Project Number: 51-HXA-DK35

BRAILLE MUSIC TRANSCRIPTION SOFTWARE AT INSTITUTTET FOR BLINDE OG SVAGSYNEDE

An Interactive Qualifying Project Report
submitted to the Faculty of the
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science
by

Sarah Bellfy

Adam Fuller

Arno Hautala

Date: 1 May 2003

Approved:

1. Braille
2. transcription
3. music

Professor Holly K. Ault, Advisor

Abstract

The need for Braille music is high among blind music students, but access is limited due to the time and cost of transcription. Recent advances in computer technology have made Braille music much more accessible through automated transcription software. To assess the software, trials were completed with blind and low vision users at Instituttet for Blinde og Svagsynede (IBS) in Copenhagen. A final recommendation was made to IBS as to how such software may best benefit the blind or low vision students through integration into their curriculum. Both the curriculum of the sponsor and needs of the individual were considered.

Executive Summary

Throughout the world, there are 38 million blind people and an additional 110 million people with low vision at risk of becoming blind (World Health Organization [WHO], 1997). These people live in a very sight-oriented world and must find alternative methods for daily activities. From the simplest task of reading this paper, to the complex task of reading and writing music, people with blindness or low vision must develop ways to achieve success. Fortunately many years ago the Braille system of reading and writing was developed to make these and other tasks possible. Along with written words, a system of Braille music was developed and has become the only universal Braille language.

In Denmark, it is estimated that there are 13,000 people with low vision and 10% of these people are students or on the vocational track. The Instituttet for Blinde og Svagsynede (The Institute for the Blind and Partially Sighted) or IBS Vocational in Copenhagen, Denmark is looking for computer software packages that transcribe sheet music into Braille that can be used by their students. They are also looking for the best way to integrate an appropriate software package into their current curriculum. The goal for this research was to identify available software packages that perform these functions and suggest ways in which these software packages could be integrated into the curriculum at IBS.

There are a variety of hardware and software packages available that make computers more accessible to blind and low vision persons. While all software and hardware tools that will aid the blind can also be used to aid those with low vision, the reverse is not necessarily true. Software and hardware targeted at improving access for

people with low vision improves readability of the computer screen, the keyboard, the printer, and other input and output devices. Screen enlargers are used to increase the size of everything on the computer monitor. The scale can be increased to different levels depending on the needs of the user. Some possible options for screen enlargement are Lunar Screen Magnifier by Dolphin Computer Access, Magic Screen Modification Software with Speech by Freedom Scientific Inc., and ZoomText by AI Squared. Blind users, however, require hardware or software that produces output for the person to hear or feel. Screen readers are used to read elements on a computer screen such as menus, dialog boxes, and contents of documents. Some of the elements that may not be read are pop-up windows and graphics. A few screen readers that may be of use to a blind user include JAWS for Windows by Freedom Scientific and Window-Eyes by GW Micro Inc. (Microsoft, 2003). In addition to speaking the output, content may be sent to a refreshable Braille display.

There are many options for sighted, low vision and blind musicians to produce music using a computer. Some of the editing software packages available are Sibelius, Finale, Toccata, and Lime. Sibelius is a versatile music software package in its ability to read music files such as MIDI, NIFF (notation interchange file format), and files created in other music programs such as Finale, SCORE, and Allegro. Sibelius can work with a computer scanner to input music by scanning the original sheet music and input from a MIDI keyboard (Sibelius, 2002). Finale is a professional level editor distributed by Coda Music. It is an industry standard application used in many music publishing organizations. Finale sports an interface very similar to that of Sibelius and it matches features as well. Finale supports MIDI and the proprietary Finale format file (Coda

Music, 2003). Toccata can accept musical input from a MIDI keyboard, MIDI or NIFF file, scanned into the computer, or entered using the computer keyboard and mouse. The software will display the notes both in traditional print and also in Braille print (Toccata, 2002). Lime allows input of music via computer or MIDI keyboard in multiple instruments. Notes are input via computer keyboard as if the keys were organized as in a piano (Dancing Dots, 2002).

There are also software packages available that transcribe music into Braille. Three of these packages are GOODFEEL, Braille music kit plug-in for Finale, and Toccata. GOODFEEL is designed for music transcribers and sighted musicians. It allows teachers to transcribe music into Braille quickly and inexpensively (Dancing Dots, 2002). Braille Music Kit is an editor for Braille music in two parts. A free plug-in for Finale converts notated music into Braille music using "the music rules of the New International Manual of Braille Music Notation published by the World's Union for the Blind in 1996" (Dodiesis, 2003). An additional editor provides a means of editing the Braille music in Braille form. The editor Toccata can also display the entered music in Braille notation.

The methodology of research into the use of Braille music software at IBS Vocational was organized into four major tasks: curriculum survey, initial assessment of software, software field testing, and preparation of recommendations. The curriculum survey included attendance of classes by the group to find where the students would use the software. The initial assessment of the software included the establishment of criteria for software evaluation, research into available software packages from websites and schools currently using these software packages, and trials by the group. The software packages were divided into two groups: notation editing software and transcription

software. The notation editing software packages tested were Sibelius, Finale, Lime, and Toccata. The transcription software packages tested were GOODFEEL, Braille music kit plug-in and Toccata. Software field testing was performed by creating specific trial tasks that were used to test the different software packages. These trials were done to determine how difficult the programs were to learn and where common places were for errors. Finally recommendations were made for which software packages would be best for use at IBS Vocational and the best ways to integrate the use of these packages into the curriculum.

The trial tasks for the notation editing software packages included opening the program and creating a new document, composing a sample piece of music (shown in Fig. 0.1), and saving the piece as a MIDI file.

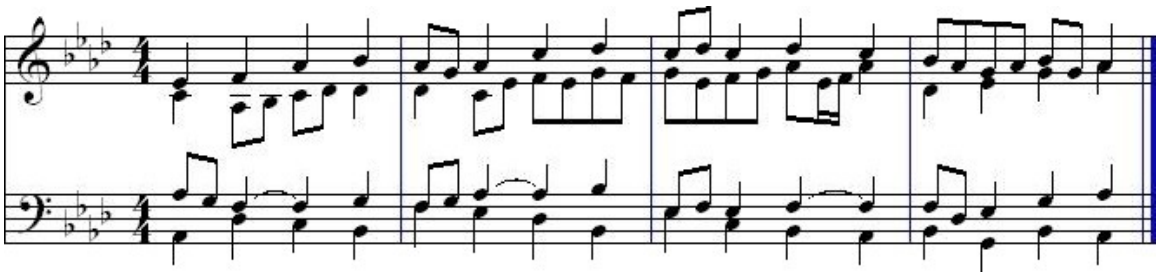

Figure 0.1. Sample four measure harmony used for software testing purposes.

The tasks for the transcription software included opening the program, transcribing the music to Braille and printing the music to the screen. These trials were completed by the group. The trials were done both with and without a mouse.

The trials conducted by the group provided a basis to evaluate the software packages. Some packages were easier to use than others when tested by sighted users. Some reasons for the differences were the different ways of entering music and the features available quickly through a graphical interface. These same reasons for difficulty extended to the student trials where the graphical interface became an important

evaluation technique. For a blind user, the use of graphics is impossible without the screen reader being able to read the elements. The trials showed that for complete independent use by a blind user, the software package must be able to be used without a mouse and must have elements that can be read by a screen reader.

Four groups of target users were identified: blind students, sighted or low vision students, blind teachers, and sighted or low vision teachers. A member of each group was able to be tested except a blind teacher because none were available to complete the trial. The tests included time required to complete each task, number of steps it took, and number of errors for each task. Along with the timed trials, the group conducted un-timed trials with the minimum number of steps required to complete the trial with no errors both using and not using a mouse. The following bar graph (Fig. 0.2) shows the results of these minimum step trials.

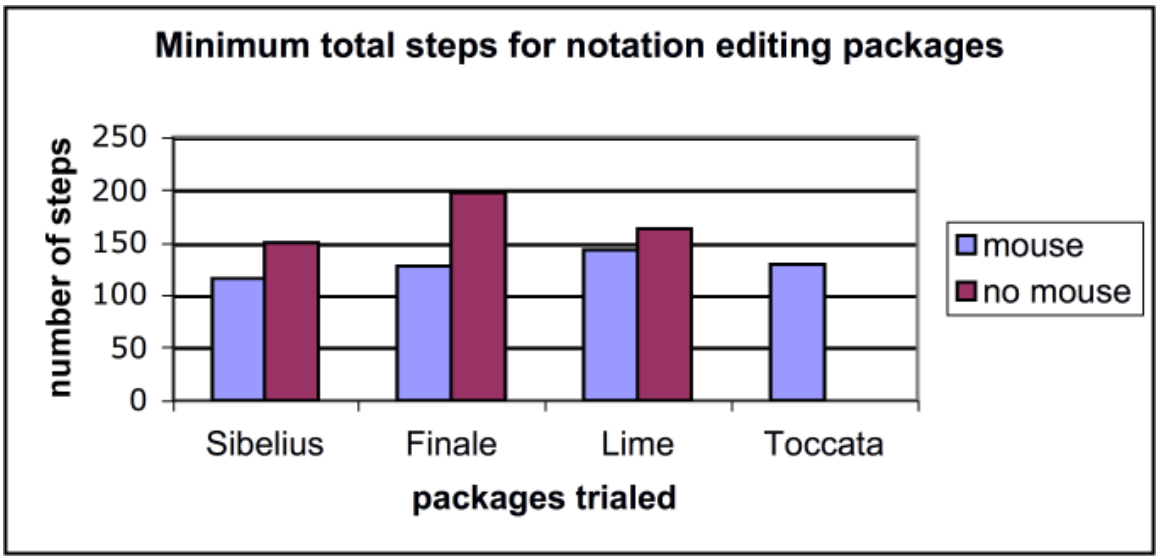

Figure 0.2. Minimum number of total steps required to complete the trial in each notation package.

From classroom observations, the group found that the most important part of the IBS Vocational music curriculum is the one-on-one teaching style. No recommendations can be made that would disrupt this. A software package must be able to satisfy the

needs of both a diversified curriculum and the varying students, either blind or low vision.

Although the students and their courses vary, the main goal of each student is the same: to become a professional musician. To be able to do this, it is imperative that a student be able to communicate what he or she is writing. Many teachers at IBS Vocational feel that it is essential for a blind student to read Braille music because in order to function as a professional musician, a person must be able to read music. It is also necessary for students to be able to use a music editing software program because equivalent sighted musicians do so. This is particularly important for those students that go on to the music academy where Sibelius is currently being used. In conjunction with the editing software, a blind student must be able to use a transcription software package to print his or her music and have a convenient storage method on a disk rather than thick volumes of paper.

In comparing software packages, all are approximately feature equivalent. In testing, the quickest entering and transcription occurs in Finale with the Braille Music plug-in, where additional software is not required. Toccata is similarly fast but was not usable without a mouse. Additionally, Sibelius provides the most accessible entering process but requires output to a MIDI file where information is lost. By using Lime before transcribing with GOODFEEL, this information may be re-entered. Lime may be a valid solution on its own but requires experience with using a piano and does not offer as many complex music editing features as either Sibelius or Finale.

Other input options include scanning sheet music and MIDI keyboard input. The scanning input tests showed that the best results were obtained from Lime. This software

package produced fewer errors than either Sibelius or Finale although they are the more professional music notation editing packages. Lime, however, does not interpret a MIDI file as well as Sibelius or Finale. Due to the differing limitations of the software packages, it seems that the best option would be to compose or import a file to either Sibelius or Finale, print the music, and scan it into Lime for final editing. In this way, Lime would not have to interpret a MIDI file and little editing would be required. Then when the music is imported to GOODFEEL, there would be nothing lost because it would be interpreted directly from its companion editor Lime, instead of from a MIDI file where many details are lost.

While the group realizes that there are no totally compatible software packages for use by a blind user, the recommendations being made are for the most viable options for IBS and other users who may not already have any investment in music editing or transcription software. The recommendation for IBS is to continue use of Sibelius, in conjunction with GOODFEEL, Lime, and SharpEye. This collection of software best matches the curriculum of IBS, and the Music Academy in Esjberg. For users who are not already using a specific line of software, either Finale with the Braille Music Plug-In or Sibelius with the GOODFEEL package are recommended as acceptable options, depending on the preferred method of music input and budget. Users who choose the Sibelius with GOODFEEL package may find it easiest to compose in Sibelius and then scan the music for transcription into the GOODFEEL package. If the use of a scanner is not possible or not preferred, Finale offers similar transcription with direct input of music and at a lower cost.

Acknowledgements

The project team would like to express our great thanks all those who lent a hand in the completion of this project, specifically: Morten Schmidt and Janne Hansen for sponsoring the project and all the help they gave; Bill McCann for providing us with GOODFEEL, Lime, SharpEye, and invaluable support; Analise and our buddies at IT-Services who made the team feel at home; the staff and students in the music department at IBS, especially those that aided in the tests; Leif and Edina at the Danish Braille Library for their assistance in determining the accuracy of software transcription; all contacts at other institutions who provided us with information about their expertise in teaching blind musicians; Holly Ault for advising us through all our research and writing; Scott Jiusto for getting us started with this process; Tom Thomsen and Peder Pedersen for coordinating our project site and teaching us about important aspects of Danish culture like hygge; Mike Cataruzolo for expanding our knowledge of the lifestyle and history of the blind; and of course Mogens Ørten for our immersion into the Danish language.

Table of Contents

List of Figures

List of Tables

1 Introduction

Throughout the world there are 38 million blind people and an additional 110 million people with low vision and at risk of becoming blind (World Health Organization [WHO], 1997). These people live in a very sight-oriented world and must find alternative methods for many daily activities. From the simplest task of reading this paper, to the complex task of reading and writing music, people with blindness or partial sight must develop ways to achieve success. Fortunately, many years ago the Braille system of reading and writing was developed to make these and other tasks possible. Along with written words, a system of Braille music was developed and has become the only universal Braille language.

Although there is a language for Braille music, in the past it has been difficult for blind and partially sighted people to gain access to the written music. Transcribing sheet music into Braille music is typically a job for a well-trained specialist of whom there are few, due to the difficulty of the transcription process. The availability and access to these specialists and the Braille music they produce is therefore quite limited.

Within the past 15 years, computers have accelerated the transcription process with automated methods. Several software packages are now available to any user and eliminate the need for expertise in transcription. This makes Braille music much more accessible and also decreases the time spent in the transcription process.

Several schools for blind and partially sighted students have integrated these transcription software packages into their music curricula. Our sponsor in Denmark, Instituttet for Blinde og Svagsynede (Institute for the Blind and Partially Sighted or IBS

Vocational), is one such school investigating the use of software packages to aid in transcription.

IBS Vocational School is an educational school for the blind with the goal of "facilitat[ing] the greatest possible compensation for the effects of visual impairment… through advice and education…" (IBS, 2003). The core course relating to music education is the Music Department. Students cover all ranges of ability and choose their area of study from a wide range of subjects in different departments.

This project investigates currently available Braille music transcription software and makes a recommendation for the integration of the software with the current curriculum at IBS Vocational. This recommendation is based on curriculum observations, a software assessment, and group and user trials at the school. Along with this recommendation, the project group provides IBS Vocational with an analysis of the current software available and contact information for other schools and organizations that are using, or are interested in, Braille music and transcription software.

The students at IBS Vocational will significantly benefit from the integration of Braille music transcription software into their curriculum. This will empower the students and teachers so that they will eventually be able to make more music available to themselves and others by having the ability to quickly transcribe their own music.

2 Literature Review and Background

2.1 Introduction

The literature review and background will focus on collecting available data pertaining to statistics on blindness and visual impairment and also on previous research that has been done to make technology more accessible to those with visual impairment.

2.2 Disabilities acts

2.2.1 United Nations

In 1994, the United Nations established its own policy regarding individuals of the world with disabilities. This resolution was passed because the number of people throughout the world with disabilities is "large and growing" (United Nations General Assembly [UN], 1994).

The resolution has specific mandates regarding both education and employment. Education is to be provided for individuals with disabilities at every level including preschool, elementary school, secondary school, and college or university. If students are attending mainstream schools, then they should be given any necessary resources, human or technological, needed for their proper education. To do this, the general assembly suggests that each nation adopt a policy, allow flexibility in the curriculum, and have ongoing teacher training (UN, 1994).

The employment section is very similar to that of the Americans with Disabilities Act (discussed below). It states that the disabled must have the same access to employment granted to all other individuals so that they are not discriminated against when trying to obtain a job. It is the responsibility of the workplace to provide both

adequate working conditions and proper training and compensation for their work (UN, 1994).

2.2.2 United States

The Americans with Disabilities Act was passed in 1990. The need for this legislation was due to the large number of people in the United States with physical or cognitive disabilities and the discrimination they encountered before this law was passed. When the bill was written, there were approximately 43,000,000 Americans with some kind of disability and the number was expected to grow higher as the population got older. Historically those with some sort of disability were separated from the rest of the population and placed in institutions. People with disabilities faced discrimination everywhere, including transportation, employment, and schooling. Prior to the passage of this act, there was no legislation protecting the rights of the disabled (Americans with Disabilities Act of 1990, [ADA]).

According to the ADA (1990), the "The term 'disability' means, with respect to an individual--

A. A physical or mental impairment that substantially limits one or more of the major life activities of such individual;
B. A record of such an impairment; or
C. Being regarded as having such an impairment."

From this definition, blind or partially sighted individuals would be included in and entitled to all rights discussed in this legislation.

With regard to employment, the Americans with Disabilities Act of 1990 says that individuals with a disability may not be discriminated against in the workplace regarding job applications, hiring, advancement, discharge, compensation, or job training.

2.2.3 Denmark

Since 1934 the Danish Council of Organizations of Disabled People (DCODP) has been involved in setting the agenda for the disability policy. Originally the DCODP was formed as an umbrella organization of four separate organizations for disabled people, but now includes 29 member organizations representing nearly 300,000 people. Parliamentary resolution B34 on the equalization of opportunities and equal treatment of persons with disabilities is the Danish equivalent to the Americans with Disabilities Act (Center for Ligebehandling af Handicappede, 2003). The key difference between Danish resolution B43 and the ADA is that the Danish resolution is a set of recommendations on how to provide for the equalization of opportunities rather than a set of laws mandating what is to be done.

During the 1950s and 1960s concerns grew about poor sanitary conditions at the state-run institutions for the disabled. Though citizens were aware of the poor sanitary conditions, many disabled people lived at the institutions through the 1970s and early 1980s. As knowledge of the poor conditions spread, "an objective to the effect that disabled people should have a life as similar to a normal life as possible, and therefore should be integrated in the society on equal terms with other people" (Danish Disability Council [DDC], 7) developed. This criticism and objective lead to a reduction in the number of the state-run institutions starting in the late 1970s and into the 1990s.

As the number of state-run institutions declined, the need to educate and provide for the disabled increased. Disabled people could no longer live their entire lives in an institution, so they needed to learn how to provide for themselves and take care of themselves. This created a need for a central organization that could oversee the education and the living conditions of people with disabilities. The DDC was formed with "an equal number of representatives from disabled people (nominated by the DCODP) and from public authorities" so that disabled people would have a voice in determining how they live their lives, and how the government would regulate their opportunities for education, safe and affordable housing, and their ability to obtain and maintain a job. Section 87 of the Danish Act on Due Process of Law and Administration in the Social Area is the Danish Disability Council's working basis (DDC, 2002). The DDC is responsible for reporting to the Government and Parliament on the current conditions of the disabled, and provide recommendations where necessary.

2.3 Experience of being blind

2.3.1 Historical experiences

It is very difficult for anyone who has never lived with a certain disability to understand what this experience is like. Sight is something that most people depend very heavily upon and it is hard to imagine not being able to rely on seeing what is around us, but this is what people who are blind or partially sighted must do. Many times, others are insensitive to the problems that a person unable to see faces while living in a very sight oriented world. This section discusses important developments that have changed the experience of being blind over time.

Before the introduction of Braille in the mid 1800s, as a reading language for the blind and visually impaired, there was no universal system for reading or writing in place. A system had been developed and used at the Royal Institute for the Blind in Paris that used some reading through raised dots, but most education was based on listening. In 1824, Louis Braille designed the system of a six-dot cell with normal spelling that is still in use today (International Organization for the Blind [IOB], 2000). The organization and use of this system will be explained later. Even after the invention of Braille, those who were blind or partially sighted still faced problems in learning because this language was not available to teachers everywhere.

One hundred years after the invention of Braille, the language was still not readily accessible to all those who needed it, as demonstrated by one woman's experience. Grace Napier described her experiences at school in the United States during the late 1920s (Napier, 1988). Although Napier was blind, she was placed in a public school because her parents did not know where else she could go. Although she was excited to learn, her teachers did not have the resources or expertise to teach her in addition to the other students. While others learned to read, Napier was left out. From this experience, Napier developed a disdain for school and learning because she was not allowed to participate as the other children did. When her parents finally found a school that taught Braille, Napier learned to read and her joy of learning returned.

In 1976, the Kurzweil Reading Machine was introduced. This device used computer technology to change print to speech for a blind reader (National Foundation for the Blind [NFB], 2000). This technology allowed the blind and visually impaired to have a machine read the written print that they were unable to read.

In 1999, the first talking automated teller machines (ATM) were put into use at banks in the United States (NFB, 2000). These machines allow the blind and visually impaired to use an ATM even though they cannot see what is on the screen.

Not all inventions, however, are accessible to blind and visually impaired individuals. Even today, experiences that one would think are the same for both the sighted and blind or low vision audience, such as listening to a musical performance, are not necessarily suited for those with trouble seeing. An example of this is viewing an opera. Although someone who is unable to see can still listen to the music, much of the experience is seeing what the characters are doing and reading the subtitles of the act, such that the full experience can be appreciated. Pfansthiehl (1997) explains that without advance preparation, and someone describing what is happening throughout the show, the only benefit for the blind of actually being in the theater is the social experience. Because of this, a service has been developed that allows those who cannot see the performance to communicate by radio with another who can describe the costumes and body language of the characters. This service, however, is only available in six cities throughout the United States (Pfansthiehl, 1997), leaving everyone else without this wonderful opportunity.

2.3.2 Geographically

The World Health Organization (1997) has estimated that there are 38 million blind people across the world, with 110 million more people with low vision and at risk of becoming blind. Throughout the world, 0.7% of the population is blind. The incidence rates, however, vary for different regions. Three tenths of one percent of people in established market economies and former socialist economies of Europe are blind, while

the incidence in China is 0.6%, 1% in India, and 1.4% in Sub-Saharan Africa (World Health Organization [WHO], 1997). China is estimated to have the world's largest blind population for a single country with about 5 million legally blind. The number of blind people in China is greater than the population of Denmark, Finland, or Norway (WHO, 1999).

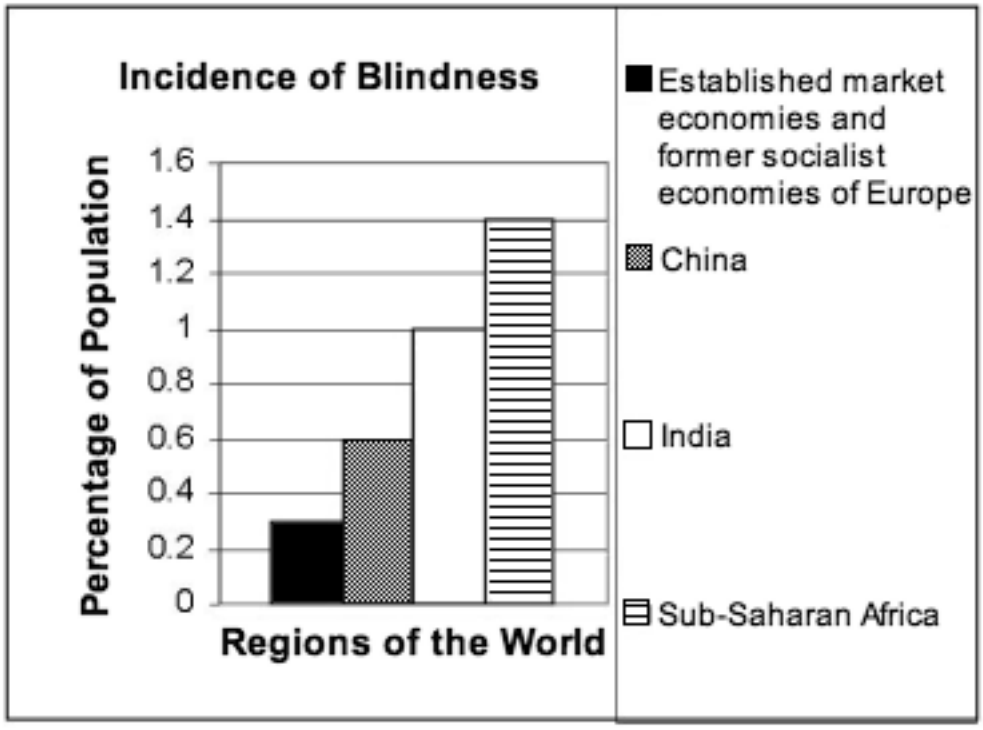

Figure 2.1. Incidence rates of blindness in different parts of the world (WHO, 1997).

