problem with the traditional print version of information. For music, this refers to anyone who cannot read a music score. The solutions presented in this document often refer to solutions for blind users, but many of the solutions have proved valuable for larger groups, including the partially sighted and the dyslexic, as the problems addressed are often very similar.

In terms of music coding the primary technology over the last century has been Braille Music (see below), but the increasing use of computers as a medium for creating and using music scores opens up new possibilities for addressing the needs of print imapired people. In many cases users have by-passed music notaion and become successful performers, creators and users of music without the need for music notation. Work in this field also opens up the music score to make it available to 'niche' markets and increases the scope of the mainstream music products currently on the market.

The problem of music encoding for print impaired people is similar to that for many accessibility solutions. The accessible market is a niche market, so the problem becomes an inherent design problem. Solutions are designed with the mainstream market in mind. Once these user requirements have been met, secondary user needs are considered. The solution at this stage is very often a *piggyback* solution, added as an afterthought. This creates a very poor design environment and fails to incorporate the basic ideals of Design and Accessibility For All. The original software is usually designed with very robust and modern design methodologies, yet a quick solution is designed for the niche markets. If the original solution incorporates extensibility and questions how the solution can be adapted beyond the primary user needs, then the solution can become available to a wider market. The main task within accessible design is to encourage just this type of thinking and design, despite the fact that the rewards are rarely reaped in the short term.

There is a need to see accessibility as part of the wider product development cycle. For music, for example, the range of users for more accessible products is wide indeed:

- Visually impaired people
- Print impaired people
- Visually impaired musicians
- Print impaired musicians
- Music schools
- Schools for the blind and visually impaired
- Music libraries
- Libraries for the blind
- Conservatories
- Transcription centres
- Music publishers
- Music content providers
- Music software developers
- Organisations developing and distributing tools and aids for the visually impaired.

Historically, blindness has been associated with musicians. This does not mean that blindness in itself favours the development of musical sense. We can say, however, that music is a crucial factor in the development of the individual, in many different dimensions, be they expressive, social, educational or creative[1]. In order to benefit from these advantages the visually impaired individual should have the opportunity to access both *performed music* and *represented music*. The expression *performed music* refers to audible music, and includes all forms of real music, both traditional and innovative (eg using web facilities). The term *represented music* is any kind of coded music, including Braille music, computer-accessible music codes, or talking music.

Performed music and represented music have the same relationship as that between spoken language and written language. Oral culture has a very high value in the history of mankind, but literacy marks the border

[1] See Quatraro, A. New Approaches to the provision of music for the print impaired, Proceedings Electronic Imaging and Visual Arts (EVA) 2002, Florence.

between pre-history and history. Analogous considerations might be outlined in the relationship with our subject. Many visually impaired people can access *performed music*: that is, they can play, sing, navigate through CD-ROMs or the internet (as with spoken language); but very few have access to written music and the consequent step towards musical literacy in the wider sense.

Generally speaking, visually impaired individuals can have access to visually coded information by touch, by hearing (including audio descriptions), by means of enlarged characters, or by any combination of these means. Touch, hearing, or use of enlarged characters, must be considered as basic channels. In other words it is not correct to adopt simple transposition procedures to render visual information into non visual information. The most realistic model to follow in this case is the “translation from one language into another”. Transposing a normal score into an alternative format is **not** a simple and mechanical copy.

In most circumstances, print impaired people can only access the written word, whether originally displayed on paper or on computer screen, if the presentation of that material is adapted in some way. Print impaired people are entitled to read the same material as their fellow citizens, at the same time and at no additional cost to the individual in order to avoid social exclusion. Naturally, creators and those who add value to creative work have legitimate economic and moral interests which should be respected. However, while there is a commercial market for a limited range of “accessible” material, most of these materials have to be created by specialist agencies operating on charitable funds or social subventions. This means that, in practice, only a small proportion of the material published currently becomes available in accessible formats.

In circumstances where it might be expected that accessible information provision meets the necessary standards, this is rarely the case. In the learning sector for example, around 90% of documents requested by print impaired students are in analogue printed formats and many libraries try to offer a digitisation-on-demand facility. A key aspect in this respect is the speed of delivery as agreements are often negotiated on a case-by-case basis. Publishers are often hesitant to provide materials in digital formats as there are few document delivery systems incorporating issues of rights management through secure gateways.

Given the situation outlined above, notions of “accessibility” are normally equated with the adaptation and conversion of digital content, where this content can be made available. On a European level, and indeed often on a national level, much of the existing expertise on creating accessible adaptations of digital content is of a highly distributed nature. Within specialist organisations supporting print impaired people; or within university research laboratories; or indeed within publishing houses, many automated tools have been designed and implemented at least partially to execute the necessary adaptation procedures. However, each automated tool has its own, highly specific, field of application. Furthermore, the knowledge required to build these very specific tools is equally distributed, so that there is currently very little re-use of either tools or knowledge.

Fortunately emerging international and European standards provide an excellent basis for the creation of accessible information at a more fundamental level than has previously been possible. Whereas many earlier solutions have been at a ’workaround’ level, with an accessibility component added at the end of the content creation process (if at all), it is now possible to see DAISY 3.0/NISO z39.86 as the de facto XML standard which can allow content creators significantly to enlarge their markets through the adoption of this inclusive format. Indeed, the navigational possibilities afforded by the forthcoming DAISY 3.0 are thus available to everyone, and not solely to those people who are print impaired.

3 Overview of current implementations

There are relatively few approaches to the provision of music in alternative formats, with the most common approaches being Braille Music; Spoken Music; use of tape or CD for provision of music examples within books on tape or digital media; MIDI files; and Large (Enhanced) Print Music.

3.1.1 Braille Music

Even before Louis Braille had perfected his system of representing letters by using six raised dots, there had been experiments to represent printed music in a form that can be read by blind musicians. These attempted to replicate the printed page in various raised forms, but it proved to be too difficult to read - and also took a lot of room on the page. After the best part of a century of experiments the linear succession of raised Braille dots remains the only successful method of allowing visually impaired musicians to read scores.

Why should a blind musician want to read music? Can't they simply listen to a recording and play it? We all know that blind people develop other senses such as audio perception and memory; don't they? While most do have to rely on memory more than sighted people, the idea of super-senses is a bit of a myth. Could you listen to a complex piano piece and guarantee to hear all the notes in all the chords? In any case why should you have to learn someone else's interpretation rather than learn what the composer wrote? Blind musicians need to be able to read all the notes and their values, the expression marks and directions, just as sighted readers. The major difference is that when sighted people look at a piece of printed music they see all the elements simultaneously. The graphic spatial relationships of the elements on the page are part of the experience.

But Braille can only present information in a series of cells with a combination of six dots in a linear stream. There have therefore to be rules about the order in which all the information is presented. Because combinations of cells are required to represent the information, further rules have to be agreed between the producing agencies of this world. There is an agreement formed within the World Blind Union and published as the "New International Handbook of Braille Music Notation" (Krolick 1996). Sixteen countries put their names to this set of guidelines.

All of which demonstrates that there is an active world of Braille Music producers who have been co-operating with each other for a long time. In addition there a large number of smaller institutions, schools and music academies where music is Brailled for individual users and small collections built up. There is no real oversight of the methods used by these producers - some are known to be using presentation methods that were rejected more than 45 years ago.

So, if there is an international system of coding Braille music and taking into account that we can all read each other's music, then there are no problems in working together? Sadly this is not the case. It ought to be possible to read Braille music no matter where it has been produced, but that would be to underestimate the genuine complexities of printed music. Because Braille Music notation was developed in different countries and because different types of music pose different problems, different methods of presenting the music on the page have been introduced, and so on. Where there is only one melody line the representation can be reasonably linear. When one considers piano or organ music, where at least two lines of music have to be read simultaneously, there are problems in presenting this as a single linear stream of information. Some present one bar of one hand and then one bar of the other; some present section by section (but then there are different ideas about the length of a section). Some Braille notation defines the interval to the following note, others are now trying to promote systems which name every note. All of which means that there is very little effective interchange of Braille Music.

