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Accessibility aspects in Music Tuition

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Abstract:
This deliverable is entitled "Accessibility aspects in Music Tuition". In order to cover the topic, the deliverable brings together all the accessibility aspects, which relate to the i-Maestro project in one document. This includes Technologies, Formats, Standard, State of the Art and descriptions of Learning modalities and training paradigms. This is the first draft of this deliverable, and it is expected that it forms a basis to feed into the other work package information, sufficient to provide a solid accessible foundation on the developments of the i-Maestro project to ensure the relevance to and inclusion of as many end users as possible.

Keyword List:
Accessibility, Standards, Print Impaired.

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3   Executive Summary and Report Scope

This deliverable is entitled "Accessibility aspects in Music Tuition". In order to cover the topic, the deliverable brings together all the accessibility aspects, which relate to the i-Maestro project in one document. This includes Technologies, Formats, Standard, State of the Art and descriptions of Learning modalities and training paradigms. This is the first draft of this deliverable, and it is expected that it forms a sound basis to feed into the other work package information, sufficient to provide a solid accessible foundation on the developments of the i-Maestro project to ensure the relevance to and inclusion of as many end users as possible.

4   Deliverable Aim

Accessible solutions are required for anyone who requires assistance in using the mainstream solution. This could be because a user is dyslexic, blind, visually impaired, or impaired in some other way, but increasingly this is age-related. Accessible solutions can range from small assisted applications (such as a screen magnifier), to full-scale operating systems and screen reading environments. The traditional problem with accessible solutions is that they are normally implemented as an afterthought or piggy-back solution. This results in solutions which are not fully integrated (or not well integrated) with the mainstream solutions. These independent applications are then at a disadvantage when software versions or operating systems are updated. In order to make this integration process easier, and provide more intuitive designs for the future, it is essential that "Design for All" and accessible design methodologies are widespread. Standard, policy and legislation also helps ensure that accessible designers have a solid standard to meet to ensure future-proofing.

Accessibility can also be viewed from a wider angle. Being able to see content in whatever modality, perceive its context, and attach a useful meaning to it requires that the user be able to access this content, its context and relevant software application in a way that meets that particular user's consumption preferences. These preferences may become requirements over time - we all get older.

If a solution is capable to impact on more senses, working around eventual imparity of the pupil, the music educational solution will be more effective in reaching the training goals and will obtain results faster and impress them deeper in the learning memory.

Technologies behind these aspects are:

- **Sonification of physical gestures and posture** to produce sound from posture and gesture, accessing to virtual instruments, bring the pupil from virtual to real instruments, passing from augmented instruments, etc.
- **Screen readers** for textual, images, video (an available technology to be integrated in the pedagogical and assessment models)
- **Music Score readers** for notation ad exercises, verbal description of music notation (spoken music, talking music) or scenarios or exercises (an available technology to be integrated in the pedagogical and assessment models)
- **Different and alternative representation** of music notation such as: piano roll, tablatures, Braille representation, Asian music, image visualisation of music, etc.

There has been a decline in the teaching of Braille music to visually impaired children in recent years. In order to rejuvenate interest in Braille music, better pedagogical models must be utilised which incorporate Braille music into part of the musical curriculum in countries across Europe. One of the essential components in achieving this is that Braille music production methods must be integrated with current pedagogical technology to ensure that Braille music representations are always close to hand in the same

environment as mainstream representations. In order to rejuvenate the teaching of music in accessible formats, a pedagogical model has to be adopted which injects life into the dwindling communities of teachers, users, and students who use music in alternative formats.

This document provides a state of the art analysis of the user requirements, file formats, standards and technologies for accessible music tuition such that the field of accessible music learning can be established to an extent that analysis of the accessibility issues and their impact on music education for regular learners and those with special needs can be made for the i-Maestro project. The assistive technologies relating to accessible music and accessibility in general (Sonification, screen readers, gesture and posture analysis, alternative representation and devices, zooming, spoken music, etc.) are overviewed such that the technology is available for incorporation in technologies that are developed in the other work packages of i-Maestro.

From the state of the art information specific difficulties in learning music from the user perspective can be detected in order that these modalities can be incorporated within i-Maestro technologies, and this can feed back into the i-Maestro project. This allows the specification of user requirements and extensible systems, which are outlined in previous work packages to link to the models used for learning, such that the technologies can be tuned to meet the correct mechanisms suited to the user needs.

Based on this document, an accessibility evaluation framework has been constructed for i-Maestro. The guidelines for this framework (based on WAI standards) are included in Appendix D. Using this framework, each MAX/MSP patch created during the development stages of the project will be assessed and then improved in terms of accessibility based on both technologies created by i-Maestro or assistive technologies native to the operating system being used. It is expected that after initial evaluation there will be several key problems which will need to be tackled to create accessible learning tools. These will be outlined in version 2 of this document.

5   Accessibility of Music Scores

Structured music scores are the first big step towards high-quality accessible musical scores. A score whose internal structure can be defined and its elements isolated and classified, without losing sight of the overall structure of the music, is a score that can be navigated.

Most adaptive technology allows the user to access a document, and to read it following the "outer" structure of the original. This would mean playback of music scores, and access to the basic musical data. But if the same score has also an "inner" structure that allows the adaptive device to distinguish between a phrase and a measure, between a movement and a score, highlighting particular articulations or dynamics then the level of accessibility (and therefore usability) of the whole score will be greatly enhanced, allowing the user to move through it in the same way those without disabilities do when looking at the printed document, following the same "logic".

In an ideal world, any score made available in electronic format should contain that inside structure that benefits to everyone. Highly-structured documents are becoming more and more popular due to reasons that very seldom pertain to making it accessible to persons with disabilities.

Some of the largest music publishers are converting their old electronic texts into full XML documents so that it will allow them greater search facility and musicological access. Whatever the reasons behind those decisions are, the use of highly-structured information is of great benefit to anybody accessing them for any purpose.

In terms of pedagogical aspects, these technological advances allow for the creation of technologies, which enhance access and usability of music scores in ways that could enhance the teaching of music, through assistive technologies in the classroom. This achieves the aims of Accessibility from Scratch [Crombie2004a] where enhancing the access to the intrinsic structure and meta information of the music score is enhancing the use cases for both impaired and mainstream users.

In order to show the variance in target groups covered by technologies for Accessible Music Learning, six cases studies are provided in Appendix C which have been taken from the UK "Access to Work" program (Described in Appendix B). While the survey has been carried out for different means than those targeted by the i-Maestro project, the case studies are interesting, as they give real life examples of the target group in question. It is interesting to note, that almost every one of the users questioned in the Case Studies uses assistive technologies, which enhance their access to music in every day life.

In recent years, the market for accessibility and assistive technologies has started to gain recognition. It is clear that the integration of accessibility notions into mainstream technologies would provide previously unavailable opportunities in the provision of accessible multimedia information systems. It would open up modern information services and provide them to all types and levels of users, in both the software and the hardware domain. Additionally, new consumption and production devices and environments can be addressed from such platforms and this would provide very useful information provision opportunities indeed, such as information on mobile devices with additional speech assistance.

As the recent Forrester report for Microsoft report [Forrester2004] stated:

"…A large and growing potential market for accessible technology exists to serve individuals who have some degree of difficulty or impairment that impacts their ability to use a computer".

This report also noted that in the US, some 44% of computer users *already* use some form of accessible technology.

Many advocates of Accessibility and assistive technology would go even further than this. An often-quoted idiom is that "Accessibility is a process not a product" [Foley2006]. While this may not be the reality of how

accessibility solutions are currently solved, it would be advantageous to move to a stage where accessibility is integrated in the main processes, which are used to cater for mainstream users. At this point, accessibility opens to a wider world and it becomes usability where systems are designed to cater for user preferences no matter the user.

This document outlines the state of the art in technologies, standards, tools and procedures for Accessible Music tuition in order that i-Maestro can create technologies, which take advantage of assistive technologies to open up new technological and educational environments to impaired users.

6 The user group

In order to address systems for Accessible Music Learning, it is important to identify which user groups are covered by the tag "accessibility". The term *print impaired* refers to anyone who has a problem understanding the traditional print version of information. In the musical domain, this refers to anyone who cannot read a music score. The solutions discussed in this chapter often refer to solutions which were primarily conceived 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. This shows the benefit of well-defined user requirements, where simple transformations of the primary development goals can be rewarding for a wider body of users.

As a starting point, the accessForAll model [AccessForAll2006] defines the following impaired groups:

- Visual (e.g. blind, low-vision or colour-blindness)
- Hearing (e.g. Deaf or hard-of-hearing)
- Physical
- Cognitive (e.g. learning disabilities)

6.1 Visual Impairments

Vision impairment [Arditi1998] is vision loss that constitutes a significant limitation of visual capability resulting from disease, trauma, or a congenital or degenerative condition that cannot be corrected by conventional means, including refractive correction, medication, or surgery. This functional loss of vision is typically defined to manifest with:

1. best corrected visual acuity of less than 20/60, or significant central field defect
2. significant peripheral field defect including homonymous or heteronymous bilateral visual field defect or generalized contraction or constriction of field, or
3. reduced peak contrast sensitivity either of the above conditions

In terms of a user group, the breadth of print impaired users is similar to that for general users, and the target audience for accessible music software also includes those who provide accessible music in different environments, as illustrated in Table 1.

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

Table 1: An overview of the user groups involved in Accessible Music

In most cases, visually impaired people can have access to visually coded information by means of touch (tactile), audio, haptics, print enlargement, or by a combination of these means. These media must be considered as basic communication channels. In other words, it is not sufficient to adopt simple transposition procedures to render visual information into non-visual information. It is useful to consider an analogy from

language translation: if we just translate one word at a time into another language much of the meaning is lost. The same is true for translations into accessible formats.

For most print impaired users, the main point of access to information is the written word. This is usually provided in the form of paper-based accessible formats, audio formats, or through hardware connected to a computer screen. 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' materials, 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 currently published becomes available in accessible formats.

6.1.1 "Focus on Music" Study

One interesting study is that of "Focus on Music" [FOCUS2006] where several children and young people with septo-optic dysplasia were surveyed in order to ascertain whether visually impaired children were more likely to have an interest or a talent for music. Septo-optic dysplasia is a rare condition that occurs in approximately one in 16,000 children. Among the likely effects of septo-optic dysplasia are visual impairment, hormonal problems, behavioural difficulties and obesity. [Mehta2004]

Parents have often reported that children and young people with septo-optic dysplasia were musically gifted. The study set out to investigate if this was true or not by asking the parents of 64 children (32 visually impaired, 32 comparison group) a series of questions relating to their children's musical ability:

- The children's interest in everyday sounds and music
- The time the children spend engaged in music
- The importance of music to the children
- The musical abilities of the children
- The nature of their engagement with musical instruments
- How the children learn and their motivation to do so
- The children's levels of musical achievement
- The extent to which these accomplishments are publicly recognised
- The specialist music tuition and musical therapy available to the children

While the study is not entirely relevant to this deliverable findings of interest to i-Maestro were:

- The levels of musical interest and ability in the partially sighted group are statistically significant.
- The levels of musical interest and ability is proportional to the child's level of sight.
- Fewer partially sighted students play musical instruments than their sighted peers.
- The range of instruments played by the partially sighted students is more limited than that of the comparison group.
- None of the children with sept-optic dysplasia had formal music lessons, so were self taught.

The report recommends that:

 "children and young people with sept-optic dysplasia and, indeed, blind and partially-sighted children more generally (including those with additional disabilities) should have access to music education and therapy programmes that meet their needs and enable them to fulfil their potential – and these should start as early as possible in the child's life"

For i-Maestro this situation provides a key market for accessible eLearning technologies for music. It is essential that these should be available for several skill levels ("as early as possible") and that they should go

beyond music education ("Therapy Programmes"). It is possible that gesture analysis tools created in Work package 5 could have a secondary use in the Music Therapy sphere.

6.1.2   Music Notation

Music is artistic content, and for many people it is a crucial factor in their development of cognitive dimensions, be they expressive, social, educational or creative. The visually impaired individual should, therefore, have the opportunity to access both performed music and represented music. Performed music refers to audible music, and includes all forms of real music, both traditional and innovative. The term represented music is any kind of coded music, including Braille music, computer-accessible music codes, or talking music.

Figure 1 Traditional Braille Music transcription. [1]

If we consider an analogy between performed music and represented music and the written and spoken word, we can see that literacy marks the border between pre-history and history. The same could be said about the understanding of music. 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.

The main provision for print impaired musicians accessing music notation over the last century has been Braille Music (see section 7 below). The increasing use of computers as a medium for creating and using music notation (in both domestic and commercial environments) opens up new and interesting possibilities for music coding and representation. More importantly, these developing initiatives for incorporating more intelligence into musical representations opens up new possibilities for addressing the needs of print impaired users. In the past many people have by-passed music notation and become successful performers, creators and users of music without the need for music notation. This is especially true among dyslexic musicians. 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.

6.2   Hearing Impairments

While this immediately appears to be entirely relevant for Music systems, it should also be considered that hearing impairment does not always mean entirely deaf, and there have been several high profile deaf musicians (e.g. Beethoven).

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[1]   Picture Source: Dedicon archive

Hearing impairments are included for completeness in describing accessibility user groups, and also to highlight an interesting research challenge, which has received little attention.

6.2.1　Hearing Impairment

Hearing sensitivity is generally indicated by the quietest sound that an individual can detect, called the hearing threshold. In the case of people (and some animals), this threshold can be accurately measured by behavioural tests. That measurement is called a behavioural audiogram. A record is made of the quietest level of sound that consistently prompts a response from the listener. The test is carried out for sounds of different frequencies. Behavioural audiograms require a certain amount of co-operation and training on the part of the individual being tested that other types of hearing tests do not require. Instead of observing behaviour these tests rely on technical measurements of activity in the auditory nervous system. These electro-physiological tests of hearing include: Auditory Evoked Potentials and Auto-acoustic emissions.

Normal hearing thresholds are not the same for all frequencies in any species of animal. If different pitches of sound are played at the same amplitude (loudness), some will be loud and clear, and others muffled or even completely inaudible. Generally, if the gain is increased, a pitch is more likely to be perceived. Ordinarily, when animals use sound to communicate, hearing in that type of animal is most sensitive for the pitches produced by calls, or, in the case of humans, speech. This tuning of hearing exist at many levels of the body, all the way from the physical characteristics of the ear, to the nerves and tracts that convey the nerve impulses of the auditory portion of the brain.

A hearing impairment exists when an individual is not sensitive to the sounds normally heard by its kind. In human beings, the term hearing impairment is usually reserved for people who have relative insensitivity to sound *in the speech frequencies*. Some people object to the term hearing impaired as a personal description, especially if a member of a community using sign language instead of spoken language (see Deaf culture). The severity of a hearing impairment is categorized according to *how much* louder a sound must be made over the usual levels before the listener can detect it. In profound deafness, even the loudest sounds that can be produced by the instrument used to measure hearing (audiometer) may not reach threshold.

There is another aspect to hearing that involves the *quality* of a sound rather than amplitude. In people, that aspect is usually measured by tests of "speech discrimination". Basically, these tests require that the sound is not only detected but understood. There are very rare types of hearing impairments which affect discrimination alone.

There is little work relating to hearing impairments and Music, but some resources are available. [DISABILITYWOLRD2003] Among these are the "Music and the deaf" website available in the UK. [MATD2006], the work of Dr. Nandini Jog on Visual Music for the hearing impaired. [JOG2006]

6.3　Physical Impairments

Physical impaired users are an extremely difficult user group to define, as the breadth of the description is very large. Almost all the impairments in this deliverable can be described as physical. Motor impairments covers a smaller range of users, but the requirements for this group are no more common across the group, so there is a still a problem of full personalisation of any solution.

The area is only briefly covered by the project, but some similar projects are listed under section 11 that covers gesture instruments, as it is an interesting area of research for the i-Maestro project.

6.4   Cognitive Impairments

To clarify a user described as having a cognitive disability we must consider many aspects. Someone with a learning difficulty, whether they show signs of intellectual limitations or not and those with language disorders, including sufferers of Alzheimer's syndrome, stroke victims and people with other types of brain damage, can all be described as having some form of cognitive impairment. Although concerns with learning issues normally addresses younger users, users can be of any age, most of which are normally elderly, and users can be from any economic background.

A breakdown of the term cognitive disability shows the wide spectrum of cases that should be considered. When one observes the term Learning Disability it can be seen that this should include reading and writing issues such as dyslexia and dysgraphia respectively, issues with numerical data and computational impairments. It is also common that those students with learning disabilities also have apparent difficulties with organisation and abstract reasoning. Attention Deficit Disorder and Hyperactivity (ADD or ADHD) are two conditions that often run alongside learning difficulties with students showing signs of low attention span or restlessness.

Victims of linguistic disorders may also lose the ability to communicate coherently or effectively and could suffer memory loss. These language complications maybe include the searching for a word and also syntax development problems. These sufferers may have totally lost the ability to organise, assimilate and retain information as would be normal for a non-sufferer. These cognitive disabilities are often accompanied a physical disability of some sort.

Users with cognitive disabilities include users with learning disabilities with or without intelligence deficits, and those with language disorders, including Alzheimer's patients, stroke victims and those with other forms of brain damage. These users can be of any age or economic group, although learning issues tend to be addressed primarily for younger users, and those with language disorders are often elderly.