2.3.3 Education

Educational opportunities for blind and partially sighted students are significantly fewer than for those with normal vision. This is most likely due to limited access to learning resources. According to the American Foundation for the Blind, approximately only 45% of students who are blind or visually impaired have a high school diploma, compared to 80% of students without this disability. Blind and low vision graduates of

high school are as likely to have taken college classes as those with normal vision, but are less likely to have completed college (American Foundation for the Blind [AFB], 2001).

2.3.4 In the work place

Although most developed nations have enacted anti-discrimination laws, prejudice still remains in the work place. Many of these laws were not passed until the early to mid 1990s. According to a 1994-1995 survey by the National Center for Health Statistics, there are two to three million blind and partially sighted individuals in the United States of working age (18-69), but only 40-45% of these people are employed (AFB, 2001). Discrimination is evident from the fact that one-third of employees with a disability have an average monthly pay rate that is 37% lower than those employees at an equal level that are not disabled (AFB, 2001). These statistics show that there is still an inequity between the disabled and those that are not, leaving the blind or partially sighted person struggling to find jobs.

2.4 Affected population size

2.4.1 United States

In the United States, there are approximately ten million individuals affected by some degree of visual impairment. Of these, 1.3 million are legally blind. There are 5.5 million elderly who are blind or visually impaired and 93,600 students. Children alone account for 55,200 of the legally blind and 5,500 of these children use Braille as their primary reading medium (AFB, 2001). These statistics indicate that many people are affected by being blind or suffering from low vision, with a significant number relying on Braille for education.

2.4.2 Denmark

A recent study, conducted by IBS Vocational (IBS, 2000), places the visually impaired population of Denmark at approximately 13,000 people. Around 70% of this population is made up of persons aged over 67 years. Only 10% are trained in a vocational atmosphere. The majority of students, who are without additional disabilities, are educated in mainstream schools. Others attend specialized schools, usually only for short periods of time. Additionally, in 1991 there were 12,039 members of the Danish Association of the Blind (Dion, Hoffman, and Matter, 2000).

2.5 Definitions

There is a difference between a person that is legally blind and someone who has visual impairment. According to the American Foundation for the Blind, *legally blind* refers to a person with vision of 20/200 corrected in the better eye where, 20/20 vision is normal. The term 20/20 vision means that at 20 feet away, a person can see what he or she would see without impairment. 20/200 means that from 20 feet away, the person can only see what an unaffected person would see from 200 feet away (Vision World Wide, 2000). For an individual with decreased vision, a severe functional limitation is defined as a person who is unable to see letters or words in print even with corrected vision while someone with a non-severe limitation has trouble seeing letters or words in print with corrected vision (AFB, 2000). Other countries define their vision terms differently. In China, for example, the definition is a person who cannot navigate without aid (WHO, 1997).

2.6 Causes

Blindness can result from infectious or non-communicable diseases as well as injury or heredity. Approximately 80% of blindness cases worldwide are those that could

have been avoided through prevention or treatment. The major causes from disease are cataracts, glaucoma, and trachoma. Cataracts cause roughly 16 million cases of blindness worldwide. Glaucoma causes 5.2 million diagnosed cases with another 105 million cases suspected to be from glaucoma. Trachoma causes 6 million incidences of blindness with another 146 million cases of the untreated disease at risk of becoming blind (WHO, 1997). With proper treatment and prevention many people could continue life with full vision.

2.7 Braille

2.7.1 General

Braille is a reading language for the blind that uses raised dots on paper. There are three different grades of Braille. Grade-one Braille uses a rectangular six-dot cell with 63 possible character combinations, plus a space. In Grade-two Braille, the dots within one cell represent two print letters (International Braille Research Center [IBRC], 1997). There is also an eight-dot cell that gives 255 characters but is used with much less frequency (Sensus Braille, 2002). Fig. 2.2 shows a sample of the Grade-one alphabet.

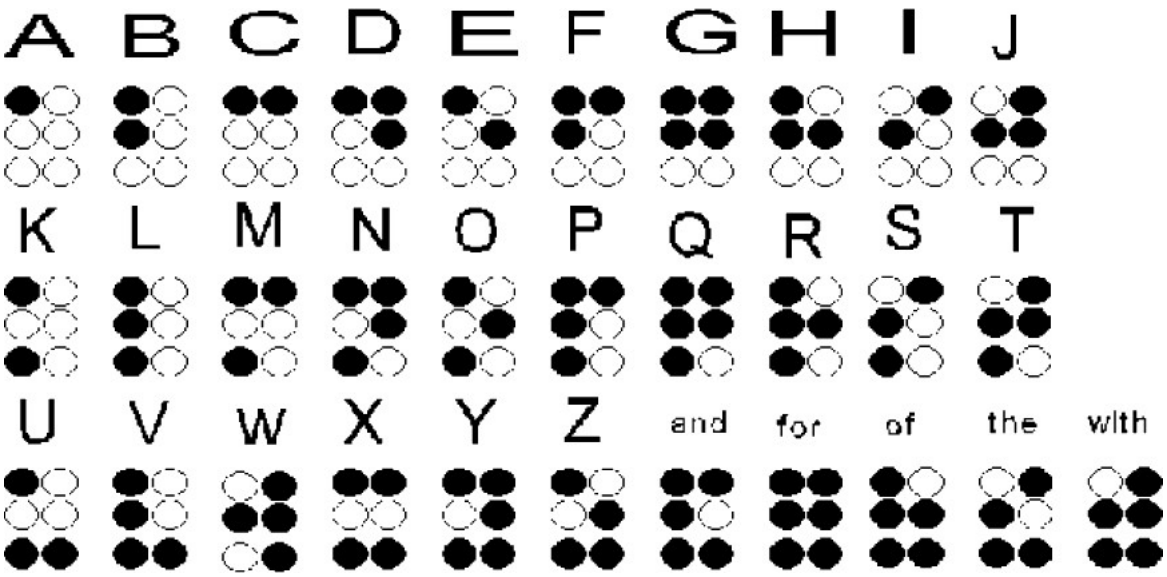

Figure 2.2. Example of the Grade-one Braille alphabet, which uses a six-dot cell (International Organization for the Blind, 2002).

2.7.2 Braille music code

Each country has its own rules for writing Braille (Sensus Braille, 2002). This means that it is not just a direct translation from the text, so a change from one language to another is not a simple task. Music, however, has been standardized several times and is the same in every country. Smaligo (1998) observed, referring to written languages, that Braille music is "the only internationally unified code" (p. 23).

Braille music was developed at the same time as Braille text and uses the same format of 6 cell characters. Other formats using embossed letters existed but Dr. Armitage of France established the standard 6-cell layout as the standard in the late 1800s with the publication of A Key to the Braille Alphabet and Musical Notation.

In 1888 an international committee, with representatives from France, Germany, England, and Denmark, met to consolidate all the inconsistencies of different countries. The results of this meeting were published as the "Cologne" Key. Almost all current Braille notations are formed with this key as a base. Several additional conferences met

over the years to standardize the music code as nuances from different countries crept into usage. Other needs also arose. For example, blind students have no need of clef signs, they are not needed to provide the pitch information as in printed music, but they do provide useful information to blind teachers of sighted students (Krolick, 1979). Currently, music notation in Braille continues to undergo changes but remains a very universal language.

Some differences do still exist. American and European formats of notation, for example, represent notes in a different order. European format organizes notation "note-by-note", where the piece is broken up into musical sections and then written out one musical line at a time. American format describes one measure at a time, and has two lines running parallel to each other to represent the two dimensionality of written music. While an experienced musician easily reads both formats, they may represent an additional challenge to the beginning student.

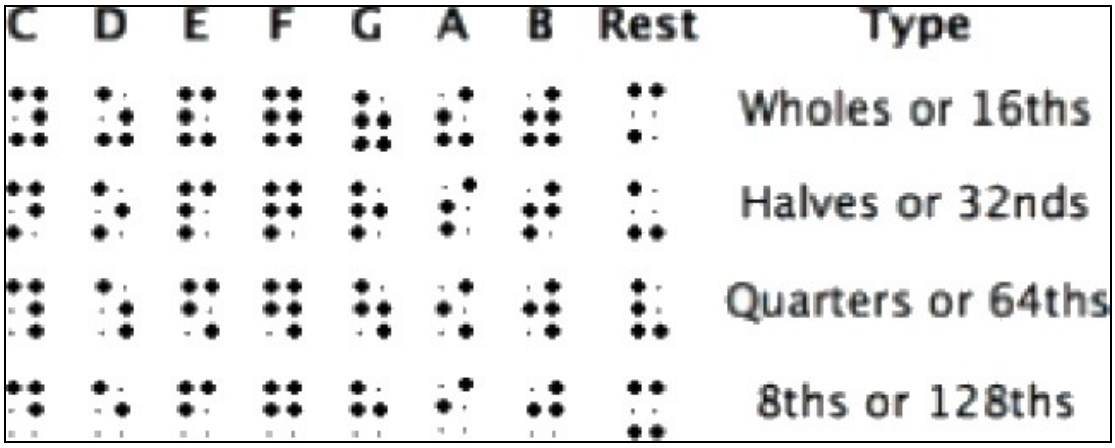

Figure 2.3. Example of a portion of the Braille music alphabet, which uses a six-dot cell (Braille Through Remote Learning, 2003).

2.8 Learning methods

2.8.1 Current music teaching methods

In many ways, the methods for teaching music to a blind student are similar to those of teaching music to a sighted student. Smaligo (1998) says that just as sighted students learn to read books around first grade, and music shortly thereafter, so too should a blind student. It is important for a blind student to not just listen to music and memorize it, but also to learn to read and write it just as sighted music students do. Playing from memory formed by listening only will not allow the student to develop his or her talent as well as if he or she were able to read music. Smaligo, however, also says that in many cases a play-along cassette will help the student to memorize the music as he or she is reading it more easily.

Another important aspect of teaching music is assuring that the blind student understands musical concepts just as most students with sight. Before teaching an instrument or learning to read music, the student must understand such concepts as rhythm (Siligo, 2001). If basic musical concepts are not understood, learning what keys to push on a piano, or even reading music, are not going to make the student a musician.

An area of teaching a blind student music, which is different from teaching a sighted student, is the hands-on approach. Siligo (2001) states that one easy way for the student to understand what is happening is to allow the student to feel what is around him or her. If the student is learning to play the piano, for example, then the teacher should put his or her hands on the keys and then allow the student to place his or her hands on top so that he or she can feel both the instructor's hands and the keys. In this way the student can feel the movement of their instructors' fingers and gain an understanding of

how his or her fingers should move much better than would be achieved from basic explanation.

Teachers must remember that although a student is blind, and he or she has learned to be a better listener, this does not mean that the student is "naturally" superior as a musician (Siligo, 2001). Blind students start at the same skill level as sighted students. Some people are born with much musical talent, others with little. Because someone has had to develop a sense better to make up for loss of another does not give this person the ability to do everything. In this respect, blind students need to be taught very similarly to sighted students when learning music.

2.8.2 Braille music

Braille music is in general readily available. The National Library Service in the United States has many different kinds of Braille music available for loan upon request of a blind student and teacher or parent (Smaligo, 1998). There are also many books written about learning Braille music. These books are written at different skill levels and can help students learning to read Braille music (Smaligo, 1998). It is important to note, however, that if the music is not already transcribed, the transcription process may take a very long time.

Braille music transcribers translate music into Braille if it is not available from any other source. The National Library Service publishes a list of people, across the United States, who provide this service (Smaligo, 1998). A new resource that is gaining use in many situations is the automated process of Braille music transcription by computer software applications.

2.9 Common challenges in music education

Learning to read music is not an easy task for most students as music is a completely different language. Any student will encounter challenges and the blind or partially sighted student is subject to additional hardship.

2.9.1 General

In learning to read music, students may have difficulty distinguishing where a note falls on a scale. Sighted students must distinguish notes similar in appearance where blind and partially sighted students must distinguish notes similar in cell-represented structure. All students face the task of mapping the notes to be played to the actual keys or action to produce them.

2.9.2 Partially sighted

Where a sighted student may have no problem deciphering a musical note or sequence, a student limited by low vision may have trouble. Not all partially sighted students who read Braille music will require a Braille form of music, however. Many are perfectly fine using magnified documents or other visually oriented, but adjusted, materials.

2.9.3 Blind

Blind students involved in music reading and performance face considerable obstacles. Where sighted and partially sighted students may use their sight to aid their playing, a blind student must rely solely on memory. Playing also introduces the additional hardship of identifying where on an instrument a correct note may be played. Boyer (1997a) states that it is typical for a student to read a specific amount of the music and then perform that section. It is likely that this section is not more than one measure.

This shortening of memorized sections makes the performing process much easier and achievable.

A recent experiment published by Boyer (1997b) indicated that some students overcome the difficulty in remembering a complex musical score by forming phonetic words from the representation of the notes. Others read the music as if it were textual Braille, remembering the resulting phrase.

As he or she is likely to read Braille text, the student must also remember both forms (text and music) and distinguish their uses at different times. The skilled reader is able to identify changes between overlapping music and text at a high rate of accuracy (Boyer, 1997b).

2.10 Writing Braille music

2.10.1 Non-computerized production

Manual translation of music to a Braille format requires a person fluent in both musical score and Braille. They are responsible for recognizing the patterns in music that the Braille is to represent and the resulting match of Braille characters. It is this translation method that sets the standard for all automatically generated transcriptions (Humphreys, 1979). Transcription of music into Braille is as much an art as it is a highly structured process. The transcriptionist chooses how to break the sections so that it would be easiest for the blind musician to read. Many times the music is written for a specific person and the editor chooses how best to format the music for the blind musician. At the Danish Braille library, a blind organist edits all music. The transcriptionist plays the music while the organist reads it and indicates where mistakes

were made (Appendix 17). The transcriptionist must be able to read both music and Braille and have an understanding of music theory.

2.10.2 Computer based production

Computer generated Braille music must remain accurate within a certain amount of faithfulness to the original score in order to remain useful. Most importantly, the translation must be as close to that which would result from the work of a manual transcriber. The system, described for Braille music, relies on the transcriber to recognize the patterns that are to be represented and faithfully record these characters. A computerized system must also recognize these patterns without input from a user, though user intervention is very beneficial in correcting error. The task for a computer is significantly harder, but aided in a series of steps of translation.

First, the musical score is translated to a digital, coded format. This code is then converted, through algorithmic approximation, to a coded form of Braille. This form can then be printed to the musical Braille format on paper.

Most systems require that they be operable by a user with no knowledge of Braille or music. Ideally, however, a user should be able to interrupt the process at any time and make adjustments to the current form of transcription. Automated pattern matching is very difficult and may not pick up conventions or obscure nuances of transcription. Manually adjusting the translated score improves the accuracy of the end result but removes the concept of fully automatic translation.

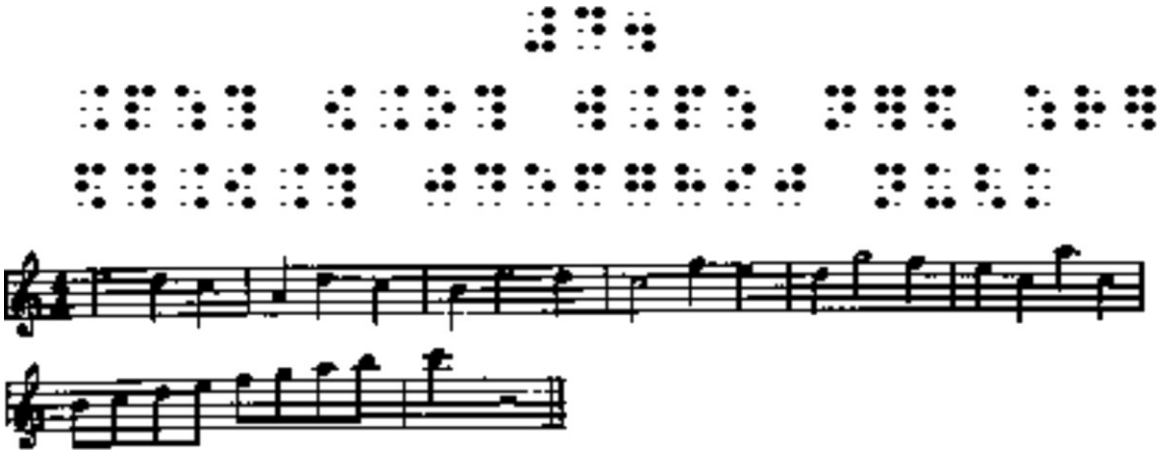

Figure 2.4. Example of a piece of Braille music and the original piece from which it was created (Braille Through Remote Learning).

2.11 Computer access for the blind

While all software and hardware tools that will aid the blind can also be used to aid those with low vision, the reverse is not necessarily true. Software and hardware targeted at improving access for people with low vision improves readability of the computer screen, the keyboard, the printer, and other input and output devices. However, software and hardware for the blind must produce output that the person is able to either hear or feel.

2.11.1 Screen enlargers

Screen enlargers can either be hardware or software. The main purpose of the screen enlarger is to magnify the images on the screen. The software that does magnification also works to keep the images crisp and clear. Some of the available screen enlargers are Lunar Screen Magnifier by Dolphin Computer Access, Magic Screen Modification Software with Speech by Freedom Scientific Inc., and ZoomText by AI Squared (Microsoft, 2003). Screen enlargers are relatively inexpensive ways of compensating for low vision.

2.11.2 Screen readers

Screen readers are software that provide audio output of onscreen text to the user. This is very helpful for people who are blind in that they can still read and write email, edit documents, and even browse web pages. Although screen readers are able to read text on screen, they still cannot accurately describe images and instead read the source (filename, file path, or other image id) of the graphic rather than describing what is shown. An accurate audio representation of what is displayed graphically is important so as not to exclude a blind user from any content available to a fully sighted user. Because complete accessibility is the goal in reaching the widest possible audience, all software would ideally include descriptions of any relevant images. "Most screen readers have mastered the PC", but due to the multitude of variations for web programming, they still struggle with correctly reading Internet sites (Federal Computer Week, 2000). Most work is being done in this area with web sites and many software packages have not been made accessible here. Two of the most popular screen readers currently available are JAWS for Windows by Freedom Scientific Inc. and Window-Eyes by GW Micro Inc. (Microsoft, 2003).

2.11.3 Speech recognition systems

To eliminate the dependence on the keyboard and on the mouse as the means of input, speech recognition systems have been developed. This can allow the blind musician to speak their music notation, rather than navigate through complex notation programs that are mostly graphical. These systems allow users to say what they want the computer to do and tell it what to write. The speech recognition system is comprised of both hardware and software. The hardware necessary is usually a microphone and a sound card that accepts input. The software must learn to accurately interpret what is

being said. When use of a speech recognition system is begun, much training of the system is required. Training the system software often includes a list of words and sentences that the user must speak so the software can learn how the user pronounces different words, consonants, and vowels. Available software includes Dragon Naturally Speaking by ScanSoft, Inc. and ViaVoice for Windows Pro Edition by IBM Software (Microsoft, 2003).

2.11.4 Refreshable Braille displays

Refreshable Braille displays allow Braille readers to read text that is on screen, line by line. While the refreshable display is hardware, it may work in conjunction with screen reading software, which may tell the display specifically what to print. The same errors found when a screen reader inaccurately reads on screen text may also occur here. Refreshable Braille displays come in varying sizes, but average around the size of a computer keyboard. While displays can range in price from $5,000 to $11,000 USD (approximately 35.000 to 77.000 DKK; note that all prices in Danish Kroner are estimated with a conversion of 7 Kroner to the Dollar.), they can be a great advantage over screen readers in the case where someone is both blind and deaf. Some of the available refreshable Braille displays are Braille Windows Display by Freedom of Speech Inc., PowerBraille by FreedomScientific, and Braille Voyager by Humanware Braille Solutions (Adaptive Technology Resource Center, 2003).

2.11.5 Braille embossers

Braille embossers are computer printers that produce Braille output. They act in much the same way as generic text printers do, except they translate the text into Braille. Most can print in the different codes of Braille, depending on which code the user selects.

These embossers can cost from $1,500 (10.500 DKK) to more than $70,000 (490.000 DKK) and are therefore prohibitive for most users to purchase. Some Braille embossers are able to emboss double-sided pages, and may also include built in speech synthesizers. Some of the Braille embossers currently available are Braille Blazer by Blaizie Engineering, Braille BookMaker by Enabling Technologies, and Braille Comet by American Thermoform (NLS Reference Circulars, 2000).

2.12 Current status of computer music technology

Being able to enter, record, edit, and print professional music should not be limited to people with sight. So the software industry has responded, and now offers an array of products that can help sighted, partially sighted, and blind persons prepare their own music. A sighted music teacher can use these programs to transcribe printed music into Braille, which can then aid in teaching blind and partially sighted students how to read music. A blind or partially sighted musician can enter his or her music through the use of musical keyboards and then arrange and print it so the music looks like professional printed music (Castan, 2002).

Most music software allows for a number of input options when entering music. A user can enter their score by scanning in their printed music, playing it in through a MIDI (musical instrument digital interface) keyboard, importing a MIDI file of the song, or arranging it themselves note by note. The software then can automatically transcribe the music into Braille notation. After the music is converted to Braille it can then be printed using a Braille embosser.

Before this type of software was available, musicians who needed music converted to Braille would need to send the original printed sheet music to transcription services,

which often was costly and time consuming. The software, while still expensive, will save the musician time and money as the software is put to use. Currently there are a few companies that offer Braille music software, and each company has different options that come with their software.

2.12.1 Band-in-a-Box

Band-in-a-Box, by PG Music Inc. (PG Music, 2002), is a music software package, which when combined with a screen enlarger becomes usable by a person with low vision. Band-in-a-Box is able to convert MIDI files into sheet music notation. Band-in-a-Box is a compositional aid in that its main elements are focused around aiding the composer in writing music in a specific style of music. Band-in-a-Box does not support Braille music notation, and its file format is unique, making it unlikely for Braille music transcription software to support translating Band-in-a-Box music into Braille music.

2.12.2 Sibelius

With the aid of a screen enlarger, Sibelius (Sibelius, 2002) becomes a powerful music software package for persons with low vision. Sibelius is a versatile music software package in its ability to read music files such as MIDI, NIFF (notation interchange file format), and files created in other music programs such as Finale, SCORE, and Allegro. Sibelius can work with a computer scanner to input music by scanning the original sheet music. However, Sibelius is not able to convert written notation into Braille music notation, so Braille music translation software would need to be able to work with Sibelius files to make this a viable solution for Braille music translation. Sibelius is also able to save MIDI files that can be output to some Braille music transcription software.

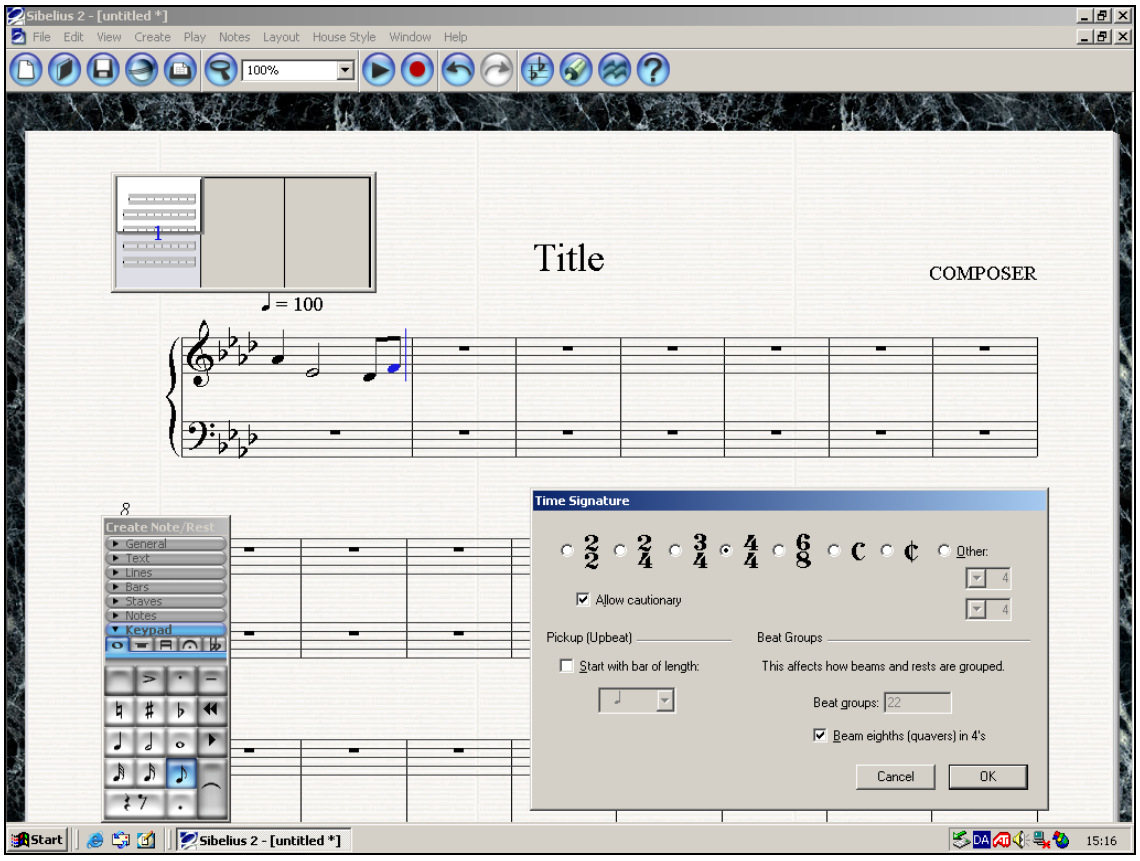

Figure 2.5. Screenshot of Sibelius 2 showing the key and time signature palette, the note selection palette, and a score with a few input notes.