4.1.2 Current Braille Music production techniques

As a result one area of accessibility to music, which is still a huge problem, is the availability of Braille scores. This is largely due to the expensive nature of music Braille production. The main factors governing the current price of Braille scores are:

- Costly manufacturing materials
- Transcription time

Moreover the number of people qualified to transcribe print music to music Braille is small. This is a result of the specialised set of skills required to do the job. Not only must transcribers have an extensive knowledge of print music, they must be equally familiar with Braille music code.

Very often the transcription process for Braille Music requires transcription by hand. The Braille transcription is then checked against the print score. This is clearly a labour intensive process. The most time consuming aspect of the process is checking the finished Braille version. There is a need for a system that eliminates the potential for human error and reduces the length of the process.

Currently there are a variety of other methods available to produce Braille music, including:

- Scanning print music and converting using digital transcribers
- Inputting music through a MIDI device (playing in or using MIDI file) and translating to Braille code
- Inputting a notated music file and transcribing to Braille
- Inputting note-for-note with a software editor
- Using a print to Braille notation editor (such as Toccata or BMK)

We can therefore surmise that to cut the cost of Braille music production, we must cut the time taken to transcribe the music; the need for only specially trained transcribers; and reduce the cost of materials. This is precisely what is being attempted by some of the software and hardware that has been developed over the last few years.

The general requirements for digital transcription of print music to Braille music are relatively straightforward. A transcription program should satisfy the following demands:

- Comprehensive compatibility with other notation file formats
- MIDI and scanning capability
- Professional quality scores
- Usable with limited knowledge of print and Braille music
- Independently usable to the visually impaired
- Easy to learn and use

At this time very few systems meet a number of these requirements or have become widely used. It is important to remember that different organisations will have diffferent requirements and in some cases a requirement is that the software itself be used independently by visually impaired people.

Furthermore, with the development of software allowing visually impaired users to edit music themselves, it would also be useful to be able to distribute digital files as an alternative to hard-copy Braille. This would require a system with several file formats to allow a greater number of end users access to digital files.

Another requirement concerns the quality of MIDI processes. It has been found that some MIDI applications result in exstensive editing due to errors. When inputting through MIDI there are still a large number of problems, such as the need to add dynamics. Some programmes are plagued by these problems even while generally helping production processes.

The need for one system that can be used to both notate print scores and perform Braille conversions has become greater. Current Braille transcription processes are extremely time consuming. Automation of the transcription processes would immediately reduce the need to check and correct transcriptions. Furthermore a system should input and output a variety of file formats. It would also be desirable to have a system which can be used by the print-impaired themselves. However there is no system capable of satisfying all of these requirements at the same time. The most suitable alternative in common use is a professional quality print notation editor and a separate Braille transcription programme, ensuring a higher quality product.

3.2 Spoken Music

Print impaired people should have access to the same information as sighted people, and only the format in which the information is presented should change. For Spoken Music, this means that everything on the page of a music score should be represented in a spoken format. Furthermore, this spoken format must be applicable to all types of music and instruments. Initially this may not seem to be a difficult task, but on further inspection a number of unique problems arise.

Spoken Music provides a spoken description of the elements of the score. These spoken descriptions are provided in such a way that the information is compressed as much as possible to ensure the spoken elements provide usable information but also that the descriptions do not become unwieldly. The format is proving very popular with print impaired users, who in the past have either had no access scores, or have had to contend with the logistic problems of traditonal production methods associated with Braille Music. Spoken

Music has therefore become valuable to many users as both a learning tool for music and also a means of obtaining a score which can be used in much the same way as a traditional score is used by traditional users.

3.2.2 Talking Music – Case Study

FNB have been researching the use and production of Talking Music for several years. This started with an in-house software package called Solfege.[2] Solfege could be used to create Talking Music scores by manual transcription of music scores into the software. The success of this format with users encouraged work to be carried out on a more automated transcription method. This work was further boosted by the inclusion of a VIP module in the Wedelmusic project.

A Talking Music Plug-in called Talking Music Maker has now been provided for Coda Music's Finale Music notation software. This plug-in will convert any Finale score into a Daisy[3] Talking Music Book.

The Daisy talking book format allows text to be structured into a hierarchy. This means that the Talking Music Scores can be navigated through by the user using a hardware or software Daisy player. The plug-in has facilites for both simple one-click score transcription and also facilites for more personalised production where the Talking Music structure can be adjusted to meet the exact needs of the user.

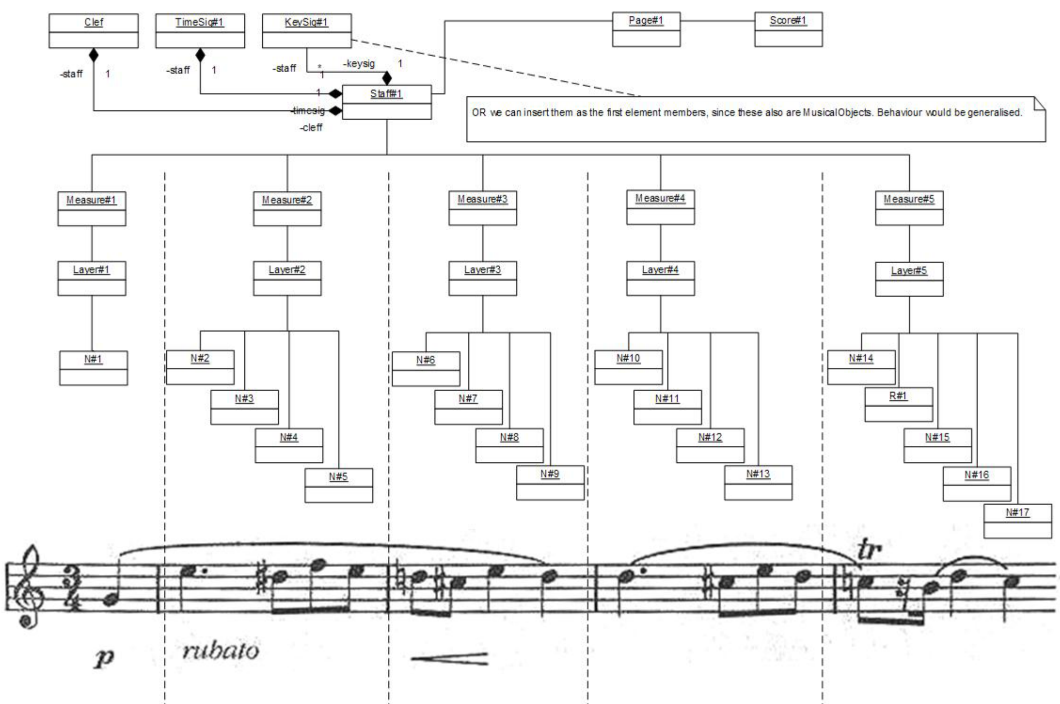

Figure 1: An example of a translation of a printed music score from a music notation editor to an object oriented music model

However, given the ever-changing requirements of music representation, the interfacing with accessibility tools is constantly set back. With every modification of the models that are used for music analysis, representation and synthesis, additional effort has to be invested to synchronise the consumption and production opportunities for print impaired users with those of the average end-user. If we were able to incorporate the 'changing' nature of music representations in the model itself, we would have a means to integrate the volatile nature of music representation.