Although this discussion will be limited to cognitive disabilities, this still covers a wide range of issues. Learning disabilities range from reading issues (dyslexia), to writing issues (dysgraphia), to computational disabilities, trouble with numbers and other areas that relate to numerical manipulation. Frequently, students with learning disabilities have trouble with abstract reasoning and organization. Sometimes, learning disabilities go hand-in-hand with Attention Deficit Disorder and Hyperactivity (ADD or ADHD). Victims of language disorders may lose their ability to communicate effectively and have short and long term memory loss. Language difficulties may include word finding and syntax development difficulties. Sufferers of language disorders may have lost the ability to organize, assimilate, and retain information. Often, these cognitive disabilities are accompanied by physical disabilities.

7   Overview of Formats for Accessible Music Education

From a production logistics point of view, the accessible solutions associated with providing for print impaired people present several problems. The accessible market is a niche market, so the problem becomes both a logistic problem and a design problem. Solutions are primarily designed with the mainstream market in mind. Once these user requirements have been adequately met, secondary user needs can be considered. However, as the accessibility requirements have been considered as a secondary solution or an afterthought, the solution at this stage is very often a *piggyback* solution. 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.

One of the most important requirements of musical presentation in Braille or Spoken Music formats for print impaired users 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. That is, the end user must be able to establish his or her location in the musical material and so be able to understand the functions of the musical material at hand. The end user must not be overloaded with redundant information, but at the same time be provided with enough musical material to be able to deduce its function.

7.1 Formats

7.1.1 The Braille cell

Braille generally consists of cells of 6 raised dots arranged in a grid of two dots horizontally by three dots vertically. The dots are conventionally numbered 1, 2, and 3 from the top of the leftward column and 4, 5, and 6 from the top of the rightward column.

The presence or absence of dots gives the coding for the symbol. Dot height is approximately 0.02 inches (0.5 mm); the horizontal and vertical spacing between dot centres within a Braille cell is approximately 0.1 inches (2.5 mm); the blank space between dots on adjacent cells is approximately 0.15 inches (3.75 mm) horizontally and 0.2 inches (5.0 mm) vertically. A standard Braille page is 11 inches by 11.5 inches and typically has a maximum of 40 to 43 Braille cells per line and 25 lines. [WikiBraille2006]

7.1.2 Large Cell Braille

Large Cell Braille, or more commonly Jumbo Braille is an alternate way of writing Braille. The dot combinations are the same as those used in traditional Braille, except that the spacing between dots and cells is increased somewhat. The dots themselves are the same size as dots in standard Braille. Large Cell Braille is used by those who have difficulty feeling standard Braille.

7.1.3 Encoding

As originally conceived by Louis Braille, a sequence of characters, using the top 4 dots of the Braille cell, represents letters a through j. Dot 3 is added to each of the a through j symbols to give letters k through t. Both of the bottom dots (dots 3 and 6) are added to the symbols for "a" through e to give letters u, v, x, y, and z. The letter w is an exception to the pattern because French did not make use of the letter "w" at the time Louis Braille devised his alphabet, and thus he had no need to encode the letter "w".

English Braille codes the letters and punctuation, and some double letter signs and word signs directly, but capitalisation and numbers are dealt with by using a prefix symbol. In practice, Braille produced in the United Kingdom does not have capital letters.

There are Braille codes for representing shorthand (produced on a machine which embosses a paper tape) and for representing mathematics (Nemeth Braille) and musical notation (Braille music).

7.1.4 Writing Braille

Braille may be produced using a "slate" and a "stylus" in which each dot is created from the back of the page, writing in mirror image, by hand, or it may be produced on a Braille typewriter or "Perkins Brailler", or produced by a Braille embosser attached to a computer. It may also be rendered using a refreshable Braille display.

Braille has been extended to an 8 dot code, particularly for use with Braille embossers and refreshable Braille displays. In 8 dot Braille the additional dots are added at the bottom of the cell, giving a matrix 4 dots high by 2 dots wide. The additional dots are given the numbers 7 (for the lower-left dot) and 8 (for the lower-right dot). 8-dot Braille has the advantages that the case of an individual letter is directly coded in the cell containing the letter and that all the printable ASCII characters can be represented in a single cell. All 256 possible combinations of 8 dots are encoded by the Unicode standard. Braille with six dots is frequently stored as Braille ASCII.

7.1.5 Braille Music

Ever since Louis Braille invented his system for representing music, blind musicians have been able to obtain scores in the Braille music format. There are international guidelines for Braille music [Krolick1996] notation. Braille Materials in Braille music make up the largest portion of the available alternative formats and include the standard repertoire for most instruments, vocal and choral music, some popular music, librettos, textbooks, instructional method books, and music periodicals. However, Braille music is produced by a relatively small number of institutions throughout the world.

A Braille model that is built on notions of BrailleCells and sequences of BrailleCells is used to codify musical aspects. The protocols of these coding rules are *not* standardised, though there is a book of guidelines that are regarded to be a standard. Though the guidelines are very complete, there are still a few serious problems.

BrailleMusic is a sequential protocol with a defined grammar, much like serial communication through a RS232 serial interface. Starting from a graphical score, this means that a great amount of parallel data has to be 'packed' into sequential packages with a consistent structure.

An example of a first measure of a piece of music produced using the WedelMusic Accessible Music module follows in Figure 2:
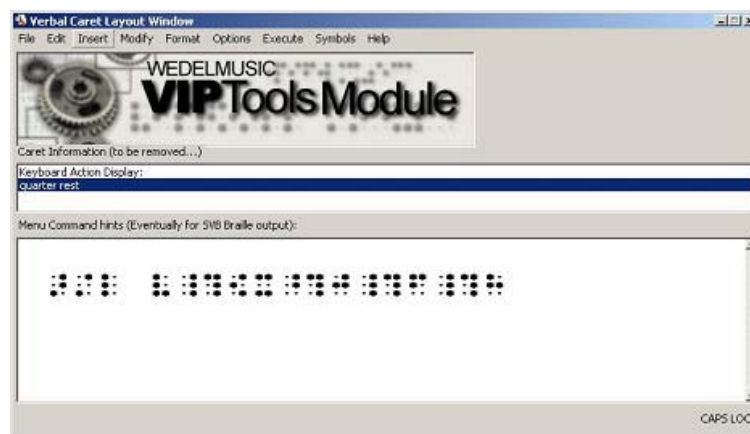
Figure 2: A navigation action through a musical score with additional real-time output to BrailleMusic

The BrailleMusic transcription can be described as follows in Figure 3:
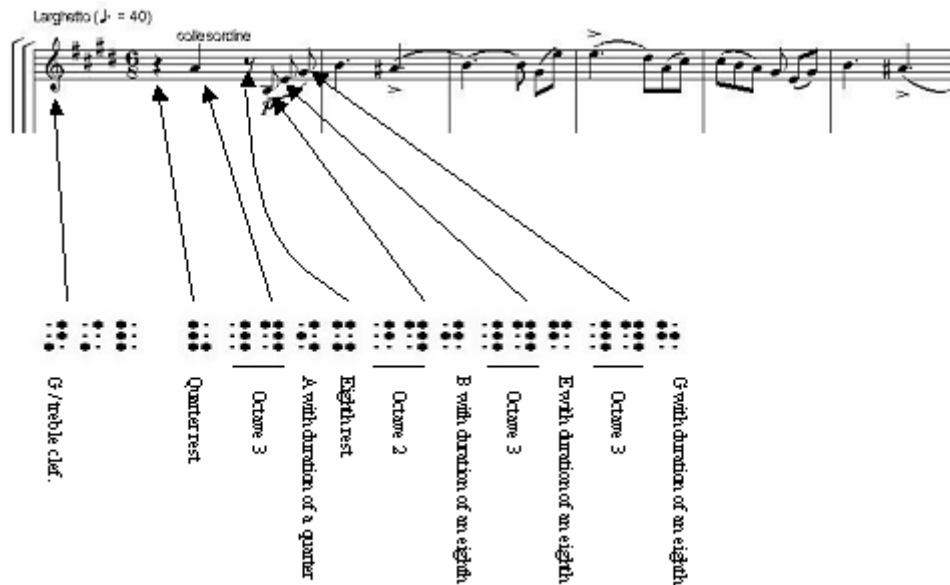
Figure 3: Measure 1, BrailleMusic explained

An example of the second measure after a navigation action by the end user to move to the next measure is illustrated in Figure 4:
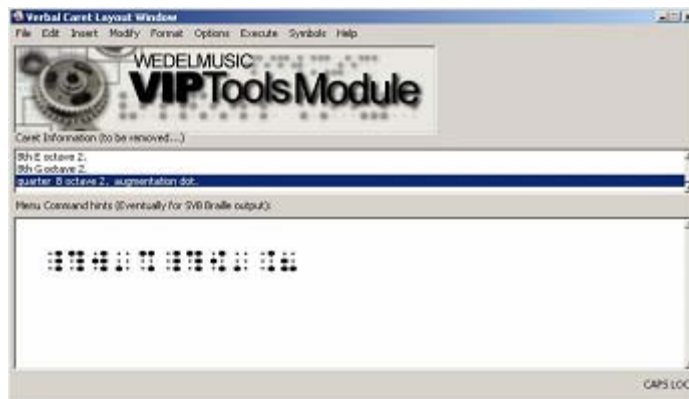
Figure 4: BrailleMusic interpretation of the second measure. Please note that the key information is missing, because the next measures contain no key information. In this particular set of interpretation settings, only key changes are presented.

Since the measures are represented in an object oriented music notation model as separate though associated objects, we can choose to interpret only these measures. In other words, we can limit the perceived context to only the current measure. Invoking the Braille interpreter on higher-level musical collections permits BrailleMusic interpretations of higher-level contexts. A simple example of such usage would be interpreting a page of BrailleMusic.
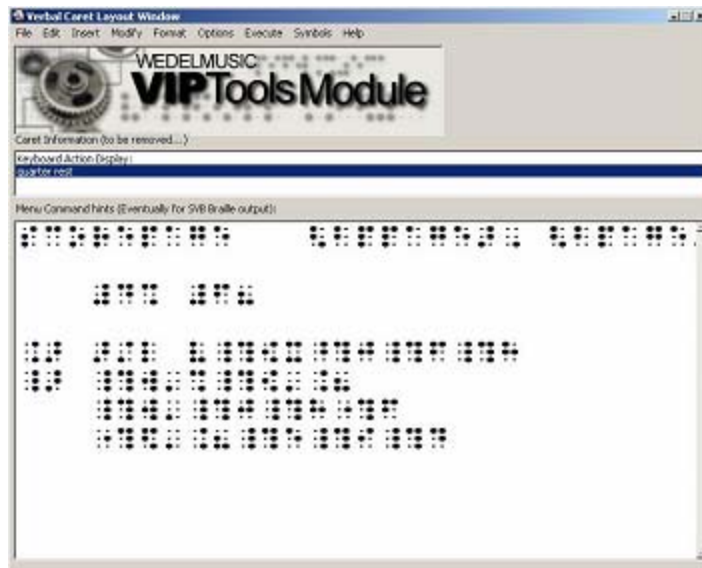
Figure 5: Real-time generation of a higher-level context description of a piece of music. In this case a page of measure.

An example of a page containing measures of a piece of music produced after selecting the appropriate menu item follows in Figures 5 and 6:
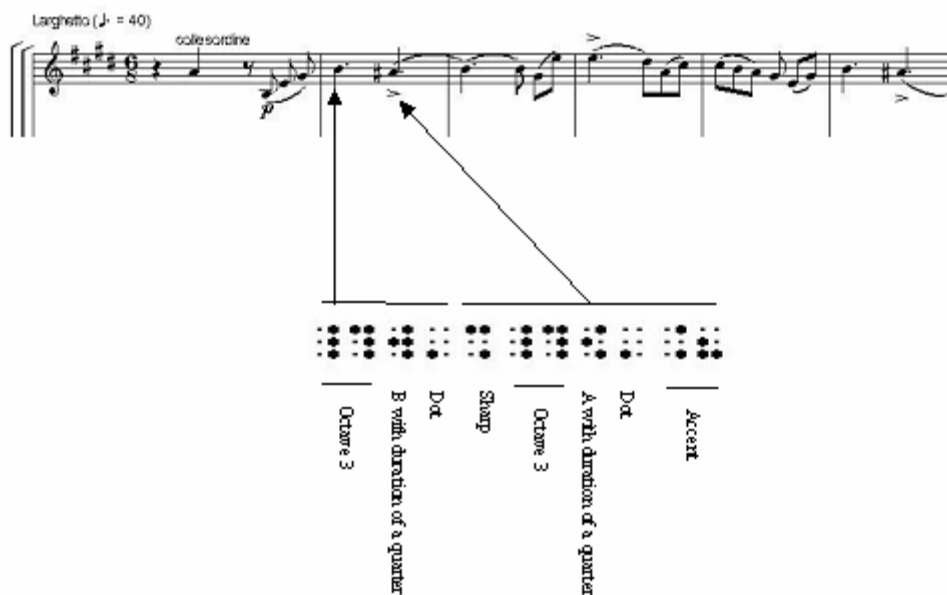
Figure 6: Measure 2, BrailleMusic explained

The lower part preview of the BrailleMusic as generated using the set of interpretation rules in this particular case are explained in Figure 7 below:

Figure 7: Higher-level musical information represented

7.2   Problems with Braille Music

Although Braille Music has been around for some time, it is not without its problems. Reading Braille Music is a complex task and for those people who become impaired beyond the age of twenty, 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.

Another problem is the lack of resources for Braille Music. There are very few Braille Music teachers, and Braille Music services, and where these are in place, the information about the resources is not widespread enough that Mainstream music schools are aware of its existence. More details are outlined about this situation in the Learning chapter (Section 9).

7.2.1 Talking Music
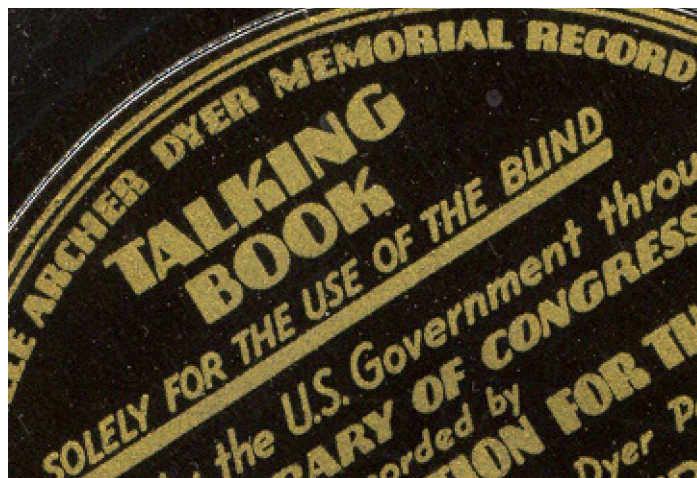
Figure 8: Talking Book on vinyl from 1939

One of the most popular alternatives to Braille music is Talking Music. Talking Music is presented as a played fragment of music, a few bars long, with a spoken description of the example. The musical examples are now produced automatically by software and as far as possible with a non-interpreted version of the music. All notes are played at the same volume, at the same velocity, and all notes of a certain duration have exactly the same duration. The musical example is there to provide the user with a context for the Talking material, making it easier to understand and play. The musical example is non-interpreted, to afford the Talking Music user the same level of subjectivity to the musical content as the sighted user.

The most important part of the information is the name of the note. All the other information should be centred around this. Some of the additional musical information should be placed before the name of the note: some of it should be given afterwards. The guiding principles are the way in which the musical information will be processed; the duration of the musical information; and the importance of the information. For instance, we must indicate which octave the note belongs to before we say the name of the note so that the listener can prepare some motor movements before playing the note. When, as an illustration of the second principle, a dynamic sign and a bow is mentioned at the same position in the score, the one with the longest duration should be mentioned first. Thirdly, not all the information is equally important for everyone. For example, fingering is additional information, and is mentioned after the note and its duration.

Naturally, it is preferable not to describe every facet of every note, as some data are implicit. Having established a basic set of rules it was then necessary to consider ways of limiting the volume of information without losing any critical data. This led to the use of abbreviations. For example, we do not need to include the octave information for every note. If the interval between two consecutive notes is a third or less, then the octave information can be excluded. In the same way, if the following note is a sixth or more above the current note, we have to include octave information. If the following note is a fourth or fifth above the current note, and the notes belong to different octaves, we do need to include octave information. The abbreviations adopted were the same as those employed in Braille Music.

One of the guiding principles of universal design and Design for All guidelines is that the print disabled should have access to the same information as the sighted, and that only the format in which the information is presented should change. For Talking Music, this means that everything on the page of a music score must be represented in a Talking format. Furthermore, this Talking format must be applicable to all types of music and instruments. By way of illustration, Figure 9 contains an excerpt form a Bach minuet:
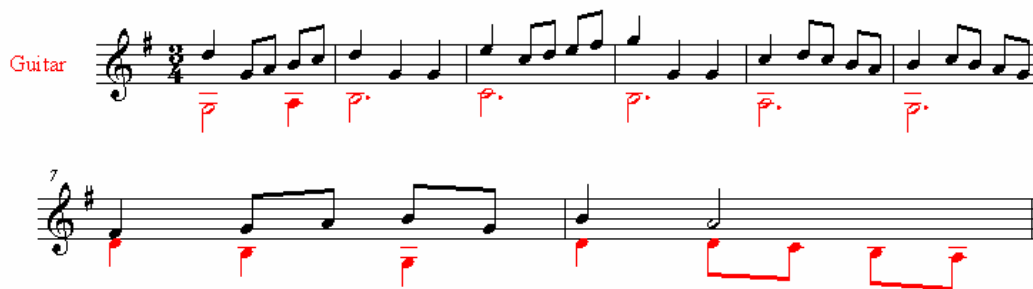
Figure 9: Bach Excerpt - Minuet in G - BMV 114

The resulting Talking Music for measure 1 of the simple example above is shown below:

> The title is: Minuet in G. Composer: Bach.
>
> This piece contains 8 bars and consists of 2 sections. The piece is read in eighth notes, except where otherwise indicated.
>
> Key Signature: 1 sharp. Time Signature: 3 fourths time.
>
> Section 1.
>
> Bar 1.
> second octave g half.
> a quarter.
> in agreement with
> fourth octave d quarter.
> third octave g.
> a.
> b.
> c.