2.12.3 Finale

Finale is a professional level editor distributed by Coda Music. It is also an industry standard application used in many publishing organizations. Finale sports an interface very similar to that of Sibelius and matches most features as well. Finale supports MIDI and the proprietary Finale format file. A powerful feature of Sibelius is the plug-in support it has. Many features can be added through the use of third party plug-ins. These plug-ins often automate very complex procedures, including transcription to Braille music.

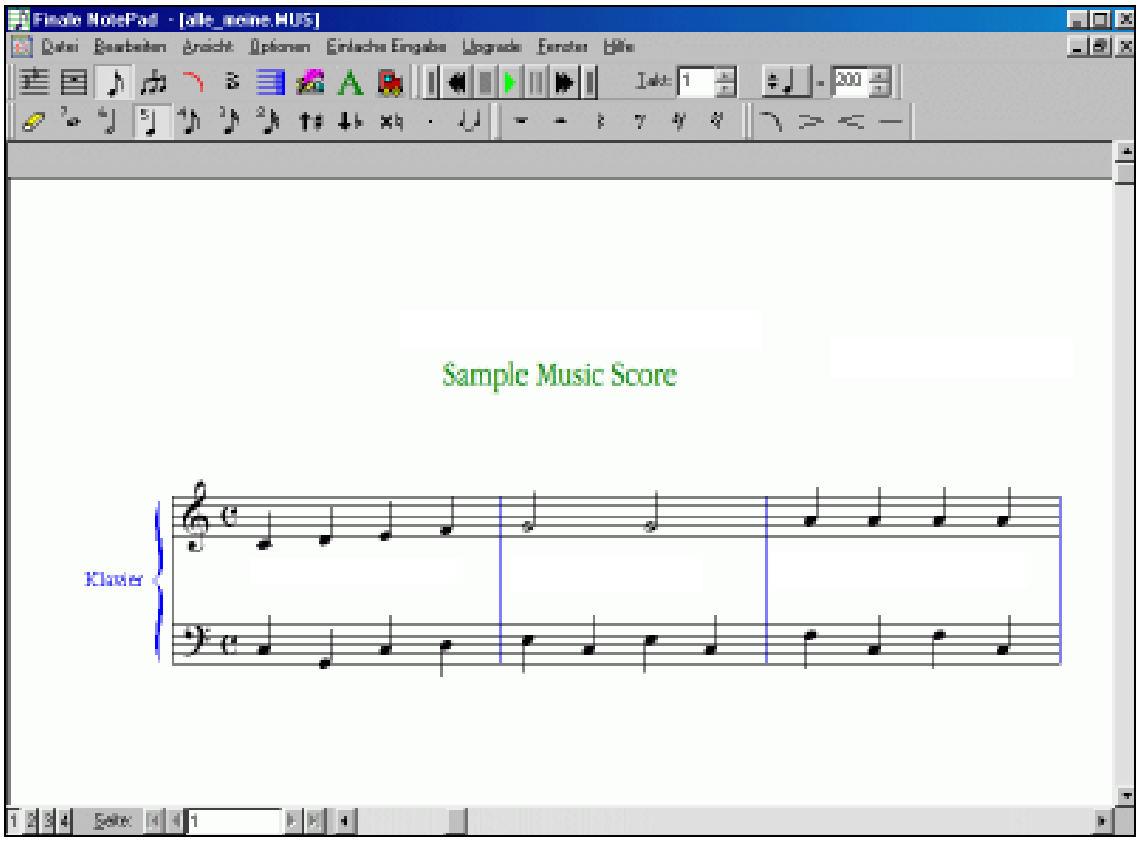

Figure 2.6. Finale Screenshot displaying toolbars and an entered sample of music (Coda Music, 2003).

2.12.4 Lime

Distributed with GOODFEEL, Lime is a music editing application produced by Lippold Haking and Dorothea Blostein. Lime allows input of music via computer or MIDI keyboard in multiple instruments. Most interestingly, notes are input via computer keyboard as if the keys were organized as a piano. Lime exports music in MIDI and, more importantly, the Lime format. GOODFEEL is capable of opening Lime files directly and thus, allows for transcription without the loss of information that occurs when a score is stored in MIDI format.

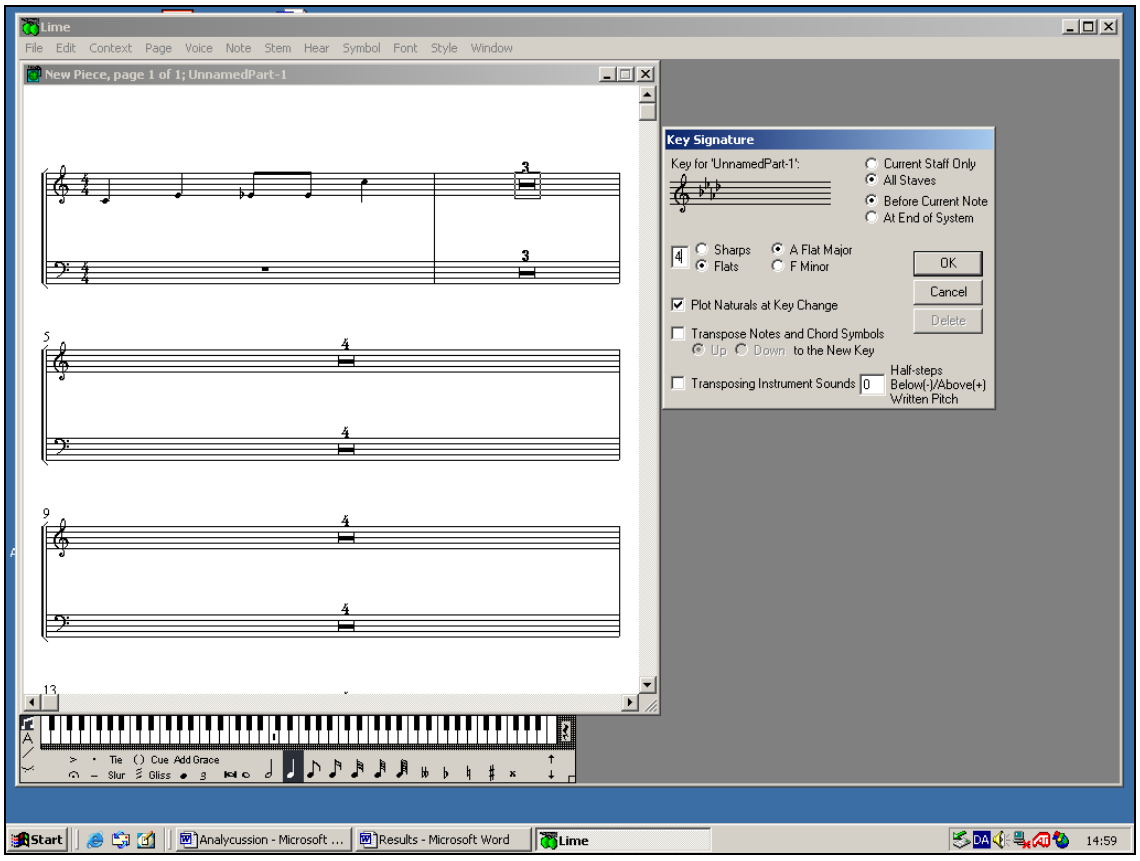

Figure 2.7. Screenshot of Lime showing the key signature selection palette, note entry keyboard palette, and a score with a few entered notes.

2.12.5 Toccata

Toccata, by Optek Systems (Toccata, 2002), can accept musical input from a MIDI keyboard, MIDI or NIFF file, image scanned into the computer, or entered using the computer keyboard and mouse. The software will display the notes both in traditional print and also in Braille print. While entering the notes, the software will play whatever note the user has just entered, with the appropriate pitch and length. While the software was not designed for use by the blind and partially sighted, with the addition of a screen reader or refreshable Braille display it becomes possible to use the software. When finished entering music the user can simply print it out using a Braille embosser. Toccata does, however, require extensive use of a mouse.

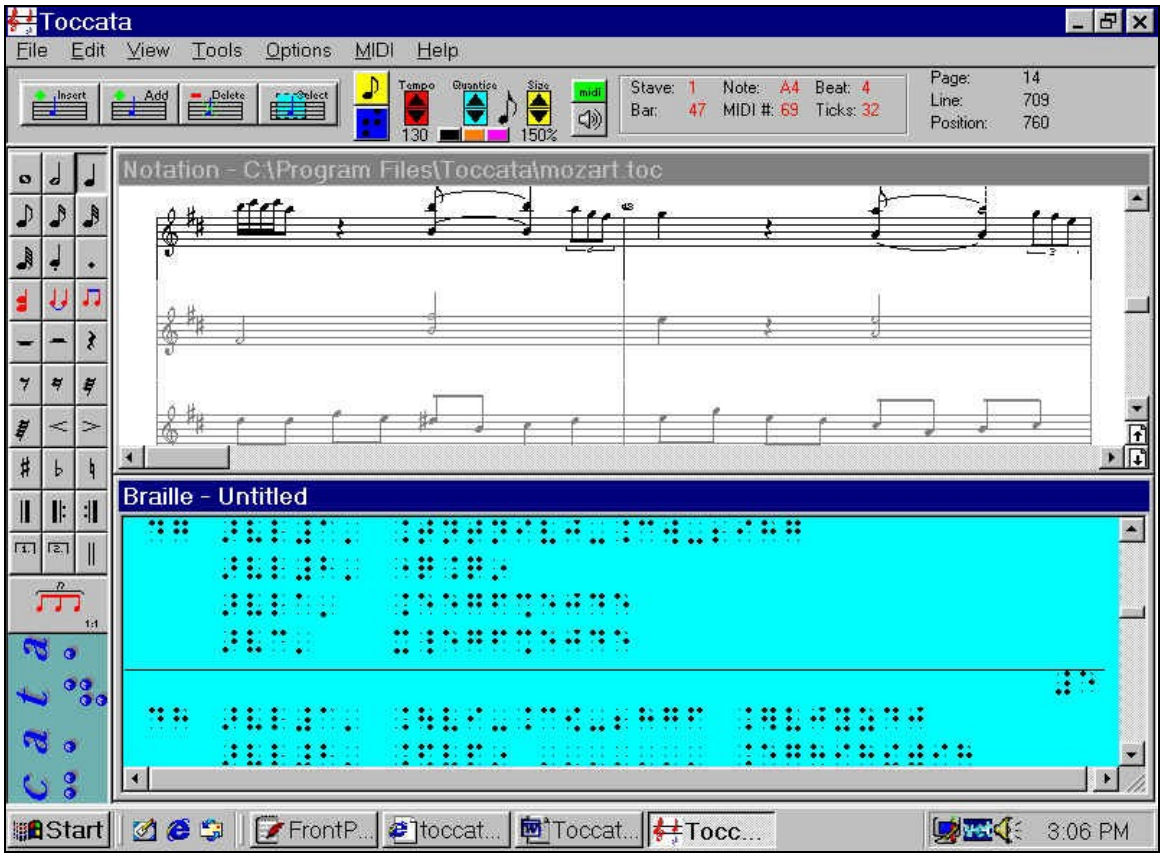

Figure 2.8. Screenshot of Toccata showing translated Braille music in the lower window and the original score in the upper window (Toccata, 2002).

2.12.6 GOODFEEL

GOODFEEL, by Dancing Dots (Dancing Dots, 2002), is designed for music transcribers and sighted musicians. It allows teachers to transcribe music quickly and inexpensively. This allows a greater number of quality Braille music productions to exist. Although GOODFEEL has its limitations, such as inability to correctly mark foot pedal and stops for organ scores, it is quick and easy to use software with many popular features.

The makers of GOODFEEL also produce CakeTalking, which was designed for blind and partially sighted users. This software is an add-on for use with JAWS for Windows, which allows blind and partially sighted users easy access to all the features available in CakeWalk. CakeWalk is standard music notation software originally

developed for the sighted musician. CakeTalking was developed in conjunction with Jaws for Windows and CakeWalk, so the Jaws screen reader is able to work more precisely with CakeWalk than it otherwise would.

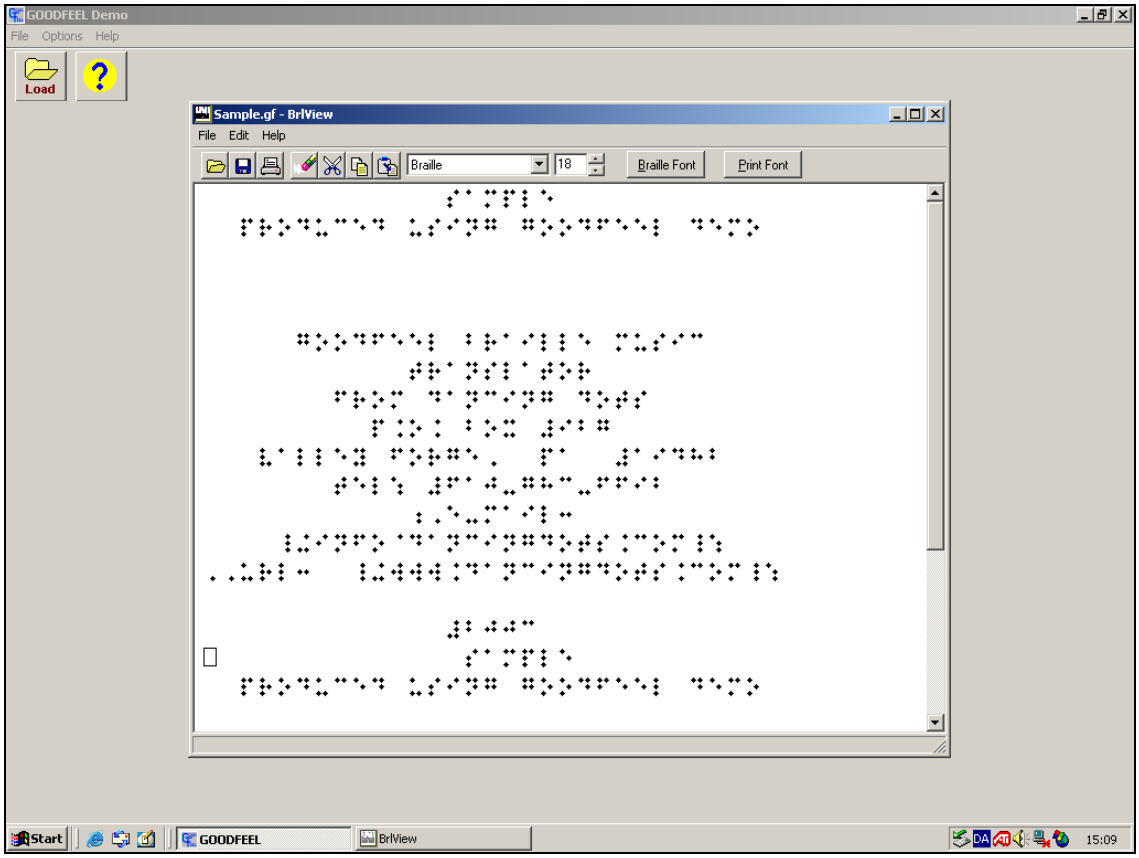

Figure 2.9. Screenshot of GOODFEEL showing Braille music transcribed from a MIDI file.

2.12.7 Braille Music Kit

Braille Music Kit is an editor for Braille music in two parts. A free plug-in for Finale converts notated music into Braille music using "the music rules of the New International Manual of Braille Music Notation published by the World's Union for the Blind in 1996" (Dodiesis, 2003). An additional editor provides a means of editing the Braille music in its Braille form and printing of the music. Use of the full kit requires Finale, the free plug-in, and the Braille Music Editor. This full kit is new and still under development (Dodiesis, 2003).

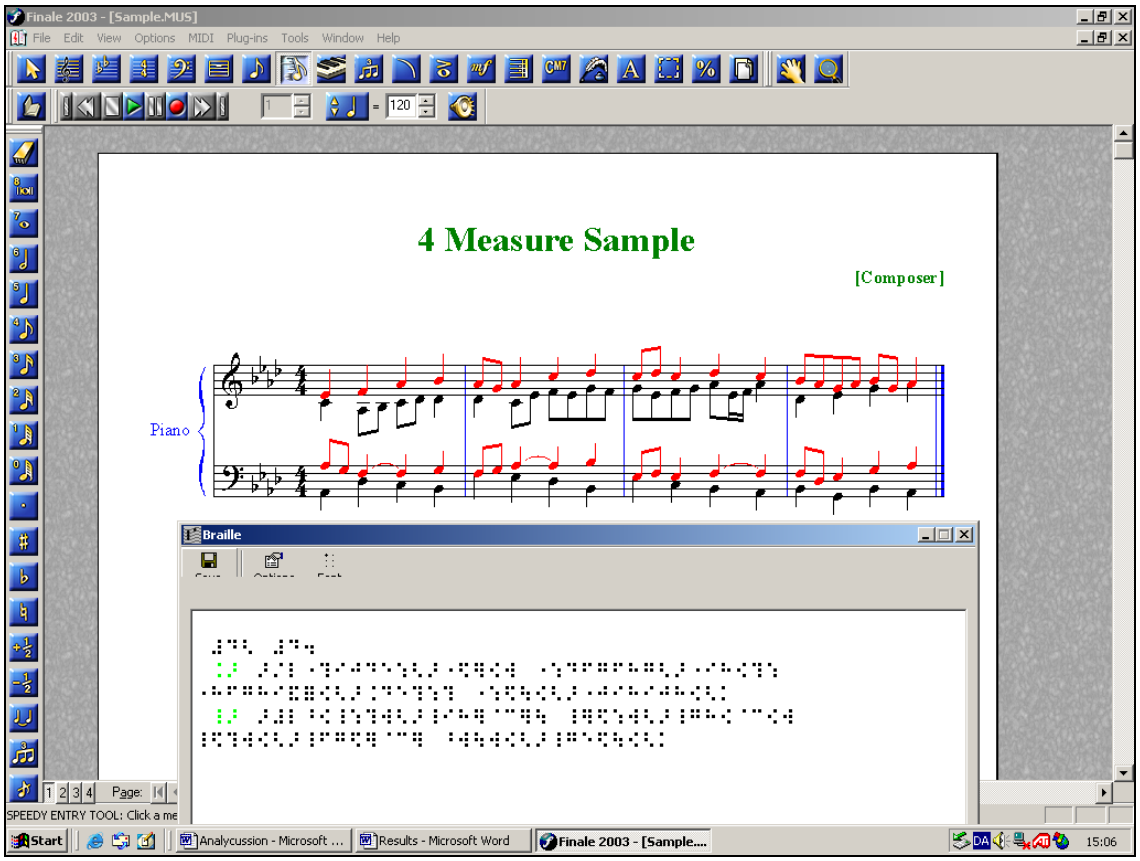

Figure 2.10. Screenshot of Finale using the Braille Music Plug-in. The lower window shows the Braille output produced by the plug-in.

2.12.8 SharpEye

GOODFEEL also includes SharpEye, Optical Character Recognition software. SharpEye is designed for the recognition of music notes in a score. SharpEye is usable with both large and small notes and imports notation with lyrics and accents.

2.12.9 Spoken Music

Spoken Music is a new alternative to Braille Music. Both Spoken Music and Braille Music use the same format of International Braille Music Notation but provide output in different forms. Currently under development by FNB, an organization in the Netherlands, Spoken Music speaks the notation rather than producing Braille output. Dutch, English, and German languages are currently supported by the project with

French, Spanish, and Italian under development. Spoken Music is a valuable resource to those persons developing blindness in later years, as well as those who already read Braille music. Spoken Music may also be of value to those who are now learning Braille music for the first time, as both formats use the same organization of notation but in different representation (FNB).

2.12.10 PLAY Project

A project team, including members from IBS Vocational and several other European schools for the blind, developed a DOS based music editor and Braille transcriber in August 1997. The focus of the project was to develop the editor for a blind user. The software was to support MIDI, Finale specific, and NIFF files, along with receiving input from a MIDI keyboard, regular computer keyboard, or a Braille keyboard. This program was only partially completed due to time and budget restraints.

2.13 IBS Vocational curriculum

The Institute for the Blind and Partially Sighted in Denmark, or IBS Vocational School, is an educational school for the blind with the goal of "facilitat[ing] the greatest possible compensation for the effects of visual impairment … through advice and education…" (IBS, 2003). IBS offers thirteen different programs to serve blind and partially sighted students. Among these are two music related courses for education in performance and study. There are currently seventy-six students enrolled in the school with twelve of these students in the music track. Eleven teachers are involved in the music program.

2.13.1 Current teaching methods and courses

The core course relating to music education is The Music Department [sic]. Here students receive one-on-one, individual education. The education is geared specifically to the needs of the student. Students cover all ranges of ability and choose an area of study from courses including piano, keyboard, guitar, accordion, the recorder, Braille music notation, ensemble playing, music history, theory, and journalism. All genres of music are included as options for study. These courses are divided into two main areas of study: organ training and the music profile program. The music profile track includes work with Vestjysk Muskkonservatorium (West Jutland Academy of Music) in Esjberg after completion at IBS Vocational. When organist training is concluded, the students are ready for the job market. The music profile program is a new addition within the past five years (1998), but as of spring 2003 there have already been three students to complete the entire program including time at the Music Academy.

2.13.2 Available and in-use technology

Most students at IBS Vocational have access to a computer with a screen reader. Specific software packages necessary to the individual student's education are loaded on the computer. The music program is currently using two music software packages, Sibelius, a music notation program, and Band-in-a-Box, which have been modified for students with low vision. There is no Braille music transcription software being used.

3 Deliverables

3.1 Introduction

There will be three main deliverables from this project. These will include a current software analysis, recommendation for integration of the software package into the current curriculum at IBS Vocational, and contact information for other organizations interested in Braille music.

3.2 Current software analysis

An analysis of current software packages for creating Braille music will be important for the sponsor to be able to choose a software package based on what is available and the effectiveness of the transcription method. This analysis will evaluate the programs based on accuracy of transcription to Braille, user friendliness, cost/benefit analysis, and availability. The sponsor may be unaware of all existing programs or features. This analysis will give the sponsor the opportunity to learn about the programs before the group makes recommendations about which software package is best suited for the IBS Vocational curriculum.

This document will also contain suggestions that could be made to each software package. Recommendations about which features are lacking or could be improved upon will be included. A list detailing what exactly should be included in a computerized Braille music production software program will be incorporated into this document.

3.3 Integration into current curriculum

The sponsor will be given a document containing the best methods of integrating computer programs into their current curriculum. This document will also pick an existing software package that would seem to fit into the current system, along with the

rankings of the next best packages. This program will be picked not only for its advantages in features but also for cost benefit and availability to the sponsor. Recommendations will be made on how integration may be accomplished without disrupting the current curriculum.

3.4 Contact information for other organizations

The sponsor will be provided with a document containing several brief reports on other music blind education organizations focusing largely on the interest that these contacts have and their current state of programs. This will allow the sponsor to contact others and see what others are doing so that IBS may evaluate the current system and gather ideas on how to make adjustments to their curriculum, giving students the best opportunities available.

4 Methodology

4.1 Introduction

The methodology of research into the use of Braille music software at IBS was organized into four major tasks: orientation to IBS Vocational and curriculum survey, initial assessment of software, software field testing, and preparation of recommendations. From these major tasks, specific methods to accomplish them and the final outcomes of these methods are explained.