[2] http://projects.fnb.nl/TalkingMusic/default.htm
[3] www.daisy.org

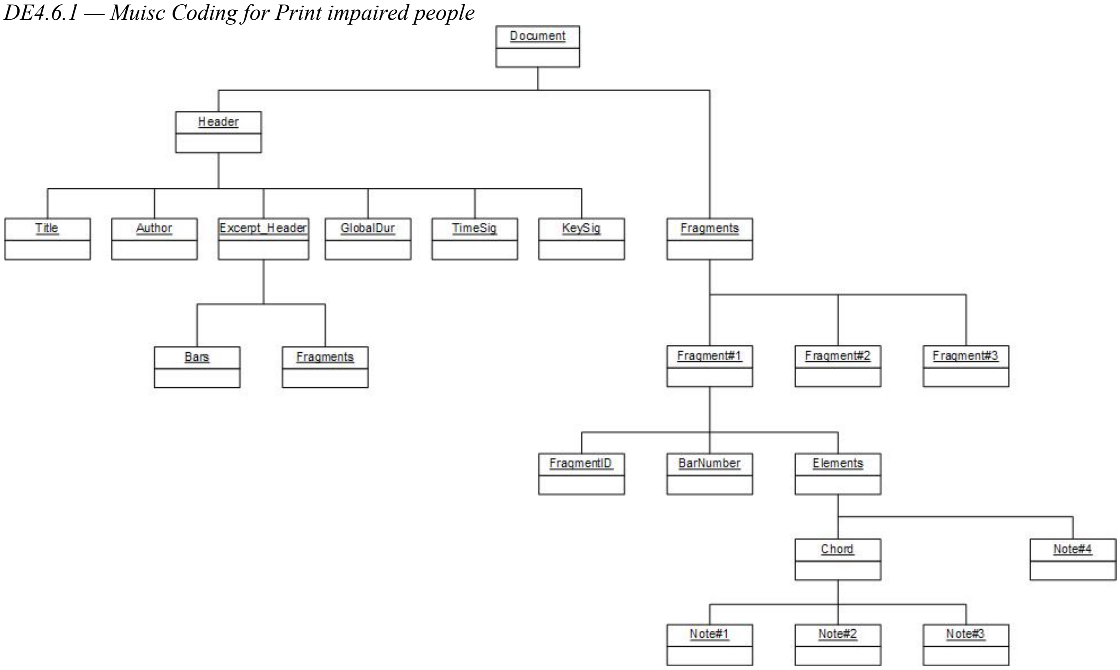

Figure 2: An excerpt of the objects used to represent a Talking Music book aimed to be transformed to a DAISY book

By doing so, we could also incorporate the modification of these representations for specialised use, such as Braille music, Talking Music and large print music. Capturing these aspects in one music representation model that can be used simultaneously for music production and consumption has one particular advantage: it allows all interest groups to cater for their own needs. In this respect the work being undertaken by the Music Network with the MPEG ad-hoc group (http://www.dsi.unifi.it/%7Enesi/mpeg/ahg-mn-65-66.html) is encouraging (see below and D4.1.1).

3.3 Other formats and solutions

In widening the scope of accessible formats, it is important to consider that many of the users in this market are not actually blind. Many people have a partial sight deficiency. A format which has received some interest in this field is that of large print music notation. This format can be more complex than a simple zooming of the music inside music notation programs. The enlargement level of the music is decided by the level of the users vision. In extreme cases normal music notation packages cannot provide the required zoom level, or the definition for this task to be useful in real life situations.

Interesting solutions would be possible if modern extensible methods were used and incorporated at the graphic rendering stage of the music notation production. One possibility in this field would be the use of SVG (Scalable Vector Graphics)[4], where an xml based description of the graphic is used, and because it is vector based, the representation can in theory be used to increase the size of the rendering to any level.

This is an instance of Design For All where the producers of tools for the mainstream markets can increase their market scope by employing extensible design methodologies. A graphical output of music notation would, after all, provide the extensibility to take the music notation much further than a computer screen.

Some organisations produce large print music using commercially available software. This is not simply a matter of enlarging the page to assist the partially sighted, as that tends to produce a score that is difficult to manipulate. In the large print version of the music score, the software enlarges the music staff within the standard page size turning a piece with, for example, six bars to a line into one with as few as one bar to a line. The copy can in effect be tailored to the needs of individual clients.

[4] http://www.w3.org/TR/SVG/

3.4 Related projects and initiatives

There have been a number of Europe wide projects in this area in recent years and a few of them are described below by way of illustration.

3.4.1 WEDELMUSIC PROJECT

The WEDELMUSIC project,[5] which ran from 2001 to 2003, is a fully integrated solution which aimed to allow publishers and consumers to manage interactive music: that is, music which can be manipulated (arranged, transposed, modified, reformatted, printed etc). This is done within a secure environment which respects copyright. The key components are a unified XML-based format for modelling music; reliable mechanisms for protecting music in symbolic, image and audio formats; and a full set of tools for building, converting, storing and distributing music on the internet.

The interface for visually impaired people enabled blind musicians to have access to and to share the facilities of the WEDELMUSIC system like sighted people. This implementation used many state of the art as well as conventional technologies like speech synthesis from text, Braille printing and technologies specifically developed by the WEDELMUSIC project.

The key element of this interface for blind people was the *speech engine*. Of course, the speech engine by itself does not provide all the required functionality to render the WEDELMUSIC system truly accessible. A screen-reader program is used instead to surrogate the lack of visual feedback by conveying audible feedback to the user. For visual feedback to be fully and efficiently replaced, any activity that results in change of focus, navigation through the current window or through the list of currently open windows, interfacing elements especially menu items or controls that represent command from the user to the system (e.g. buttons) or options made by the user to prescribe the behaviour of the system (e.g. dialog boxes, containing check boxes, radio buttons, list views, etc.), is reported to the user. Moreover, the users gain a precise understanding of the current system or application state and of the effects their commands had on it.

The editor supported multi-modality so as to increase the efficiency of the conveyed information. In fact the editor integrates both synthetic speech and Braille bar output to provide more complete and often redundant information to the users in a form of their preference. A Braille printing module was also developed to ensure that a Braille music output is easily available, and in the format specified by the end-user.

The importance of this development is considerable, as it allows far greater access to reading and creating music scores for visually impaired people. For example, if a publisher were to make their materials available in the WEDELMUSIC format and system, the scores would be easily available as printed braille music. Making even a modest number of scores from a smaller content-provider available (eg 20,000 scores), exponentially increases the amount of represented music for the print impaired that is available within Europe. Additionally, the WEDELMUSIC approach was the first significantly to move music into the interactive multimedia age.

3.4.2 PLAY2 PROJECT

The PLAY 2 project was an EU-funded project which aimed to facilitate access to digitised music for visually impaired people. Perhaps the most innovative aspect is the Braille Music Editor.

The Braille Music Editor (BME)[6] is conceptually a real file editor, with normal facilities like input facilities, reviewing facilities, output, saving, cut and paste, print etc. The difference is that BME deals with Braille music notation. In particular BME allows a blind person to use his/her PC keyboard as if it were a Perkins writer or, optionally, to use the numeric pad to input data with the much the same procedure as with stylus and slate: that is one dot after another, reproducing the vertical layout of the Braille cell. This meets the needs of elderly people, who might be not so familiar with the Perkins Brailler.

[5] www.wedelmusic.org

[6] http://www.dodiesis.com/asp/bmk.asp?language=2

The input code is the Braille Music notation, as coded in the New International Handbook of Braille Music Notation. In other words the blind user types in his/her score as he/she would do with a Perkins writer, following the rules of Braille music notation, and without any knowledge of common music notation (for normally sighted people). Reviewing is done using the 4 arrows, and ctrl+arrows, much like normal reviewing in text environment.

Acoustic feedback happens simultaneously in three different ways: Braille (on Braille display); midi; and through a vocalized musical element. In other words, the user can simultaneously read his / her fragment, listen to it and listen to the description of each musical element, which is named in the familiar way (using spoken language depending on the country).

Each musical element has its name and, in case of more than one sign for a single element, the programme says the first sign and the whole symbol (e.g. "fifth octave of right hand sign"). This is due to the fact that in Braille the right hand sign is made up of two signs: fifth octave and text sign. Saving a file and retrieving it again happens as in every similar editor. The end user may print his /her score either in Braille, or in ink print. In other terms, once the blind musician has produced hi /her score, he / she can listen to it, review it and finally print it for a sighted person, without external help.

The BME can accept data not only from a keyboard, but also from a scanner scanning Braille paper, although this is now no longer innovative. The BME can accept data even from an Ascii file, which corresponds to a Braille printable file. In other words we could have a back translator, which translates a Braille score into its normal correspondent. This feature turns out to be particularly useful for proof-reading. In fact, normally the sighted music transcriber needs a blind colleague to check whether his job has been done correctly. With the back translator the sighted transcriber is able to view directly and personally the result of his work, and this reduces time and costs in Braille music production.

3.4.3 MIRACLE PROJECT

In 1987 the Braille Music Subcommittee of the World Blind Union decided to update the existing Manual of Braille Music Notation and to try to bring the major library music services together. A conference held in 1990 lead to the formation of a small consortium; FNB (Amsterdam), SBS (Zurich), ONCE (Spain), and the RNIB (UK). Together these four music braille libraries decided to build a central catalogue representing their holdings.