The description above shows the information within the Talking Music book taken from a DAISY Software player. The description starts with a header which delivers the document data about the score (composer, title, production notes), a description of the score (in terms of length and content), and then the key and time signatures. The description then continues to section 1, where it describes the first measure note by note. The lowest voice is described first.

This information exists as audio files, and the text description is used for production use and explanatory reasons. The audio files are structured in such a way that the user can easily navigate from one section of the score to another, in order to build up an idea of what is in the score. The tree structure of a more complicated score taken from a DAISY Software player is shown below in Figure 10:
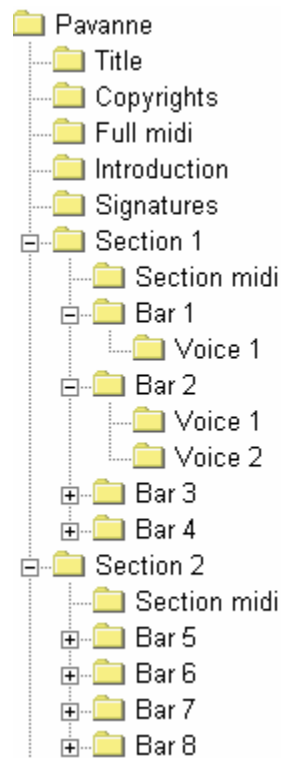
Figure 10: Talking Music Score structure.

A Talking Music book exists as a collection of files controlled by an .ncc file but to describe the structure it helps to think of a folder hierarchy. The Talking Music Book contains at the first level folders for the header information and folders for each section. The folders for the header information can be navigated through vertically in order to skip to the desired piece of information. There is then a midi representation of the entire score. This is usually played at the standard tempo, but the tempo can be altered in the production process if desired. The sections then contain a folder with the midi for that section (usually slower, depending on the complexity of the piece). The midi is then followed by a folder for each measure which in turn contains a folder for each voice. After the first level the score can be navigated both vertically and horizontally. This means that the user can jump from section to section, measure to measure or voice to voice. This affords the user the luxury of relating the information with its context in a way similar to a sighted user, who can overview the score at several levels of abstraction.

7.2.2   Large (Modified) Print Music

A large number of the users of accessible formats are not blind. One popular accessible format for many years has been that of Large Print Music (or modified stave notation). Because this is based on traditional Common Western Music Notation (CWMN) it is very widely used by people with diminished sight who could once use CWMN.

The concept is simple; the music notation is made larger than normal, where the scale factor is relevant to the quality of the user's eyesight. The common way to do this is to take the A4 score, and to increase it to A3 using a photocopier. With the increasingly common use of computers as a composer's or typesetter's tool, the score becomes more adaptable to accessible solutions. If we consider the previous example of the Bach minuet, we can increase the size of the zoom in a music notation package, and an example is given in Figure 11:
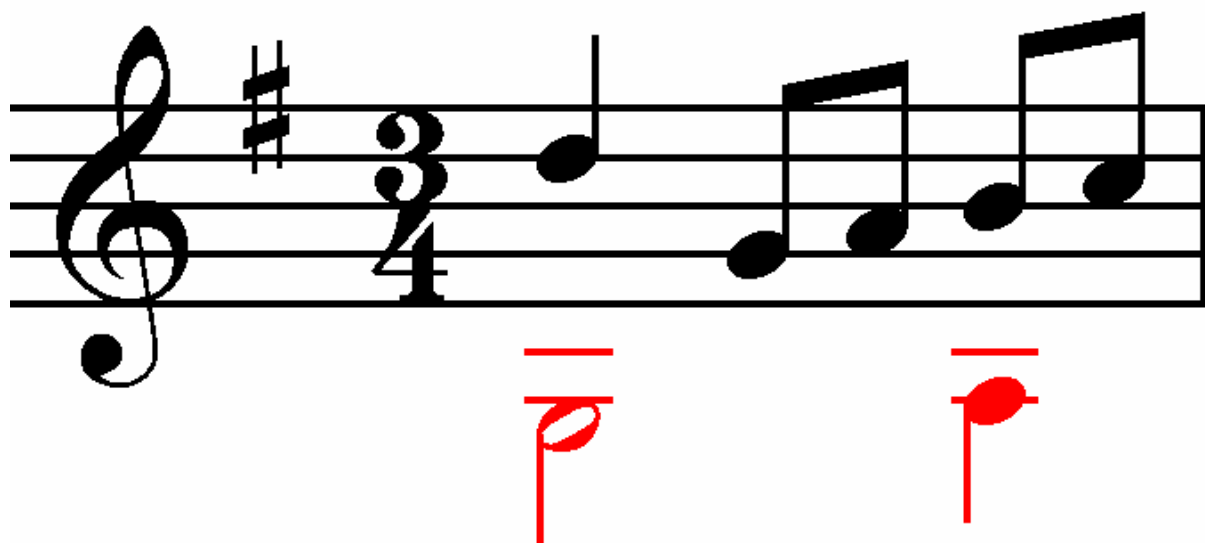
Figure 11: An example of Large Print Music notation.

This is sufficient in many cases, but this resolution is the highest achievable before the pixels become visible, and the image becomes less useful. When using music notation editing software it is possible to optimise the score for large print versions. The notes can be typeset in such a way that the durations are placed evenly across the measure. There should be little or no overlapping information. As with all accessible solutions consistency should exist wherever possible; if dynamics appear below the measure they should continue to appear below the measure for the whole score. These guidelines make the score more viewable at small font sizes, and so should help the user in understanding the different elements of the data.

Large Print Music notation can benefit from the information digitisation process. It is important from an accessibility point of view that the traditional score is not modified, but that the information is presented in different ways. 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 Scalable Vector Graphics (SVG), 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 extensible modularisation of the information also allows the different elements in the score to be represented in different ways. This is especially important for dyslexic users, as the variance in problems with information is greater, and personalised accessible formats may be a viable option.

8   Creating Tools for Accessible Music Education

From the perspective of i-Maestro, the project aims to create author ware for lesson packages; this requires consideration of many aspects of accessibility relating to the content, the software and the music excerpts used. This section overviews what is required to create environments which offer solutions for Accessible Music Education, and what tools are available to assist in the creation of these environments. [W3cAUTools2006]

There are three groups of accessibility choices for learners defined within AccessForAll [AccessForAll2006]:

1. Display (how the user interface and content should be presented)
2. Control (alternative ways of controlling a device)
3. Content (specification of auxiliary, alternative or equivalent content requirements).

8.1   Display: Accessible Interfaces

The most important way of ensuring that a user can access a piece of software is to look at how the user interacts with the piece of software. Whether you are providing text-based content, images, media components or interactive tools, they are generally accessed through a GUI or graphical user interface. It is therefore important to consider how accessible GUI's on software are and what can be done to maximise the number of users who are able to make use of that interface. In the case of curriculum design, we are delivering education, to diverse learners, with diverse needs. To be effective, we will need to make certain that pages remain usable to the widest possible range of users, who have varied technologies, techniques and situations. The following cases highlight some of these needs:

- Although it is a graphical user interface, visually impaired or blind users may be accessing the functionalities using a non-visual format that involves text only browsing, screen readers, and refreshable Braille bars.
- Users, maybe using hardware with non standard set ups, such as no mouse, low resolutions screen, black and white screens etc.
- Learners may have any range of cognitive disabilities, learning disabilities or other requirements that affect their needs.

The question of how to meet these needs is a complex one. It boils down to good software design, good communication and being aware of any guidelines and standards that are available. Specific to web content, there are lots of guidelines. The Web Accessibility Initiative (WAI), a sub-committee of the World Wide Web Consortium (W3C), is the present leader in establishing accessibility guidelines for page authoring. The WAI is coordinating many organizations that have produced Web accessibility reference documents in the past, in order to develop a comprehensive and unified set of accessibility recommendations. The most current version of the guidelines may be found at the World Wide Web Consortium site. [WAI2006]

In addition to being familiar with the guidelines, educational resource developers will want to make use of validation tools such as the W3C's own HTML Validation Service [VALID2006] and Bobby [BOBBY2006] from the Centre for Applied Special Technology. Both of these tools will validate Web pages, providing a summary of potential concerns, with links to information on the specific issues identified. While the automation of the validation process is the key to ensuring accessible design, further gains are possible if the validation utilities are integrated into authoring tools, and support the designer beyond identification of potential problems, by correcting or repairing the potential barriers to access as well.

Studies such as the SNOW study [SNOW2006], allow us to look at the feasibility of an inclusive eLearning system for the future. The survey looked at the accessibility of 7 packages for creating eLearning Courseware. (CourseInfo, Topclass, Web Course in a Box, Virtual-U, Web Knowledge Forum, WebCT and Lotus Learning Space). While the study is dated (1999), two key conclusions were clear:

- The simpler the package was, the more accessible it was. Increased functionality tended to mean lower accessibility. While we would not want to reduce software functionality, this could be seen as the less is more, or "reduce it to the maximum" idiom.
- In 1999 there were no adequate solutions for creating accessible eLearning content.

While eLearning is not entirely restricted to Web content, the guidelines serve as a good starting point for looking at how i-Maestro can make its Learning software more accessible. i-Maestro will create several software modules, which come together as a set of learning packages. These modules will be created by several different software developers, utilising several different skill sets. In order that the level of accessibility can be evaluated, Dedicon have included an accessibility evaluation framework. The first draft of these guidelines is available in Appendix D. More up to date versions will be made available on the i-Maestro portal (www.imaestro.net).

This evaluation framework provides an overview of how the accessibility of the various software components can be improved.

8.2   Control: Controlling devices

Although there are only a handful of technologies and software, which are specific to Accessible Music, there are several technologies that have to be covered in this section as general technologies, which are used by visually impaired users on a day-to-day basis. They are important assistive technologies for any learning endeavours carried out by visually impaired users. They provide the end user with hardware means of interfacing with computers. This may include input devices, or output devices.

8.2.1   Refreshable Braille bars

A Refreshable Braille display is an electro-mechanical device for displaying Braille characters, usually by means of raising dots through holes in a flat surface. The display usually sits under the computer keyboard. It is used to present text to computer users who are blind and cannot use a normal computer monitor. Speech synthesizers are also commonly used for the same task, and a blind user may switch between the two systems depending on circumstances.

Because of the complexity of producing a reliable display that will cope with daily wear and tear, these displays are expensive. Usually, only 40 or 80 Braille cells are displayed. Models with 18-40 cells exist in some notetaker devices.

On some models the position of the cursor is represented by vibrating the dots, and some models have a switch associated with each cell to move the cursor to that cell directly.

The mechanism that raises the dots utilises the piezo effect of some crystals, whereby they expand when a voltage is applied to them. Such a crystal is connected to a lever, which in turn raises the dot. There has to be a crystal for each dot of the display, i.e. eight per character.

The software that controls the display is called a screen reader (See above). It gathers the content of the screen from the operating system, converts it into Braille characters and sends it to the display. Screen

readers for graphical operation systems are especially complex, because graphical elements like windows or slidebars have to be interpreted and described in text form.

A new development, called the rotating-wheel Braille display, was developed in 2000 by the National Institute of Standards and Technology (NIST) [NIST2006] and is still in the process of commercialization. Braille dots are put on the edge of a spinning wheel, which allows the user to read continuously with a stationary finger while the wheel spins at a selected speed. The Braille dots are set in a simple scanning-style fashion as the dots on the wheel spins past a stationary actuator that sets the Braille characters. As a result, manufacturing complexity is greatly reduced and rotating-wheel Braille displays will be much less expensive than traditional Braille displays.

In order to incorporate Braille Bars within Max/MSP environments, the functionalities for controlling midi devices can be used. This may require different set ups depending on the manufacturer of the Braille Bar. If this is the case, several open source drivers for Braille Bars are available and functionality can be provided for the main manufacturers. An interfacing dialog can be provided in the I-MAESTRO client tool to choose specific setups for such devices. (Number of characters per line, Serial port, USB connecting, etc.)

8.2.2 Braille Note

Braille Note is a very popular portable note taking device used by visually impaired users, which allows keyboard entry of Braille using a 6 key entry system. This is similar to the traditional Perkins Brailler, which was a mechanical machine, popular for many years. The Braille Note can output synthetic speech renditions of the notes, or feed the notes out to a refreshable Braille Display (see above).

The Braille Note is not without problems. Typically the unit costs between 4000 and 8000 euros and the units must be sent back to the manufacturers regularly for cleaning.

Braille Lite is a simpler version Braille Note, created by the company Freedom Scientific [Freedom2006]. They currently cost around $3750 and have a reduced functionality compared to more expensive models.

8.2.3 Jaws and Screen readers

JAWS [JAWS2006] stands for Job Access With Speech and is a screen reader for the visually impaired. It is produced by Freedom Scientific who are mentioned above in the description of Braille Note Takers. Its purpose is to make the text in MS-DOS and Windows software applications accessible to visually impaired user through the use of text to speech technology, which "speaks" the text on the screen. The text can also be output onto a Braille display.

There is some scripting capability in JAWS, which allows further optimisation for what is output from the screen. This allows some adaptability of a system, which is widely used among visually, impaired computer users.

JAWS is the most popular of a number of screen readers on the market. There are different screen readers for various operating systems and various levels of computer use. This again highlights how the needs of visually impaired users vary.

8.2.4 OS native technologies

Section 508 [Section2006] required that electronic and information technology developed, procured, used, or maintained by all agencies and departments of the Federal Government be accessible both to Federal employees with disabilities and to members of the public with disabilities, and that these two groups have equal use of such technologies as federal employees and members of the public that do not have disabilities.

Following this there has been much more pressure to make systems and technologies accessible to meet this legislation.

Most operating systems have a level of native accessibility built in. There are active projects for the main Linux distributions for Accessibility [KDE2006] [GNOME2006], these projects arguably provide a more adapted and usable system for Linux users than the mainstream solution, but since most of the users of Linux are programmers themselves they are more likely to be able to adapt systems to their own criteria and personalisations. A full description of the assistive technologies available to users of Apple OS X and Windows Operating systems is outlined in Appendix E. The lack of standardization of these technologies across operating systems makes it frustrating to rely on these technologies for multi platform accessible software, but they provide a starting point for control mechanisms, which can access content.

8.3   Content: Accessible Content creation

The technologies and facilities for accessible content consumption all rely on one thing; Accessible Content is being consumed. There are several reasons for content not being accessible. Content and information are such wide concepts, that this deliverable only has the scope to give an overview of what is required in creating Accessible Content, but other materials are available which cover the topic in greater depth. [EUAINWIKI2006]

8.3.1   General Rules about creating accessible content creation

In the training materials for EUAIN, an overview of formats is provided and linked to relevant guidelines and standards. For the need of this deliverable a brief overview is given of the main criteria in creating accessible content. There are also further guidelines on accessible authoring tools and an evaluation form specific to i-Maestro in appendix D. Some generic guidelines are outlined below.

Text Content

Almost every application uses (or should use) some kind of text descriptions. It is also one of the main communication mediums on the web. As a result some effort should be made in ensuring that users can access it.

- Text should be of adequate size and intricate typefaces should be avoided. Ideally users should be given the option of setting typeface, size, and colour of text.
- Good contrast should be provided between text and background and colour combinations that are known to be problematic e.g. red-green, avoided.
- Example of text over graphics. Text that overlays graphics can be hard to read and should not be used unless absolutely unavoidable. Again if possible allow users to set their own background colours and if decorative backgrounds are used, allow users to switch them off.
- When applications are being created ensure that text is written to the screen as text not as graphics. This allows users of screen reading software to gain access to the text and it allows people to select text and then Copy it to the clipboard for re-use.
- Anti-aliased fonts should be avoided because they enlarge poorly when a screen magnification program is used. The magnified version appears blurred compared to single colour text and the smoothing algorithms used by such programs are prevented from working.
- In contrast, text rendered as solid colour, in a high contrast (user selected) colour. Can be magnified and subsequently smoothed by the screen enlarger.

Visual content

Providing text equivalents of graphical material for blind and visually impaired users can be a major task for subjects with significant visual content. Diagram description advice can be obtained from the National Braille Association. The textual descriptions may simply be a label for a purely decorative item e.g. "Photograph of the author" or "Company logo". For graphics containing important learning material a full description may be needed and this may require some very careful thought. The relevant content needs to be described to get the information across but superfluous detail may be unhelpful. Thought needs to be given as to what existing knowledge the reader will have so as to judge what can be assumed and what needs to be fully described. This task is probably best done by the original author of the material rather than added retrospectively by another.