4.2 Orientation to IBS Vocational

The first task in achieving all objectives was the development of a familiarity with IBS Vocational and their curriculum. Providing a proper recommendation on integrating transcription software with current classes requires a good working knowledge of how the curriculum of these classes is carried out. Essential to the task is an understanding of the goals and needs of the students, teachers, and administration. This includes understanding how music is taught to blind and visually impaired students.

4.2.1 Initial presentation and meetings

An initial presentation detailing background information, goals, current progress, and intended procedure plans for completion of the project was presented to members of the IBS Vocational faculty and staff. This presentation aided in introducing the goals of the project, as well as clarifying the intended methods and procedures for bringing these goals to realization.

Upon completion of the presentation, a question/answer and discussion forum provided additional clarification of plans and goals. This meeting also put into motion any plans for completing interviews, class observation, and software testing.

4.2.2 Orientation to working with low vision students

Early in the project observation, interaction and interviews with blind and partially sighted students provided the most complete information regarding student and teacher abilities and needs. It was therefore essential to have a small amount of training in working with and around, guiding, and interacting with students and teachers who have low vision. A short course was completed approximately one week into the project, which aided in following interviews and software trials with blind and partially sighted students.

4.2.3 Student-Teacher observation

The bulk of knowledge gathering began with observation of student-teacher interaction. Sitting in on classes, observing teaching methods and techniques, and noting student and teacher reactions provided insight on the approach towards teaching at IBS. The focus of the observations was on uses of computers and software in the classroom, although other classes such as Braille note teaching and piano instruction classes also provide valuable information regarding classroom dynamics. During the observation period, the team examined areas in which the students and teachers perform music composition or editing using software. These compositions can then be output to Braille transcription software, if needed. It is in these areas where music software packages will provide the most benefit to the IBS curriculum.

A final observation session occurred near the end of the project at the Music Academy in Esbjerg. Many students continue their studies, begun at IBS, by studying at Esbjerg. Observation of work and classes at the Academy provided valuable information on work occurring after leaving IBS, what curricula might look like, and what

preparatory education is important or worth while in regard to Braille music and music software.

4.2.4 Survey of technology

The technological capabilities at IBS were investigated on order to assess the available resources. Hardware components and software packages, such as screen readers, screen enlargers, and music notation software were investigated. This information provides a starting point for an assessment of IBS Vocational capabilities in accepting new technologies and programs into their current music curriculum. This survey of technical resources has also aided in a cost/benefit analysis. The use of transcription software may not be feasible at IBS if overly expensive hardware and/or software must be purchased. This survey of available resources was necessary in order to develop a recommendation for an appropriate and feasible application.

4.3 Software assessment

4.3.1 Assessment development research

The first step in developing an accurate set of criteria for use in assessing potential software was research into the currently available and in use software. In surveying the available technology, interviews were completed in order to provide accurate criteria for assessment of potential software. Interviews in Denmark included Lars Pedersen, a teacher of Braille notes at IBS and an experienced church organist, Hans Rassmussen, a data processing consultant employed at IBS, and Leif Haal, a Braille music transcription expert recently retired from the Danish library. Each has experience using software and Braille music and/or with the assessment of software and technology. Information from

these interviews was valuable in developing an accurate and concise rubric for evaluation of software.

Additionally, the typical hardware and software costs associated with each software package were recorded so that the effective cost for each package was provided.

4.3.2 Software availability research

The second major task completed was an assessment of software. Group members accomplished this through an intensive software review and initial trials of the software packages. This review contributed to the software analysis and requirements document of the deliverables.

The software assessment was completed by review of existing software packages and information gathered from other schools for the blind currently using software packages to transcribe music to Braille. This research has come from company websites containing information about the software and interviews with the software developers. These tasks were begun before arriving in Denmark.

Part of the review consisted of information from teachers at other schools using the software. This information provided a user level critique of the software, giving advantages and disadvantages of the particular program along with information as to how this software is used in different curricula.

The music teachers at several schools for the blind throughout the world were interviewed via email and phone. Schools that have responded include Washington State School for the Blind, Maryland School for the Blind, Florida School for the Blind and Deaf, Royal National Academy for the Blind in the United Kingdom, and Royal New Zealand Foundation for the Blind.

4.3.3 Group software trials

After the software review, the project team conducted program trials. Experienced computer users, the project team, completed these trials, which aided in the assessment of the time required to learn the software. A rubric of criteria and an explanation of the ranking system that were used to evaluate the software are included in Appendices 18 and 19 respectively. The team generated specific tasks to be completed during trials that would represent typical use by the teachers and students. Tasks selected for evaluating the editing software included: opening the application and creating a new document, composing a piece of music, and saving the composition as a MIDI file. The task of composing a piece of music was standardized through the use of a predefined melody with harmony, which was then copied during each trial. The sample melody is included as Fig. 4.1. Opening each program, selecting a file for transcription, and printing the transcription to the screen served to evaluate the Braille music transcription software.

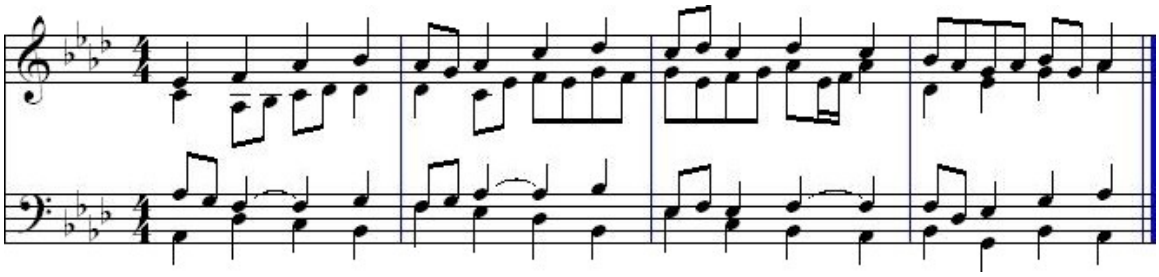

Figure 4.1. Sample four (4) measure harmony used for software testing purposes.

The level of computer knowledge held by both students and teachers at IBS Vocational covers a broad range from beginner to advanced, so people familiar with current computer technology were the first to try the programs. Basic software features were evaluated by their ease or difficulty to learn. These trials evaluate the difficulty in learning the software, the compatibility of the software with a screen reader and the ability to operate the program without a mouse. Those participating in this trial are not

experts in either reading Braille or in teaching blind or visually impaired students, the software was not assessed for accuracy or ease in teaching to blind and partially sighted students during these trials. Judgments of accuracy and ability to teach was left to field testing of the software by those who are experienced in these areas.

4.3.4 Specific trial tasks

Notation software – Finale, Sibelius, Lime, and Toccata

- Open: Be able to open a blank document with the following conditions:
    - Piano score: 2 stave
    - Title: Trial #n
    - Composer: Trial user's name
    - Copyright Date: Current Date
    - Time Signature: 4/4
    - Key Signature: Ab Major
- Input: User should be able to input notes using multiple sources:
    - Mouse and/or Keyboard
        - 2 layers
        - 4 measures of notes
        - Quarter, Eighth, and Sixteenth notes
        - Ties
        - Bar lines
    - MIDI File
        - Import a one instrument MIDI file for editing
        - Edit music using the Mouse and/or Keyboard Input
- Output: User should be able to output the music by printing, saving as a MIDI file, or saving as an editor specific file.
    - Printing
        - Print the finished sample piece
    - MIDI file
        - Save the sample piece as a MIDI file for use in other editors or transcription software

        - Editor Specific File
            - Save the sample piece in the file format of the specific editor for future editing of the piece in the original format

Transcription Software – GOODFEEL, Toccata, and Braille Music Plug-In

- Open – Be able to open a file for transcription
    - MIDI file
        - Open a MIDI file saved from another program, to be transcribed
    - Program specific file
        - Open a file designed specifically for the transcription program
        - Program should transcribe a file upon opening, or during the opening procedure
- Print – Be able to print the transcribed file.
    - Print to a Braille embosser
    - Print to the screen for display

4.3.5 Additional group trial tasks

MIDI Keyboard

- Enter trial piece of music into different programs using MIDI keyboard.
    - Windows
    - Finale
        - Directly from MIDI keyboard
        - From MIDI file recorded in Windows
    - Sibelius
        - Directly from MIDI keyboard
        - From MIDI file recorded in Windows
- Check input of piece for errors made by the program used.
- Import the file into GOODFEEL from each program.
    - Finale
        - Windows file version
        - Direct MIDI version
    - Sibelius

        - Windows file version
        - Direct MIDI version
    - Check for differences in transcription from each source

Scanner

- Scan piece of music (selection of different pieces) directly into
    - Windows
    - Finale
    - Sibelius
    - Sharp Eye
- Scan regular music
- Scan large music
- Pieces
    - Trial piece
    - Piece with dynamics and articulation markings
    - Song with lyrics

In addition to completing these trials in a typical use environment, the group completed the trials of the editing software under "perfect" conditions and without error. Only the minimal number of steps taken to complete a task was recorded in each of these "perfect" trials. This information is useful when comparing software packages and their performance under different levels of experience.

4.4 Field test software

The third major task was to field test the software with the teachers and students. Field tests of the software helped to evaluate the feasibility of integration of the software packages into the curriculum at IBS Vocational. Software trials by teachers, followed by interviews, provided the data required to complete the rubric-based evaluation of each software package.

4.4.1 Software trials – teachers and students

Based on observations by the group of classes, initial discussion groups, and interviews with the IBS staff, four main user groups were identified and chosen for testing the software. The four main user groups are partially and fully sighted teachers, blind teachers, partially and fully sighted students, and blind students. These groups are further defined in Appendix 18. Teachers completed the previously described trials of the music software as they are experts at teaching, and more specifically at teaching blind and visually impaired students, so they were able to best assess the usability of the different software packages. Leif Haal, a former Braille music transcriptionist, was best able to assess the accuracy of the transcription.

The users tested one of three music editors (Sibelius, Finale, or Toccata). Toccata includes transcription features and does not require an additional component. The output from Sibelius or Finale can provide output for transcription by either GOODFEEL or Toccata. The Braille Music Kit plug-in provides transcription directly in Finale. This way user feedback was not influenced due to experience gained by using multiple packages.

After a short explanation of how the software works, short and simple tasks for the users to work through were given in order to give a sense of how the software works and the process behind typical tasks. The tasks were the same as those completed by the group and included: opening the application and creating a new document, composing the piece of music shown in Fig. 4.1, and saving the composition as a MIDI file.

Throughout the trials, user and program errors, speed, steps per process, keyboard functionality, and screen reader integration were recorded using the assessment tool, to critique each package.

4.4.2 Software trial interviews

Following the software trials, individual interviews with the test takers were conducted to gain further feedback and opinions regarding each software package. This process reflected the opinions of the users and provided a view of the real world effectiveness of the software. This also provided an opportunity to further investigate how the software would enhance current and future classes.

Of particular focus was a discussion regarding the usability of the software. Key aspects of the software in determining usability were the level of difficulty for using a screen reader, using the software without a mouse, and incorporating the software into a classroom setting. These comments helped in preparing recommendations for which Braille music software to use at IBS Vocational.

4.5 Prepare recommendations

The final task that was completed was to prepare recommendations for IBS Vocational of software packages and any hardware needed to go along with these packages. This was accomplished by analyzing all obtained data, evaluating the software including different needs for different classes, and making recommendations for curriculum changes and additions. A separate recommendation suggested schools with which IBS Vocational can establish extended contact. The resulting document recommended integration of computer software for Braille music transcription into the current curriculum at IBS Vocational as well as an outline on the use of software at other schools.

All gathered data were analyzed collectively. The software packages were evaluated on the basis of the results from the literature review, information from other schools and teachers, trials by experienced computer users, and trials and evaluations

completed by teachers and students at IBS Vocational. This evaluation included: the important features that were found to be required in any effective software package, obtained from the literature review and interviews with teachers at other schools, the ease, or difficulty, for an experienced computer user to learn the program, the problems encountered by a user, and an evaluation of the accuracy of transcription and the teacher predicted ease of teaching the software to blind and visually impaired students.

4.6 Conclusion

The first three tasks provided the necessary background to present IBS Vocational with a recommendation of software to integrate into the current curriculum. Contacts made during research initiated the process of establishing a communications network between schools teaching music for the blind and visually impaired.

5 Results, Analysis, and Discussion

5.1 Relevance of project

5.1.1 Music department

Interviews with the teachers in the music department at IBS Vocational have indicated that learning Braille notes will be a main goal for future students at the school. Many of the teachers feel that the only way for a person to function as a professional musician is to be able to read music. For a blind musician, the only written music available is Braille, and the supply of this valuable resource is limited. For a student to eventually function as a professional musician, he or she needs to be able to produce music on the same level as a sighted user. In order to achieve this, the student must be able to use both music editing software and a Braille transcription package such that their music is easily accessible, both to the student and others who may want to play it. The project is important to the music department so that they are able to teach and use the most accessible program to their students while they are still in school at IBS. This is essential so that as students continue at the Music Academy and begin work at the professional level they are able to productively use the software packages.

5.1.2 Other departments at IBS

This project is important to IBS as a whole as it establishes criteria for evaluating music editing and transcription software packages. Additionally, these criteria could be applied to different types of software packages in the future. Before a software package can be used, it needs to specifically be evaluated in regard to efficiency when used by a blind user. Efficiency includes the ability to use the software package without a mouse and the ease with which a screen reader can read all elements. This project sets criteria in

the software assessment tool that with slight modification could be used for other software packages. Through interviews it was found that the most important feature of the software package for use by a blind person is that it can be used without a mouse and after this, how well it works with a screen reader. There are some elements that a screen reader does not read including the text in a pop-up window that indicates errors and some graphics. The assessment sheet created allows a comparison to be made of how many steps it takes to use a computer program without a mouse and if it works in conjunction with a screen reader. The evaluation of future software packages can be made in a similar way.

5.1.3 Other groups of interest

This project is important to two main groups of people outside of IBS. The first is students who have graduated or will graduate from the school. When the students are no longer at IBS, they will still need music editing and Braille transcription software packages. Through interviews and contacts with previous students, the group learned that most blind musicians want a software package that is on an equal level as one that can be used by a sighted user. Although there are some simplistic music editing software packages that may be used by a blind user, these cannot be used on the professional level. The evaluation of the different packages available will help these students to make informed choices when they are buying software packages for their own use.

The second group outside of IBS that will be helped by this project is other schools and associations for the blind. From research conducted by the group and information from these other schools and associations, no study comparing music notation editing and Braille transcription software available for blind users has been conducted in the past.

This study will help schools to decide what software package they would like to purchase and teach in their curricula.

5.2 Orientation and curriculum review

The orientation to IBS Vocational gave the group an understanding of how the institution functions. Each teaching department is a separate entity. For some projects, however, different departments work together. There are some departments that work for the entire institution such as the department that evaluates computer software to be used for the blind and low vision person. The group members are working for the music department and the results will be directed specifically to this teaching unit.

The group attended a class on how to work with blind and low vision students. This orientation gave an insight into some of the basic problems faced by the blind. This orientation started with a short class about how to help blind students through the school. A longer version of this course is given to all new members of the IBS staff. Some of the difficulties experienced by the group during the introductory class on how to lead blind students were walking through the hallways of the school, getting up and down stairs, and finding a chair. These were all performed using a blindfold to simulate being blind. Another important part of this orientation to working with the blind and low vision individuals was a field trip to tour the Oslo ferry with a group of students from the IT services department.

The insights gained through the orientation of working with blind and low vision students put a more human aspect on the project. There are many tasks that people perform each day relying mainly on sight that become much more difficult when done without sight. Simply walking through a doorway or getting up and down steps becomes

a much more difficult task without sight, and yet most of the blind and low vision students have no trouble when in familiar surroundings. Learning how to properly help and guide the students allowed the group to be more useful in the school. The field trip to the Oslo ferry not only gave the group an opportunity to help students by being guides, but also gave an opportunity to see how students function in a new environment. The students adapted quickly to the new situation.

From discussions with Janne Hansen, Morten Schmidt, and Lars Pedersen, it was found that the music department has two programs. These interview notes can be found in Appendices 9, 10, and 11 respectively. The organist training program allows students to become professional organists at different levels. There are three different modules and for each module there is a test after completion of training. Employment opportunities correspond to the student's final training level. All students in the organist program take similar classes and have the same basic training.

The music profile program, however, is much different. In this track, the program is very individualized. The goal of completion of the music profile from IBS is to move on to the West Jutland Academy of Music. No specific classes need be completed before moving on so each person has a curriculum designed specifically for the individual. Before entering the music profile program at IBS, a prospective student will sit down with a group of teachers to evaluate the goals and needs of the student. There are three to six of these meetings with a final test given so that the teachers can recommend that the student begin his or her education or try something else. The testing is shaped specifically to the goals of the student but most would include tests dealing with ear

training and music theory. A final evaluation is the capability of the person to be a student and their motivation to complete the program.

The goals of the study at IBS besides music training are to become an independent person so that going to the music academy is an easy transition. The student must be able to study and live independently before moving on. The student must be able to explain his or her disability so that he or she can help the new teachers at the academy who have less experience working with a blind or low vision student find the best methods for teaching.

5.3 Classroom observation

After observing classes at IBS Vocational such as music theory, organ training, and Braille note learning, the classroom setting was found to be a one-on-one program. Each class lasted approximately one hour. Computers are used in the music theory classes so that the students can learn the notation editing software along with learning how to arrange music. The computer was used in conjunction with another instrument, such as a piano or an organ.

The most important part of the education at IBS Vocational is the one-on-one setting of the teacher and student. From this, the teacher is able to know exactly what the student is having difficulty with so that the teacher can adapt the course and important concepts are not missed or skipped before moving on to the next topic. This one-on-one interaction allows each student to proceed at his or her own pace and focus on a particular interest rather than a general education. The students and teachers genuinely seem to enjoy the process with some laughing and joking in the class as well as learning. This provides for an enjoyable learning atmosphere.

This one-on-one classroom dynamic shows the diversity of the curriculum. Due to the variety of classes and students, the software needs to be able to adapt to a changing environment just as the teachers and classes do with every new student. It is important for a software package to be able to change with the needs of the students.

In the Braille music notation classes taught by Lars Pedersen the students read the notation out loud. Lars and the student both have the same book. Lars follows along and corrects when necessary. As the students are still in the beginning process of learning the notation, no computers are used. This class does not require the transcription of music because there are books for beginners to learn notes that are already printed in Braille. In more advanced stages of the learning process, short pieces of music may need to be transcribed for reading.

5.3.1 IBS faculty and student interviews

Information was also gathered through interviews with students, former students, teachers, and other professionals at IBS Vocational. These people are interested in finding what software packages are available that could give blind and low vision students the same opportunities as a sighted student. The school is now using Sibelius as a music editing software package for students that use a computer in music theory and composition classes. The Sibelius music notation software package was chosen because it seemed to be the easiest to use and worked best in conjunction with a screen reader. JAWS and ZoomText are the two screen readers currently used at the school.

Lars Pedersen, a blind musician who also teaches at IBS has used both CakeTalk and GOODFEEL to write music and transcribe it into Braille. CakeTalk is only used

with input from a MIDI keyboard. Right now, however, most music that this teacher uses comes from the Danish Braille library.

Hans Rasmussen, a blind computer consultant at the Institute said that the most important features of a computer software package for a blind user are if the package can be used without a mouse, if the screen reader can identify elements and if the elements are clearly defined. An element is anything shown on the screen including text boxes, radio buttons, scroll menus, graphics, etc. For the element to be clearly defined, the screen reader must be capable of interpreting and reading the element. If the screen reader sees the graphic and reads the name rather than what it is a picture of, this would not be clearly defined.

5.3.2 Computer use in classes

Students and teachers use computer software as an editing and arranging tool, but an essential part of the curricula involves learning how to use the software. The music editing software currently being taught is Sibelius. There is no Braille music transcription software being used at this time by either students or teachers. The computer is an important aspect of the education because music editing software is used at the conservatory in Esjberg where the music profile students plan to go when their education at IBS is complete. A full understanding of how to use the software package is therefore important to learn while at IBS so that these skills can be used in later stages of the education.

The use of software at IBS is important because professional sighted musicians use music editing programs in their work. In order for a blind or low vision musician to compete in the professional world, he or she must have access to the same tools as a fully

sighted person. The goal of the students and teachers at IBS is for the students to become professional musicians in their particular subject of interest. A sighted user does this using music editing software and printing the music for later use. In the same way, a blind student must be able to not only produce their music, but also put it into a form that they will be able to read later. To fulfill this goal, the student must be able to not only use the music notation editing software, but also the Braille transcription software to allow use of the music at a later time. The use of the music editing and transcription software completes the goal of equal opportunities of professionalism between a blind or low vision and sighted musician.

The composition of music also gives a musician a way of communicating with other musicians. The software allows a blind or low vision student to compose music for other people to read when this may not have been possible in a traditional manner of writing music. The music can also be stored in a more convenient manner. The music can be stored electronically which takes up much less space and makes the music easier to find for the blind or low vision musician.

Because software education is already included in the education, new strategies for this do not need to be made. The addition of another software package into the curriculum is realistic as students already learn how to use many different software packages. A software package working completely without a mouse and with a screen reader will integrate easily into the current curriculum.

5.3.3 Needs of students and teachers, current and future

The needs of a software package for students and teachers in the current curriculum are very similar. Teachers in music theory classes assign tasks of harmonizing a melody

that the students must complete using music editing software. Both students and teachers must have an understanding of how the software works and the best methods of use by the individual student including shortcuts and techniques to make the software more accessible for the individual user. Due to time limits, the software's basic functions must be easy to learn so that the majority of the theory class is not used to learn the software. An informative and straightforward reference sheet detailing common functions would enhance program use, as this would allow the student to learn the program more easily at home. This way only more difficult functions of the program would need to be learned in school. A sheet like this for Sibelius is placed near the computers in the music department. A software package that is easy to learn, and easy and worthwhile to use, would most easily integrate into the curriculum.

Software programs not only aid in the learning of various subjects, but also in the teaching. Music theory can more easily be taught using a computer because it is faster to write out a short piece of music on the computer than by hand. The computer can make the music more accessible to a student. If the student requires white on black in order to read something, this is much more easily accomplished through the use of a computer. The music can also be made bigger or smaller as the student requires.

The future goal of the education is to teach students to read Braille music and incorporate the use of this music into the curriculum. In order to do this, the teachers need Braille music to be more accessible. Another goal is to give the students the best opportunity to become professional musicians, which as discussed earlier is accomplished through development of musical ability and the use of a music editing software program.

There are possibilities for use of technology other than music editing and Braille transcription software. There are software packages available that aid in the learning of Braille notes. Richard Taesch has developed a teaching program (Appendix 6) that only requires a Perkins Brailler, a piano, and Music Touch Courseware, which has not been released, but is being developed by SAL and marketed by Freedom Scientific. Music Touch Courseware is a piece of hardware that allows a student to lay a piece of Braille paper on a touch screen so that when the note is touched, the computer reads what the note is. Another software package under development is Spoken Music, which speaks the music in the same way that Braille music is written. The intended use of this software is as an alternative to written Braille music, but there is a possibility that it could also aid in the learning of Braille notes (FNB, 2003).

5.3.4 Potential uses in curriculum

While there is no typical curriculum for all music conservatories, many of the goals are the same. Berklee College of Music, in Boston, Massachusetts, divides their core curriculum into four parts: music arrangement, ear training, harmony, and music technology. Students take four arranging courses that move in an increasingly complex direction. Some assignment in these courses may include arranging rhythms or combinations of instruments, such as violins, trumpets, and piano. For students at Berklee, ear training is considered essential in "master[ing] the basic components of musical craft." These courses would include listening to music, identifying intervals and different pieces, and writing out what the student hears. The courses in harmony teach the students accepted standards in the harmonization practice, so that they can incorporate these into their own music when composing. Music technology courses deal mostly with

recording studio technology including mixing labs, principles of audio technology, vocal production (Berklee, 2003).

Students study at the West Jutland Academy of Music in Esjberg for five years. Classes at the academy include solo instrument teaching for five years, music history for three years, music theory for three years, ear training for three years, and also classes in teaching, performance, and chamber music. The careers for students graduating from the academy will include performing musician, music teacher, or rhythmic music. Sibelius and Finale are used in the music theory classes. Students from IBS will design their own program of study while at the academy, which will be a continuation of the education received at IBS. Due to the nature of this individualized education some students from IBS will take fewer classes with the use of transcription or editing software being used infrequently depending on the student's needs and goals. After graduating from the academy these students may seek out non-traditional music careers or limited work in their chosen profession. If the software packages are going to be used at the academy, then the best place for the student to be exposed to and become comfortable with the packages would be while at IBS.