Over a period of six years the consortium defined its cataloguing rules based on AACR and ISBD, using Smiraglia Rules and "The New Grove Dictionary of Music and Musicians" as the authority. In 1996 the "New International Manual of Braille Music Notation" was published. In the following year the CANTATE project produced a system which linked music catalogues and databases of digital scores. The following MIRACLE project, supported under the European Commission IST framework, incorporated the four original partners along with the technical partner Shylock Progetti (Italy), together with the Danish Library for the Blind and Regione Toscana Stamperia Braille as associate partners. The EC-funded project began in January 1999 and formally ended in January 2001. With the encouragement of the European Commission, though without further subsidy, corresponding members joined the project from Canada, USA, Italy, South Africa, Russia, Australia, New Zealand, UK, Finland and Sweden.

The MIRACLE-project[7] aimed to build a virtual on-line library of music in alternative formats and the main aims of the project have been substantially met. It is now possible to browse and search the catalogues of three libraries for the blind (FNB-The Netherlands, RNIB-UK, ONCE-Spain), and it is also possible to download those files that are digitally available. In this way libraries do not only know what is available in other countries but they can also request files that they then do not have to produce themselves.

The MIRACLE catalogue of braille music consists at the moment of more than 15,000 records in total, supplied by the original partner organisations in the MIRACLE project. In the catalogue one can find records of items of braille music in hard copy, digital files and enlarged format which are held by the partner organisations in the MIRACLE project. With the MIRACLE system it is possible to down load digital braille

[7] http://miracle.fnb.nl

music files. Formats other than digital can be obtained via an online request mechanism. The catalogue is currently available in English, Dutch, Spanish, German and Italian.

The creation of a worldwide virtual library of music braille files should make a dramatic difference to the services offered to visually impaired clients needing access to music in alternative formats. The Miracle Group partners are committed to maintaining and fully implementing this practical service.

3.5 Bettye krolick and the International Manual

Bettye Krolick has been a professional symphony violinist for 55 years and a professional transcriber of music braille for 33 years She is from the state of Colorado in the U.S.A. She wrote the Dictionary of Braille Music Signs that was published by the U.S.Library of Congress in 1979. Mr. Vassio started corresponding with her at that time. In every letter he stressed the need for an international music code of braille. Bettye was the compiler of the international manual. The authors were the representatives of 15 countries who almost unanimously approved its contents after 10 years of work. Two years ago Bettye quit transcribing braille in order to have time to help spread the word about new software programs for music and to give public school teachers help with the use of these programs.

3.5.1 The International Manual and the new technologies

The New International Manual of Braille Music Notation was compiled by Bettye Krolick in 1996. It should be a cornerstone for all people working at writing Braille scores. Therefore, it should be a starting point even for those who create and develop Braille software for the production of new scores.

During the development of the Play2 project, for example, the conference titled "Music and Braille: International exhibition on the New technologies for Braille Music" was held in Madrid. The conference was a good opportunity to present the results of the Play2 project, but most of all it offered a chance to analyse the situation of Braille writing within various countries after 7 years from the Manual publication. In particular, it was very important to understand whether the International Manual had standardized Braille music or whether each country had been using its peculiar notation. Furthermore, the conference urged the World Blind Union Braille Music Committee to revise the Manual in the light of the new software developments and to clarify some underdeveloped aspects. (Following the Madrid conference, the World Committee has decided to hold a meeting in September 2004).

3.5.2 "An Overview of the Preparation of Braille Music" by Bettye Krolick

"I have prepared an overview of the preparation of Music Braille from the viewpoint of a professional musician. I am a sighted symphony violinist, who learned about braille in order to write letters to my blind father-in-law. In the process of learning literary braille I asked if there was a braille system for music. When I saw the code for music, I was immediately captivated with the good musical sense it makes, and I started a life-long trek to learn as much about it as I possibly could. My plan is to give you a few detailed bits of history that I believe are pertinent to the success of the new technology. Then to discuss New Technologies for Music Braille with three questions. 1. "Where did these Technologies come from?" 2. "Where are we Now?" and 3."Where are we Going?"

The first detail of the history and possibly the most important is the excellent, solid, base every country had to work from. Louis Braille was a musician. He started the music code, in a way that was quite different from print music. The piano has 89 keys. As you know, the sign for each one of those notes is written on a staff in a different location, so musicians are aware that a sighted piano student must gradually learn at least 89 different print signs to be able to read the notes. Thanks to Louis Braille, blind readers only have to learn seven different characters in order to read every note of music!

Whether you are sighted or whether you are blind, the only notes used in music are do, re, me, fa, sol, la and ti or A, B, C, D, E, F, & G. These seven different notes are used in each different octave from the lowest to the highest, so Louis Braille introduced octave signs, and octave signs are only needed occasionally - not before every note.

Talk about making music braille practical and easy, Louis Braille did that at the very beginning of the code's development, and, you will be interested to know that his work was agreed upon internationally. Louis Braille lived from 1809 to 1852. The first international meeting took place in Cologne, Germany in 1888. The second historical detail that I feel is important, occurred many international meetings later, in 1954, This meeting took place in Paris. By this time music was much more complex in print, and in braille some of the signs varied between countries, but the goal of that particular meeting was to eliminate different formats being used in Braille. - to find one common format for music braille. The biggest difference was between writing music in paragraphs of various kinds or writing it bar-over-bar. That is the format that resembles print music; the right-hand part is directly over the left-hand part. In addition were several other formats.

The delegates succeeded in eliminating some of these until the final vote between paragraphs versus bar-over-bar. Bar-over-bar won - by one vote, but the countries on the European side claimed that somebody had cheated! The Germans immediately left the meeting, and I think it was good that the TV cameras were not around at that time to display all the unhappy things that were said. Dr. Alexander Reuss, from Germany, wrote up the European version of the international handbook for that meeting, and Mr. H.V.Spanner of the U.K. wrote up the North American and English version of the same meeting. I had no knowledge of this event until I happened upon the European version in our Library of Congress. Neither book makes any reference to the other. Both books claim to be the official minutes of that same meeting. Even though the meeting had taken place more than 28 years earlier, I was fortunate to locate Harry Ditzler, the official U.S. delegate, who was present at the meeting and to talk with him to learn these details. The reason I bring this up is to help programmers understand that there are different formats for the music code; and that countries will fight hard to keep their own formats and to use them.

Something totally different is part of my history to the field. That was writing the Dictionary of Braille Music Notation. I was quite surprised that there was no dictionary to assist me as a transcribers or to assist a blind musician, so when the Library of Congress of the U,S. asked me to prepare a listing of all the braille music characters, I agreed, and arranged to do the research at the Library of Congress where they have braille music from all over the world, That enabled me to include signs used in different countries, and list their meanings as well. When it was published, the dictionary was distributed by the Library of Congress to the other countries who were active in this field, and that put me in touch with people from the World Blind Union. I began to hear regularly from Guillermo Vassio of Turrino, Italy. In every letter Mr. Vassio went into great detail about why there was a need for blind musicians to have an international code. After several years of communication by letter (this was long before e-mail), my husband and I made a trip to Italy. My husband had been to Italy before as an infantry man during WW II. He fought from Napoli to Bolzano and survived. We followed his general path, although this time he was able to travel by train rather than on foot. We were in the country for a month and made it a point to finish in Turin in order to meet Mr. Vassio.

Mr. & Mrs. Vassio treated us wonderfully for 3 days. He continued to stress the need for unification, and he told me that clef signs were the biggest stumbling block in the code between Europe and North America. We did not know that Mr. Vassio was seriously ill, but he died of cancer less than a month after our visit. I decided then to dedicate my work with music braille to his memory. Of course Mr. Vassio was not the only person to be acutely aware that blind people need to be able to order braille music from any country, just as sighted people can order print music from any country. In October of 1982 Gleb Smirnov of Russia started things off by organizing the first international meeting for this new manual or handbook. The meeting was held in Moscow. In preparation for the second meeting, I took Mr. Vassio's remarks about clef signs to the music committee of the United States and Canada. Then, at the second international meeting in Marburg, Germany in 1987, I was able to announce that North America was willing to give up its way of writing clef signs and would agree with the European clef signs. The meeting was instantly filled with friends, and we were off to a good start!