Little can be done with bitmapped graphics except to provide text alternatives as already noted. Line drawing however offers similar scope to text for enhanced visual formatting. Clear, bold, high contrast lines can be used and colours made user selectable. Line drawings can also benefit from using zoom facilities if they are available. The colours used in graphics should be chosen with care to ensure that people who are colour-blind do not miss important content.

Audio content

i-Maestro tackles music directly, but it should not be forgotten, that sound can also be used as a navigation tool, as content and as a feedback tool.

For audio cassette or video cassette materials, where the material is linear, a paper transcript may be sufficient. For non-linear material, such as an interactive multimedia application, the text should ideally be provided on-screen and synchronised with the audio.

For non-essential audio content (for example, background music used in a multimedia presentation) it is sufficient to alert the user as to the nature of the sound so they can choose to disregard it.

Multimedia Content

Multimedia is, of course, an amalgamation of the content already described. However, it has particular problems because of the tools used for authoring it. These sometimes hide features of the operating system from the designers making accessibility harder to implement. The wrong choice of development environment can make an application inaccessible and may mean that little or nothing can be done to improve matters retrospectively. Macromedia Director is probably the most popular of these authoring environments and some designers have resorted to creating Director applications that incorporate speech output and which directly implement tab-able controls because of the difficulty in making them work with screen readers.

Documentation

Documentation should be provided in alternative formats. This is generally best done as electronic documents that allow users who require special facilities (e.g. large print or Braille) to produce their own extracts in the format they require. Preferred formats for documents are "standard" formats such as ASCII (ANSI), RTF and HTML and proprietary but widely used formats such as MS Word. Adobe PDF format is not ideal because it is not (generally) editable and therefore users are constrained to use the page design features of the original. Adobe has released accessibility tools to offset this criticism but these are not completely successful and can be rendered ineffective by poor construction.

8.4   Tools specific to Accessible Music

8.4.1   Dancing Dots

Dancing Dots Braille Music Technology, L.P., was founded in 1992 to develop and adapt music technology for the blind. In 1997 Dancing Dots released its first product, the GOODFEEL® Braille Music Translator. Bill McCann, Dancing Dots' president and founder, sees GOODFEEL® as the first in a series of high-tech tools to harness the power of the personal computer for creative people with disabilities. Bill McCann himself is a blind musician and programmer.

The programme is fast and flexible. A single part, selected parts, or an entire score can be Brailled in seconds. It features integrated literary Braille translation for most western languages so both the words and the tune can be Brailled. GOODFEEL® supports U.K. formatting and can be configured to conform closely to the formatting conventions used for Braille Music production in the UK. The programme runs on the latest versions of Windows: Windows XP Home, XP Professional, 2000, NT, Millennium, 98 and 95.

With GOODFEEL® combined with a few mainstream products, any sighted musician can prepare a Braille score without needing to be a Braille music specialist. Blind users can make sound recordings and print and Braille editions of their compositions and arrangements. Music scanning software can be used to speed data entry. Dancing Dots offers a variety of products including Braille music courses, and assistive technology such as JAWS and the Duxbury Braille Translator.

8.4.2   BME (Braille Music Editor)

BME is a music editor that:

- Recognises all chief Braille music signs;
- Allows to listen edited music;
- Allows to save Braille music files in proprietary format, convert them into scores through a plug-in for Finale
- And vice versa allows to convert music files realized with Finale, to Braille.[BME2006]

This BME allows recognising and interpreting the typical signs of music, in particular for piano. The program features a database containing a number of Braille music signs as reported by the New International Manual of Braille Music Notation. Moreover, a number of further signs widely used have been added. Yet, not all existing Braille music signs are filed into the program; therefore, a single Braille sign or sequence might not be recognised by the program. A warning message will appear to signal that what has been written cannot be interpreted.

8.4.3   Accessible Music suite from DEDICON

DEDICON [DEDICON2006], created a suite of technologies for Accessible Music Production [accessmusic2006] in 2003. The software is now available as open source.

Braille Music Maker

Figure 12: Braille Music Producer

The Braille Music Producer has been designed for people working in the area of music. You do not necessarily need any prior knowledge of either music notation or Braille notation to use this software. You can use this software to customise your Braille output to meet your precise needs, or you can select the required formats by creating or loading templates. Just follow the simple steps to create your own Braille music output.

The **Braille Music Producer** has the following key functionalities:

- No previous knowledge of music notation or Braille necessary
- Automatically produce Braille music in different formats as required
- Directly print out Braille music from new or existing scores
- Calibrated for all major embossers and printers
- Selection of templates for Braille formatting
- Optional Braille bar output
- Context sensitive help and built-in Braille Music tutorials
- Create whole scores or specific voices or instruments
- Save in different file formats (e.g. ASCII, NIFF, GIF, JPEG)
- Ability to create re-usable templates
- Insert and create new or personalised Braille codes (e.g. for fonts, symbols, language etc)
- Document format options (characters per line, margin settings)
- Title/header options (e.g. insert catalogue information, language, copyright)

Talking Music Maker

Figure 13: Talking Music Maker

The Talking Music Producer has been designed for people working in the area of music. You do not necessarily need any prior knowledge of either music notation or Talking Music notation to use this software. You can use this software to customise your Talking Music output to meet your precise needs, or you can select the required formats by creating or loading templates. Just follow the simple steps to create your own Talking Music output.

The **Talking Music Maker** has the following functionalities:

- No previous knowledge of music notation or Talking Music necessary
- Automatically produce Talking Music in different formats as required
- Create Talking music from new or existing scores
- Complies with Standard DTB (DAISY Talking Books) standard
- Create whole scores or specific voices, instruments or sections
- Save in different file formats (e.g. DAISY, mp3, WAV, Text)
- More control over Document Formatting options; fragment size, context level
- Ability to create re-usable templates

8.4.4 Prima vista

The Prima Vista system can automatically produce transcriptions of single-stave Sibelius files; as well as "nuances" such as dynamics, expression text and articulation marks, it will transcribe lyrics and guitar chords at the same time as the stave elements. Unlike other transcription tools currently available, it works entirely within the notation software environment and is not dependent on any other applications. A number of user modes are offered, including an Interface mode, aimed specifically at teachers who are themselves, learning Braille music for the benefit of a blind pupil. In addition to producing a transcription in the form of a Braille text file, Interface mode also adds Braille cells in a SimBraille font above each note in the standard notation score, allowing both the teacher and pupil to stay in sync when the pupil reads the score on an RBD or Braille notetaker.

In another component to the system, a blind user can create both a Braille score and a standard print notation score from a Midi keyboard. By assigning different functions to different areas of the keyboard, a method has been developed whereby both music data (pitch and duration) and text data can be created using notes.

Trinity College of Music in London have been using the first component for in-house transcriptions for the past year, and have just received the loan of a keyboard to start testing the second component.

9 Learning, eLearning and Accessibility

In order to consider Accessible Music Technologies for learning, some of the concepts behind learning and eLearning must be considered, and how these relate to Accessibility.

The teaching of Music to the visually impaired varies depending on which country the student is learning in, who is teaching the student, and at what level it is being taught. There is a little consistency in the curricula. If a visually impaired student is lucky enough to have access to a teacher, it may only be for a short time once a week. This puts focus on alternatives to one on one learning methods.

i-Maestro considers three learning modalities:

- Classroom work
- Self Study
- Distance Learning

Each of these exists in an accessible learning curriculum, but there are small differences put in place relating to disability of the student.

The "Focus on Music" [FOCUS2006] report points out, that although blind and partially sighted students are more likely to have special ability in music, that there is less likelihood of them having access to learning resources. This shows that new learning environment and paradigms are needed to meet the requirements of these end users.

9.1 Class room learning for the visually impaired

The big division in classroom learning is whether the visually impaired student is taught in a specialist school for the visually impaired or whether they are integrated with a mainstream environment where they are taught side by side with sighted students.

If the student is taught with sighted students, then the focus comes in ensuring that integration is possible with the mainstream curricula. This requires that any extra technology or learning materials for visually impaired students can be made available at the same time as those for the rest of the class. This is not currently the case for music lessons, as the time taken to produce a Braille score is considerable enough that the curricula must be known months in advance of the class, or there is a no score available for the visually impaired student. Most technologies surrounding Accessible Music aim to shorten this gap in preparation time, be it through using score formats that are quicker to produce (Talking Music of Large Print is applicable), or automating the transcription process with software (See Section 7).

In the case of specialist schools, the student may be more integrated with the rest of the class, but will lose out on vital experience in integrating with mainstream users in the workplace or in future life. One model which has worked well in other countries (Australia and New Zealand) is the idea of a Braille Music Camp. This is essentially a one week Braille music boarding school where visually impaired students are given tuition and are able to interact with students of similar levels and with similar interest. From this communities form which rejuvenate music in alternative formats and ensure that the level of musical literacy among the visually impaired increases for future generations.

Classroom learning of Braille Music relies on the availability of teachers. In some countries, there is no teacher availability, so all learning is informal. In other countries such as Spain it depends on location. Most Blind and visually impaired students learn Braille either in specialist schools or mainstream schools. When it comes to learning Braille Music, it is more difficult, especially in small towns. The charity for the blind in Spain, ONCE [ONCE2006] will help students to get in touch with a Braille Music teacher, but in cases where this is not possible, the student must rely on informal learning. ONCE publish a book, which assists with the early stages of teaching/learning of Braille Music. (See below)

Classroom learning in specialist schools was the traditional way of teaching visually impaired students. In these specialist schools, music was almost always on the curriculum, where it would be taught by a mixture of teachers, who were probably Braille Music musicians themselves, and older students. For example "Music through Braille" by Anne Burrows presents a full method for learning Braille Music [Burrows1987]. Now, students are more commonly integrated with the mainstream, where expert Braille Music tuition is less likely to be available. In this case a mainstream music teacher will learn the basic of Braille Music along with the student using one of the books mentioned in the reference section. RNIB have published a guide for teaching music to young visually impaired students. This is aimed at introducing teachers to the concepts of music for visually impaired children in order that they can use it as support material to teach Braille music to visually impaired students in their class. The materials cover many of the aspects surrounding Braille Music, introducing concepts such as memory and perfect pitch.

Braille Music learning is not confined to teachers and students. Transcribers also need to learn Braille Music in order that scores can be created. Technologies exist which aid the creation of Braille Music, but it is not completely automated, so there is still a need for Braille transcribers to either assist the creation of Braille scores using software or to create Braille scores from scratch. The materials for doing so are usually aimed slightly differently, as the transcribers in most cases will be fluent in music notation from the onset. [DeGarmo1974]

9.2   Informal Learning for the visually impaired

Due to the lack of teaching resources for Braille Music and other accessible Music Notations, it is common for visually impaired students to take it upon themselves (often with the assistance of a relative of friend) to learn Braille Music. When this is the case, one person is learning and passing the knowledge on to the student, or learning along with the student. As a result there are several sets of materials designed for this purpose.

ONCE publish a book for their users, "La Musicografia Braille: Un acercamiento a la escrtura musical para uso de las personas ciegas" [ONCEBraille2001]. The book is distributed to visually impaired end users, who have an interest in learning Braille Music. The description of Braille Music is intended to give the user a general impression of how Braille Music can be used to convey music notation. The basic overview of how Braille Music is organised covers the basic signs for each of the notes, then introduces the concept of the octave, which is important in Braille music as the octave of the note cannot be determined visually. The book then builds to basic phrases, adds articulations and stops at the level of a basic two hand piano phrase. Users who wish to take their interest in Braille Music further are pointed towards the "New International Manual of Braille Music Notation" [Krolick1996]

There is a book published by Dancing Dots and written by Richard Taesch called "An Introduction to Music for the Blind Student: A Course in Braille Music Reading". It equips the mainstream educator with no prior experience with Braille for teaching and learning music Braille The author, Richard Taesch, is a lifelong music educator and guitarist who is certified by the Library of Congress as a Braille music transcriber. He heads the Braille Music Division of the Southern California Conservatory of Music and chairs the guitar department. The book has proved popular in the USA.

9.3 Distance Learning for the visually impaired

For reasons of pedagogy, economics, access and efficiency, an exponentially increasing amount of teaching and learning is occurring over computer networks. As our use of technology in education increases, developers and writers are faced with new and interesting challenges to ensure that students with disabilities can take advantage of these technologies which would appear tailor made for their user needs in some cases. [ATRC2006]

Accessible eLearning can benefit end users in the following ways:

- Electronic delivery of eLearning materials provides greater flexibility in presentation which provides for a greater coverage of user needs and communication formats.
- Electronic delivery allows for the "create once" design for all paradigms. This content can then be easily adapted for speech alternatives and Braille alternatives and formats suitable for use with adaptive technologies.
- The wealth of information available on the web means that learning resources can tap into this information, and ensure that learning materials remain more current.
- Online learning encourages users to interact and communicate with fellow students with similar learning needs. In the case of Accessible User Groups, these communities are often already in place.
- Distance learning allows students who have problems with on-campus learning to still take part in education.

To reap these benefits, resources, standards and guidelines must be developed to ensure that the following aspects of eLearning remain accessible to users with specific and special needs:

- **Automating validation of Accessible Content –** The validation of content for accessibility is currently a very time consuming task, and many developers will justly ignore guidelines for accessibility in order to meet deadlines for completion of projects. If the means for validation can be incorporated in the means of creation, accessibility guidelines such WAI [WAI2006] will have more success.
- **Accessible Courseware –** The first port of call in accessible eLearning is accessible interfaces. This requires technologies which relate graphical user interfaces to access technologies (see section 8).
- **Accessible Curriculum Formats –** Interactivity of mainstream solutions and accessibility solutions relies heavily on multimedia formats that are open, standardised and well designed. A guide to standards for accessible eLearning is presented in the appendices.

i-Maestro aims to take advantage of new developments in eLearning and couple this with the current environment for Accessible Music Tuition to provide better support for visually impaired students through assistive technologies, for distance learning and supported classroom teaching.

9.4 Additional Complications for the Visually Impaired Musician

While these issues do not relate specifically to learning technologies for music, they relate to support technologies, which can be important for the visually impaired musician.

Taken from work that RNIB (Royal National Institute of the Blind) have carried out, a list of guidelines are available for music teachers which highlights some of the additional considerations that should be taken into account when considering learning curricula. The full descriptions are provided in the Annex, but an overview would be:

Teachers of Visually Impaired students should be aware of the learning curve in learning to play in unfamiliar environments. While this is an issue for any student of music performance, the lack of sight enhances the effects of different acoustics and different stage set up in a new environment.

Complications can arise from public performance, where the visually impaired student has to become comfortable with sitting on stage during breaks and rests in the performance.

The conductor controls much of group performance by gesture, the visually impaired student has to learn to follow this communication, and other non-verbal communication associated with public performance.

As a result of these very practical elements of Music education, curricula for visually impaired students should be designed with these criteria in mind.

9.5 SCORM and Accessibility

In order to tackle create technologies for eLearning in Music Tuition, i-Maestro has chosen SCORM technologies to implement these resources. Sharable Content Object Reference Model (SCORM) is a collection of standards and specifications for web-based eLearning. It defines communications between client side content and a host system called the run-time environment (commonly a function of a learning management system). SCORM also defines how content may be packaged into a transferable ZIP file. SCORM is a specification of the Advanced Distributed Learning (ADL) Initiative, which comes out of the Office of the Secretary of Defence. SCORM 2004 introduces a complex idea called sequencing, which are rules that specify the order in which a learner may experience content objects. The standard uses XML, and it is based on the results of work done by AICC (CBT), IMS, IEEE, and Ariadne. When the term "accessibility" is used in conjunction with SCORM they are referring to "The ability to locate learning content in multiple locations and to deliver it to multiple locations." Accessibility to persons with disability is not addressed in the SCORM specifications.

Currently SCORM is not WAI compliant, but it is suspected that with the finalisation of the Web Content Accessibility Guidelines 2.0 there will be functionality added to incorporate SCORM. Currently, full accessibility requires Javascript. These issues will be tackled as and when they become relevant in i-Maestro.

10 Standards for Accessible Music Education

The i-Maestro project tackles the innovative area of learning technologies for music. From an accessibility standpoint there are interesting developments in the eLearning sphere for ensuring that accessibility can become a fully integrated part of future technologies and standards. Standards and legislation pertaining to accessibility within the areas tackled by i-Maestro are outlined below.

Digital information networks, especially the internet, have come into the life of every citizen. They offer new services at home or at work and an incomparable source of knowledge for leisure or for professional documentation. Most of the paper resources now have their equivalent on the Web: encyclopaedias, dictionaries (definitions and translations), commercial documents of companies, governmental documents and public services, news (newspapers web sites or information portals), leisure or professional books (through on-line booksellers), internet bank accounts and internet bill-paying services. Digital information networks have also been introduced in schools and universities, with projects on electronic school bags or distance education.

The digital age has offered new opportunities for print disabled people to access information in their everyday life. But actually there is still a challenge to take up: making digital information accessible to everyone especially to people with disabilities. Unlike printed books transcribed in Braille or large print, online information cannot be reworked to become accessible to print impaired people. Unlike other distribution channels, there is no intermediary between a customer and a web site. So web authors become responsible for information accessibility. This is why accessibility guidelines and standards exist and are widely promoted.

Standards are needed for many reasons, but probably the most relevant one is that they tell manufacturers how to make their products accessible in a detailed, coherent way. Legislations promote the existence of standards, and they advocate for "accessible" technology or information. But it is standards that give the technical specifications of how this accessibility can be implemented and tested.