At IBS music notation editing software packages are and will continue to be used anywhere there is a need for the teachers or students to print out their own music compositions. This includes the theory classes, where teachers may print out figured bass lines for the students to realize. For a low vision student the teacher may either print a large version of the music, or save the Sibelius file so that the student can work on their own machine, using their accessibility enhancements. This could potentially benefit a blind student who would then be able to take the Sibelius file and transcribe it using

GOODFEEL. Other classes where the music notation editing software packages may be of assistance include the instrument classes where short learning pieces could be produced, ear training classes where the students would analyze the music and write it out in the software package, and in any personal composition that the student or teacher may be working on.

Eventually, the transcription software could be used in Braille classes also. When students are able to read Braille notes, a software package could be integrated into this class so that assignments can be made using the software. Students could be given a short piece of music and asked to read it. Music could be prepared outside of class by the teachers using the transcription software. The transcription software provides an additional benefit by giving the blind student the ability to create his or her own embossed music.

5.4 Software analysis and results

Music notation editing software trials were completed by the group and by students and teachers at IBS Vocational. There were four groups defined for the student/teacher trials: blind teachers, sighted/low vision teachers, blind students, and sighted/low vision students. The tasks for the trials were the same for all groups. The software packages tested were Sibelius, Finale, Toccata, and Lime. Sibelius, Finale, and Lime were all tested first with the option to use a mouse, and then tested where the keyboard was the only input allowed.

For the notation software packages the trials consisted of three tasks: opening the program and creating a new document, entering the required sample composition, and saving the composition in a MIDI file format. A more detailed listing of the tasks can be

found in the Methodology section. The data collected by the group included the number of steps to complete a process, the number of user and program errors, the number of steps to correct any errors, and the time to complete each task. The assessment sheets for each trial can be found in Appendix 23.

Along with the trials to test the usability of the different programs without a mouse, a screen reader test was also used to determine which elements of a program the screen reader interpreted. This is important because a blind user relies on the screen reader to get information. If there are elements that are not read which will affect the use of the software package, it is not accessible for the blind user.

5.4.1 Sibelius

Sibelius is a professional grade music notation editor. It supports entry of music via computer keyboard, number pad, and mouse, MIDI instruments, scanned music, and stored music files. These supported file formats, for input or output, may be Sibelius or MIDI. Sibelius also supports notation in multiple voices and instruments. It also supports user and 3rd party created plug-ins, which can enhance Sibelius in any way, although currently no Braille plug-in is known to exist. Sibelius utilizes a natural mapping for note input, where an A on the keyboard corresponds to an A on the music staff, but changing voices requires multiple steps and is not always accurate. It should be noted that the demonstration license on Sibelius disabled the saving of documents.

Group – Trial 2

The process of opening and creating a new document took only 7 steps and had no errors. The addition of a key signature was not included in this task, and the four steps required to do this were included in the composition task.

The composition task was completed in 25:08 minutes with 466 steps. There were 28 errors, with seven left uncorrected due to the user not recognizing the incorrect notes as errors. The reason for the large number of steps and lengthy composition time was that the user entered notes both using the mouse and by using the keyboard, while exploring what other options were available during this process. The task of saving the composition was completed in six steps with one error, which was corrected in one step. The overall trial took 479 steps in 28:11 minutes.

Group – Trial 4

This trial was completed using Sibelius without a mouse and with JAWS. The task of opening and creating a new document took eight steps to complete. This is fewer than the number required in a perfect test because setting the time signature and key signature were not completed. No errors were made in the task.

Composition of the sample piece took 177 steps, with 6 errors. The process lasted 11:00 minutes. Saving the piece took only 6 steps, although one error was produced when selecting the file type, which was corrected in the same step. The process was just as easy as without a mouse. Overall the trial required 191 steps in 12:15 minutes. During the trial, JAWS did not read everything, including the key signatures being selected or the notes previously entered.

Blind student – trial 5

This trial was completed with a former student. The student is an advanced computer user who uses a computer at home for tasks such as writing letters and reading news. The student also has experience using JAWS to accomplish these tasks. In regard to music however, the student has not used software due to problems with screen readers.

When writing music, the student writes it in his head and remembers it or plays it into a recorder.

The trial was completed using audio feedback from JAWS. Opening and saving documents was a very easy process with no errors. In order for the composition portion of the trial to be completed, the piece of music was read to the student to tell him which notes to enter. Composition of music was a very difficult process. Notes are played as they are entered, adjusted, and selected but adjustment must be made entirely using recognition of the note by ear. These difficulties lead to an entering process with little feedback as to which notes were correctly entered. The composition process was therefore cut short after entering four bars of one voice.

Feedback from the former student indicated that the biggest shortcoming of the software is reading of all elements in the software. JAWS did not always read dialog boxes and left out elements of the music including time signature. Additionally, entering notes was fairly easy and intuitive with good mapping of input to result but correcting incorrect notes could be easier.

Overall, the entering process was very easy to remember and with more time to become accustomed to shortcuts, Sibelius would be very easy to use. The total time taken was 13:40 minutes, with 79 steps.

Because the student was completely blind, this trial provided a unique look at how a blind musician might use Sibelius. Entering notes was fairly easy due to the mapping of input on the keyboard, but correcting notes still relied on detecting an incorrect note as it was entered, by ear. Notes, dialogues, and pop up windows were seldom read in their

entirety, and sometimes not read at all. With better interaction with a screen reader, Sibelius might be much more easily accessible by a blind user.

Only the first four bar voice was entered in its entirety. Adjusting the results to account for having saved a document brings the time taken during the trial to 12:37 minutes and 69 steps. Additionally, this trial was the only trial to include a screen reader.

These results reflect the difficulties a blind user may experience when using software. The student did respond that the mapping of keyboard input was a nice feature and input was not very difficult. With improved accessibility via a screen reader, Sibelius would be very easy to use.

Low vision student – trial 14b

A former student completed both this trial and trial 14a, which was done using Finale. The student previously used Sibelius at the West Jutland Academy of Music, but has not used the software in many years. He is currently using the Cubase recording software. Due to differences in Sibelius versions, the student indicated that some learning was required in order to complete each task. Opening was completed with only one error in selecting the type of document, which was quickly corrected. Composition was completed in a shorter amount of time, but more steps and similar number of errors, as in the Finale trial. The student suggested that a portion of the steps taken to enter might be eliminated by a more familiar situation such as a more familiar and personally customized computer station. The total time taken for this trial was 15:06 minutes with 286 steps taken.

Low vision student - trial 12

This trial was completed with a current student who has been using Sibelius on a weekly basis for the past five months. The student uses Sibelius in classes where it is

used for composition and harmonizing of other music. In order to use the program, the student uses both Zoom Text and an inverted screen with white letters on a black background. He used both the mouse and shortcuts for entering of notes for the trial.

Opening and creation of a new document was completed quickly and with only one error, occurring as the time signature was selected. Composition of the entire four voice piece was also completed in a short amount of time. This includes the time required to supply instruction on changing voices.

Overall, the student indicated that Sibelius is very easy to use and would use it in a home setting. While the teachers know an older version of Sibelius, using the new version, which is installed on the classroom computers, has not been a problem due to the similarities between the two versions. The total time taken for this trial was 9:56 minutes with 128 steps taken.

Sighted teacher – trial 16

This trial was completed with a music theory and piano teacher at IBS. In his music theory classes he has used Sibelius for students to write short pieces of music or analyze music that he writes for the class using the software package. He also uses the piano during his classes so that the student is able to hear and feel the music and not just read it.

The trial was not completed in its entirety because of time constraints. Opening the program and creating a new document took 1:40 minutes and ten steps with two errors. The errors were a failure to enter the time and key signatures. The teacher entered the first voice of both the treble clef and bass clef staves. Entering of the treble clef took 2:43 minutes and 43 steps with 2 errors while the entering of the bass clef took 1:30

minutes with 47 steps and 1 error. The first two errors were due to note changing and the third error was due to entering the notes an octave too high.

The teacher who completed this trial uses the program for music theory classes to harmonize melodies and build chord structures with his students. The teacher had very little trouble with the trial as he had used the program in the past. He felt he was a little out of practice because he could not remember all the shortcuts that he used in Sibelius and when he uses the program, he often enters the notes using a MIDI keyboard rather than the composition feature on the computer keyboard.

Screen reader test

In Sibelius, during the opening of the program and creating new document process, the registration window, menu bars, manuscript paper, and key signature of major/minor options are read. The key signature buttons (sharps or flats) and time signature (2/4, 4/4, etc.) are not read. When entering music the pop-up windows entitled Sibelius are all read. The entering of music is not read although the buttons pushed, A, B, C, etc., are read. The numbers used to select the length of the note (quarter to half) are read but the length of the note is not read. These forms of feedback would be useful, and critical, to the low vision user as this information is not otherwise available and is the heart of any notation package. When saving, the menus and pop-up windows are correctly read. Due to the fact that the composition window is not read to the user, this is a fatal flaw with the software package that would need to be corrected before this package can be fully accessible to a blind user. The lack of reading of the time and key signatures are not fatal errors as these could be quickly memorized.

5.4.2 Finale

Finale is also a professional music editor. Like Sibelius, Finale supports plug-ins, which is where Finale gains the ability to transcribe music into Braille. Finale also supports entry of music via computer number pad and mouse, MIDI instruments, scanned music, and stored files. Notes are entered using the computer keyboard by selecting the length of the note with the number pad and moving the position of the note on the staff with the arrow keys. Supported formats for file input and output are Finale, Coda notation, ENIGMA, and MIDI files. The version used in review had no limitations.

Group – trial 1

The process of opening a document was simple, but had many steps. The user had two errors when creating a new document. Each took one step to correct. These errors were user errors and did not affect the functionality of the software.

While composing the piece, the user had a total of 16 errors. These were mainly errors due to entering incorrect notes. The errors were easily corrected in one step. The entire process took 8:16 minutes to complete with a total of 157 steps, 32 of which were related to the creation of and fixing of problems. The user felt that although the process of fixing mistakes was uncomplicated, it was too easy to make mistakes. The mistakes were made due to the inputting of the notes using a mouse to choose the value of the note and the velocity of the note must be set before hand so that on many occasions a user entered the note and then realized that it was the wrong length. The user then saved the completed composition as a MIDI file type with no errors during the process. The overall trial took 9:27 minutes and a total of 184 steps.

Group – trial 3

This trial was completed with Finale using JAWS and without a mouse. The process of opening and creating a new document took 33 steps, including one error. The

process took 2:24 minutes. The user felt that although the process took many steps it was not difficult, just time consuming when compared with completing the same process using a mouse.

The composition task took 264 steps and contained 8 errors, which were all corrected in one step each. The process lasted 11:20 minutes. Although the user was able to successfully enter the music, the user needed sight to do so. JAWS does not read what has already been entered, or what is being entered for notes. The user must be able to recognize the note he or she is entering by hearing the pitch, and must remember what has already been entered.

Saving the document was easy to do without the mouse. It took only 8 steps in 23 seconds. The overall process took 14:07 minutes and had a total of 305 steps. Due to the screen reader's inability to describe what has been composed, the user must make any corrections by listening to the piece and memorizing what note, in which measure needs to be changed and how.

Low vision student – trial 14a

The same former student who completed trial 14b with Sibelius completed this trial. Opening and saving were completed with minor errors in file selection, which required a repeat of the task. The most difficult portion was selection of the time signature. Composition was completed with some initial difficulty but as the user became more comfortable with the input, the notes were entered with increasing speed. Due to time constraints, composition was stopped after the first voice was completed. Entering of notes was indicated to be similar to Sibelius so learning to enter notes in Finale would not be a difficult task. The total time for this trial was 19:17 minutes with 220 steps taken.

Screen reader test

During the process of opening Finale and creating a new document JAWS reads the setup wizard with title, composer, and copyright along with the choosing of parts (instruments). In this process, the quick start pop-up box video tip is not read. When setting up the document, the time signature, key signature, tempo, and pickup measure options are not read. When composing the piece, the menu bars were read but the entering of notes, changing of beats such as from a quarter note to a half note, and the moving of notes up and down on the staff are not read. When saving the document as a MIDI file, the file type, folder, and export MIDI file options are read. As with Sibelius the fatal flaw is the inability of the composition window to be read. With Finale, this is even more of a problem because of the way the music is entered using the computer keyboard.

5.4.3 Lime

Lime is a notation editor supporting input from computer or MIDI keyboard and stored music files. Notation in multiple instruments is also available. Entry of notes on the computer keyboard simulates a piano keyboard; therefore the person entering the music must know the layout of a piano keyboard. Instead of an "A" note being an "A" on the keyboard, as in Sibelius, the letters on the keyboard have no instantly intuitive meaning. Instead, the computer keyboard acts as a piano keyboard, as seen in Fig. 5.1.

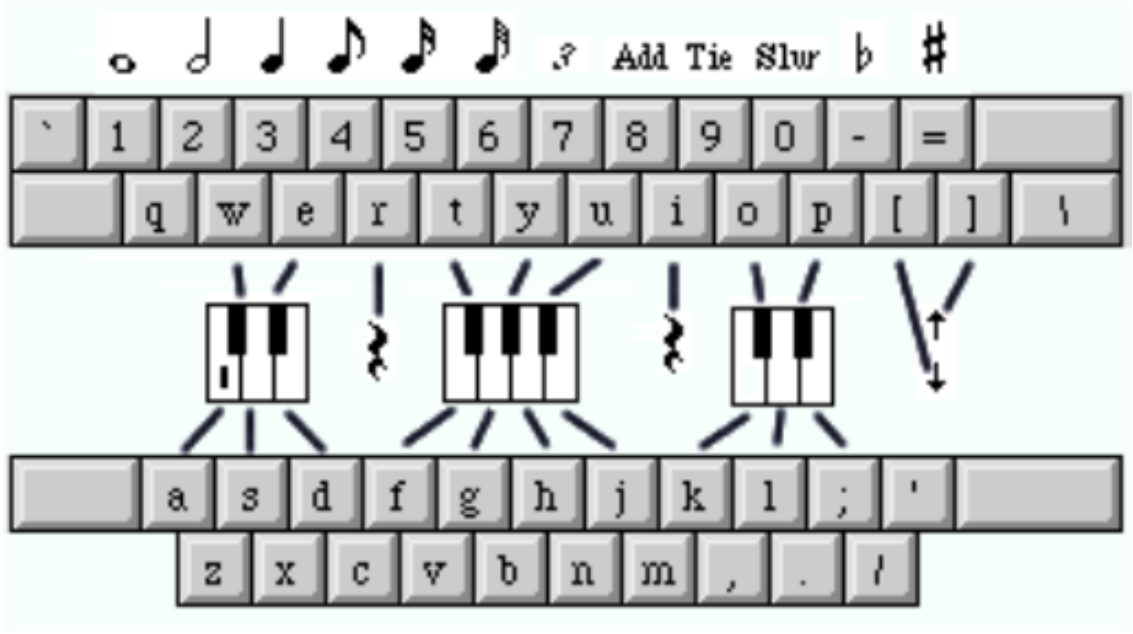

Figure 5.1. Key mappings of computer keyboard to piano keys in Lime.

Also, the user must switch octaves to achieve proper placement of notes, which can be confusing. When he or she moves the octave down on the computer keyboard, by pressing the left-bracket key, the piano keyboard on the screen moves the pointer up one octave, as shown in Fig. 5.2. This is counter intuitive as the visual feedback is contrary to what the user is doing, until he or she realizes that the pointer on the piano keyboard is always on middle-C and, therefore, when it moves to the right the screen is showing that the pointer has actually moved to the left, or down one octave.

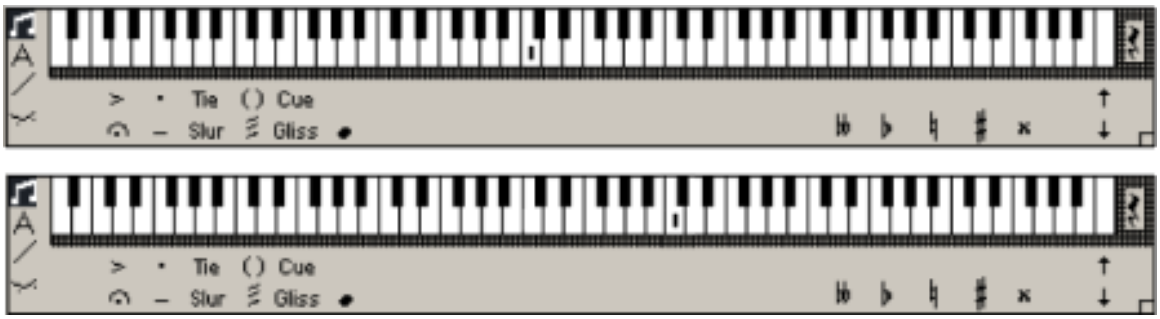

Figure 5.2. Screenshot from Lime of the note entry keyboard palette. The lower image shows middle-C after having moved down one octave.

Output can be achieved through Lime or MIDI files, as well as directly to GOODFEEL for transcription. The version used in review had no limitations.

Group – Trial 15

This trial was completed with Lime using a mouse. The task of opening and setting up a new document was completed with 13 steps in 32 seconds. There were no errors, and therefore no corrections to be made.

The task of composing took 230 steps and lasted for 22:37. The large number of steps and lengthy time was due to the requirement of using the computer keyboard to enter the notes. The process of saving took only 5 steps in 19 seconds. There were no errors and the user found this task to be very simple to complete. The entire trial took 248 steps in 23:28.

Group – Trial 11

This trial was completed using Lime without a mouse. The process of opening and composing a piece of music took 20 steps and was completed in 43 seconds. There were no errors during this process. The user found the process easy to complete. The composition task took 181 steps, with 18 errors, and a total time of 15:41 minutes.

For the composition task, the user needed to know the layout of a piano keyboard, making the task difficult, as the user did not know how to play a piano. This accounts for 58 errors occurring in the composition task.

The process of saving was relatively easy, with only seven necessary steps. The process took 35 seconds to complete. The entire trial took 208 steps and lasted for 16:59 minutes.

Screen reader test

In Lime, during the opening of the program and creating new document process, the warning box about MIDI output, the welcome to Lime pop-up window, menu bars,

new piece options such as name, time, staff, and key signature options are all read. When entering music, the notes are not read although the names of the keys pushed (A, U, Y, etc.) are read. Reading of pressed keys that don't correspond to the value of the actual note is counterintuitive and potentially distracting to a low vision user. All save options are read. As with the other music editing software, the inability of JAWS to describe the composition window would prevent a blind user from being able to use all functions of the software package.

5.4.4 Toccata

Toccata is a notation editor and Braille transcriber in one package. It supports entry of music via computer mouse or stored music. Braille notes may be made visible on-screen concurrently with their form in typical notation. Output may be in MIDI, NIFF, or Toccata format. The version used in review was a demonstration version and was not able to save documents.

After testing Toccata, the group decided not to have teachers or students trial this software package due to the software's need for the user to precisely layout their music when entering the composition, where the other notation editing packages take care of the layout. Toccata relied solely on what could be seen on the screen. Even with perfect vision it was difficult to see which line a note was being placed on and the only way the group could find to enter a note was to place it on the staff using a mouse and look to see where it was. The program did not provide checks on data entry, so even if the number of beats in a measure is defined by the key signature, a user is still allowed to place as many notes as he or she would like without restrictions or constraints imposed by the program.

Group – Trial 9

This trial was completed using Toccata as a notation editing software. The process of opening and creating a new document took ten steps, with no errors, in a total time of 40 seconds. The user felt that it was a fairly easy process. Completing the process of opening and creating a new document in ten steps is the fewest number of steps necessary given the requirement of a grand staff, with the key of A Major, and the time signature 4/4.

The task of composition took 197 steps and had 19 errors, with some errors going uncorrected. The process took 18:22 minutes to complete. The user was not satisfied with the process of entering notes, due to the intensely graphical nature of the program. The program relies on the user to place the notes in the correct location on the staff using the mouse, both vertically and horizontally, and relies on double-clicking to place notes.

To save the piece took only three steps and had no errors. The overall trial took 210 steps and lasted 19:13 minutes. The user found the opening and saving tasks very simple, but was displeased with the entering of the composition. Due to the program's dependency on the user to accurately space the music, correct playback of the piece was not achieved and the software could not be used by a user that can not see the mouse pointer on the screen. The software package was not able to be used without a mouse so a screen reader test was not done.

5.4.5 Analysis of music notation software

Of the four music notation editing software packages, two stand out in the testing. In testing under perfect conditions and when used with a mouse, both Sibelius and Finale have the lowest minimum number of steps required for a complete trial. In addition, both have the lowest number of steps required for input of the music sample. Lime and

Toccata require the most steps in both cases. When used without a mouse Sibelius remains with the lowest number of steps and Lime has the second lowest number. Toccata was unable to be used without a mouse.

Because both Toccata and Lime were consistently more difficult to use in group trials, they were excluded from user trials. The user trials, completed with Sibelius and Finale, indicated that either of the tested packages would be acceptable for standard use in terms of their professional output, but both would be difficult for a blind user to use independently. These two packages could, however, be used for a low vision musician. In the trial results, Finale had somewhat slower input of notes with more errors. In general, errors in both applications were due to incorrect note placement. A few of the errors in some trials were due to lack of an entered time and key signature. Only the note placement errors are relevant to the analysis of the software. In this respect Sibelius remains with fewer average errors. Errors in trials completed with both packages were usually easily corrected with one additional step.

With Sibelius, trials were completed in shorter time than the trial with Finale and errors were generally corrected in fewer steps. Most importantly, Sibelius offers easier mapping between input and result. In order to use Sibelius without a mouse, the notes are entered in an intuitive manner with the keyboard letter A as the note A and a B as a B and so on. In Finale, however, the notes cannot be entered using keys on the keyboard. The note is automatically entered as the note at the last position and then must be moved up or down with the arrow keys to the desired place on the staff. The entering of notes using the keyboard letter as the note not only makes input of notes a very simple process but also provides an additional assurance that the note entered is what was desired.

The entering of notes in Sibelius proved to be very important to each user who tested the package or has had experience with the software. Finale has no such mapping and relies on placement of notes using first the number pad to determine note length and then the arrow keys to place the correct note on the staff. Toccata also lacks an intuitive mapping and additionally requires input of notes via a mouse. Lime takes an interesting approach to the mapping aspect and imitates a piano keyboard with the computer keyboard, seen in Fig. 5.1. Unless the user has previous experience playing a piano, entering notes with Lime can be very difficult.

An added challenge for using Lime without the mouse was changing the octave of the note, as seen in Fig. 5.2. The bracket pressed to change the octave seemed backwards to the user. Placing a note in the wrong octave accounted for many of the mistakes. The error could easily be corrected, but the user never gained full understanding of why the mistakes were being made before entering the wrong note. The task of changing octaves and correctly using the computer keyboard as a piano keyboard made the note entering process the most difficult of the trialed software.

Mapping of keys becomes especially important with the use of a screen reader. Notes are only played as they are entered and when selected for editing. When used with a screen reader, it becomes increasingly difficult to determine where in a piece of music the editor is and what notes have been entered. Additionally, if the user is not capable of perfectly distinguishing different notes as they are played, it is difficult to determine a correct note. By providing an intuitive mapping of letters between computer keyboard and music notes, a screen reader is able to read the note as it is entered. Lime for example maps a “C” note to the “A” key on the keyboard. A screen reader therefore

reads an “A” as a “C” is entered in the score. When an “A” note is entered in Sibelius, JAWS reads an “A” because it is mapped to the keyboard letter “A”. This feedback of information is very helpful to a user who is unable to see the notes on the screen.

5.4.6 Minimum step trials

In order to accurately compare the editing and transcription software packages, non-timed trials were completed by the group in the minimum number of steps required to complete each task, specifically without error. Opening the program and creating a new document, composing the sample piece of music, and saving the music were all tested. When testing the transcription software packages, a step was counted every time a key had to be pushed or the mouse clicked. Dragging the mouse was not counted as a step. Scrolling through folders in the save menu was counted as only one step as the number of folders could vary depending on the user and a file only had to be selected for loading. A summary of results for these trials are shown in Figs. 5.3-5, with specific numbers included in Appendix 25.