There were three large international meetings and a number of smaller working-group meetings on specific problems. I remember with delight the working-group meeting we had here in Madrid in May of 1988. We heard marvellous guitarists as they played music for flamenco dancing, and then we worked on the best way to notate that type of music in braille. The meetings during that period were wonderful. The goal for braille music to become as unified as print music is was so strong that even the tough questions and necessary compromises were faced fully and worked out well together. Most of the final international agreements were completed at a meeting in, Saanen, Switzerland in 1992, final details were completed in Marburg in 1994, and the New Manual of Braille Music Notation was published in June of 1996, by Switzerland and The Netherlands.

3.5.2.1. "Where did the new technology come from?"

When I started putting music into braille, our technology was a slate and stylus. If you technicians don't know what a slate & stylus is, simply ask a blind friend. Every braille character has a possibility of 6 dots in it. To use a slate and stylus you insert each one of up to 6 dots by hand. Then you can start the dots for the next character. Fortunately, we soon changed to the new technology. I was able to obtain a mechanical Braille-writer. I could press all six keys at once to make one complete character - similar to a print typewriter. Oh my, that was great! I actually transcribed hundreds of pieces of music this way.

Then computers entered the picture in the 1970s. Main-frame computers had been doing some Braille, and music braille was being produced in a few countries but when the small computers came to the market, individuals like myself and smaller organizations could and did prepare music with a delete key and other editing capabilities. I had enough ram to save up to 10 pages of music at a time, and that music could be duplicated by computer any number of times. That was wonderful. But when I look back now, I realize that the computer was a slate and stylus in comparison to the computers we have today. With the help of this history, I have the feeling that your ability to sell your software to the widest numbers of countries, will depend on your ability to make the results adaptable to different formats and also to a number of local rules in individual countries. For individual countries who want the extremely helpful software, it may be important to evaluate some your local rules and adjust them in order to use software that can significantly support blind musicians' success as performers, as conductors, as composers, or what ever they choose.

3.5.2.2. Where are we now

Now we have the New International Manual, or hand book of Braille Music Notation. It has been translated into other languages and it is in use from New Zealand and Australia to South and North America, and through many of the European countries. The most recent translation I am aware of, was done in Taiwan. I am fascinated with the beautiful Chinese characters that I cannot read at all, but I can read the print music examples and the very familiar braille dots that go with each example. These are just as clear in Chinese as they are in any other language. Incidentally, I was not the author of the New Manual of Braille Music. The authors were the representatives from 16 countries who were actively involved in the production of Music Braille at that time. Each representative contributed their information, their ideas, their friendship, and their willingness to compromise. My job was that of compiler. It consisted of organizing and reporting the many conclusions we had agreed on. The strength of the new handbook is the international signs. The hand book does not include the local rules, and it does not display the formats. It is the signs that are international and these will fit in all formats and in all different kinds of music. Because the music code is international it is a wide-open field for software programmers. This has put us in the midst of a totally unexpected but wonderfully welcome explosion of work on software far beyond just a delete key and the other editing capabilities.

3.5.2.3. "Where are we going from here?"

The programs we have today will be perfected further and will lead to new ideas. Meantime, I am going to sit back and enjoy seeing each new development. Some things that will help, though, are having more international exhibitions such as this, sharing useful information, doing your best to come up with a sensible way to outdo everyone else, and being able to have financial support, such as the European Commission.

4 Creating accessible music

4.1 Accessible music

Building on the experience gained in projects associated with music modelling (such as Wedelmusic above), it seems clear that we should base music representation on extensible music representation models. Combining the document modelling notions from the XML domain and the Object Oriented design paradigm will lead to a Document Model. Document Models which can effectively collect the specialised requirements each specific document poses on music information presentation. The Document model is an architecture layer that communicates with specialised output devices, such as Braille printers or Daisy players.

There is a need to integrate such an approach within existing and new DRM systems and thereby satisfying commercial needs. As the framework is based on several independent components and communication layers between these components, a DRM extension can be provided. DRM could be regarded as a transformation of the represented music to the needs of the commercial content providers, albeit with implications for the consumer. It represents an individual model for transaction management that should not be too closely entwined with the actual content representation. DRM is related to the provision of the content and not the representation.

There is a need to integrate such an approach with future alternative presentations. As a result of the separation between the music representation model and the transformation model, not only can the existing presentations be fine-tuned to specific needs, but we can also add new alternative presentations. Using the intrinsic properties of a transformation based representation system, the newly created alternative presentation remains based on the existing framework.

The issues discussed above imply that there is no such thing as one ultimate music model: that is, one large model that covers every imaginable musical attribution and the relations between these entities. Such an approach would suggest that we would have to know beforehand the exact locations in the model that need changes to facilitate new representations. The question would then have become: "*What additional transformations will be needed to produce the alternative music representation?*". Both representations would become separate specialised representations in close relationship. This relationship is expressed in the transformation procedures that describe and specify the changes needed to travel from one representation to the other, from one specialised application to the other.

This approach should strengthen as it grows to incorporate the input and output formats of the future. This includes both the near future, where advances in OMR will open the notation models to a whole new world of applications, and also the distant future, where one day audio processing could allow us to print off music notation (including Braille) of our favourite CDs as we listen to them.

Every representation of musical material has its own specialised properties, attributes and requirements. It is highly unlikely that we can foresee which musical entities will be needed for specialised representations that will become needed in the (near) future. The representation requirements do not solely depend on technological representation possibilities. We must also consider user preferences, cultural preferences and scientific needs. Naturally, these preferences and requirements will evolve over time.

4.2 Marrying Producer and Consumer needs

The producers of accessible music are typically organisations for the visually impaired, music publishers, digital libraries, universities, research institutions, music schools, information technology companies and commercial distribution companies. The main goal behind our research and development activities in this area is to allow the producers of alternative music presentations to fulfil the needs of the target audience far more quickly than is currently possible, and at a far lower cost.

As noted elsewhere, reading Braille Music is a complex task and for those people who become impaired beyond a young age, it is extremely difficult to learn Braille. For those who *can* learn Braille Music, there are often significant delays in receiving music scores as the highly specialised production process is both time-consuming and expensive. Indeed, in many European countries the service either does not exist, or has been discontinued for reasons of cost or a drop in demand caused by fewer people learning Braille Music.

The presentation of music in alternative formats should be tailored to the specific needs and preferences of the user. Furthermore, we want to provide the possibility for *consumers* to transform musical information to any alternative presentation they need themselves, effectively giving them the opportunity to cater for their own needs in the same way as non-impaired users. This would have the added attraction of making users less dependent on particular content providers.

Most of the requirements for the consumers of accessible music are the same as those for the producers of accessible music. Most of the time a producer of accessible music must have a means to check the consistency of the musical material they produce. The tool for verification would also be the consumption tool. If the effort involved in creating accessible production tools is combined with the effort in producing accessible consumption tools, a harmonic relationship between the two is guaranteed.

Traditional methods for producing music in alternative formats are both expensive and time-consuming. The delivery time for academic literature and especially for accessible music can range from a few weeks – if the title is already catalogued - to several months in the case of complex new productions. This delay could also include the logistic errors that can occur in every production process. For obvious reasons, the two most important considerations for clients are acceptable delivery times and the highest possible quality of delivered product.

Every application of information in alternative formats has its own requirements. Alongside these application requirements, every person using this enhanced information has their own additional personal requirements or preferences. Using traditional production techniques we can offer a small degree of personalisation; but this personalisation only occurs within the production process. Once the product is delivered, it cannot be altered. In effect this means that the content represented in the product cannot become 'more accessible' than it is at the point of delivery. However, the requirements of the person using the product might change and become more stringent. So if we could achieve greater personalisation of the final product, this would be very much appreciated by end users.

Given the personalisation and production commonalities between producers and consumers of accessible music, some kind of sharing of responsibilities can take place. Essentially this would provide the consumer with a higher level of freedom and would in turn relieve the producers of their responsibilities for content preservation quality. In this way, producers could invest this new source of responsibility in logistics, research and the development of these accessible information services. In short, it would provide a higher level of freedom at both ends of the delivery chain..