The existence of standards, though, does not imply that accessibility will be implemented in the same way or with the same results in all products. The existence of a number of standards for producing the same product (a music score) may occasionally lead to two different levels of accessibility for the same "accessible" final product. Even within the same standard it sometimes happens that some features are considered essential while others may be considered expendable – as a result of this, the application of the same standard with different views about what is needed and what is not to make information accessible may provide a wide range of accessibility levels for the same product, making it fully accessible for some users and just slightly accessible for others.

It may also happen that different standards are developed for the same purpose and though they deliver the same level of accessibility they are not compatible. This usually leads to confusion for manufacturers and service providers while it also "divides" users between the different existing standards (we all remember the Betamax vs. VHS example). We can distinguish between formal (or *de jure*) standards and de facto standards. The former are those who have been "formalized" by standards organisations, while the latter are technical solutions that have been adopted informally by users due to its usefulness and/or reliability. Among these de facto standards, we also have two categories – proprietary standards (those developed by a commercial company) and open standards (outside vendors' control, freely developed and updated by independent developers).

Standards are an important component of the Design for All concepts which allow accessibility to be built from the first stage of production and that accessible processing notions can be applied to emerging standards so that all the features needed to grant accessibility to the final product are built into the system right from the beginning, instead of the traditional approach of adding those features later.

There are many different standardisation agencies around the world, but what is considered to be fully accessible in the United Kingdom may not be seen as accessible in the same degree in Australia —Universal Design Principles help to create products that can be considered accessible everywhere.

Music technology is a good subject for standardisation. For years there have been various technologies, which have become de facto standards without official standardisation. As a result, the only real standards in music are a rough historical standard of Music Notation which has no limits on extensions of the information set, and midi which is a very old technology, but one that has become so accepted that it has become ubiquitous for music technology. Since XML has come along, there have been several different flavours of XML, which claim to be the best Music Notation XML. These have received varied support from Music technology software. As a result of the Interactive Music Network [MusicNetwork2006] a standardisation action was set up to look at the possibilities of incorporating Music Notation within MPEG.

MPEG Symbolic Music Representation (SMR) will enable the synchronization of symbolic music elements with audio-visual events that are represented and rendered using existing MPEG technology.

The breadth of MPEG standards for multimedia representation, coding, and playback, when integrated with symbolic representations of music will provide content interoperability and an efficient high quality, peer reviewed, standardized toolset for developers of these products. This will open the way for a large number of new applications with increased power and flexibility, as well as new markets for these kinds of applications. The repercussions may have a wide effect on music education, music entertainment and on the development of music as a whole.

11 Accessible Music Education and Gesture Instruments

There some work ahs been done in the area of Gesture instruments and their application in accessibility and assistive technologies, but much of it remains theoretical and resides in academic research. i-Maestro will create new tools in its software suite for Interaction models and creative gesture interfaces, and it makes sense to investigate how these tools can be coupled with those for accessibility to highlight possible means of musical expression which can be used as assistive technologies. By way of illustration, the MEDIATE project lead to the creation of an artificial environment packed with sensors and response means, that serves as a playground for autistic children; a group of individuals with tremendous communication difficulties. In this environment, sensors exist to trace the child's location, movements, touch, sounds etcetera. Response means are amongst others screens with computer-generated graphics, sounds, movements and so on. The experiment aims to examine the existence of relations between the child's responses to presented stimuli different than traditional means, such as speech. The MEDIATE project aimed to signal regularities in any input/output signal and turn this into a trigger that can be used to control a system. The meanings that are to be associated with these triggers are evaluated and defined by groups of psychologists that observe the interaction process between the child and the system. So any relation between audio and/or video may be decided to be attributed an action; the behaviour turns into a "button". The interaction "data" turned into "information" beneath a conceptual button. Such systems need a governing framework that is able to serve as a virtual "switchboard" that shows all the links, feeds, sensors, reactions, etc, and allow a level of control.

This area will be tackled through Work Package 5.2 on Interaction Models and Creative interfaces, sensors and Gesture Analysis. This section of this deliverable points to the few projects which have covered work in this area, as a review of interesting work which could be of use to the i-Maestro project.

11.1 Mediate Project

One of the few European projects, which have directly tackled the link between gesture instruments and accessibility and cognitive expression, was the Mediate project [Mediate2006]. The Mediate project aimed to design, produce, build and validate an intelligent, immersive, multi-sensory, interactive environment that reacts to the unique user, and allows that user to create expressions of their own sensory experience: creations which can be replayed and communicated to others. This environment was transportable and was used in user tests across several countries.

People on the autistic spectrum were co-designers in a process of iterative prototyping to produce a multi-sensory interactive environment. This environment performed in interaction with the individual autistic children through interfaces that were controlled and modified by pattern matching "signature" software that recognised and identified unique individual user characteristics.

The results and deliverables of the Mediate project are available online and may be of use in looking at interesting and innovative ways of using gesture instruments to facilitate new means of expression within i-Maestro.

11.2 Drake Project

The Drake Music Project [Drake2006] was established in 1988 to enable disabled children and adults who are unable to play conventional musical instruments to discover their musical abilities and explore, compose and perform their own music. The project has a track record in delivering a wide range of initiatives - (workshops, Research and Development, training) across England and the staff and team of freelancers currently work in London and the South East, North West of England, South West of England and the East Midlands.

Drake Music's contribution to Research and Development in assistive music technology has created technologies and techniques that provide previously unimaginable music-making opportunities.

This has led to the development of specially designed 'E-Scape' [Escape2006] music software, which caters for specific musician and tutor needs, which cannot be fulfilled with existing music software and/or overlays. Switch operation is built in to E-Scape, which has meant that even beginner users can successfully operate the system to start composing and performing.

E-Scape can be used to compose music or to perform music in many different ways. You can write your own music, import MIDI files from the internet and arrange or perform these pieces. E-Scape can be operated by switches, or by MIDIcreator, Soundbeam, keyboards or drum pads.

Given the scope of the Drake Project and its overlap with the Interaction models and creative gesture interfaces sections of i-Maestro the Drake project could be a very interesting project to look at when investigating possibilities of combining Accessibility components and assistive technologies with i-Maestro's technologies for gesture control.

11.3 Tenori-On

For a more commercial perspective, Yamaha have a product called Tenori-on [Tenori2006]. Tenori-on is an electronic musical instrument, designed and created by Japanese artist, Toshio Iwai, in collaboration with Yamaha. It consists of a screen, hand-held, of a sixteen by sixteen grid of LED switches, any of which can be activated in a number of ways to create an evolving musical soundscape. The LED switches are held within an aluminium frame, which has two inbuilt speakers, as well as a number of buttons and a dial, which control the type of sound produced. Though Toshio Iwai has been using the Tenori-on in live performances (such as at Sónar in Barcelona, in June 2006, and Futuresonic in Manchester, in July 2006), it is currently in development, and not yet for sale.

Iwai's intention in creating the Tenori-on is to create an electronic instrument of beauty. In his own words:

   "In days gone by, a musical instrument had to have a beauty, of shape as well as of sound, and had to fit the player almost organically. Modern electronic instruments do not have this inevitable relationship between the shape, the sound, and the player."

The instrument builds on Iwai's previous work, such as on his Electroplankton software [Electroplankton2006] for the Nintendo DS in the blending of light and sound, as well as the aesthetic elements of the interface.

The hardware is interesting from an accessibility and gesture perspective as it challenges what we consider to be standard interfaces for musical and audio expression. This is an important frame of mind to be in to consider interfaces for accessibility as well as musical expression.

12 Other interesting projects and initiatives in the area

12.1 Wedelmusic

The WEDELMUSIC project, which ran from 2001 to 2003, provided a fully integrated solution that aimed at allowing 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 that 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 share the facilities of the WEDELMUSIC system in the same manner as sighted people. This implementation used many state of the art as well as conventional technologies like speech synthesis from text (widely known as TTS), Braille printing and technologies specifically developed by the WEDELMUSIC project. The key element of this interface for blind people was the speech engine. A screen-reader program is used to provide a surrogate for the lack of visual feedback by conveying audible feedback to the user. For visual feedback to be fully and efficiently replaced, any activity is reported to the user. A Braille printing module was also developed to ensure that Braille Music output is easily available, and in the format specified by the end user. The importance of this development was considerable, as it allows far greater access to reading and creating music scores for visually impaired people. Additionally, the WEDELMUSIC approach was the first significantly to move music into the interactive multimedia age. [wedel2006]

12.2 Play 2

The PLAY 2 project was an EU-funded project, which aimed at facilitating access to digitised music for visually impaired people. Perhaps the most innovative aspect was the Braille Music Editor. The Braille Music Editor (BME) 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. 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 the score as on a Perkins writer, following the rules of Braille Music notation. 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 vocalised musical element. The end user may print the score either in Braille, or in ink print.

The BME (see section 8) can accept data not only from a keyboard, but also from a scanner, scanning Braille paper. The BME can also accept data from an ASCII file, which corresponds to a Braille printable file. This feature turns out to be particularly useful for proofreading. With this 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. [Play2006]

12.3 Interactive Music Network

The Interactive Music Network is a Centre of Excellence created to assist the music industry to enter the marketplace by drawing on the assets and mutual interest of the different actors in using technologies, tools, products, formats and models. This thematic network, funded by the European Commission Fifth Framework IST Research Programme, addresses chiefly the area of music coding, as there is still no accepted standard for music encoding. The main aim of the network is to bring music into the interactive media era by setting up a series of activities such as:

- Creating a web gateway;
- Publishing specific periodic reports and surveys;
- Producing integrated solutions and guidelines proposing standards;
- Producing guidelines for the adoption of current active standards.

The main idea of the Music Network was to create a community to bring the European music industries and content providers together with research organisations and emerging technologies. The Music Network set up seven different working groups on the most important aspects, in order to bring music industries into the interactive multimedia music age. The working groups integrated their results in order to produce new standards or guidelines to the existing standards in the area of coding multimedia interactive music according to the needs of the music industry. Project partners, multimedia companies and research institutes have produced trial applications customising their present applications in order to demonstrate the effectiveness of the provided network support.

The Music Network working group on Accessibility was set up to bring together the issues which surrounded Accessible Music, its formats, standards and the technologies which can create these formats. Following several meetings, where experts in the area presented work in the area, the working group liaised with the other working groups within Music Network and as a result set up the MPEG Ad-Hoc Group on Symbolic Music Representation which would investigate possibilities of including music notation within the MPEG standard. A standard for SMR is currently under standardisation within MPEG-4 Audio. This includes functionality for Accessible Music notations. [MusicNetwork2006]

12.4 eBrass

With the support of EU funding, under the eTEN Programme, and the joint effort of five European partners (UIC, BIC, ONCE, ACAPO, KFKI) the eBRASS project wants to make Braille music more easily and quickly accessible to blind and partially sighted people as well as to music teachers and schools who deal with the visually impaired.

eBRASS intends to offer an internet-based trans-European service which will see an on-line library hosting Braille electronic music texts to be downloaded and used by non-sighted musicians thanks to an appositely created software (Braille Music Editor), this too downloadable from the net. The library catalogue will be constantly widened and enriched with a variety of Braille music scores selected on the basis of the tastes and needs of Portuguese, Spanish and Italian end users (the project market validation phase takes place in these countries). Thanks to the BME software, visually impaired musicians and music students will be in the position to exchange titles, modify existing files and create their own piece of music to circulate on the web, in accordance with the common rules laid out by the New International Manual for Braille Music Notation.

Braille music will become easier to access and share, cheaper and quicker to obtain in electronic format, and subsequently on paper. [EBrass2006]

12.5 NIDE Project

With the view of expanding opportunities in *distance learning* for those with disabilities, the Network for Inclusive Distance Education (NIDE) was created as a collaborative project partially funded by Networks Ontario's, Telecommunication Access Partnerships (TAP) program.

The major player in the project was the University of Toronto's own Adaptive Technology Resource Centre (ATRC) where the objective was to produce viable technologies enabling educators to deliver accessible courseware to students with disabilities by method of computer networking.

The intrinsic benefits to distance education are obvious, more so for those with disabilities. Students can undertake courses at home or within the workplace and communication with the faculty and fellow students is simple and efficient via software: E-mail, web forums, peer-to-peer messaging systems and by video conferencing to name a few. Issues with transportation to and from the educational establishment and access to the classroom or equivalent are avoided by distance learning and a lack of adaptive technologies at some traditional educational settings provides another positive aspect.

Objectives:

- Creation of accessible curriculum through web-based courseware authoring tools and student interface designs.
- Development of accessible methods of delivering math, science and *music notation* to distance education students.
- Development of authoring utilities that assists in the creation of interactive courseware and software simulations for students who are visually impaired or have mobility problems.
- Creation of synchronous communication tools (like real-time chat utilities) to support distance learning.
- Evaluation of the various technologies through testing conducted by a broad spectrum of educators and learners.
- Implementation of an educational network the models inclusive teaching and learning practices through emerging technologies.

Many successful sub-projects were evolved from the NIDE project:

- Synchronous Communication Tools
- CSS Generator
- Haptics Pendulum Project
- A-Prompt
- **Music Notation**
- Interactive Learning Tools
- MathML project.

As annotated, the main area of note is that of the Music Notation sub-project. Most commonly, music is presented on the internet on Portable Document Format (PDF) of by some form of image (GIF, JPEG) but these formats are totally inaccessible to those with disabilities. The aforementioned ATRC explored two possible solutions to this problem, looking at integrating various existing authoring tools with some music notation file formats such as NIFF (Notation Interchange File Format) and TILIA as a means of enabling educators to create accessible musical notation for their students.

The end result, although still flawed, was the JScoreML online musical notation editor with playback and MIDI file creation capabilities, a Java applet that describes composed musical scores. The final product was proof that it was possible to create an accessible music notation tool. [NIDE2006]

12.6 Contrapunctus

The Contrapunctus Project will design and develop easy-to-use systems allowing visually impaired users to benefit fully from Braille music files. [Contrapunctus2006].
The project aims are:

- Developing instruments in order to preserve Braille music files, existing in the most important European libraries for the blind and sharing them over the internet.
- Developing innovative access methodology to music.

To achieve this the consortium intend:

- Unification of existing national ASCII format, thus assuring compatibility between all texts. Libraries will therefore be able to share music scores.
- Development of a Braille music oriented XML code.
- Development of a software integrated package, capable of reading and interpreting Braille music scores.
- Development of a flexible browser/reader for the blind in order to access digitalized music, allowing the user to read, manipulate, print scores, according to personal specific needs (beginner, blind music teacher, amateur, etc.);
- Development of a demonstrative on-line portal to access a Braille score library.

12.7 The AMBER Trust

The Amber trust supports blind and partially sighted people - particularly those with additional disabilities – in the field of music. The trust recently raised funds for the construction of the Soundscape Centre, a performing arts centre for people with visual impairments, and was opened in 2002. The trust also supports individuals in the purchase of musical instruments, gives grants for tuition and sponsors research. [Amber2006]

12.8 SEMPRE

Originally known as the 'Society for Research in Psychology of Music and Music Education' ('SRPMME'), SEMPRE remains to this day the only society which embraces research in both music education and music psychology, providing an international forum to encourage the exchange of ideas and to disseminate research findings. The Society is particularly keen to encourage the participation of those at the start of their research career and to maintain a broad membership that reflects the considerable range of interests that are represented within music education and the psychology of music. Membership includes free copies of the journal, reduced fees for attendance at conferences, and entitlement to apply for a range of financial awards that are intended to foster new research and assist the work of new researchers. [SEMPRE2006]

12.9 Soundabout

Soundabout was set up in Oxfordshire in 1997 with a mission to foster the development and enhance the quality of life of children and young people with severe disabilities by enabling them to participate in and enjoy interactive music making. Soundabouts's main focus is on working in the classroom side by side with teachers and teaching assistants who often underestimate their own musicality, offering them simple techniques, which facilitate musical expression and participation among their pupils. Soundabout is unique in that it is specifically designed for the most profoundly disabled children and young people, a client group almost entirely overlooked in the world of music education. [Soundabout2006]

13 Appendix A: RNIB Guidelines for Formal Music Performance teaching

13.1 Formal music performance at Primary Level

- Pupils are expected to perform in unfamiliar settings where the acoustics may be very different to rehearsal rooms
- Pupils are expected to cope with raised stress levels around them without opportunities for verbal explanation
- Pupils are unsure what to do in "silent" parts once on stage before the performance and after the piece has finished, and concerned about getting on and offstage unobtrusively.

Key action points
- The more organised and more rehearsed the whole performance package is, the better (from off stage to on stage, through performing, bowing and leaving the stage the better, with plenty of verbal description clarifying adult expectations).
- Explain how to stand or sit on stage before the music begins, including standing still and having heads up (if appropriate).
- Keep instruments to be used in the same relative position as in rehearsals.
- Discuss with the group how the sound is different in the performance area to the rehearsal space, perhaps getting a pupil to talk loudly whilst walking all around the edges of auditorium, giving some idea of the size of the area.
- Make sure your pupil has a friend who can whisper an explanation of any change in plan as surreptitiously as possible.
- Rehearse posture for all in rests between verses in songs and in passages where other pupils are the centre of attractive, particularly if this requires sitting down. This can be made musical, as in after the piece count four beats in your head then all sit down.
- Getting on and off stage may be a good chance to practise sighted guide amongst the pupils, or may just require good line walking, noting steps and sudden contrasts in lighting. More dramatic entries that involve holding hands and skipping can be helpful for orientation and confidence.