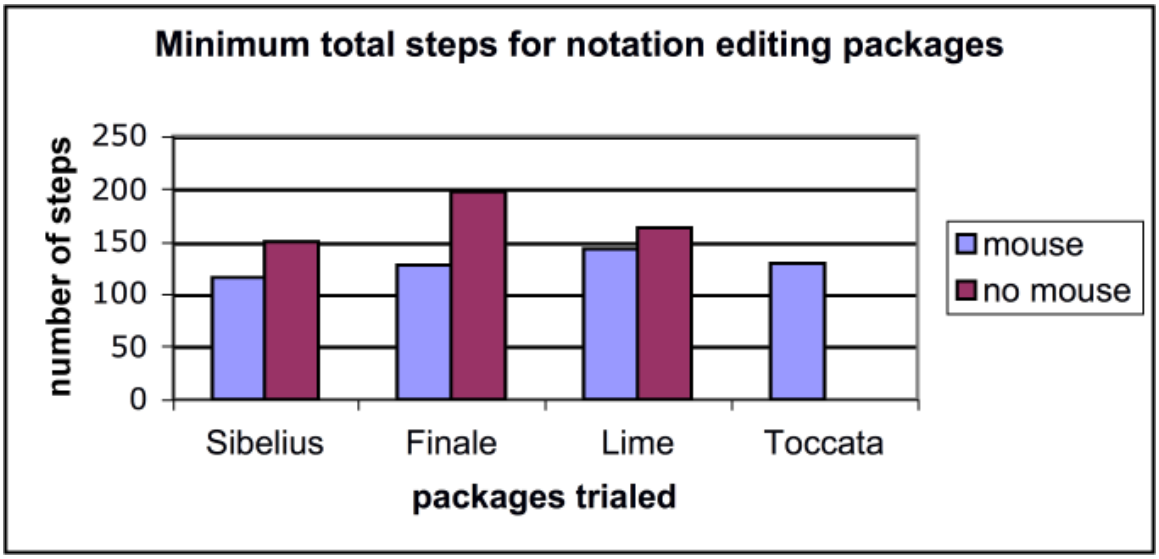

Figure 5.3. Minimum number of total steps required to complete the trial for each music notation package.

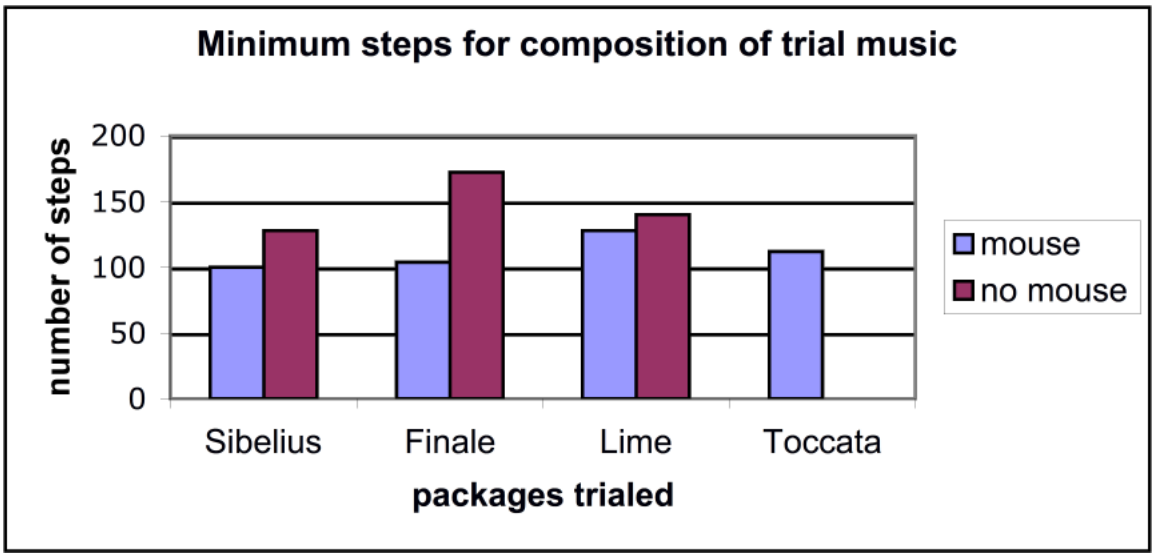

Figure 5.4. Minimum number of steps required to compose the trial piece of music in each package.

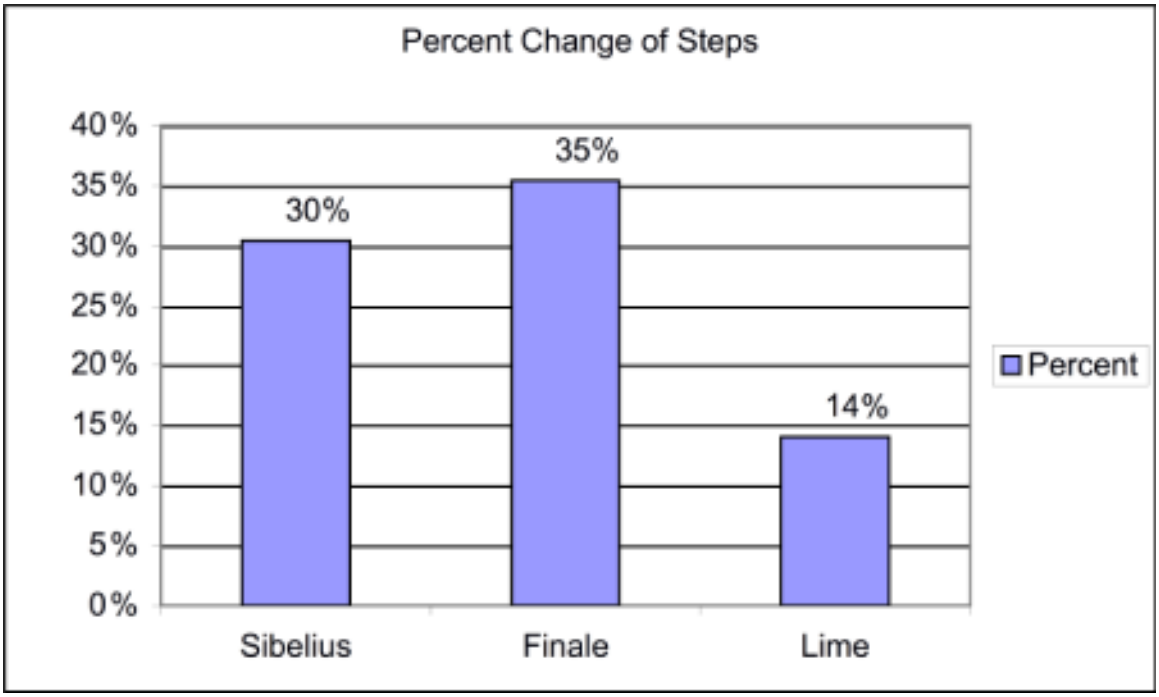

Figure 5.5. Percent change in the number of total steps between trials when the mouse was used and when it was not used in notation packages.

For both GOODFEEL and the Braille music kit plug-in for Finale, there were a few additional steps for using the packages without the mouse. The steps were added when opening the program because more keys had to be pushed instead of just dragging the mouse through the program menu. This could not be observed with Toccata because it is

not used without a mouse. With the notation editing programs the largest differences in the number of steps when using a mouse and not using a mouse occur during the composition task. A summary of these trials is included as Fig. 5.6, with specific numbers included in Appendix 25.

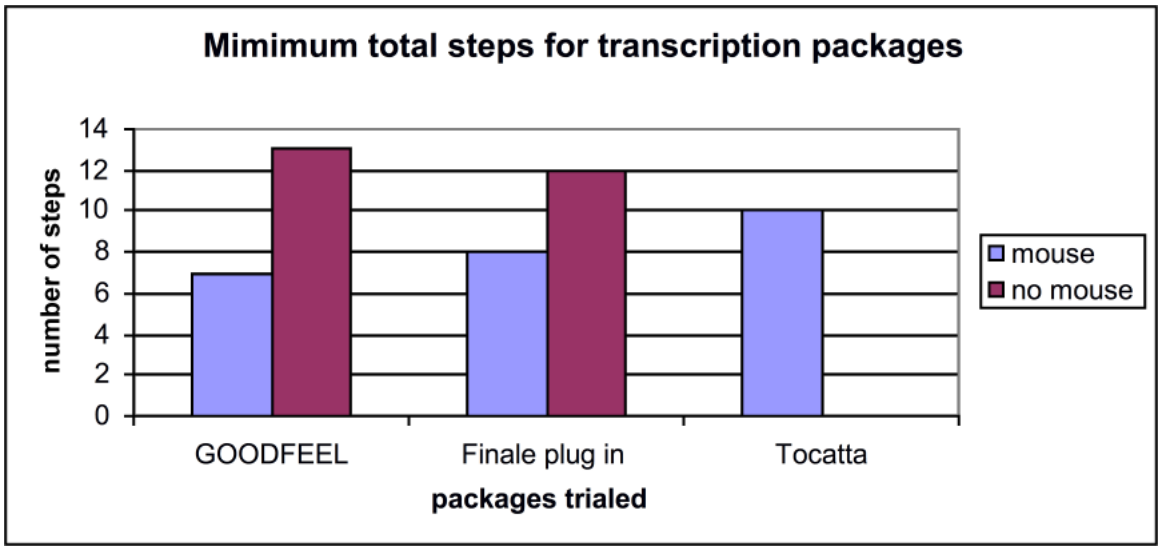

Figure 5.6. Minimum number of total steps required to complete the trial for the transcription software packages (note that the Finale plug-in was unable to print and does not include the number of steps required to complete this action).

5.4.7 MIDI keyboard tests

For these tests the 4 measure sample music was used. In each program the music was recorded first by playing one staff at a time and then by playing each voice separately. The sample music is in 4/4 with a key signature of A*b* major. The note values are quarter, eighth, and sixteenth notes. There are no rests in the piece.

All software packages required setting the time and key signatures before entry could be started. If time signature and key signature were not set up, the programs defaulted to common time and C Major. All the programs were able to accurately determine the note pitches; values were not always interpreted correctly. Both Finale and Sibelius contain alterable quantization settings. The quantization sets a limit on the

smallest note accepted, to increase accuracy of input note values. For Finale and Sibelius the quantization was set so that 16^{th} notes would be the smallest accepted. Lime accepts 8^{th} notes as the smallest notes played in.

None of the programs were able to select a key signature or time signature based on the notes recorded, so time and key signatures were pre-set before recording. The largest differences between the tests were the software packages' different interpretations of the MIDI data being sent to it by the keyboard. MIDI data contains the pitch of the note, the value for how long it was played, and the force with which the note was played, known as velocity. None of the trials were able to select different dynamics based on the velocities of the notes. Appendix 28 contains the screen shots of each test, showing the differences of output between each software package. The following table (Table 5.1) details the results of each test.

Table 5.1. Results of entry into notation software via MIDI keyboard.

Software Package	Time Signature	Key Signature	Rests	Notes	Accidentals
Sample Piece	4/4	A*b* Major	None	Quarter, 8th, & 16th	None
Finale – 1 Staff at a time	4/4	A*b* Major	None	Quarter, 8th, 16th, and dotted 8th	Flats and naturals due to misplayed notes
Finale – 1 Voice at a time	4/4	A*b* Major	Sixteenth note rest at start of piece	Quarter, 8th, 16th, and dotted 8th	None
Sibelius – 1 Staff at a time	4/4	A*b* Major	None	Quarter, 8th, 16th, and dotted 8th Tied 8th notes used to simulate quarter notes opposite 8th notes in the same staff.	None
Sibelius – 1 Voice at a time	4/4	A*b* Major	None	Half, Quarter, 8th, 16th, and dotted 8th notes. Tied quarter notes were written as half notes.	None
Lime – 1 Staff at a time	4/4	A*b* Major	None	Quarter and 8th notes. Tied notes were ignored, except across measures.	None
Lime – 1 Voice at a time	4/4	A*b* Major	None	Half, Quarter, and 8th notes. Tied quarter notes were written as half notes. When 16th notes were played the one played longer was interpreted as an 8th note and the other note was dropped.	None

The MIDI keyboard provides a way for the blind musician to enter their music without having to see the screen. Sibelius, Finale, and Lime all work with a MIDI keyboard for music input. Each software package gives the user the ability to set the smallest note accepted and change the speed at which notes are entered. The easiest way for a user to input via a MIDI keyboard is to set up their score with the appropriate time and key signatures before entering. This aids in the accuracy of fully formatted music as it is displayed.

Playing the music in through the MIDI keyboard is a simple process. In each of the software packages the music was played in once by staff, and then also by staff and voice, meaning that the music would be played in soprano and alto parts together and then also just the soprano part followed by the alto part. The software was most accurate when each voice was played in separately. Using the sample piece, in the first measure, beat two of the soprano voice is a quarter-note F; if the music is being played in by staff then this was written as either two eighth-note F's tied, or as just one eighth note, but when entered by voice it was correctly recorded as a quarter-note. This difference in interpretations is displayed below in Fig. 5.7. The top measure (Fig. 5.7a) is from entering the music by staff and shows the circled incorrect note, while the bottom measure (Fig. 5.7b) is from entering music by voice and shows the same circled note entered correctly. Additional errors do occur in the base line of both samples indicating that neither method is perfect. In this case, a very simple note, a quarter note "F", is intended. The measure on the right (Fig. 5.7c) shows the original sample with the correct note circled. All three measures were taken from tests in Sibelius.

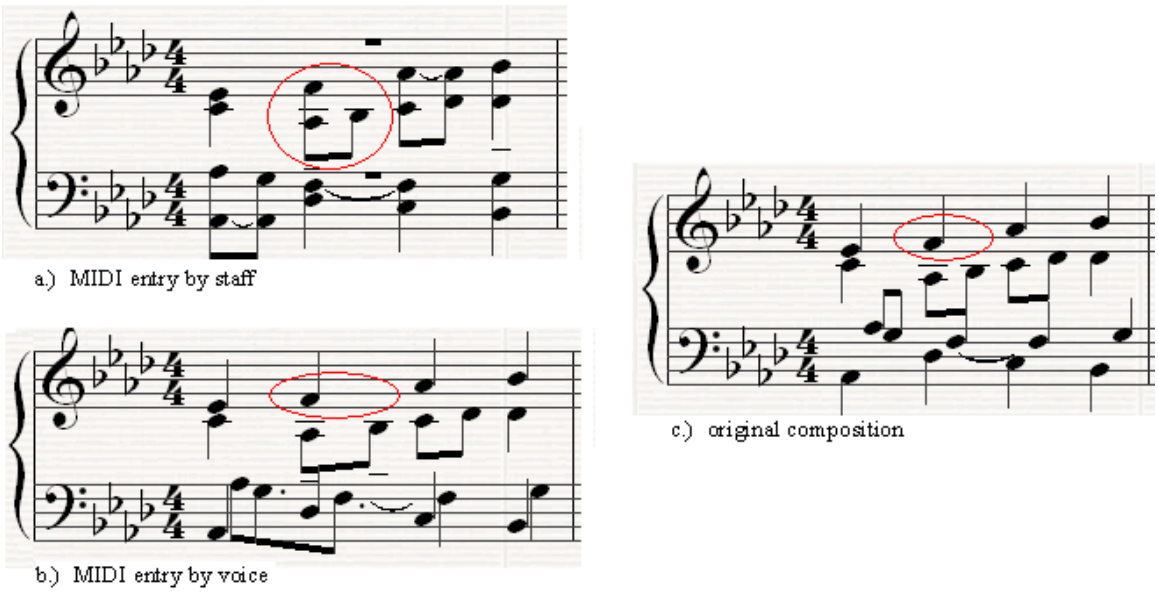

Figure 5.7. Interpreted music from a MIDI keyboard.

As can be see in Fig. 5.7 great care must be taken when entering music through a MIDI keyboard to have notes of exact length. One way that the programs offer to avoid entering notes of incorrect length is to use the MIDI keyboard to enter the note's pitch, but set the value using the computer keyboard. Playing the music into the editor via a MIDI keyboard may be a better option than converting MIDI files. The user has more control over how the data from a MIDI keyboard is interpreted, whereas using a MIDI file for input can vary greatly from program to program. In Fig. 5.8 the sample music is shown as was interpreted by Finale, Lime, Sibelius, and Toccata, after being saved as a MIDI file. Beginning with a MIDI file saved by different applications did not have an effect on the subsequent interpretations, as long as the original file is without error. The samples from top to bottom are Finale, Lime, Sibelius, and Toccata.

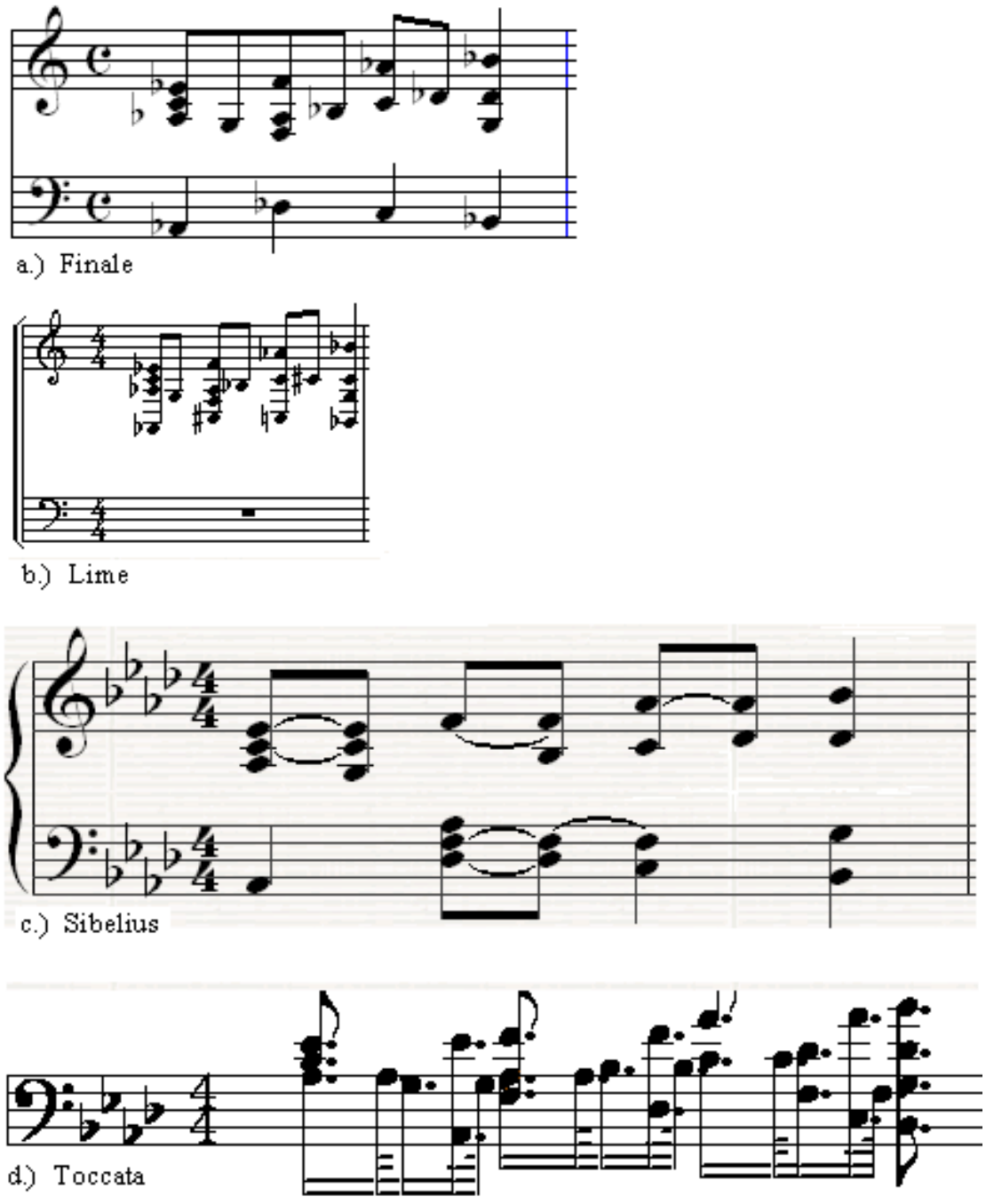

Figure 5.8. Interpreted music from a MIDI file. Top to bottom: Finale, Lime, Sibelius, Finale.

In Fig. 5.8 we see how both Lime and Toccata interpret the MIDI file as a single staff, whereas Sibelius and Finale interpret the file as two staves. The MIDI file was interpreted using the default settings for all programs and the output was not altered in any of the programs.

5.4.8 Scanning trials

Tests were conducted using the second page from a Schumann piece, the four measure sample piece from the user trials at the original size, the sample piece reduced 50%, and the sample piece enlarged to 200%. For each program the music was scanned in using a Hewlett Packard ScanJet 4200c scanner.

Sibelius and Lime have scanning programs that allow editing the scanned pages before interpreting them in Sibelius and Lime. Sibelius uses PhotoScore Lite to open the Hewlett Packard scanning software and set the resolution and document options. Lime works in conjunction with SharpEye through the use of NIFF files. SharpEye opens the scanning software to set resolution and document options as well. Finale requires the music to be scanned in through the Hewlett Packard software and saved in a TIFF file format and is interpreted through SmartScore Lite. SmartScore Lite comes with Finale and is integrated directly into Finale; another program window is not opened. TIFF is the industry standard file format for scanned documents.

The following tables (Tables 5.2-6) detail the different notation editors' interpretation of the scanned pieces. It includes what key signature they identified, how many voices were recognized, whether a time signature was identified, whether lyrics, dynamics, or articulations were read, and the accuracy in recognizing the value and pitch of the notes. Copies of the scanned pieces can be found in Appendix 27.

Table 5.2. Scanning settings for each notation package.

	Schumann	*Finale*	*Sibelius*	*Lime*
Image File Format:	N/A	.bmp, .tiff	.bmp	.bmp, .tiff
Color Format:	N/A	256 Grey scale, black-and-white (.tiff only)	256 Grey scale, black-and-white	black-and-white
Optimal Dots Per Inch (DPI)	N/A	300 dpi	200-400 dpi (dependent on staff height, from largest to smallest)	200-400 dpi (dependent on staff height, from largest to smallest)
Required Software:	N/A	SmartScore Lite	PhotoScore Lite	SharpEye

Table 5.3. Results of scanning a normal sized score and interpreting it with various notation packages.

	Schumann	*Finale*	*Sibelius*	*Lime*
Staves:	3	3	3	3
Most layers per staff:	2	2	2	2
Time Signature:	6/8	4/4	6/8	None – All measures add to 6/8
Key Signature:	G Major	C Major	C Major	C Major for Voice and Piano-treble G Major for Piano-bass
Lyrics:	Two lines: First line – Italian Second line – Danish	None	None	Two lines: Neither with the correct complete set of lyrics
Dynamics:	*piano* marking	None	None	*piano* marking
Articulations:	Slurs, ties, staccatos, fermata, tempo marking (Allegretto)	None, but added a tie due to wrong note recognition	None	Slurs, ties, staccatos, tempo marking (Allegretto)
Accidentals:	Sharps and Naturals	Sharps and naturals	Sharps and naturals	Sharps and naturals
Notes:	Quarter, 8^{th}, 16^{th}	Half, Quarter, 8^{th}, 16^{th}, Dotted 8th	Quarter, 8^{th}, 16th	Quarter, 8^{th}, 16^{th}

Table 5.4. Results of scanning a normal sized score and interpreting it with various notation packages.

	Sample – 100%	*Finale*	*Sibelius*	*Lime*
Staves:	2	2	2	2
Most layers per staff:	2	2	1	2
Time Signature:	4/4	4/4	4/4	4/4
Key Signature:	A*b* Major	A*b* Major	A*b* Major	A*b* Major
Lyrics:	None	None	None	None
Dynamics:	None	None	None	None
Articulations:	ties	Ties	Ties, but in wrong places with incorrect notes	Ties
Accidentals:	None	Flats	None	None
Notes:	Quarter, 8^{th}, 16^{th}	Quarter, 8^{th}, 16^{th}	Quarter, 8^{th}, 16^{th}	Quarter, 8^{th}, 16^{th}

Table 5.5. Results of scanning a score at half size and interpreting it with various notation packages.

	Sample – 50%	*Finale*	*Sibelius*	*Lime*
Staves:	2	2	2	2
Most layers per staff:	2	2	1	2
Time Signature:	4/4	4/4	4/4	4/4
Key Signature:	A*b* Major	B*b* Major	C Major	A*b* Major
Lyrics:	None	None	None	None
Dynamics:	None	None	None	None
Articulations:	ties	None	None	Ties
Accidentals:	None	None	Flats	None
Notes:	Quarter, 8^{th}, 16^{th}	Quarter, 8^{th},dotted 8^{th}, 16^{th}	Quarter, 8^{th}, 16^{th}	Quarter, 8^{th}, 16^{th}

Table 5.6. Results of scanning a score at double size and interpreting it with various notation packages.