One of the most important requirements of musical presentation in alternative formats for print impaired consumers is the ease of comprehension of the context of the musical material. This means that the important information regarding context deduction must be clearly perceivable. The consumer must be able to distinguish their location in the musical material and thus be able to understand the functions of the musical material at hand. The consumer must not be overloaded with redundant information, but at the same time be provided with sufficient musical material to be able to deduce its function.

The production of Braille and Spoken Music transcriptions of requested musical material is a highly time-consuming task, requiring co-operation between several key people. Firstly, the request has to be evaluated to check the availability of a transcription. If the transcription is not available, the piece itself must be evaluated. A music expert will analyse the piece of music and parse it to logical musical pieces. The musical information must be grouped logically onto the page and it must also be feasible to read the music.

A number of general technological production requirements arise. There are clearly needs beyond intuitive production assistance, as this would only increase analysis and production speed. Logistic issues must also be addressed. The right individuals need the musical material at the right time and a representative overview of the product's status would provide the producer with the means successfully to estimate the delivery time of a product. The combination of these aspects enables the producers of accessible music to deliver the requested music to the end user in a respectable time.

Once these requirements and definitions are clear, we must consider whether or not there is a way to merge consumer and producer requirements using newly emerging interactive multimedia technologies.

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In effect, this means that the effort taken to create accessible consumption tools can be re-used to create production tools, and vice versa. Both tools share a very important technological backbone and it is this shared backbone that enhances the availability and usability of the concept of accessible music distribution and consumption.

Several fundamental similarities between the production and consumption requirements appear to be present. Both user groups can ideally work within an intuitive and familiar environment. If the producer is able to create the musical transcription in such an environment, they can concentrate on producing an alternative musical representation. If the consumer can receive the delivered musical material within an intuitive environment, they can concentrate on perceiving the information and building their own interpretation of the music. By working to open standards and providing interactive navigation through well-formed information, the opportunity exists to provide a harmonic basis for the production and consumption of accessible music.

4.3 Extensible solutions

Given the ever-changing requirements of music representation, the interfacing with accessibility tools is constantly set back and this causes problems. With every modification of the models that are used for music analysis, representation and synthesis, additional effort has to be invested to synchronise the consumption and production opportunities for print impaired users with those of the average end-user.

If we were able to incorporate the 'changing' nature of music representations in the model itself, we would have a means to integrate the volatile nature of music representation. By doing so, we could also incorporate the modification of these representations for specialised use, such as Braille music, Spoken music and large print music. Capturing these aspects in one music representation model that can be used simultaneously for music production and consumption has one particular advantage: it allows all interest groups to cater for their own needs.

Enhanced music representations can be produced by the consumers themselves, because the specialised transformation knowledge can be applied to the music model. No intermediate service provider is required and no separate specialised music tool is needed.

Designing models of information transformation and their applications is based on a conceptual design. To tackle the difficult domain of enhanced accessible information provision we partly have to incorporate notions borrowed from the knowledge representation domain. By doing so, we hope to get a fruitful combination of quantity and quality of accessible information. One aspect of accessibility in this respect would be interaction with the information provided by the end-user: interaction that would manifest itself as far reaching preferences regarding the presentation of the information in terms of complexity and formatting.

In recent years, significant advances have been made in the adoption of 'Design for All' strategies to ensure that products are designed in such a way that people with the widest range of abilities have access to them. This approach has led to some notable successes, such as the inclusion of the DAISY specifications[8] within emerging ebook technologies. In the field of music, however, relatively little progress has been made, and there is a need to define and develop the concept of accessible multimedia music for the print-impaired.

[8] www.daisy.org

5 Music Coding and Accessible design

5.1 Music coding as it relates to accessibility

Given that the above accessibility approaches and software development theories can become increasingly complex, there is always need for clear and well-defined architectures. This can be carried out as in Figure 5, by ensuring that the process domains are both explicitly defined and separated. Each process domain contains its own domain specific knowledge. These domains can then be interwoven into the desired architecture and implementation paths. The explicit definitions ensure that these transparent couplings between domains build into a manageable architecture.

Some initiatives regarding music encoding capture these global yet fundamental requirements. The most important of them are described below.

5.1.1 SMDL

In a European context, the CANTATE project[9] examined for the first time the significance of SMDL for music coding. In a similar way, the HARMONICA[10] concerted action examined the future of music collections and libraries and recommended the establishment of the Music Encoding Initiative along the lines of the Text Encoding Initiative, although this fact has recently been overlooked in some quarters. For a comprehensive evaluation of SMDL, reference should be made to the CANTATE deliverables which are available online[11]. Similarly, the deliverables for the HARMONICA concerted action[12] are also available online.

SMDL is a complex language, though it was very well defined and remains important.

5.1.1.1 Providing an "Infrastructure for musical information"

One of the fundamental goals of SMDL was the provision of a framework for musical information. The SGML derived format and associated process principles provide a framework for representation of musical information that is separated in four processing domains. A useful feature of the SMDL proposal is the HyTime based linking of specialised music description formats. SMDL itself provides basic building blocks for notation representation and for specialised and more adequate notation features for specific applications, other external notation formats could be linked in. This provides a conceptual framework for the notions we call extensibility.

5.1.1.2 Separation in abstract processing domains

5.1.1.2.1 Logical Domain

This domain contains logical descriptions of the basic musical content. It provides a format for storing pitches, rhythms, dynamics, etc. The musical description in this logical domain should be considered as a centralised music description repository from which all other processing domains can draw their information. This domain is considered to be a neutral music description that collects all available information without filtering this for a specific use. This filtering can occur in the Domains that draw upon the musical content for a specific use.

The use of such a 'neutral' layer in the context of accessibility is manifold. This domain may provide a neutral source of content that can be used for transformations into other accessible musical notations such as Braille Music and Talking Music. Because the logical domain can be considered a centralised domain, one can transform more than one transformation from it. That is: the source can be used to transform into

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[9] http://projects.fnb.nl/cantate
[10] http://projects.fnb.nl/harmonica
[11] http://projects.fnb.nl/cantate/deliverables.htm
[12] http://projects.fnb.nl/harmonica/Harmonica%20Deliverables/introduction.htm

BrailleMusic and TalkingMusic. The structure and integrity of the source material in the logical domain is not modified.

5.1.1.2.2 Gestural Domain

The Gestural domain describes the specific performances of the music described using the logical domain building blocks. It contains performance descriptions that can be linked to parts of the cantus whose content is described in the Logical Domain using hyperlinks.

In the context of accessibility this domain links into the performance translations that can be used to highlight musical information in the performance of the music. Since the Gestural domain describes *musical performance interpretations,* one can consider the possibility of highlighting musical structures in a musical way. This approach to accessible music could express itself as a performance in a slower pace, a performance that articulates more clearly near the boundaries of musical gestures or a performance that plays a phrase with far more contrast in dynamics. All these signatures can function as pointers to important locations in the musical material and with that: function as 'musical' extensions for the navigation and location requirements for the print impaired musicians.

In the context of knowledge preservation the Gestural domain is used to store procedural descriptions of *how* a logical musical description should be performed. Of this performance is related to an accessible performance, we can consider this procedural description to describe *how* to generate an accessible performance. It defines accessibility in the gestural domain.

5.1.1.2.3 Visual Domain

The visual domain describes the musical typographic detail of any number of scores. Each score element represents a visual instantiation of the logical domain. I.e. how each component of the logical domain is rendered in some edition.

In the accessibility domain this visual interpretation layer could render accessible forms of music rendering, like print enlarging, Braille music, etc.

5.1.1.2.4 Analytical Domain

Music may vary in complexity and may require notes, comments and even simplifications of the musical material described in the logical domain. The analytical domain provides a viewpoint to collect these approaches. In the context of accessibility this domain could contain procedural descriptions of music analysis algorithms to simplify the musical material for –for instance- dyslectic users. Essentially much of the interpretation logic required and described in other layers could be categorised in the analytic domain. From the knowledge management perspective we could consider the analytical domain to represent the expert knowledge on the score described in logical domain. This expert knowledge might provide new and novel ways of presenting accessible musical information to end users. Additionally it will enable the preservation of the knowledge applied to achieve the level of accessibility.