Review
- Does your pupil enjoy performing in a group?
- Does your pupil look one of the crowd getting on and off stage, and whilst performing?

Resources
- Research in the area of adult performance, including RNIB's analysis of artists' communication with audience as part of the RNIB Concert Series.
- Looking and discussing video of famous musicians in concert who are visually impaired.

Formal music performance at secondary level

- Using appropriate gesture and facial expression in performance to suit style of music and size of venue.
- Being one of the crowd in travelling to and from gigs.
- Doing sound checks in unfamiliar environments.
- Following conductor's/director's gesture through sound only.

Key action points
- Walk and talk the performance space when deserted by others, and discuss ways that the pupil is comfortable about getting into singing/playing position, and checking that sound levels for electric and electronic instruments are fine.
- Rehearse how to start and end solo pieces, perhaps lifting up head before the start and lowering it after a silence at the end to show the audience can applaud. Rehearse how to acknowledge applause and then judge when to move off stage. If using a sighted guide, make sure the guide is on the side away from the majority of the audience. If unhappy with sighted guide, experiment with trailing fishing wire from a door handle to a chair or microphone stand centre stage. Have a way of checking angle to the audience is correct if possible having something to touch, such as the well of a grand piano.
- Rehearse facial expression and posture in rests in pieces, avoiding any mannerisms that spoil the atmosphere of the music.
- Consider using dark glasses in intimate settings where other artists might rely heavily on eye contact.
- Place Braille or modified print music or cue sheets in attractive folders and place on solid music stands.

Review
- Pupils do not just perform solo, slow, smooth, sensitive numbers, but vary the style and tempo, daring to perform faster more lively numbers.
- Pupils look as good and confident as they sound on stage, not only during pieces but on the way into position and way off stage.
- Pupils are happy to discuss the whole package of performing; both the musical sounds and the visual presence (dress code to body language).

Resources
- Discussion of video of live musicians in specific styles being used, including Young Musician of the Year footage and Youth Music concerts.
- Invite experienced young musicians who are visually impaired to give concerts at your school and to be interviewed on how they do what they do.

14 Appendix B: The Access to Work Case Studies from RNIB

Access to Work (AtW) is a Government scheme administered by Jobcentre Plus, an agency within the Department for Work and Pensions (DWP). AtW was introduced in 1994 when it brought together and replaced a number of disability programmes. The scheme is designed to give practical support to disabled people in work and those entering the labour market. Through AtW the Government will give a grant towards extra employment costs that result only from disability. A report was carried out to find out information about individuals who work as freelance/self-employed musicians, are blind and partially sighted and receive support and funding from the Access to Work scheme (AtW). The purpose of the report was to find out if freelance musicians who are blind and partially sighted are satisfied that the AtW scheme fully supports them. Six individuals were interviewed, and their case studies illustrate the positive and negative experiences of the scheme.

14.1 Case Studies

14.1.1 Case Study 'A'

'A' has worked as a freelance musician for six years, and is totally blind. 'A' and his business partner who is fully sighted, work together as a two-man band. His partner deals with the more visual aspects of their work. They record backing tracks of drums, bass and guitar. Using the backing tracks they work at many gigs performing on keyboard and vocals.

'A' has received some support through the scheme. AtW has covered the total cost of a Braille Lite note taker (a portable note taking machine for people with a sight problem). 'A' uses taxis, paid for by the 'Fares Within Work Scheme'. There are occasions when 'A' will need to visit music shops, and his business partner is not available to drive. At present the scheme allows him sixteen journeys of up to £8.00 each, for a four-week period.
The nature of his work makes his taxi requirements unpredictable and irregular. This will mean some months he does not use up his full quota of journeys, whereas other months he may require more.

'A' uses speech software on his PC, however, he has not received financial support to meet the cost of this access technology. His reason for this is 'by the time you have had the assessment and purchased the software, the programme has been superseded, the scheme is too slow'.
'A' acknowledges the support he receives is good, however at times finds the scheme is not flexible. He suggests the scheme could be improved by AtW setting up a lump sum allowance per year on a case-by-case basis.

14.1.2 Case Study 'B'

'B' performs as a concert, opera and cabaret singer, and actress and music educationalist. She is blind and reads literary Braille.

'B' has been receiving support from AtW for sometime. She uses a support worker for fifteen hours a week. The support worker covers the following:
promotional and administrative support, reading of correspondence, a driver, facilitator at functions and for the dictation of repertoire.
'B' makes a claim once a month for the support worker. 'B' also has a computer (recently upgraded), complete with Scanner and Jaws, for which she was given training, all funded through AtW.

She has never applied to the 'Fares within work scheme', she says this is too complicated, 'You are permanently recording journey lengths, petrol costs etc'.

'B' is satisfied with the scheme and on the whole felt it most efficient, except, 'it was rather a lengthy process to set up, it took six months'.

14.1.3   Case study 'C'

'C' is partially sighted and has been a pop singer, composer and producer for over ten years.

When 'C' first became freelance, she received support form AtW, which she continues to receive. The scheme funded the cost of a driver and also some access technology software; Jaws and Zoomtext, including training and tutorial discs.
'C' currently has a support worker for twenty-one hours a week who amongst other supporting roles is her driver. These hours are flexible, as some weeks she may need the support more than other weeks, so it balances out. This support is reviewed on an annual basis, with the hours being increased or decreased as appropriate.

'C' has a driver who not only takes her to and from gigs but is also responsible for helping her to set up at different venues. This would obviously have been difficult for 'C' to attempt on her own. Given the extra assistance her support worker was providing, 'C' felt that £4.50 an hour he was being paid was insufficient. In November 2003 'C' requested an assessment of payment for her support worker. Despite her regular calls the revised rate of pay was not agreed until February 2004. They queried her reasons for requesting a pay rise for the driver. She stated that the driver also offers a level of technical support at gigs. They agreed with her request for him to be paid £6.50 an hour. She was also applying for the scheme to fund a radio microphone, as she will find this easier to use than a wired microphone. They agreed to fund this, less the cost a normal microphone. She only had to pay £120.00

Overall 'C' feels the scheme is very good. Her only issues are the length of time the process takes and she finds the new claim forms are extremely difficult to access as she has these in hard copy and they are in a small font. (Claim form: appendix C)

In the above case study, the individual questioned the amount the support worker was being paid. The rate of pay for support workers varies, with generally a higher rate being paid for those using expertise in music. It was found that support workers being paid by the scheme were receiving similar levels of pay as other support workers, most notably those working with students.

14.1.4   Case study 'D'

'D' has the eye condition Retinitis Pigmentosa. He was partially sighted, but his sight has deteriorated in the last five years, and he now has no functional vision.
He has been a self-employed musician for two years. He is a keyboard player and a versatile vocalist, playing repertoire from the 1950s to the present day. He always performs solo.

'D' has a support worker who acts as a driver. The support worker is employed for twenty hours a week at £6.25 an hour. The support worker helps set up equipment on stage, to ensure that lights are aimed directly on him and the speakers are not blocking the audiences view. 'D' works out the hours at the end of each month, pays the support worker and then invoices AtW.
He has a Braille display and Jaws access software funded through AtW, including a seven-day training programme.

AtW refused him a computer, scanner and printer, giving the reason that anyone setting up in business would require this equipment.
'D' commented that 'it took a huge amount of effort on his part to have this support agreed. These early days of setting up as a new business were tough'. AtW were not satisfied with his business plan of April 2002 even though his bank manager had said this was the best business plan he had seen.

It took 6-9 months before ATW agreed the business plan.
Once 'D' had a few agents interested in his work ATW took him more seriously – things then moved on quite quickly,

'D' concluded by saying,
'This scheme cannot be black and white as everyone's case is different. However, regions do need to offer the same support as friends of mine in other regions have been provided with equipment that I have been denied'.

14.1.5   Case study 'E'

'E' has worked as a freelance musician for twenty years. She is a performer and workshop leader. She is blind and reads literary Braille.

She has been receiving support from AtW since the scheme was set up in 1994. She receives help from a support worker for ten hours a week, who reads information and carries out some computer work. She submits invoices to AtW on a regular basis for her support worker. Other support for her has included a Braille Lite and Jaws speech software has been installed on her computer. She received two days training on Jaws and a day on the Braille Note.

'E' has faced some issues with the scheme. On two occasions the technology she had through the scheme has gone wrong. However, AtW do not take responsibility for the costs of repairs. For 'E', as a freelance worker who is on a low income, it proved to be difficult to meet these costs. Sometime ago she misplaced her Braille Lite. AtW agreed to replace this with a Braille Note. She had to wait three months before the equipment was replaced. Once she had received the equipment she had a further wait to be trained on how to use it. She also had a considerable wait for Jaws training.

'E' feels that the scheme is essential for disabled people who work and on the whole it is positive. 'E' commented that she would benefit from having a driver, through the 'Fares within work' element, however the paper work she would be expected to complete stopped her from applying, as invoicing and completing claim forms would be hard as they are not particularly accessible.

14.1.6   Case study – 'F'

Case study 'F' is self-employed working as a performer, lecturer and teacher. He is blind and is a fluent literary and Braille music reader.

He has received support from the scheme since it started in 1994. He regularly works with a support worker who in the early days was employed to read print and the dictation of music scores. The support worker will now help him with the transcription process of music notation into Braille through the use of modern technology software programmes. The support worker is currently paid £12.00 an hour, and 'F' submits his invoices via email (those interviewed in previous case studies did not know this was an option).
In 1999 'F' put forward a further business case for a large amount of equipment. He received the following:
a computer, scanner, printer, access technology software (Jaws), music transcription software (Goodfeel, Cakewalk, lime), midi scan and a Braille embosser.
AtW has upgraded the technology and software whenever necessary.

He says, 'In my particular case the scheme functioned magnificently and I wouldn't be able to work without it'.

He mentioned that people in other regions have not been as fortunate as he.

15 Appendix C – Standards for Accessible Music Learning

These descriptions are taken from the EUAIN [EUAIN2006] project deliverable "Standards for Accessible Information Processing". The standards have been chosen for their relevance to accessible Music Learning.

15.1 ANSI/NISO Z39.86 (DAISY) and NIMAS

This standard for creating digital content in structured multimedia is developed and maintained by the DAISY Consortium (www.daisy.org). Using XML text files and MP3 audio files, with the DAISY format we can create a range of text only, fully synchronized text and audio and audio only books that are fully accessible and navigable for blind and visually impaired users as well as persons with other disabilities, such as dyslexia. The DAISY version that is now being used more widely is 2.02, though NISO has already ratified the 2005 revision of Z39.86, which will become version 3.00.

The DAISY format was first aimed to substitute analogue "talking books". Today, the standard allows for different types of books, so that they can include not only the audio rendition of the printed text but the text itself and/or images to go with the text. All the information contained in a DAISY book is fully defined in a set of XML tags, and it is structured in a way that the impaired person reading it can move through its contents in the same way as a sighted reader can do with a conventional printed book. The versatility of a DAISY document allows the user to produce different formats out of a single source file an e-book, an audio book or a Braille book.

The DAISY format originated in a very specific need of a very specific group of disabled users. As a result of this, software and hardware products that are used to produce and/or read DAISY books are dedicated programmes or devices. However, this standard has proved to be useful for all kind of users. In fact, tools based in the DAISY standard, such as AMIS are being used in developing countries for disaster awareness for illiterate people and persons with disabilities. One of the objectives of the DAISY Consortium is to bring this standard to commercial products, such as audio playback devices and software that produces XML documents, to make it available through desktop PCs.

DAISY is currently used as the standard for Talking Music Scores, so is an important standard for the accessible music notations, which are used with i-Maestro.

15.2 Web Content Accessibility Guidelines (WCAG 1.0)

These guidelines became a W3C recommendation on May 5th, 1999. A working draft for WCAG 2.0 already exists. The aim of these guidelines is to tell web and authoring tool developers how to make accessible to persons with disabilities the web pages they create. This does not mean that the final result is intended for these users only, but the accessibility features are good for everyone, helping them to browse those pages and to find the information in them more quickly and efficiently. The guidelines tell them also how to implement multimedia in an accessible environment, so that developers do not have to sacrifice images or video to make them more usable.
The idea is to offer alternate solutions that convey the same information given by inaccessible elements, such as video, images or auditory content. All these guidelines are browser- and technology independent. The Web Accessibility Initiative (WAI) website provides such information.

The Web Content Accessibility Guidelines provide a basis for looking at how content can be made accessible. The Guidelines have been adapted in a document, which will be used to evaluate the Accessibility of i-Maestro technologies.

15.3   Design for All Foundation

Design for All is the intervention on environments, products and services with the aim that everyone, including future generations, regardless of age, gender, capabilities or cultural background, can enjoy participating in the construction of our society, with equal opportunities participating in economic, social, cultural, recreational and entertainment activities while also being able to access, use and understand any part of the environment with as much independence as possible.

To apply the Design for All concepts in products and services, two simple principles should be taken into consideration:

- Make the use of products and services easier for everyone.
- Ensure that the needs, wishes and expectations of users are taken into consideration in the design and evaluation processes of products or services.

The Design for All Foundation is an international foundation with the following aims:
- To develop, promote, research and disseminate Design for All among companies and organisations both at public and private level, administrations, educational agents and also designers and professionals who intervene with the environment, products and services.
- To offer advice and services on Design for All to companies, organisations and administrations at national, European and international level with the aim that the ethical values that Design for All promotes are integrated into quality processes.
- To organise Courses, Seminars and Congresses on Design for All.
- To design the methodology and the development of the appropriate tools so that companies and organisations can implement Design for All in each level of their organisation.
- To award an added value to the administrations, companies, professionals and organisations strengthening their image and competitiveness. The official stamp "Organisation Recognised by the Design for All Foundation" is a guarantee that human diversity is taken into account in all its fields and that its objectives are socially positive.

The concepts of Design for All have been incorporated in all the accessibility work and components of i-Maestro.

15.4 EDeAN (European Design for All e-Accessibility Network)

Created in accordance with one of the specific goals of the e-Europe 2002-2005 Action Plan, EDeAN is mainly engaged in raising the profile of Design for All and emphasizing its importance in achieving greater e-Accessibility.

DfA (Design for All) is in the core of the EUAIN project as the solution to avoid adaptation of materials in a later stage. Accessibility must be an essential part of the design. When it is not possible to build full accessibility within the design of a product, then the objective is to promote a design that would allow for easy adaptation of this product to be made accessible.
EDeAN consists of a number of Special Interest Groups that are relevant to the EUAIN objectives:
- Benchmarking. Development of a structured mechanism for consensus creation and assessment of available knowledge on DfA.
- Standardisation. Contribute to pre-standardisation activities aiming to support groups active in European standards making (e.g., CEN/ISSS DfA Worksop on "DfA and Assistive Technologies in ICT"), as well as international standardisation bodies, in developing implementation strategies for DfA.

- Proactive assessment. An effort towards providing an account of technological developments likely to take place in the future, with the intention to assess both the impact of these developments on certain user communities, and the validity of DfA as an instrument for proactively accounting for technological accessibility. This SIG will be concerned with future aspects of the emerging information society, and will aim to inform and validate DfA as a proactive philosophy of design.

15.5   ISO/IEC JTC1/SC29 (MPEG-4/MPEG-7/MPEG-21)

The MPEG standards are revised and approved under the supervision of SC29, the Committee that deals with the standardization of the coding of audio, picture, multimedia and hypermedia information within the Joint Technical Committee 1 (JTC1) of ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission), two of the leading organizations that produce international standards (together with ITU, International Telecommunication Union).

MPEG-4 is a direct consequence of the need of streaming high-quality multimedia through the World Wide Web. Now, MPEG-4 is much more than that and is able to use low bandwidths to transport video and audio to a number of different devices, from Digital TV to a mobile phone. The audio/video codec is based completely on existing standards and it is an open standard itself. Other interesting features are:

- It is highly interactive and allows for real-time stream control.
- The audio, video and all other objects can be tightly synchronized with high accuracy.
- The objects can be broadcasted, including interactive features (i.e. selectable subtitles for video).
- Interfaces to proprietary DRM systems (more interoperable DRM under development in MPEG-21).
- Supports video/audio and rich 2D/3D mixed media, synthetic graphics, etc.

MPEG-7 is a standard for description of multimedia content. It will be used for indexing, cataloguing, advanced search tools, program selection, smart reasoning about content, etc. It allows the management of high amounts of content locally stored, on-line and in broadcasts.

MPEG-21 is an emerging standard with the goal of describing a "big picture" of how different elements work together to build and infrastructure for the delivery and consumption of multimedia content. It includes a universal declaration of multimedia content, a language facilitating the dynamic adaptation of content to delivery network and consumption devices, and various tools for making DRM more interoperable. MPEG-21 is about managing content and access to content.

The MPEG suite of tools will be of great importance in the development of new ways of accessing multimedia content.
The i-Maestro consortium continue their work in standardising SMR within MPEG-4. This includes support for Braille and Talking Music formats.