	Sample – 200%	*Finale*	*Sibelius*	*Lime*
Staves:	2	2	2	2
Most layers per staff:	2	2	1	2
Time Signature:	4/4	4/4	4/4	4/4
Key Signature:	A*b* Major	A*b* Major	C Major	A*b* Major
Lyrics:	None	None	None	None
Dynamics:	None	None	None	None
Articulations:	ties	ties	None	Ties
Accidentals:	None	None	None	None
Notes:	Quarter, 8^{th}, 16^{th}	Quarter, 8^{th},dotted 8^{th}, 16^{th}	Half, Quarter, 8^{th}, 16^{th}	Quarter, 8^{th}, 16^{th}

Finale, Sibelius, and Lime all offer the option to recognize scanned music. Each software package has varying levels of success with scanned music. Out of the three programs, the program that most accurately scanned and interpreted the music every time was Lime, which uses SharpEye to scan and interpret the music. SharpEye interprets the music and places the information in a NIFF file, which Lime is then able to read.

In each test of the sample music, SharpEye correctly identified the key and time signatures, which have a major impact on how it interprets the rest of the piece. In the tests where Finale or Sibelius did not detect the correct key or time signature the interpreted notes contained many accidentals and also there were more inaccurate notes. Such errors may be corrected later, but add additional steps in the process of achieving an acceptable transcription. Examples of this are the tests of Finale and Sibelius with the sample music at 50% size. Details of these test can be seen in Appendices 25 and 26.

The size of the sample music does alter the accuracy with which the different programs operate. While all of them correctly identified the key and time signatures in

the sample piece that is standard size, only Lime correctly identified the key and time signatures when the sample was 50% smaller, and Sibelius was unable to identify the key signature when the music was twice as large. When comparing the sample music at standard size to the Schumann sample, we see that the sharpness of the original makes a difference as well. Whereas the sample music's time and key signatures were identified most of the time, Schumann's key signature was not interpreted correctly at all, and the key signature was only interpreted correctly by Sibelius.

While Sibelius and Finale were less accurate than Lime, it should be noted that both Sibelius and Finale offer a Professional version of their scanning software, which offers better options than their Lite versions that were used for these tests. One of the main differences between the Lite programs and SharpEye which is a full version scanning package is that SharpEye can read lyrics, dynamics, and other articulation markings and text. This is more cost effective as the only version of SharpEye available is a fully functioning one, whereas the Professional versions of Sibelius and Finale's scanning software packages are more expensive than the Lite versions.

Considering the difficulty all the programs have interpreting MIDI files, scanning music may provide an alternative way to get the most information transferred between programs. Lime can be used in conjunction with GOODFEEL to transfer detailed notation files, rather than just MIDI files which can be misinterpreted. So using the scanning capabilities of Lime to get the music which is entered into either Sibelius, Finale, or from other sources, may give the most detail to a Lime file, and provide the least amount of editing of the music before sending it to GOODFEEL for Braille output.

5.4.9 GOODFEEL

GOODFEEL is a Braille music transcription package designed to integrate specifically with Lime. It provides a great amount of control over the formatting of the output, including whether the Braille is to be formatted for US, UK, or international music. The version used in review is limited to transcription of only the first few measures of a piece of music.

Group – trial 6

This trial was completed using GOODFEEL with a mouse. The process of opening the program, selecting the MIDI document to transcribe, and transcribing took 19 steps in 1:12 minutes. The user does not need to know Braille music in order to transcribe the notes, however they would need to know Braille music to edit the output of the transcription process. Printing the music is accomplished in one step, following directly after the transcription process.

Group – trial 7

This trial was completed using GOODFEEL without a mouse and with JAWS. The process of opening the program, selecting the document, and transcribing the document took 25 steps in 1:39 minutes. There were two errors in the process, due to an embosser not being installed on the computer system. During the process there were warning boxes that the screen reader failed to read the contents of, but did inform the user that there were new windows. Printing the transcription took only one step and was easy to complete.

Sighted teacher – trial 16 – demonstration

After the trial of Sibelius with a sighted teacher, the group gave a short demonstration of GOODFEEL with Lime. For this demonstration, a MIDI file was imported into Lime from pieces that had come from Finale and Sibelius to show what the

music looks like when it was imported. The teacher was disappointed in the results of the importing as he had been hoping that there would be very little editing needed. The transcription process was very straightforward, but he could not read Braille so there could be no comparison to determine if the programs were actually transcribing what was on the screen.

The teacher said that he would like to use a transcription program himself to be able to give music to his blind students in a theory class but that he would probably not be teaching the use of the software to his students. An important feature for the software package to have for this teacher would be to build chords with different markings on them like he does in Sibelius. This would not be possible without a large amount of editing because the markings were lost in the MIDI file and would have to be added in during the editing process in Lime in order to transcribe in GOODFEEL. It was mentioned that Lime works better with either scanning or MIDI input so the teacher suggested trying to scan in a piece of music made in Sibelius to Lime in order to see if this would eliminate some of the editing time. The time the transcription process would take would be very important because the teacher would be completing the process and it would be more convenient if the pieces of music did not require a great deal of editing.

Screen reader test

In GOODFEEL, when opening the program the menu bar, embosser setup, MIDI import window, and the output choice window entitled "GOODFEEL Braille process: success" are all read. The GOODFEEL warning windows and errors are not read. When printing, the transcription menu bars in the Braille music viewer are read. While the warnings and errors did not affect the group trials, the lack of reading the descriptions in the warning and error boxes could affect the proper use of the program.

5.4.10 Braille Music Kit Plug-in for Finale

The Braille Music Plug-In is a free part of the Braille Music Kit. The Plug-In integrates with Finale to provide direct transcription of entered music. Because only the Plug-In was trialed, printing was not available.

Group – trial 8

This trial was completed using the Braille Music Kit Plug-in for Finale using a mouse. The process of opening the program, selecting the sample piece in Finale format for transcription, and transcribing it took only 5 steps in 20 seconds. Printing could not be accomplished, as the entire Braille Music Kit is required to enable printing. The process of transcribing the music was very simple.

Group – trial 13

This trial was completed using the Braille Music Kit Plug-in for Finale without a mouse. The process of opening the program, selecting a piece to transcribe, and transcribing it took 31 steps in 1:02 minutes. There was one error during the process, which was fixed in one step. The task of printing was not accomplished, as printing is not allowed without the entire Braille Music Kit.

Screen reader test

In the Finale plug-in, when opening the program the screen reader does not read all the options under plug-in. For the Braille option JAWS reads “Br” instead of Braille. When printing the transcription to the screen, the reader reads all tool bar options and the editing window. There were no elements left unread.

5.4.11 Toccata

The ability to transcribe music into Braille is included in the Toccata music editing software package. No additional software is required.

Group – Trial 10

This trial was completed using Toccata's music transcription feature with a mouse. To open the program, select the sample music in a MIDI file, and transcribe took only 5 steps with no errors. The process of printing took only 3 steps with no errors. The entire trial lasted 37 seconds with a total of 8 steps.

5.4.12 Braille music transcription software

Transcribing music is a very easy task in all three software options. GOODFEEL, Toccata, and Finale are capable of opening MIDI files and therefore provide support for any editing package. Toccata and Finale, however, support transcription without the intermediary step of a MIDI file. Both support transcription in essentially one action by selecting transcription from a menu. The advantage of this is that there is no loss caused by saving to a MIDI file. GOODFEEL requires an intermediary step of saving as a MIDI file and then transcribing through Lime. Beginning the editing process in Lime eliminates this step. The loss of information in a MIDI file is aided by editing in Lime before transcribing. A Lime file can be imported directly into GOODFEEL.

The steps taken to transcribe in each package are very similar, but the fewest occur in GOODFEEL. Without a mouse, GOODFEEL and the Finale plug-in require a similar number of steps. In both sets of trials, the actual transcription process is just one step. Many of the added steps for the GOODFEEL trial were due to the error boxes having to be closed because a Braille embosser was not found. Even if there is a refreshable Braille display, if there is no embosser attached to the computer, these messages will appear. If a Braille embosser were installed on the computer, these messages would not appear and thus the number of steps would be fewer.

In group trials of the transcription software, Toccata and the Finale Braille Music Plug-in required the lowest number of steps, when completed with the mouse. Without using a mouse, Toccata could not be used and GOODFEEL requires the fewest number of steps. The Finale plug-in requires few more. Times are relatively the same across similar tests, but indicate that the fastest process is transcription in Toccata or Finale where it occurs without an additional application. When used without a mouse, however, GOODFEEL does not require additional time when compared to trials with the mouse. This makes GOODFEEL more accessible for a blind user, which is important to the students at IBS Vocational.

The Braille transcription feature of Toccata was easy to use and had a feature different from the others that allowed the user to see both the transcribed music and the file that the music was transcribed from. Toccata, however, is not sold solely as a transcriber. The total package is the editor and the transcriber and as stated earlier the editor is very difficult to use.

The sample piece of music transcribed in the three different Braille music transcription software packages was given to a transcriptionist at the Danish Braille Library for evaluation. GOODFEEL and the plug-in for Finale both transcribed the music correctly. GOODFEEL was written in the bar over bar format while Finale was written section by section. The transcriptionist said that she liked the format of both pieces. Toccata did not write the slurs in the sample music and the formatting was not as easy to understand.

A second, more complex, piece was also examined. The addition of more advanced dynamics, tempo marking, and articulation is important to inspect as these features will

be required as a musician becomes more advanced. GOODFEEL accurately transcribed all portions of the music. The Braille Music Kit Plug-In performed decently, but skipped or incorrectly transcribed some of the more advanced markings. The piece is included in Appendix 24 with further information on what was and wasn't transcribed in Appendix 14.

5.5 Curriculum integration

Many students at IBS do not need a Braille transcription software package because they are able to see printed music well enough that they don't need to read Braille music. In this case, editing software would still be useful. For students that do need transcription, it may be easier for both students and teachers to have a package that can be used as both editing and transcription software. Based on research done by this group, there is no perfect solution. Although Toccata is both an editing and transcription package, it was not able to be used without a mouse, and it does not automatically format the music, but relies on the user to properly layout the music using a graphical interface. While this may work for a sighted user, it is not an option for a blind user. Finale can be used as an editor and a free plug-in can transcribe the music to Braille, but in order to print the transcribed music the user must purchase the full Braille Music Kit. GOODFEEL comes with an editing package called Lime whose files can be output to GOODFEEL. For transcription, GOODFEEL can also take files from Sibelius or Finale in the MIDI format. With students of varying degrees of sight, two separate software packages would be best so that both do not need to be used if both are not needed.

The nature of the transcription software makes it almost impossible to use without the editing software. Even when scanning in music, the music must first be scanned into

an editing software and saved as a MIDI file before being output to the transcription software. A MIDI file downloaded from the Internet for input to transcription software should be examined and edited before use, due to the limits of MIDI files. Lime files found on the Internet, however, may contain proper formatting, eliminating the need for editing MIDI files.

The integration of software packages should be unproblematic because software is already being used and taught in the curriculum. The possibility for software upgrades and replacement should be considered in the integration of the software into the curriculum. Currently software developers are working to make Sibelius more accessible for a blind user. Specifically they are trying to make JAWS function better with Sibelius. If a professional level editing program such as Sibelius or Finale could be used in conjunction with a screen reader and everything was read, this would make a much more desirable software package for blind users.

5.6 Information from other schools and organizations

Many people were contacted from other schools and associations for the blind. Of these many contacts, ten supplied the group with information regarding their use or planned use of software for Braille transcription. Five of these contacts were from the United States, two from Europe, and three from the rest of the world. Appendices 2, 3, and 5 contain the responses from these contacts. None of the schools are teaching the use of Braille transcription software to their students. Eight of the schools are currently not using any music transcription software package. Of these eight, two transcribe their music in the traditional way using the Duxbury program, a software package for Braille editing. One teacher is in the process of trying out software to choose transcription

software. Three of the schools or associations are not transcribing music in any way. The last two of these eight teachers are using software for recording music and producing CDs but not Braille transcription software.

The other two teachers are both using GOODFEEL as Braille music transcription software. These teachers are using the software package in conjunction with Lime and SharpEye to produce music for use in their classes. They are not teaching their students how to use the program to transcribe their own music. The advantages that they find from this package are that the process is much faster than traditional methods, the package is easy to learn, and multiple copies of the music can be made. Some of the disadvantages of the package as seen by the teachers are that when music is scanned in it must be edited before going through the transcription process and all three programs must be used in conjunction with each other, which can be time consuming. Of the eight people that were not using any transcription software, two had tried GOODFEEL but no other package. Their reasons for not using the software are that the music still requires a large amount of editing and a thorough knowledge of the Braille code so the software does not save any time or allow any other transcribers of music besides an expert in Braille music notation.

From contact with these schools and associations for the blind, it was found that no one is aware of any studies comparing and contrasting different music editing and Braille transcription software packages that could be used by the blind or low vision musician. Most schools or associations have little contact with outside sources. They speak with the association for the blind closest to the school and possibly a nearby school but there is no established communications network for teachers between schools. Software

decisions are made either by advice of an IT Service department at the school or recommendations of a user of the program at a nearby location. The criteria for recommending the software are not given to the teachers so the reasons for choosing the software may not be known to them. Most of the people contacted have only tried one Braille music transcription software package and so they have nothing to compare the results to. These teachers are not teaching the software to their students so the ease of teaching this software to a blind or low vision student has not been tested. The teachers are using the software to transcribe music themselves for their students.

Teachers and associations for the blind have expressed interest in learning what music editing and Braille transcription software packages are available for a blind or low vision musician, and how they compare to each other. To this point they have not been able to find a package, particularly for editing, that a blind user can use independently. Low vision students at IBS Vocational are independently using Sibelius with great ease using a screen enlarger and/or inversion of the colors on the screen, but blind students are not currently using the software.

A main goal of the teachers, students, and musicians is to have an easily accessible supply of music available in Braille, which is where the transcription software will be of use. As of right now, most music must be borrowed from a library and returned. If a person wants a piece of music to keep, such as an original piece, he or she must wait up to a year for the music to be transcribed. With the transcription software the music can be obtained much faster and increase the speed of progression of the student.

5.7 Summary

The most important part of the IBS Vocational music curriculum is the one-on-one teaching style. No recommendations can be made that would disrupt this. A software package must be able to satisfy the needs of both a diversified curriculum and the varying students, either blind or partially sighted.

Although the students and their courses vary, the main goal of each student is the same: to become a professional musician. Many teachers feel that it is essential for a blind student to read Braille music because in order to function as a professional musician, a person must be able to read music. In order to accomplish this goal, it is necessary for students to be able to use a music editing software program. This is particularly important for those students that go on to the music academy. In conjunction with the editing software, a blind student must be able to use a transcription software package to print his or her music.

The trials conducted by the group provided a basis to evaluate both editing and transcription software packages. Some packages were easier to use than others for sighted users. Some reasons for the differences were the different ways of entering music and the features available quickly through a graphical interface. These same reasons for difficulty extended to the user trials where the graphical interface became an important aspect in the evaluation. For a blind user, the use of graphics is impossible without the screen reader being able to read the elements. The trials showed that for completely independent use by a blind user, the software package must be able to be used without a mouse and must have elements that can be read by a screen reader.

In comparing software packages, all are approximately feature equivalent. In testing, the fastest composition and transcription occurred in Finale with the Braille

Music plug-in. Toccata was similarly fast but was not usable without a mouse and had poor editing output. Additionally, Sibelius provided the most accessible composition process but transcription required output to a MIDI file where information is lost. By using Lime before transcribing with GOODFEEL, this information may be re-entered. Lime may be a valid solution on its own but requires experience with using a piano and does not provide professional notation features.

6 Recommendations

Through research completed over the past eight weeks, the group has found that there is currently no music notation editing or Braille transcription software that is totally compatible for use by a blind or low vision user. This is due in part to issues with screen readers and limited interpretation of on-screen content. What is being presented here are the recommendations for the most viable options for IBS Vocational and for other potential users who may not already have any investment in music editing and/or transcription software. These software packages should provide users with methods of transcribing written music into a Braille format that are much faster, easier, and inexpensive than current manual transcription services with limited availability.

6.1 IBS Vocational

At IBS Vocational there exists a variety of curricula, each molded to the needs of the individual student. This presents a challenge when trying to find a software package that works for all students. Ultimately, the most important aspect of using the software is to allow a student to communicate their musical understanding to other music professionals and increase their access to different forms of music for the blind musician. Currently IBS is using Sibelius as their means of achieving this communication through composing and editing music.

6.1.1 Notation editing software

The group tested Finale, Sibelius, Toccata, and Lime for their notation editing capabilities. These software packages were tested for usability with and without a mouse. The group found that Finale and Sibelius offer the most professional options for editing, composing, and output of music. Over the course of study, the most essential need of a

blind or partially sighted musician was found to be the ability to use software that allows them to compete on the same level as a sighted musician. Both Finale and Sibelius fit this requirement of professionalism. The group found that the interface for entering music in Sibelius is a more logical mapping between the entered notes and the corresponding keys on a keyboard. By mapping each note to its alphabetic representation on the computer keyboard the screen reader is able to give more accurate feedback on the notes being entered as each key press results in the reading of that letter.

With these findings, it was also found that Finale requires 35% more steps to complete the same task without a mouse as it does with a mouse, whereas Sibelius only requires 30% more steps. While these are similar changes, in an environment where the software is to be used a great deal, every decrease in work is very beneficial. Additionally, Sibelius begins this comparison with the fewest number of required steps, resulting in a equally low number of steps when used without a mouse. Discussions with teachers, and others who have used Sibelius or another notation package, have also indicated that Sibelius is the easiest to learn; a very important note when considering that Sibelius is to be an important component of courses for some students at IBS and the West Jutland Music of Academy.

Due to the overall similarities between Finale and Sibelius, either package should be suitable in a learning environment. Because Sibelius has better entry mapping, and thus better interaction with a screen reader, and taking into account that IBS is currently using this software package, it is the recommendation of the group that IBS Vocational continue using Sibelius as their music notation and editing software package.

6.1.2 Braille music transcription software

In researching transcription software, the group tested the capabilities of GOODFEEL, Toccata, and the Braille Music Kit Plug-In for Finale. These tests revealed that all three provide an easy and fast way to transcribe written music notation. GOODFEEL and Toccata allow the user more control over how the music is to be transcribed. GOODFEEL allows the user to transcribe their music by musical part, as a piano score or as an orchestral score. Also, GOODFEEL allows for setting transcription preferences depending on the country in which the notation is to be used. This is very important where notation differences may exclude some users from understanding a piece of music. All three packages perform similarly in the number of steps and errors and amount of time occurring in transcription.

Toccata comes as an editor and transcription program in one. As stated in the results section, music notation in Toccata cannot be completed without a mouse, and editing of input before transcription is essential to obtaining an accurate result. Toccata also did not transcribe the sample music correctly while the other two programs did. Therefore, Toccata is not considered a viable option for blind musicians. Eliminating Toccata leaves GOODFEEL and the Plug-In for Finale. As the recommendation on notation editing software is for Sibelius, the group recommends GOODFEEL as the Braille music transcription software for IBS Vocational.

6.1.3 Complete package

As the group has recommended Sibelius as the music notation editing software and GOODFEEL as the Braille music transcription package, there are certain functionalities of each program that can make them operate more accurately and smoothly with each other. Input in Sibelius can be completed in any of three ways for a blind or low vision

user: using a MIDI keyboard, importing a MIDI file and editing, or entering music using the computer keyboard. The low vision or fully sighted user may also enter and edit their music in Sibelius using the mouse.

Transferring music between Sibelius and GOODFEEL requires the Lime notation software included with GOODFEEL for best results. It was found that the easiest way to transfer the music was by printing the music from Sibelius and then scanning it into Lime using SharpEye, also included in the GOODFEEL package. Transferring music between Sibelius and Lime or GOODFEEL using just MIDI files was found to lose information and produce an inaccurate, and less professional, representation of the intended music. Transferring the music using a scanner reduces the amount of editing necessary to produce accurate output.

The complete package being recommended would include a scanner, MIDI keyboard, printer, Braille embosser, Sibelius, GOODFEEL, Lime, SharpEye, and a computer capable of supporting these hardware and software. This complete package would cost approximately $4,300 USD, or 30.100 DKK. IBS currently has the necessary hardware, as well as Sibelius, so their total cost is for GOODFEEL, Lime, and SharpEye, which is available from Dancing Dots as one package for $800 USD, or 5.600 DKK.

6.1.4 Curriculum integration

While no changes are being recommended to the current curriculum to integrate the software, there are considerations for where the complete hardware/software package may be used. Sibelius is currently being used at the West Jutland Academy of Music, and it would be most beneficial for students continuing their studies at the Academy to be familiar and comfortable with Sibelius. Using Sibelius for composition, arranging, and

analyzing music in classes at IBS can accomplish this. The students who would benefit most from this are those whose tracks would include the use of Sibelius while they are at the Academy and afterwards.

To enhance the ability to communicate musical knowledge between teachers, students, and professionals, GOODFEEL would provide students with the ability to transcribe their own music in a timely manner. This could be useful when students are given printed assignments. Students who are going to want or require Braille music, and are capable of using a computer, should learn how to use Sibelius and GOODFEEL to fulfill their needs. Teachers may also use GOODFEEL to produce exercises and short samples of music. Communication with teachers and other users of Braille transcription software has indicated that the transcription software be used only for short pieces of music. Most users have encountered errors with large, complex pieces of music. The most accurate method of obtaining large, complex pieces of music is still through transcription professionals.

6.2 Individual users

As IBS Vocational currently uses Sibelius, the recommendation of GOODFEEL is one that fits best and is most cost effective. For an individual user, without such an investment, the following recommendation is made. For music editing, either Sibelius or Finale will provide professional output and ease of use. The limitations for the blind user in both Sibelius and Finale are discussed in the Results and Analysis/Discussion sections and are primarily limitations regarding screen reader compatibility. In both programs, the blind user may find entering music via a MIDI keyboard to be the fastest and easiest way. Editing of music will still require use of the computer keyboard.

For users who do not want to use a scanner, or find the use of a scanner too difficult, Sibelius with Lime and GOODFEEL may not be a an acceptable option and Finale, combined with the Braille Music Kit Plug-In, is the best option. When the Braille Music Kit Plug-In is used to transcribe music, notes entered in Finale are translated as is into Braille music, without any additional steps. Inaccuracies are therefore not introduced when a MIDI file is used as an intermediary before transcribing to Braille.

For those users who receive much of their music in the form of a MIDI file, it was found that Sibelius best interprets these files. Sibelius with GOODFEEL is again the best option, as long as the user is comfortable using a scanner. If the user does not wish to use a scanner, but still receives their music via MIDI files, then Finale with the Music Kit Plug-In would be their best option, although additional work may be required to correct errors introduced in conversion from the MIDI format.

Users who do not need a complete music notation and editing software package, and receive printed music, would find the GOODFEEL package, including Lime and SharpEye, to be the most accurate and cost effective option. For users who have full-sight, need the most inexpensive package, and do not need an upper level, professional music package, Toccata is a stand-alone editor and transcriber and costs only $795 USD (5.565 DKK). For those requiring professional grade music notation and editing software, Finale with the Braille Music Kit is the best option and costs $920 USD, or 6.440 DKK.

7 Conclusion

Throughout the entirety of this project, the group was presented time and again with the importance of making Braille music available to the individual student, teacher, and musician in an affordable and timely manner. Braille music can take up to a year to transcribe and one book may cost as much as $15,000 USD (105.000 DKK). This demonstrates how vital Braille music transcription software that can be used by the blind or low vision musician is in allowing them to compete in the professional music world. It is imperative that a musician be able to compose his or her music and communicate this work to an audience. Without the use of music notation editing and Braille transcription software this task becomes very difficult for the blind musician.

As of this writing, the software available for blind and low vision students is not perfect. Improvements in the use of the music notation editing software with a screen reader and accuracy of Braille music transcription are an ongoing process. Through the continued work of computer professionals advancing the music recognition ability of scanning software, screen readers which allow the user to accurately use all functions of a program, and improving the transcription process of Braille music, the possibility of making professional Braille music at the same cost and availability of traditional written music will become more and more of a reality.

Another consideration is the human aspect of music transcription. Current techniques rely heavily on the transcriptionist to organize breakpoints in music and produce a friendly and very usable Braille piece. As computer automation reduces the time required for this process, the assurance that the music is represented in a simple and logical format must remain. In addition to representation of all notes and articulation,

logical organization in a recognizable layout is the most important concern in automated transcription. It is very likely that human intervention may be required here, in proofreading of transcribed music, for some time.

Due to these difficulties in different aspects of the Braille music transcription process via computers, it is important that the teachers and professionals in the field of blind and low vision musicians stay in close communication so that advances in technology will not leave any users behind. It is the hope of the group that the initial contacts made during this project will be continue to be expanded upon and utilized to benefit the education of blind and low vision students as a whole.

Appendix 1 – Initial School Contact Email

Template email sent to schools in the United States and United Kingdom.