5.1.1.3 Relations of domain separation and Information Accessibility

Accessibility can be considered to be an interplay of various processing domains. These processing domains relate to processes in production and perception of musical material. Through clear separation of the technological descriptions of music storage and music manipulations procedures, the ideal 'mix' of the interplay between the processing domains –logical, gestural, visual and analytical- can be described. Where additional specialised requirements are needed, an linking mechanism of external formats and models is provided. This not only ensures future expandability of the framework and representation capabilities. It also ensures expandability to other musical styles, that require different music notation schemes. Because of the logical domain description that is not effected by these transformations and because of the non-destructive nature of the accessibility transformations, availability of music for groups of end-users is ensured.

5.1.2 XML Interchange Format

It is important to note here that XML is not a data representation model. It is an interchange format. As an interchange format it is good at what it does, but naturally not perfect. The usefulness and applicability of the XML formats and processing models involved in using these formats rely on the quality of the analysis of the representation requirements. Description, and with that representation of these properties, involves programmatic description of requirements on a relatively high abstraction level. The communication between these abstraction and implementation layers is very important, since it is this communication layer which provides the interaction between the processing layers. It is this interaction that is used to solve problems and requests.

This implies that if an initiative uses XML to represent music as a format, this will become a static format. It will remain at the level of an abstract description that captures the requirements for music (notation) representation at that moment. On the other hand, if one focuses on using XML as a interchange format, this interchange format will remain a static description of the requirements on interchanging at that very moment.

Fundamental representation problems are not solved through merely introducing XML representations of them. It is the interaction between the various processing layers that would represent the really sustainable solution to some of these problems. XML would be a 'transportation vehicle' for such a solution. It would not be the solution itself. Enabling the transportation vehicle to do its work, requires thought on the levels of data representation, implementation and interchange.

As a format for representing music, XML is therefore less than perfect, although it remains useful in some circumstances. There are also some good attempts being made to create a useable interchange format from XML based languages:

- MusicXML
- MEI (Music Encoding Initiative)
- MML (Music Markup Language)
- Enhanced Musical Notation Markup Language (EMNML)
- eXtensible Score Language (XScore)
- Music and Lyrics Markup Language (4ML)
- FlowML: A Format for Virtual Orchestras
- MusiXML
- IMS MUSIC-XML Project
- ChordML, Actos, and ChordQL
- MuTaTeD! - Music Tagging Type Definition
- MusicML
- Musical Notation Markup Language (MNML)
- WEDELMUSIC XML format

The sheer number of dialects of XML above illustrates part of the problem. Easily the most developed and promoted of these is MusicXML. An OASIS TC on music notation (http://xml.coverpages.org/xmlMusic.html) was recently proposed to try to bring together several of these XML formats and tackle some of the problems outlined above, but no agreement was reached between the participants. The OASIS group has been closed while the activity on MPEG is still working on http://www.dsi.unifi.it/%7Enesi/mpeg/ahg-mn-65-66.html

The only accessibility related issues in this respect are that when creating an accessible system it is important to synchronise the most complete set of information relating to the content as possible in order to ensure that all the information is provided in alternative formats. Similarly any standardised interchange format would be open source and should also be easily expandable by those working in the field of accessibility.

5.1.3 MPEG Environments

Integration of accessibility notions into the MPEG family will provide previously unavailable opportunities in the provision of accessible multimedia information systems. It will open up modern information services and provide them to all types and levels of users both in the software domain and the hardware domain. In particular, the work being undertaken by MPEG will provide access to multimedia content to print impaired users. Additionally, new consumption and production devices and environments can be addressed from this platform and will provide very useful information provision opportunities indeed, such as information on mobile devices with additional speech assistance. MPEG7 provides various tools and specifications for describing and managing descriptions.

The choice of MPEG7 as a key area for focussing on accessibility follows from the statement from the document *Introduction to MPEG-7 (v3.0)*[13]:

> ***"**MPEG-7, formally named "Multimedia Content Description Inter-face," is the standard that describes multimedia content so users can search, browse, and retrieve that content more efficiently and effectively than they could using today's mainly text-based search engines. It is a standard for describing the features of multimedia content. MPEG-7 will not standardize the (automatic) extraction of AV descriptions/features. Nor will it specify the search engine (or any other program) that can make use of the description. It will be left to the creativity and innovation of search engine companies, for example, to manipulate and massage the MPEG-7-described content into search indices that can be used by their browser and retrieval tools."*

The latter means, that the knowledge to elicit accessibility from the content has to be defined, specified and described by the institutes and organisations that maintain knowledge on accessible content production and provision.

The MPEG initiative provides a technological framework that explicates the areas of representation, distribution, processing and preservation of multimedia information. Not only does this initiative provide these standards for the software domain: various parts of the standards also apply to the hardware domain and are already in use in various consumer devices (mpeg2/3/4). In time hardware and software will merge into unified personal devices. These will create new multimedia information provision opportunities for enhanced (accessible) information consumption for print impaired users. Ensuring that the design, application and theoretical notions of the MPEG initiative in all its perspectives are used as a backbone for the construction of an accessibility standard and its digital counterpart, these future applications and platforms remain open.

In the MPEG(7) arena an explicit distinction is made in the direction of engaging an information flow for consumption. One direction is the *pull* strategy and the other is the *push* strategy. The pull strategy is defined by the initiative for the information exchange by the consumer or producer (from now on the end-user). It is the end-user who decides what to see, hear or interact with. In the push scenario, information is pushed or proposed in the direction of the end-user in a proactive manner, preferably because of preferences an end-user has defined regarding this kind of application behaviour. The selection of a *pull* scenario heavily relies on the assumption that an end-user knows what he/she wants to retrieve and is able to navigate though the presented content freely and without barriers. This is the domain in which print and vision impaired end-users are set back. Most of the content provided is *not* freely explorable by this category of end-users. The *push* strategy on the other hand relies on the availability of a detailed description of the end-users wishes, requirements and interests. Next to the 'normal' end-user wishes and preferences, a print and vision impaired end-user can have specific additional requirements. A clear centralised overview and a detailed structural knowledge on how to address these issues using technology still needs to be formulated.

5.2 Accessible Design

In recent years, significant advances have been made in the adoption of 'Design for All'[14] strategies to ensure that products are designed in such a way that people with the widest range of abilities have access to them. The Design For All approach[15] is now a very familiar one and most designers are aware of the basic tenets. Despite this, one has to look very hard indeed to find concrete examples of the successful implementation of this approach. If we are fundamentally to examine the different aspects of designing a more inclusive world,

[13] ISO/IEC JTC1/SC29/WG11 N4325
[14] http://www.design-for-all.org/
[15] See http://www.design-for-all.org or http://www.e-accessibility.org

we must also consider the education of software designers and innovators to think about an inclusive world. This activity cannot be performed in isolation, as there is a parallel need to educate consumers to make their demands more explicit.

We must also provide software designers and innovators with a clear insight of the fundamental impact of the Design For All approach. This can be achieved through educating software designers who in turn will educate consumers. The products from these designers should raise public awareness of Design For All through demonstrably useful products. These products will have a built-in software interface that enables a dialogue between the developers and consumers and it is this dialogue that forms the basis for favourably influencing public opinion. In this way, the emerging results of this educational process would be a far wider and more 'openfocus' within design processes. It would then be more likely that inter-operable software (and hardware) will emerge and a more inclusive world can begin to take shape.

When designing, specifying and building applications and infrastructures to store accessible content, several apparently unrelated issues arise. How do we describe the knowledge and capabilities we possess and capture the repository of resources we can use to implement these capabilities? How do we describe the questions and problems of end users and content providers? How do we marry both within manageable and consistent frameworks? How do we re-apply this knowledge and combine these resources with new insights to solve new problems? How can we accelerate the process described above?

When providing accessible media for print impaired users, many of these issues must be examined in a more *extreme* context. Creating accessible media requires a whole range of processing stages and involves many different people and tasks. Given the need to provide reliable content transformations to end users, which can involve diverse materials ranging from mathematics and physics to musical scores, a great deal of additional effort is needed for researching production tools and representation techniques that keep these specific requirements in mind.