15.6 ISO/IEC JTC 1 Special Working Group on Accessibility

ISO/IEC Joint Technical Committee (JTC) 1 believes that the work in the area of information communication and technology standardization for accessibility is a major undertaking, encompassing many international, regional and local interests. Additionally, there are significant standards efforts taking place in ISO, IEC, ITU and the national and regional standards bodies as well as various consortia/fora and user groups. As identified in its long term business plan and to be responsive to international, regional, national, and end user requirements in the area of accessibility, JTC 1 establishes a Special Working Group on Accessibility with the following Terms of Reference:

This SWG, to which EUAIN is a contributor, will:

- Determine an approach to, and implement the gathering of user requirements, being mindful of the varied and unique opportunities (direct participation of user organizations, workshops, liaisons).
- Identify a mechanism to work proactively between meetings to make forward progress.
- Gather and publish an inventory of all known accessibility standards efforts.
- Identify areas/technologies where voluntary standards are not being addressed and suggest an appropriate body to consider the new work.
- Track public laws, policies/measures and guidelines to ensure the necessary standards are available
- Through wide dissemination of the SWG materials, encourage the use of globally relevant voluntary standards.
- Assist consortia/fora, if desired, in submitting their specifications to the formal standards process.

15.7 Learning Technologies Workshop

The Learning Technologies Workshop was officially launched by CEN/ISSS in February 1999. Its objective is to encourage the effective development and use of relevant and appropriate standards for learning technologies for Europe.

At the "Kick-off-Meeting" of the Workshop, the Workshop members agreed to allocate the secretariat responsibility to DIN.

The Learning Technologies Workshop decided, as a matter of principle, not to duplicate work already being done elsewhere, but to ensure that diverse European requirements are properly addressed by global initiatives. Specifications, agreements, guidelines or recommendations will be developed when no initiative addressing the identified requirements is in place yet or when global solutions developed elsewhere need to be localized to European requirements.

Finally, in the domain of eLearning and eTraining, considerable efforts are invested under the IST programme as well as via many national or European initiatives. Projects producing specifications, architectures, reference models, etc., with the intention of attracting broader support and recognition of their work, can use the Workshop as a useful tool for reaching a European-wide consensus on their deliverables.

15.8 Accessibility Properties for Learning Resources (APLR)

It is desirable to meet the needs of encoding Accessibility Meta-data for Learning Objects in Europe that APLR harmonise and integrate with an ongoing work in IMS, Dublin Core Accessibility, ISO IEC JTC1 SC36, W3C WCAG (and XHTML), W3 Device Independence Working Group, an ongoing revision of IMS Content Packaging likely to include material suggesting how accessibility-related alternatives can be packaged and other Meta-data efforts including, not detailed here but highly significant, groups working on interoperability of content repositories. Achieving harmonisation across all these groups is a very difficult task. A core set of these activities for which progress on harmonisation may be more immediately obtainable would include the IMS work, Dublin Core and SC36.

15.9 IMS Global Learning Consortium

The mission of the IMS Global Learning Consortium is to support the adoption and use of learning technology worldwide. IMS is a non-profit organization that includes more than 50 Contributing Members and affiliates. These members come from every sector of the global eLearning community. They include hardware and software vendors, educational institutions, publishers, government agencies, systems integrators, multimedia content providers, and other consortia. The Consortium provides a neutral forum in which members with competing business interests and different decision-making criteria collaborate to satisfy real-world requirements for interoperability and re-use.
IMS develops and promotes the adoption of open technical specifications for interoperable learning technology. Several IMS specifications have become worldwide de facto standards for delivering learning

products and services. IMS specifications and related publications are made available to the public at no charge.

The IMS consortium carry out work relating to Accessible eLearning through the IMS AccessForAll Meta-data Specification. These specifications have been used as background information for the work in this deliverable.

15.10 EUAIN Training Centre and Wiki

The Training and Resource Centre for the European Accessible Information Network (EUAIN), provides an up to date online information portal for stakeholders who are involved in Accessible Information Processing which highlights how information can be made accessible. The material is divided into several sections in order that different stakeholders can find specific and appropriate information. There is a focus on workflow and processes which allow stakeholders to personalise the information they receive and find specific standards, guidelines and best practice which are relevant to their work. [EUAINWIKI2006]

16 Appendix D – MAX/MSP Accessibility Guidelines for Usability Evaluation

As an adaptation of the pre-approved web content guidelines 1.0 and 2.0 and the WAI guidelines for designing Authoring Tools, this document aims to provide an insight into accessible software design and the ability to evaluate their products for accessibility to people with disabilities. It should be noted that detailed within are design guidelines and not restrictions, thus providing developers with the knowledge to create ultimately accessible software that can be used by a wide audience. These criteria aim to point in the direction of ensuring that the i-Maestro technologies meet the available criteria where necessary.

16.1 Introduction

The guidelines discuss accessibility issues and provide accessible design solutions. They address typical scenarios (similar to the font style example) that may pose problems for users with certain disabilities. For example, the first guideline explains how content developers can make images accessible. Some users may not be able to see images, others may use text-based browsers that do not support images, while others may have turned off support for images (e.g., due to a slow internet connection). The guidelines do not suggest avoiding images as a way to improve accessibility. Instead, they explain that providing a text equivalent of the image will make it accessible.

How does a text equivalent make the image accessible? Both words in "text equivalent" are important:

- Text content can be presented to the user as synthesized speech, Braille, and visually-displayed text. Each of these three mechanisms uses a different sense -- ears for synthesized speech, tactile for Braille, and eyes for visually-displayed text -- making the information accessible to groups representing a variety of sensory and other disabilities.
- In order to be useful, the text must convey the same function or purpose as the image. For example, consider a text equivalent for a photographic image of the Earth as seen from outer space. If the purpose of the image is mostly that of decoration, then the text "Photograph of the Earth as seen from outer space" might fulfil the necessary function. If the purpose of the photograph is to illustrate specific information about world geography, then the text equivalent should convey that information. If the photograph has been designed to tell the user to select the image (e.g., by clicking on it) for information about the earth, equivalent text would be "Information about the Earth". Thus, if the text conveys the same function or purpose for the user with a disability as the image does for other users, then it can be considered a text equivalent. Note that, in addition to benefiting users with disabilities, text equivalents can help all users find pages more quickly, since search robots can use the text when indexing the pages.

While Web content developers must provide text equivalents for images and other multimedia content, it is the responsibility of user agents (e.g., browsers and assistive technologies such as screen readers, Braille displays, etc.) to present the information to the user.

Non-text equivalents of text (e.g., icons, pre-recorded speech, or a video of a person translating the text into sign language) can make documents accessible to people who may have difficulty accessing written text, including many individuals with cognitive disabilities, learning disabilities, and deafness. Non-text equivalents of text can also be helpful to non-readers. An auditory description is an example of a non-text equivalent of visual information. An auditory description of a multimedia presentation's visual track benefits people who cannot see the visual information.

16.2 Conformance

The original guidelines aim at conformance of various levels of accessibility based on the guidelines, but as these are adapted to be more specific to i-Maestro, the levels of conformance are no longer valid or official, so conformance, priority and certification issues have been removed, and the document serves as general information only.

16.3 General Usability:

16.3.1 Input devices:

Keyboard:

- Does the software provide keyboard equivalents for all mouse actions including buttons, scroll feature, text entry fields and pop-up windows?
- Are shortcut keys provided for all pull-down menus and are users able to scroll the menus from the keyboard?
- Is there a logical tabbing order among fields, text points and focal points to allow efficient navigation?
- Is there a well defined focal point that moves with keyboard navigation? For example, can a user use the arrow keys to navigate a list followed by ENTER or similar to select the item.
- Does the software support existing accessibility features integrated into some of the major operating systems? Such features include sticky keys, slow keys and repeat keys.

Screen aspects:

- Are descriptions and labels logically positioned immediately to the left or directly above the control and ending in a colon, so that screen reading software can associate the labels with the corresponding fields?
- Do all windows, objects and controls have a clearly assigned unique label?
- Does the software utilise standard controls as opposed to some owner-defined custom controls?

16.3.2 Output devices:

Sound:

- Where audio alerts are applicable there should be visual cues provided to accompany the sounds.
- Can the user adjust volume or disable sound completely?
- If information is being conveyed within the audio it must also be available visually.
- Does the software support operating system feature for sound such as the "show sounds" feature.

VDU:

- Is the software application free of confusing patterned backgrounds used behind text or other important graphics?
- Is there a good contrast between background and foreground information?
- Can a user override default fonts for printing and text displays?
- Can a user disable flashing, rotating or moving displays?

16.4   General Interface - Appearance and Usability

16.4.1   Guideline 1: Provide equivalent alternatives to auditory and visual content.

Designers should provide content that, when presented to the user, conveys essentially the same function or purpose as auditory or visual content.

Although some people cannot use images, movies, sounds, applets, etc. directly, they may still use pages that include equivalent information to the visual or auditory content. The equivalent information must serve the same purpose as the visual or auditory content. Thus, a text equivalent for an image of an upward arrow that links to a table of contents could be "Go to table of contents". In some cases, an equivalent should also describe the appearance of visual content (e.g., for complex charts, billboards, or diagrams) or the sound of auditory content (e.g., for audio samples used in education).

This guideline emphasizes the importance of providing text equivalents of non-text content (images, pre-recorded audio, video). The power of text equivalents lies in their capacity to be rendered in ways that are accessible to people from various disability groups using a variety of technologies. Text can be readily output to speech synthesizers and Braille displays, and can be presented visually (in a variety of sizes) on computer displays and paper. Synthesized speech is critical for individuals who are blind and for many people with the reading difficulties that often accompany cognitive disabilities, learning disabilities, and deafness. Braille is essential for individuals who are both deaf and blind, as well as many individuals whose only sensory disability is blindness. Text displayed visually benefits users who are deaf as well as the majority of Web users.

Providing non-text equivalents (e.g., pictures, videos, and pre-recorded audio) of text is also beneficial to some users, especially non-readers or people who have difficulty reading. In movies or visual presentations, visual action such as body language or other visual cues may not be accompanied by enough audio information to convey the same information. Unless verbal descriptions of this visual information are provided, people who cannot see (or look at) the visual content will not be able to perceive it.

Checkpoints:
Create useful alternative examples to those given.

16.4.2   Guideline 2: Do not rely on colour alone.

Ensure that text and graphics are understandable when viewed without colour.

If colour alone is used to convey information, people who cannot differentiate between certain colours and users with devices that have non-colour or non-visual displays will not receive the information. When foreground and background colours are too close to the same hue, they may not provide sufficient contrast when viewed using monochrome displays or by people with different types of colour deficits.

Checkpoints:
2.1 Ensure that all information conveyed with colour is also available without colour
Techniques for checkpoint 2.1
2.2 Ensure that foreground and background colour combinations provide sufficient contrast when viewed by someone having colour deficits or when viewed on a black and white screen.

Techniques for checkpoint 2.2

For example, a dark background with light text and vice-versa.

TEXT **TEXT**

2.3 Does the software ensure that colour-coding is never used as the only means of conveying information or indicating an action?

2.4 Is highlighting also available for inverted colours?

2.5 Does the application support user defined colour schemes generically throughout the system?

16.4.3   Guideline 3. Ensure direct accessibility of embedded user interfaces.

Ensure that the user interface follows principles of accessible design: device-independent access to functionality, keyboard operability, self-voicing, etc.

When an embedded object has its "own interface", the interface -- like the interface to the browser itself -- must be accessible. If the interface of the embedded object cannot be made accessible, an alternative accessible solution must be provided.

Note. For information about accessible interfaces, please consult the User Agent Accessibility Guidelines ([WAI-USERAGENT]) and the Authoring Tool Accessibility Guidelines ([WAI-AUTOOL]).

Checkpoint:
3.1 Make programmatic elements such as scripts and applets directly accessible or compatible with assistive technologies

16.4.4   Guideline 4. Design for device-independence.

Use features that enable activation of software features via a variety of input devices.

Device-independent access means that the user may interact with the user agent or document with a preferred input (or output) device -- mouse, keyboard, voice, head wand, or other. If, for example, a form control can only be activated with a mouse or other pointing device, someone who is using the page without sight, with voice input, or with a keyboard or who is using some other non-pointing input device will not be able to use the form.

Generally, software that allowskeyboard interaction should be easily adapted to be accessible through speech input or a command line interface.

Checkpoints:
4.1 Ensure that any window that has its own interface can be operated in a device-independent manner.
4.2 Create a logical tab order through links, form controls, and objects.
For example, in HTML, specify tab order via the "tabindex" attribute or ensure a logical page design. see input devices - keyboard
4.3 Provide keyboard shortcuts....

16.4.5 Guideline 5. Use technologies and guidelines.

What technologies exist for making appearance consistent etc?
Consistent design etc....

16.4.6 Guideline 6. Provide context and orientation information.

Provide context and orientation information to help users understand complex windows or elements.

Grouping elements and providing contextual information about the relationships between elements can be useful for all users. Complex relationships between parts of a window may be difficult for people with cognitive disabilities and people with visual disabilities to interpret.

Checkpoints:

6.1 Title each window to facilitate frame identification and navigation.
6.2 Describe the purpose of windows and how they relate to each other if it is not obvious by titles alone.
6.3 Divide large blocks of information into more manageable groups where natural and appropriate.
6.4 Associate labels explicitly with their controls.

16.4.7 Guideline 7. Provide clear navigation mechanisms.

Provide clear and consistent navigation mechanisms -- orientation information, navigation bars etc. -- to increase the likelihood that a person will find what they are looking for on a window

Clear and consistent navigation mechanisms are important to people with cognitive disabilities or blindness, and benefit all users.

Checkpoints:
7.1 Clearly identify the function of each button or menu field.
7.2 Use navigation mechanisms in a consistent manner.
7.3 Provide navigation bars to highlight and give access to the navigation mechanism.
7.4 If search functions are provided, enable different types of searches for different skill levels and preferences.
7.5 Place distinguishing information at the beginning of headings, paragraphs, lists, etc. Note. This is commonly referred to as "front-loading" and is especially helpful for people accessing information with serial devices such as speech synthesizers.

16.4.8   Guideline 8. Ensure user control of time-sensitive content changes.

Ensure that moving, blinking, scrolling, or auto-updating objects or windows may be paused or stopped.

Some people with cognitive or visual disabilities are unable to read moving text quickly enough or at all. Movement can also cause such a distraction that the rest of the page becomes unreadable for people with cognitive disabilities. Screen readers are unable to read moving text. People with physical disabilities might not be able to move quickly or accurately enough to interact with moving objects.

Note. All of the following checkpoints involve some content developer responsibility until user agents provide adequate feature control mechanisms.

Checkpoints:

8.1 Until user agents allow users to control flickering, avoid causing the screen to flicker.
Note. People with photosensitive epilepsy can have seizures triggered by flickering or flashing in the 4 to 59 flashes per second (Hertz) range with a peak sensitivity at 20 flashes per second as well as quick changes from dark to light (like strobe lights).
8.2 Until user agents allow users to control blinking, avoid causing content to blink (i.e., change presentation at a regular rate, such as turning on and off).
8.3 Until user agents allow users to freeze moving content, avoid movement in pages.
When a window includes moving content, provide an option to allow users to freeze motion or updates.
8.4 Until user agents provide the ability to stop the refresh, do not create periodically auto-refreshing windows.
For example, in a multi-window application, do not cause a window to auto-refresh/update from a change made in another window until user agents allow users to turn off the feature.

16.4.9   Guideline 9. Ensure that documents are clear and simple.

Ensure that documents are clear and simple so they may be more easily understood.
Consistent page layout, recognizable graphics, and easy to understand language benefit all users. In particular, they help people with cognitive disabilities or who have difficulty reading. (However, ensure that images have text equivalents for people who are blind, have low vision, or for any user who cannot or has chosen not to view graphics. Refer also to guideline 1.)

Using clear and simple language promotes effective communication. Access to written information can be difficult for people who have cognitive or learning disabilities. Using clear and simple language also benefits people whose first language differs from your own, including those people who communicate primarily in sign language.

Ensure instructions are widely available for users regarding I/O devices and the general operation of the software, on multi-formats.

Are all user manuals and other documentation provided in electronic format (such as pdf) as well as ASCII text files, including text descriptions of any diagrams or graphics of any nature?

Can a user choose to have any report or on-screen textual alert made available in a "print to ASCII file" format?

Any future information sent out from the developers or their partners should consider the needs of their user and should thus be provided on the appropriate format. For example, large print, Braille or on Audio format for the visually impaired.

Checkpoints:

9.1 Use the clearest and simplest language appropriate for an application's content.

9.2 Supplement text with graphic or auditory presentations where they will facilitate comprehension of the page.

9.3 Create a style of presentation that is consistent across

17 Appendix E – OS native assistive Technologies

Most operating systems have a level of native accessibility built in. There are active projects for the main Linux distributions for Accessibility [KDE2006][GNOME2006], these projects arguably provide a more adapted and usable system for Linux users than the mainstream solution, but since most of the users of Linux are programmers themselves they are more likely to be able to adapt systems to their own criteria and personalisations.

17.1 Apple

Apple have an accessibility project [Apple2006]. This offers a variety of accessibility features, many of which are native to the MacOS environment.

17.1.1 Physical and Motor disabilities:

The following features will help those with physical or motor disabilities where use of input devices like a mouse, track-pad or even keyboard can be difficult or impossible.

Slow Keys

By utilizing the slow keys feature, users can initiates a delay between key presses thus eliminating unintentional, multiple keystrokes. This feature also allows users to take more time as they navigate.

Sticky Keys

Sticky keys let you create key combinations (pressing multiple keys simultaneously, such as Command-Q and Shift-Option-8) by pressing them sequentially. With Sticky Keys active, each key in the sequence is translucently displayed on screen so you can verify the sequence and correct it, if necessary, before it is executed. For those who can press only one key at a time, this feature gives them more flexibility.

Keyboard Settings

The system preferences allow a user to modify key repeat and delay rates in accordance with their preferences. This can be found in the Keyboard and Mouse settings. This feature can be used in conjunction with Slow Keys to maximize keyboard usability

Keyboard Navigation

Keyboard navigation allows you to navigate the operating system and applications using the keyboard. Keyboard shortcuts let you quickly perform tasks on your computer by pressing keys on your keyboard. Shortcuts are customizable and can be used system-wide or assigned to individual applications.

Mouse Keys

For those having difficulty using the mouse, they can use the numeric keypad to navigate the cursor around the screen. MacOS X also allows efficient use of the keyboard to navigate menus, windows, toolbars, palettes, the dock and other application controls. Apple makes sure that everything can be done with the mouse, can be done with the keyboard.

Speech Recognition & Talking Alerts

Many applications cater for speech recognition, where users can use recognized vocal commands to perform tasks such as opening and closing an application, navigating the menu bar, switching between programs, controlling application-specific items, entering keyboard shortcuts and even speak front window controls like a check box or radio button name. There is no need to train the computer to your voice as with many other voice recognition features

The talking alerts feature gives voice to alert and dialog windows by verbally identifying the application and reciting the contents of its dialog box.

17.1.2   Hearing Impairments:

Integrated into the MacOS environment is an array of audio-based accessibility features designed to aid those with hearing difficulties. Audio alerts and other sounds can be accompanied by text or amplified in the following ways.

QuickTime

The Apple media player, QuickTime, allows you to create and display a text track to provide closed captioning.

Visual Alert

A visual alert feature can be enabled on MacOS X to notify the user when the operating system or an application sounds an audio alert. The visual alert flashes the entire screen to let the user know that their attention is required.

iChat and iSight

Apple's iChat and iSight system uses state of the art audio and video technology to provide the first video conferencing solution capable of sign language communication over the internet. With high quality video capable of clearly showing the fingers and hand movements of the person with whom you are communicating, users can comfortably communicate with the same emotional input experienced from an intimate conversation.

17.1.3   Visual Impairments:

If a user has difficulty seeing a computer screen, MacOS can provide magnification of the screen or a particular object and display characteristics can be easily altered to aid viewing.

VoiceOver

The Universal Access capabilities of Mac OS X are now enhanced with a spoken interface that provides a new way, through speech, audible cues, and keyboard navigation, to access the Macintosh.

Zoom

With Zoom view you can magnify everything on screen making it larger and easier to see. Both text and graphics are enlarged for easier reading and QuickTime video plays magnified without any performance degradation, a capability not available on any other operating system. The powerful Quartz rendering and compositing engine makes Zoom view possible, delivering magnification up to 40x, and sophisticated filtering and anti-aliasing to make text and graphics look good at larger sizes.

Zoom includes a number of options like the ability to set maximum and minimum values for rapid zooming in and out, a preview rectangle that outlines the portion of the screen that will be magnified, and the ability to customize how the screen moves as you navigate with the mouse pointer.

Scalable Cursor

Mac OS X enables you to easily increase the size of the mouse cursor so it is easier to find and follow when you move the mouse. The cursor remains scaled to your preferred size even when the cursor shape changes from an arrow to an I-beam, to cross-hairs, or any other shape. It remains in effect until you change it, even when you logout, shutdown or restart your computer. Cursor scaling works together with other screen magnification technologies in Mac OS X, allowing you to combine them in unique ways to suit your needs.

Talking alerts and spoken items

Talking alerts and spoken items provide an audible method for getting feedback from the computer. With talking alerts visual notifications are spoken aloud by the computer providing an audible method that alerts you when the computer needs your attention. Spoken items reads back the text under which you are holding the mouse and can also read back selected text when used with a customizable key combination.

Display Adjustment

Mac OS X includes flexible display adjustments with which you can control contrast by switching the screen to White on Black or using the enhance contrast slider for varying degrees of contrast, and set Mac OS X to display in grayscale, removing all colour from the screen.

The growing popularity of the MacOS system is providing developers with opportunities to create third-party accessibility software for the existing Apple software that after quality testing may be approved and endorsed by Apple.

17.2 Microsoft Windows OS:

17.2.1 Display and Readability

On a Microsoft Windows operating system a user has the following accessibility options to cater for any visual impairment they may have.

Adjust Display and Appearance

By using the Display icon, one can modify the appearance of windows, menus, fonts, icons and other desktop objects as some colours, fonts and sizes are easier to visualize.

Use Large Icons

Enlarging the icons on your screen to make them easier to see or to access is another simple feature that the Microsoft environment has to offer.

Choose Screen Resolution

As with most systems, the screen resolution can be adjusted (reduced) to enlarge on-screen items. An increase in resolution will subsequently reduce the size of icons but allows more information to be displayed.

Choose a High Contrast Colour Combination to Improve Screen Resolution

Like Apples Display adjustment, **High Contrast** is a Microsoft accessibility feature designed for those who have vision impairment. High Contrast colour schemes are known to increase legibility for some users by heightening screen contrast with alternative colour combinations. Some of the schemes also change font sizes for greater legibility.

Adjust Cursor Blink Rate and Cursor Width

The blink rate and width of the cursor can be changed making the cursor easier to see or even less distracting for those with vision or seizure disorder accessibility needs.

Using Magnifier

The Magnifier utility enlarges the screen to make it more readable for those with low vision by creating a separate window displaying the magnified screen section.

Sounds and Speech

Windows XP includes options to make sounds easier to hear or distinguish. There are also visual alternatives available to sound. A variety of speech-to-text options are also available.

Volume adjust

The computers volume can be adjusted for those with a hearing impairment work in a noisy environment or for similar complaints. For those that rely heavily on the sound output, like blind or visually impaired users, sound is very important for the relay of information and it must bee loud and clear. The volume of external speakers can also be adjusted.

Choose a Sound Scheme

A sound scheme can be chosen to assign to many program events in Windows XP. Every sound scheme consists of a set of events and sounds associated with them. A new sound scheme can also be created. Sound schemes can benefit people who rely on audio for the relay of information from their computers including people who are blind or have other vision impairments

ShowSounds: Display Captions for Speech and Sounds

ShowSounds is an accessibility feature, which instructs applications that usually convey information solely by sound to also provide all information visually, such as the display of text or informative icons.

SoundSentry: Get Visual Warnings for System Sounds

SoundSentry is an accessibility feature designed for people who have difficulty hearing system sounds generated by the computer. SoundSentry allows you to change the settings to generate visual warnings, such as a blinking title bar or a screen flash, whenever the computer you are using generates a sound. You will be able to choose visual warnings (for example, a flashing border) for sounds made by windowed programs and for sounds made by full screen text programs.

Notification—Get sound or visual cues when accessibility features are turned on or off.

Adjusting Speech Options

Using the **Speech** icon in Control Panel, you can control the voice properties, speed, and other options for text-to-speech (TTS) translation. For example, you can choose text-to-speech voices, the rate of speech for text-to-speech playback, and select a preferred audio device as output for text-to-speech playback.

17.2.2 Keyboard and Mouse

In Windows XP a number of options are available to make the keyboard and mouse faster and easier to use. These options include:

Double–Click Speed of the Mouse

The double-click speed of the mouse can be altered to make it faster or slower.

ClickLock: Highlight or Drag Without Holding Down the Mouse Button

The ClickLock option allows a user to drag or hold an item without the need to keep the mouse button depressed.

Select a Pointer Speed

According to user preferences and requirements, the pointer speed, that is the rate that the pointer moves with respect to the mouse, track-pad or other input device, can be adjusted.

SnapTo: Move Pointer to the Default Button in a Dialog Box

This feature makes the pointer move too the default button in a dialog box so that is easier to trace the whereabouts of the cursor for option selection, for example when the ENTER button is pressed.

Adjust Cursor Blink Rate

You can adjust the speed at which the cursor (insertion point) blinks to make it more visible, or less— depending on your needs. People with seizure disorders related to flashing or blinking objects may want to set the blink rate to **None** to turn blinking off completely.

Display Pointer Trails

For increased visibility of the mouse pointer, Windows XP allows the user to display a trail behind the pointer on Liquid Crystal Display (LCD) screens; the length of the tail can also be adjusted.

Hide the Pointer While Typing

For those using an enlarged pointer there is a feature that can hide it whilst typing, for greater visibility of the subject document. The pointer reappears when the mouse, trackball or equivalent is moved.

Show Location of Pointer

After activating the show location of pointer feature, by pressing the CTRL key on a Windows system a brief animation will locate the pointer for the user, a usual aid for those with visual impairments.

Reverse the Function of the Right and Left Mouse Buttons

The mouse has a primary and secondary mouse button. These buttons can be reversed for accessibility reasons or for left-handed mouse use. The default primary button on a mouse is the left, after reversal, the primary button becomes the right button.

Choose a Pointer Scheme

The user can choose a pointer scheme—a predefined set of mouse pointers, such as Magnified or Windows Black (extra large)—to increase visibility of the mouse pointer on the screen.

17.2.3 Keyboard Options:

Adjust Character Repeat Rate

You can adjust both the **repeat delay** (amount of time that elapses before a character repeats when you hold down a key), and the **repeat rate** (the speed at which a character repeats when you hold down a key). Adjusting these settings can benefit people with mobility impairments.

Dvorak Keyboard Layout

An alternative keyboard layout known as the "Dvorak" layout has been known to increase typing speeds for those that type with one hand or finger. This layout places the more frequently typed characters in a more accessible location than that of a standard "Qwerty" style layout. Thus, the amount of motion required to type common English text is reduced. The use of such a layout may help avoid some types of repetitive strain injuries occurring whilst typing.

StickyKeys: Press One Key at a Time for Key Combinations

StickyKeys is an accessibility feature designed for people who have difficulty holding down two or more keys at a time. When a shortcut requires a key combination such as CTRL+P, StickyKeys will enable the pressing one key at a time instead of pressing them simultaneously.

FilterKeys: Ignore Brief or Repeated Keystrokes and Slow Down the Repeat Rate

FilterKeys is an accessibility option that adjusts the keyboard response so that inadvertently repeated keystrokes are ignored. Using FilterKeys, a user can also slow a keys repeat rate when it is held down.

Togglekeys: Hear Tones When Pressing Certain Keys

ToggleKeys is an accessibility feature designed for people who have vision impairment or cognitive disabilities. When ToggleKeys is activated, the computer will provide sound cues when the locking keys (CAPS LOCK, NUM LOCK, or SCROLL LOCK) are pressed. A high sound plays when the keys are switched on and a low sound plays when they are switched off.

MouseKeys: Control the Mouse Pointer Using the Numeric Keypad

Mousekeys is an accessibility feature designed for people who have difficulty in using a mouse. MouseKeys allows you to use the numeric keypad to control the movement of the mouse pointer. If one wanted to use the numeric keypad for data entry as well as for navigation, you can set MouseKeys to be activated by pressing NUM LOCK.

Show Extra Keyboard Help in Programs

When this accessibility option is selected, extra keyboard help is displayed in programs in which it is available.

17.2.4   Accessibility Wizard and Utilities

The Accessibility Wizard can help new users quickly and easily set up groups of accessibility options that address **visual**, **hearing** and **dexterity** needs all in one place. The Accessibility Wizard asks questions about accessibility needs. Then, based on the answers, it configures utilities and settings for individual users.

17.3   Accessibility Features In The Forthcoming Windows Vista

17.3.1   Preview of Accessibility in Windows Vista

Microsoft Windows Vista includes built-in accessibility settings and programs that make it easier for computer users to see, hear, and use their computers. Microsoft invested in more than three years of research to better understand the needs of people who experience a wide range of physical challenges that can impact their computer use. The accessibility settings and programs in Windows Vista are particularly helpful to people with visual difficulties, hearing loss, pain in their hands or arms, or reasoning and cognitive issues.

Major accessibility improvements in Windows Vista are the Ease of Access Center and state-of-the-art speech recognition and magnification capabilities.

17.3.2   Ease of Access Center

The new Ease of Access Center in Windows Vista provides a centralized location where you can get quick access to adjust accessibility settings and manage assistive technology programs.

The Ease of Access Center includes:
1 **Quick Access.** Start Magnifier, Narrator, On-Screen Keyboard, and High Contrast.
2 **Recommended Settings.** Based on answers to questions about performing routine tasks, such as whether you have trouble seeing faces or text on TV, hearing normal conversations, or using a pen or pencil, Windows Vista provides a personalized recommendation of the accessibility settings and programs that are likely to improve your ability to see, hear, and use your computer.
3 **Explore available settings by category.** The Ease of Access Center also lets you explore settings options by categories: including making the computer easier to see, using the computer without a display, changing mouse or keyboard settings or using the computer without a mouse or keyboard, using alternatives for sounds, and making it easier to focus on tasks.
The Ease of Access Center can be found in the Control Panel of Windows Vista, or by selecting Winkey+U. The Ease of Access Center replaces the Accessibility Wizard and Utilities Manager in previous versions of Windows.

Make Things on the Screen Larger with Microsoft Magnifier

The newly improved Magnifier, the magnification program built into Windows Vista, enables you to magnify the computer screen up to sixteen times. The magnification quality is significantly improved and now you can choose magnification levels from 2 to 16 times the original and choose to track the mouse, the keyboard, or text editing. Magnifier can be found in the Ease of Access Center.

Hear Text Read Aloud with Microsoft Narrator

The newly improved Narrator text-to-speech tool, built into Windows Vista, now reads Narrator menus without leaving the active window. Individuals who use Narrator will also find a more pleasant, natural sounding voice. Narrator can be found in the Ease of Access Center.

Speech Recognition Interact with Your PC with Your Voice

Speech Recognition in Windows Vista empowers you to interact with your computer by voice, significantly reducing the use of a mouse and keyboard while maintaining or increasing your overall productivity. You can dictate documents and e-mail, fill out forms on the Web, and command applications and the operating system by saying what you see. Right from the beginning, you are guided through an easy setup process and an interactive training application that will familiarize you with the voice commands. Whether it is starting an application, selecting a word, or correcting a sentence, you are always in control and guided toward a list of smart choices. Find Speech Recognition in the Control Panel of Windows Vista.

Compatibility with Assistive Technology Products

Microsoft works closely with assistive technology (AT) manufacturers through the Microsoft Assistive Technology Vendor Program to ensure that AT products are ready when Windows Vista is available. Many AT products, including multiple screen readers, will be available on Windows Vista when it is released. Be sure to check with your AT manufacturer before upgrading if you have concerns.

Ease of Access Center

Provides a centralized location where you can adjust accessibility settings and manage accessibility programs.

Speech Recognition

Enables you to interact with your computer using only your voice while maintaining, or even increasing, your productivity.

Magnifier

Enlarges part of the screen while you work, leaving the rest of your desktop in a standard display.

Narrator

A text-to-speech program that reads aloud on-screen text and describes some events (such as error messages) that happen while you're using the computer.

On-Screen Keyboard

A visual, on-screen keyboard with all the standard keys that you can use instead of a physical keyboard. On-Screen Keyboard also lets you type using an alternative input device.

Keyboard shortcuts

Use keyboard shortcuts as an alternative to the mouse. Keyboard shortcuts can be found in the menus of programs, or, if a letter is underlined on a menu, that usually means pressing the ALT key in combination with the underlined key has the same effect as clicking that menu item.

Mouse keys

Instead of using the mouse, you can use the arrow keys on the numeric keypad to move the pointer.

Sticky Keys

Instead of having to press multiple keys at once (such as when you must press the Ctrl, Alt, and Delete keys simultaneously to log on to Windows), you can press one key at a time when Sticky Keys is turned on.

Filter Keys

Ignores keystrokes that occur in rapid succession and keystrokes that are held down for several seconds unintentionally.

Visual Notifications

Replace system sounds with visual cues, such as a flash on the screen, so system alerts are announced with visual notifications instead of sounds.

Captions

Turn on text captions for animations and video.

Replacement for SerialKeys

Windows Vista does not include SerialKeys. In previous versions of Windows, Serial Keys provided support so that alternative input devices, such as single switch or puff and sip devices, could be plugged into the computer's serial port. For individuals that used these devices, it is important to install an alternative solution prior to upgrading to Windows Vista. Recommended solutions: AAC Keys and SKEYS from Eyegaze.

Keyboard shortcuts are integral component of accessible interface design. If the system specific keyboard shortcuts are not used by the Native OS in question, decisions will have to be made as to which keyboard shortcuts to use. There are standards for this. [freestandards2006]

Full keyboard support should be included as part of the interface design. Care should be taken to ensure that a sensible tab order for controls is preserved and that the focus can be visibly tracked.

When course material is in the form of data that will be displayed and manipulated through another application (for example as web pages viewed through a browser or spreadsheet data used in a standard office spreadsheet program) content designers need to be aware that their material can adversely effect the way the application works. We may 'know' that Internet Explorer and Microsoft Excel are fundamentally *accessible* but this can be defeated by poorly designed content. Using a standard application does not remove the need to check that it works with new content.

Frequently used functions should have logical (and memorable) keyboard shortcuts assigned to them. Wherever possible standard operating system conventions should be supported. For example, in Windows, Ctrl-C and Ctrl-V for Copy and Paste, Ctrl-S for Save, Ctrl-P for Print.

Designers should avoid re-using standard Windows keyboard functions for application specific purposes.

Keyboard support should be documented and visual clues (such as underscoring a letter) provided so that users are aware it is available.

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