One part of the challenge described above is to provide end users with a sense of freedom. This means actively pursuing a strategy that merges accessible media with 'normal' media. While adhering to the principle that all original information is also provided in alternative format materials, key choices regarding the structure of these adaptive materials remain. As content producers, a great deal of effort is invested in production procedures and researching innovative applications that help our customers as well as, for example, the library community, computer community or the production community. This represents a wide range of overlapping (and highly specialist) requirements. If content providers in general, with no specialist knowledge of these issues, are to have greater integration in production processes, it is incumbent upon us to explain the ways in which sustainable accessible information provision can benefit them directly.

New products tend to be used as a de facto reference for future research, but if these new products have been designed with a short-term view, they will only solve short-term problems and they will severely limit any ability to step over the boundary of application. Fragmented short term solutions for accessibility problems might provide only inflexible boundaries to the solutions we can come up with to address the needs of all users involved in the design process. We are all familiar with the oversized, one-off 'prototype accessibility application' which gathers dust in the corner of the research lab.

Musical material is a very rich corpus of data. Data with all kinds of features, entities, relations and a potentially endless number of abstraction levels on all these perspectives. It is therefore important to establish which set of elements we are going to use for the preservation, processing and provision of music; which features are redundant; which building blocks are mandatory; and how many can be shared amongst all of them. These considerations hold especially true for the community that is dependent on the accessibility of music.

Requirements never stay the same over time: requirements change for all users of any service. The end user's sight or other senses might deteriorate over time, their needs being met with appropriate features in accessible media. The differentiation of user requirements in general might grow, forcing the system to deal with a broader variety of processing possibilities with which it cannot cope. The processing system *itself* might in due time signal changes in memory requirements. The consumer base might be expanded to cater not only for visually impaired users, but also for dyslexic users. How can we anticipate fundamental changes like this? On the other hand, there exists a dynamic group of accessible music producers who are pressed to keep up with the new media technology possibilities. The changing nature of requirements-and with that the potential design of *any* system-is a fundamental issue in the design of a inclusive world.

5.3 Braille music decoders

Through the creation of a Braille music decoder the following could be made possible:

- Greater standardisation through use of the following elements of Braille music production: Braille music printing preferences; Braille music output based on the International Braille Music Manual; Braille representation preferences at a document level
- Interpretation of the MPEG framework to Braille Music
- Protocol for communicating the musical information to the relevant output device (Braille embosser etc.)

A Braille music decoder could be built around a Braille interpretation component which would be native to several Braille music modules. An MPEG to Braille music decoder would make use of this componentand return the required result based on the user's preferences. The various output media required by users of such a system would each have a similar module specific to the output requirements for that medium.

This could take place if all modification of the input components takes place with output specific settings for classes and objects. This allows specific separation to take place between the generic MPEG framework and the various decoders required to meet the needs of users of alternative music notation formats. This can be seen as extensibility, where the modifications are specific to the application logic. This extensibility becomes important to encourage re-use between the components of such a system. The Document settings module may require re-use of the interpretation module's classes and objects.

In order successfully to attain this separation and extensibility, the various layers and stages in a Braille decoder must be understood:

1) Objects which reflect the preferences of specific hardware are included to ensure that output needs of this very specific medium are met. These objects manage their own persistence and explicitly state the protocols required to communicate with this hardware. Much of this hardware is OS specific.
2) A level down from the hardware components are device specific components which provide classes specific to the settings of a type of device. Depending on the nature of these devices, the setting values are based on both information from the MPEG framework data and the Braille decoder settings, and can be taken from the appropriate parameter blocks within each of these data frameworks
3) The components within such a Braille Music decoder are examples of non-visual components. The user is unaware of their use other than their interface with the settings through setup dialogs. Many of these interactions will remain transparent to the user depending on the end user's specific use of such a system.
4) In order to ensure maximum coverage of user requirements, many of these transparent objects will have options to decide the level of abstraction within this transparency. Based on recently emerging accessibility recommendations for User Interfaces for visually impaired people, any GUI/UI which controls this abstraction will be accessible.
5) It would be most suitable to design a Braille music system using a meta system, where rule classes and objects can be modified externally to the application. This creates a system which is in some ways closer to future proof

Ensuring a degree of extensibility is important as:

- Employing some dynamic push and pull allows the language used (in this case Braille Music) to move with the times
- The system can prove itself on the common Braille music rules, and then build future dialect inclusion onto a working system
- There are many dialects of Braille music and as these come into view they can be incorporated in the decoder
- Where weaknesses are found in the guidelines governing Braille music, enthusiastic users (for research or otherwise) could create advanced rule sets (i.e. Baroque Braille music)

It is important that the implementation of such a system takes place in an object based environment. This requires that early implementations make an effort to apply rules within methods. These methods then become objects in their own right. This can be wrapped in a rule container allowing communication with specific scripting engines to provide further functionality to the rule, which essentially should take place in a file external to the core code for the decoding module. In this way one decoder could yield several branches of executable code.

5.4 Future Possibilities

One problem of designing accessible applications for digital music content, is the creation of the digital content in the first place. There is very little input at this stage for accessibility apart form what is mention above, where the digital representation should be created in such a manner that the content is extensible and can be moulded and shaped into as yet unthought of representations at the output level.

One major step forward is the field of OMR(Optical Music Recognition)[16]. As this research improves and mainstream products reach the market, there will be far more digital content, and the ease at which alternative outputs can be created will increase. Ultimately an automated system will require very little input from the scanner to the alternative production stage, but as of now this process is carried out in many different ways using a plethora of different programs and modules. The unification of this process will be both cheaper and of a higher quality. There would also be a standardisation of many of these processes, as currently every alternative format is produced to a different standard and with different tools. This makes the already difficult task of learning to use new formats even more difficult when the content is arriving from different sources.

[16] http://www.dsi.unifi.it/~hpcn/wwwomr/le.html

6 Links

Music Notation software

Finale
www.codamusic.com
Sibelius
www.sibelius.com
Cakewalk
www.cakewalk.com
Lilypond
www.lilypond.com
Lime
http://www.cerlsoundgroup.org/cgi-bin/Lime/Windows.html
Midiscan
www.musitek.com/midiscan.html
SharpEye Music Reader
www.visiv.co.uk
Comparison of music notation software
www.computermusic.co.uk/product/score.asp
WEDELMUSIC
www.wedelmusic.org

Braille Music software

Goodfeel Braille Music Translator
www.dancingdots.com
Toccata
http://members.optusnet.com.au/~terryk/toccata.htm
Play2 (BMK)
www.dodiesis.com

Talking Music software

Solfege
http://projects.fnb.nl/spokenmusic
Wedelmusic VIP editor
www.wedelmusic.org
Talking Music Maker
www.multimediamusic.org

Interesting Sites

About Braille: Code Formats, Computers and Braille ASCII
http://www.tusc.net/~lizgray/codes.html

Guidelines for production of multimedia teaching materials: Access for disabled students
http://met.open.ac.uk/access/guidelines.html

Network for Inclusive Distance Education
http://nide.snow.utoronto.ca/music/index_old2.html

Music Notation Links
http://www.music-notation.info/en/compmus/braille.html

DELOS
http://delos-noe.iei.pi.cnr.it/index.html?content=home_c.html

ICEVI
http://www.icevi.org/initial/welcome.shtml

IFLA Section Libraries for the Blind
http://www.ifla.org

IAML
http://www.cilea.it/music/iaml/iamlhome.htm

ICEVI
http://www.icevi-europe.org/

Comparison of music notation software
www.computermusic.co.uk/product/score.asp

CSUN
http://www.csun.edu/cod/conf/index.htm

Music, Mind Machine
http://www.nici.kun.nl/mmm/home.html

Music Notation Software List
http://ace.acadiau.ca/score/others.htm

DAISY Consortium
http://www.daisy.org

WBU
http://umc.once.es/

MPEG AHG on Music Notation
http://www.dsi.unifi.it/%7Enesi/mpeg/ahg-mn-65-66.html

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W3C Web Accessibility Initiative: http://www.w3.org/WAI/