To Whom It May Concern:

We are students at Worcester Polytechnic Institute (WPI) in Worcester, MA conducting a research project evaluating computer music access for the blind. This research is being conducted for the IBS Vocational School in Copenhagen, Denmark. The goal of this project is to find quality Braille music computer programs available for blind students and the best way to integrate these into standard teaching methods.

The Members of our group are Adam Fuller, Arno Hautala, and Sarah Bellfy. We are currently juniors here at WPI, majoring in Computer Science (Fuller and Hautala) and Biology (Bellfy). Our advisors for the project are Professor Scott Jiusto and Professor Holly Ault.

In order to aid our research, we would be very interested in learning what kind of methods you are currently employing with your music program. Any information that you could provide us with regarding your curriculum would be greatly appreciated. We believe that this information will be an invaluable asset to our research.

Thank you for your time and any information you can provide us with. We can be contacted by email at braille@wpi.edu. We eagerly await your response.

Sincerely yours,
Adam Fuller
Arno Hautala
Sarah Bellfy

Appendix 2 – School and Organization Email Responses

Leslie Costello at Florida School for the Deaf and Blind

Adam, Arno, and Sarah;

I'd be happy to help with your research for your project. Relating specifically to the instrumental program and the technology we use here at the Florida School for the Deaf and the Blind, it is dependent upon the levels of each of the children. For those who are able to handle reading Braille music, we use a program called GoodFeel to help us transcribe the music. I use it in conjunction with Lime and an embosser to take print music and turn it into braille music for them to read. The program allows for music to be scanned, but I have found the needed editing of scanned music to be more time consuming than for me to just input the music into Lime, where I can also eliminate much of the "extraneous" notations that many of our students aren't able to handle. My colleague also has Cakewalk available for her use in this matter. For any text material, I use the Duxbury program.

In my job, I teach private lessons, wheel rotation classes, and band. I use a combination of ear training and music fundamentals with my lesson students, and music reading for those who can read large print or can handle beginning braille music. I allow the students to use a note system that makes sense to them at the beginning (writing down the notes on paper or in their Braille Lite, using a poster board, writing down patterns or themes...I let them make the decision that is best for them....later on I take their systems and relate them to music notation) The rotation classes (gr. 6-8) meet for 9 weeks each group before we switch, and they are on a 3 year curriculum rotation...last year (our first year with this setup) was an introduction to the instruments, this year is Orff, and next year will most likely be history/cultural. With band, I use mostly ear training techniques. We are also beginning a percussion ensemble, where we will use ear training and improvisation techniques. With a small student population, each year brings many changes in the curriculum based on the student makeup.

I hope this background helps. I wasn't clear on exactly what you are looking for, so please feel free to ask any questions you may have. We also have a performing arts technology class taught here, so hopefully he (Bill Sabo) responded to your request, as well. If you are interested in tech. items beyond the scope of music, I can also point you to some people who could help with that.

Leslie Costello
Instrumental Music Teacher
Florida School for the Deaf and the Blind

[contact information removed]

Bill Sabo at Florida School for the Deaf and Blind

I instruct recording, performance technologies, and stage. As such, my students do not use music lesson programs. They do, however used recording and editing programs.

We use Roland digital recorders which have small lcd screens. They are a challenge to learn even with full sight and consequently we have had only one totally blind student - now a working graduate - who has mastered the 18 track recorder. He does it strictly by memory and hearing. We have several low vision students who navigate the devices quite well.

From the recorder, it goes to an independent cd burner (which all students master) to a windows pc where the songs are edited, reproduced, and labelled. This area has been problematic for several reasons.

1. Roland should be able to interface with the computer to allow direct input (thus eliminating the need for a cd), however we have had difficulty in making this work. It appears that we will have to go to a dedicated sound card. We would love to bring it in with all 16 tracks acting independently - not in the stereo wav form we now use.

2. E-Magic has software that should allow the ROland to be shown on the computer screen (we got this to work once on a home computer) and thus 'blowup' the small lcd screen. I am hopeful that once this is accomplished that we will be able to put one of the windows speech programs to use with it, thus allowing access to the full editing potential. The goal is to move the 8 and 16 track editing out of the Roland and into the computer.

3. The biggest problem is locating others who are doing the same thing - that is, blind people running music edit programs on computer. If you have any info, please pass it on. It has occured to me to use Cakewalk to bridge the Roland-computer gap but I think we may lose quality in the process. Another problem is working over the phone - I have spoken with Roland and other recording engineers and seems to me that unless you have them all in the same room at the same time there will be little agreement as to how to resolve the problem. Perhaps you can help.

4. I won't go into the cd labeling at this time. It's considerably simpler than the editing problem.

Why don't you drop me an address, and I will send you our latest compilation cd. I think you will be pleasantly surprised at how well the studens have done to this point recording, editing and producing a product.

I look forward to hearing from you.

Bill Sabo

Wendy Cullitan at The Hadley School for the Blind

Hi Sara.
Thanks for thinking of Hadley. How did you hear about us? I hope you found us on our website at hadley-school.org

We teach Braille Music Notation completely free of charge to our blind students and professionals.

I spoke with our access technology specialist and he suggests you go to dancingdots.com to find lots of information on braille music programs and translators.

If you need additional information, please don't hesitate to contact me again.
Thanks you.

Wendy

Wendy L. Cullitan
Director of Communications
The Hadley School for the Blind
[contact information removed]

Rebecca Lindsey at The Maryland School for the Blind

Adam Fuller, Arno Hautala, and Sarah Bellfy,
In response to your questions....

what kind of methods you are currently employing with your music program?

Our school uses mainly music therapy techniques to teach students with severe mental and physical disabilities. We do use some braille music with our short term placement and some mainstreamed students. We use the Goodfeel/Lime/Sharp Eye computer program to transcribe most of our music into braille. This program appears to be the best that is currently available. We also use the Richard Taesch Introduction to the Piano for the Blind Student to assist the students in learning braille and reading braille music.

I have created my own curriculum to teach braille music using Betty Krolich's information and the braille music code. Recently, Richard Taesch has developed a curriculum, but I have not purchased this curriculum yet, so I do not know what it is like. The curriculum is in print and braille, and not on computers that I know of.

Hope this answered your questions.
Rebecca

Rebecca Lindsey, MM, MT-BC

The Maryland School for the Blind
[contact information removed]

Cheryl Stewart at Overbrook School for the Blind

There is indeed technology available for transcribing music into braille notation. The program is called Dancing Dots and was developed by Bill McCann. Mr. McCann is visually impaired and has maarried computer technology to music to create a program that can convert written or played music into braille music notation. I suggest you look up the key word "Dancing Dots" and you should be able to find this information.

Cheryl Stewart
Overbrook School for the Blind
[contact information removed]

Rob Gale at Perkins School for the Blind

Sarah, Adam and Arno -

Thank you for your email. We have several people here at Perkins who teach blind and deafblind students music. I'm sure they would be glad to assist you in your project, time permitting.

Amazing as it seems, these individuals do not have email within the Perkins school. If you would be so kind as to provide a phone number and a fax number, I will forward that information along with this email.

Thanks,

Rob Gale
Perkins School for the Blind

Sid Carpenter at Queen Alexandra College

Hello,

Can I start with an apology. I have only just managed to get around to responding to the e-mail you sent to the college last month. I am sorry that I cannot give you any good news, I'm afraid. We have a small music programme and do not currently have student accessing it who reads music. We are currently using music as a recreational tool or a means of developing other skills rather than as a strict educational route.

I am sure that you will get more information from RNC at Hereford as they have a large music technology area. You may also want totry some general FE colleges on the offchance that they have some VI students. In Birmingham you could try Josiah Mason College or Sandwell College.

Sorry I could not be of help.
Sid Carpenter

Ray Piggott at Queen Alexandra College

Thanks for your e-mail.
Unfortunately we do not use braille music here. The leading expert is Bill McCann, based in the USA, his company is called Dancing Dots.
www.dancingdots.com

I hope this is of some use

Ray Piggott QAC

Cathy Fletcher at Royal National College for the blind (see Appendix 3 for additional RNC responses)

Hello

Thanks for your email. I recommend you make contact with

PHil Kennedy - Head of Piano tuning and repairs. He is partially sighted himself, is an accomplished pianist and knows a lot about braille music

Cara Tivey - music lecturer at RNC

Paul Cobbold - lecturer in music technology

they can all be reached on **[contact information removed]**
good luck

cathy fletcher

Jennifer Hervey at Washington State School for the Blind

Dear Sarah,

Good luck! I can tell you probably what you already know. Dancing dots is the main program. I do not find it not very helpful, although most of my students that study music braille are fairly competent computer users, and they have a firm grasp on the music braille code, their piano skills are weak and the music software is picky. I
braille all my music manually using Duxbury with a braille input keyboard and can then save and emboss whatever is needed. It isn't that slow of a process for me because I can transcribe almost as fast as I can scan, translate, proof it for the many errors that usually arise and then fix them. If a totally blind student is paired with a sighted person to run the program and check for mistakes it works well, but I thought the original idea was for independence and I haven't found that with any of my students. When they create a song, they manually braille it on a Perkins braille writer and I transcribe it into music using either Finale or by hand. I would be interested in reading your research to see if I am one of the few or many that has trouble with the software that is available.

I am not aware of any other teachers in the state of Washington that actively teach music braille along with the software for transcribing it. I am sure there are others, but I seem to be the one most people in the state contacts for information.
Curriculum wise, I teach braille music through the Primer of Braille Music published by APH, along with many exercises that I have created throughout my ten years of teaching music to the blind. I hope this information helps, and you are welcome to contact me with any further questions.

Sincerely,
Jennifer Hervey
Washington State School for the Blind
[contact information removed]

Julie Woods. Royal New Zealand Foundation for the Blind.

Hi Adam, Arno and Sarah

Or as we say in New Zealand Kia ora

I have been recently appointed as Braille Literacy Co-ordinator at the Royal New Zealand Foundation for the Blind. Paula Daye, our Acting Chief Executive, has asked me to respond to your request for information with regard to computer music Braille.

I have enquired from two key people in New Zealand and attach their email correspondence below. I apologise for not reformatting this but actually I thought it might be more helpful for you in this format.

I wish you luck with your research and if you require any further information please do not hesitate to contact me directly using the contact details below.

Julie Woods-Dalloway, Braille Literacy Co-ordinator
Royal New Zealand Foundation for the Blind
[Contact information removed]

From: Wendy Richards
Sent: Tuesday, 25 March 2003 8:55 a.m.
To: Julie Woods
Subject: RE: information regarding music programs in your area

Hi Julie
As yet we haven't got into any of the programs, but the other one we are looking into is called SONAR produced also by dancingdots in America. It is a digital/MIDI sequencing program that has a notation program. This is the bit we are interested in as the Sibelius program that most schools use is not very user friendly for Blind users. Hope this helps
Wendy

> -----Original Message-----
> From: Janet Reynolds
> Sent: Monday, 24 March 2003 11:50 a.m.
> To: Julie Woods
> Subject: RE: information regarding music programs in your area
>
> Hi Julie
> We are not currently using any music braille software here but we
> have been looking into two products together with Wendy Richards from
> Homai. One is called "Goodfeel" produced by a company called "Dancing
> Dots" in the USA. The other is "Toccata" which is produced in
> Australia. Both are based on mainstream score writing programs with
> automatic translation to Music Braille and are designed for music
> braille production. They have been trialed recently by RNIB in the
> UK. There is another program that a student can use for composition -
> I've forgotten the name but Wendy would know. You can contact her
> through Homai on **[contact information removed]**. Janet

Janet Reynolds

Mrs. Marietjie Botes. South African Braille Music Library.

Greetings from Worcester, South Africa to Worcester, USA

Your e-mail to **[Contact information removed]** was referred to me.

I am the librarian of the South African Braille Music Library. The SABML is the only library of its kind in Southern Africa. We have a collection of ±15 000 titles of braille music notation as well as literature in general on music, on braille music and on the teaching of music.

The largest part of our collection was bought from overseas braille printing houses. But we also do our own music transcribing. Every piece of music transcribed by the Pioneer Printing Press automatically becomes part of the SABML holdings.

As you are probably aware *iftb* in the e-mail adress stands for the Institute for the Blind in Worcester. The Institute is a tree with many branches, a.o. the Pioneer School, the Pioneer [braille] Printers, the SABML, etc

Before I was appointed at the music library I was a transcriber at Pioneer Printers for 12 years.

At the Pioneer Printers we use the Duxbury programme to write direct braille.

I received a demo programme from Dancing Dots. We decided that Dancing Dots would still require so much editing for the precision work that we are doing, that you still need a thorough knowledge of the braille music code.

I also teach the braille music code to the music teachers at the School. The teachers also use the Duxbury programme for doing their assignments but they must be able to use the ordinary braille machine to teach their pupils.

All in all we find knowledge of the braille music code essential.

As for the curriculum that is followed at school I will forward your e-mail to our two music teachers at the primary as well as high school.

We have a ten-day school holiday starting today. I wanted to reply to your e-mail before going away.

I am very interested in your research project and would like to keep in touch with you, because making music available to the blind, whether as profession or hobby, is very important to me.

2nd email.

Dear Sarah, Adam, and Arno

Our second term kicked off on Tuesday. I forwarded your e-mail to my teaching colleagues, asking them to respond to you directly.

Thank you very much for the offer to become part of a network of teachers of blind musicians. Please pass my e-mail address on to IBOS Vocational.

I am personally interested in this subject, apart from the fact that my work requires it.

I came from a blind background and am married to a deafblind man. I knew quite a number of blind organists and music teachers as a child.

When I took up the post as braille music transcriber the whole aspect of what you communicate in your transcription by your selection of the information that is included or excluded interested me. I was fortunate that I was taught the music braille code by a blind music teacher. We had many discussions on the aspect that you communicate with your blind musician through *what* and *how* you transcribe. For instance, the outlay of the text (in braille called formatting) for a beginner book of recorder music will differ from recorder music at a higher music grade.

Later when I was training other music braille transcribers and proofreaders I also tried to convey these aspects to them.

Although the Pioneer School used to have a large number of blind and partially-sighted learners who studied music, became teachers and/or musicians, members of choirs, etc the situation changed drastically during the past 15 years since the Department of Education no longer provided posts for music teachers in Schools.

At the moment we have two music teachers, one for primary and one for high school.

I teach them the braille music code. But teaching a teacher the code is not the same as training a braille transcriber.

All apects of teaching music as such, and when and how you introduce the braille code to a learner, must be considered.

At the moment I find myself having the enthusiasm to partake in this marvellous opportunity of teaching music to blind children because of what it can mean to these children professionally and personally, but I lack information of the teaching aspect.

The library suffered the same drawback in that the music collection was not kept up to date during the years of decline. When I started here two years ago, the new primary school teacher asked me for books on teaching music to a blind child – there was nothing available in the library collection.

Therefore, I also aim to obtain not only music, but also material related to the teaching process for the library collection.

I would really appreciate it if you can pass my e-mails to you on to the IBOS Vocational.

I wish you luck with the completion of your project. I am looking forward to receiving your results.

Regards from Worcester to Worcester.
Marietjie Botes.

Erich Schmid. Austira School for the Blind.

Hello,

I am a teacher for music and information processing at the Bundes-blindenerziehungsinstitut (School for the blind) in Vienna, Austria and I am blind myself.

These are my experiences with music transcription programs:

There are two ways of music transcription: from ink print or digital source to Braille or from digital source to inkprint.

1. Digital source to ink print:

1.1 Score: operating system DOS. In some parts it was usable for a blind user. It was capable of justifying text correctly to corresponding notes. I think the company was called Passport Systems (USA), but I do not know neither if this program is still available nor if it has been further developed.

1.2 Manuscript writer: operating system DOS. Author Silas S Brown, **[contact information removed]**, http://epona.ucam.org/~ssb22/ (not checked!). This program was able to convert from digital source (midi) or from input via editor to Braille and to ink print. It depends what You want to do, but some results were good!

1.3 Capella: operating system WINDOWS: Author Prof. Hartmut Ring, Germany, **[contact information removed]**, program produced by a company (sorry, but i do not remember the website). With only a few obstacles i can key in scores with text. In my experience the best program for a blind person to write scores!

2. Digital source (midi or editor) to Braille:

2.1 Manuscript writer (see above)

2.2 BrailleMusik: operating system DOS. Author Prof. Rudolf Lindner: **[contact information removed]**. I think that dr. Lindner plans a migration to WINDOWS. This is the program, wchich has implemented nearly all available character combinations of the Braille musik notation system. I think it supports only the "continental layout" of braille musik: bar after bar in linear transcription. Source is a text file in which You code notation and text in a meta language.

2.3 Goodfeel: operating system WINDOWS. Company Dancing Dots (USA), www.dancingdots.com. Source is either a file produced with lime editor or a midi file. Especially with midi files (even if it consists of only one track with one voice) we had problems with the transcription. This program supports anglo american layout: each voice in one line.

2.4 Toccata: operating system WINDOWS. Sorry I have only the e-mail availabel: **[contact information removed]**. Source is either midi file or "text". Scores can be "recognized" by the aid of program Sharp eye. Braille can be made visible on the screen. Anglo American layout. We achieved good results.

2.5 Plugin to Finale: I neither know website nor have i ever tested this program. I only know that there is a plugin to convert scores lproduced with finale to Braille.

If You have results of Your work, please let me know!

Best wishes from Erich Schmid

2nd email.

Hello,

Are you using any of these software packages now?
Sorry, but except of cakewalk I do not use any of these packages intensively. I only tested them and tried to find out about there capabilities. I have been head of a mixed voice church choir. But at that time there were no such programs to use. Nowadays my interests have changed, so I am not an active musician like before. Are you using them in the classroom or teaching your students how to use them?

In Our school nearly each two years we make project with sound: 1998 a double CD with blind musicians; 2001 "Der kleine Prinz" (may be "The little prince") by Antoine de Saint-Exupéry, a "sond drama" for all senses (CD, tactile pictures ...); in this year two litle sound projects about our school. In all these projects we use cakewalk to cut and paste sounds. Sometimes I do the work myself, sometimes I show tutors or students how to do it. I Do not use these programs in classroom. - In addition in Austria every year there is a computer camp for visually impaired students. During this week i sometimes gave workshops about these programs.

I hove I could help again!

Best wishes from Erich Schmid

Wendy Richards. New Zealand.

Hi there
I'm afraid it is actually all a little bit out of my depth. Essentially all I am after is a program that will allow the students to notate their compositions (which they need for the school cirriculum) unaided. At present all of the schools use the sibleius program which requires the assistance of a teacher aid, and their ability to clearly hear in their

head what it is they want to notate. I met last year with a blind musician calles Lisette Wesling who does some work with the Blind Foundation in England, and she reccommended the 'Sonar' program produced by Dancing Dots, as it can be run with Jaws, and the student can work independantly. They also produce the Goodfeel program which I think is suitable for a school situation that needs to notate simple music (eg. orchestral parts or class music bits and pieces) and convert it into braille straight away.

As you can see I haven't yet actually had a chance to check them out, I am just going on recommendations of others. If you have any advice of other suitable programs, please, please let me know.
Thanks
Wendy

Appendix 3 – Royal National College Correspondence

Initial request for a response to interview questions via e-mail after being referred by Cathy Fletcher (see Appendix 2).

To Whom It May Concern:

We are students at Worcester Polytechnic Institute (WPI) in Worcester, MA conducting a research project evaluating computer music access for the blind. This research is being conducted for the IBS Vocational School in Copenhagen, Denmark. The goal of this project is to find quality Braille music computer programs available for blind students and the best way to integrate these into standard teaching methods.

The Members of our group are Adam Fuller, Arno Hautala, and Sarah Bellfy. We are currently juniors here at WPI, majoring in Computer Science (Fuller and Hautala) and Biology (Bellfy). Our advisors for the project are Professor Scott Jiusto and Professor Holly Ault.

We recently attempted to contact three teachers (Phil Kennedy, Cara Tivey, and Paul Cobbold) at your school. Our initial attempts unfortunately found these three unavailable. As per your recommendation, we now present a selection of questions which we hope they might be able to respond.

While we believe some might be directed towards a particular respondent, any relevant, alternate information would also be greatly appreciated.

Finally, would you have any objections to our using the results of these questions in our project? We are sure that your answers will be very helpful, but if you have any reservations in regard to your responses being used we will be happy to exclude them from the final report. In any event, anonymity of your responses will be preserved. If we find the need to quote you directly be assured that we will contact you first.

General:

A. Interviewee Background:
    1. What is your position at the Royal National College for the Blind.
    2. How long have you been teaching?
    3. What does your field of teaching entail?

B. Organizational Background:
    1. About how many students attend your school?
    2. About how many are involved in the music program?
    3. What are the age ranges of your students?

Mr. Kennedy:

A. We've been told that you are an accomplished pianist and read Braille music. Do you use any software to transcribe your music?
    1. If Yes
        i. What software do you use?

ii. What do you like about it?
iii. What don't you like about it?
iv. How difficult was it to learn?
v. How did you hear about it?
vi. Have you tried any other software?
Several schools in the United States have mentioned that they use Dancing Dots, have you heard of this or used it? What are your thoughts in this area?

1. If No
i. How do you transcribe your music?
ii. Have you heard of, or tried, any transcription software?

2. Do you teach how to read Braille music?
i. If so, what techniques have you found that work well?
ii. What are some major challenges in teaching Braille music?
iii. Have you taught people how to transcribe music to Braille music?

3. Are there circumstances under which you are able to read the Braille music while playing? If so how is this accomplished?

4. What memorizing techniques do you use?

5. Do you find some students to have increased difficulty in memorizing the music? If so, how do you accommodate these students?

B. Is there any other information you can provide that we have not mentioned?

Mr. Cobbold:
A. What types of music technology do you work with?

B. Do you use Braille transcription software?
1. If Yes
i. What do you use?
ii. Have you tried other software?
iii. What do you like about this one?
iv. What don't you like about this one?

C. Do you teach the use of any Braille music software?
1. If Yes
i. What difficulties do you find when teaching the software?
ii. How long does it take your students to become comfortable with the software?
iii. We've talked with one teacher at Washington State School for the Blind in America who said that she did not like Dancing Dots specifically because it doesn't seem to have been designed for the blind and low vision user.
a. Do you see similar problems with your software?
b. Are your students able to use the software unassisted?

D. Have you input music directly from a synthesizer and then edited that?
1. What synthesizer did you use?

2. What editing software did you use?
3. Did your synthesizer have a small LCD screen?
    i. Yes
        a. How did you accommodate your students?

E. Is there any other information you can provide that we have not mentioned?

Ms. Tivey:
A. What do you lecture on?

B. Do you teach Braille music reading or writing?
    a. What techniques do you use to teach reading?
    b. What techniques do you use to teach writing?

C. Do you teach reading or writing using technology?
    a. Do you use any particular software in your teaching?
    b. What eases learning in this area?
    c. What causes difficulty in this area of learning?

D. Is there any other information you can provide that we have not mentioned?

Other:
A. Are their other people within the organization that we should contact?
B. Are their other organizations we should be in contact with?
C. If so, what contact information do you have available?
D. Would we be able to speak with you again if any further questions arise?
E. Would you like a copy of our final findings.

Your responses and any questions with which we might help may be directed to braille@wpi.edu

Thank you very much for taking the time to answer our questions. We eagerly await your response.

Sincerely yours,
Sarah Bellfy
Adam Fuller
Arno Hautala

Response from Cara Tivey

Hi, sorry it's taken so long to get back to you but hope this will be of use.
I am the Music lecturer at the Royal National College for the Blind in Hereford.I have been teaching for 5 years.
I am currently delivering the music modules for the Btec National in Music technology and also music modules for the Btec National and First in Performing Arts.
We have on average 150 students per academic year.

Roughly 50 students are studying music technology either full or part time or attending drop in sessions.
There are 10 National performing arts students.
Ages range from 16 to 50.

I seldom use Braille music as the majority of students coming to college do not read it and show no inclination to do so.Occasionally we have classically trained students who do prefer to use it and we have a comprehensive library and also a braille music transcriber on call.I personally do not use it and certainly as far as the Btec National is concerned there is no need for people to be able to read any notated music.I tend to write out or braille up chord sheets lyrics etc and again the majority of students are perfectly capable of learning by ear. As you will probably have discovered in your research there is a high incidence of perfect and relative pitch within the visually impaired community and fortunately it enables the students to learn by ear with relative ease.

This academic year there are no creative writing modules for either the Music tech or Performing Arts certificates so I am not teching reading or writing.In the past when I have had a mixed ability group with limited skills I have initiated simple improvisation sessions.We also sit down and work chord patterns out from cd's etc.
I do not use any software in teaching, the only thing I occasionally do is to download midi files and use them as backing tracks.

I don't know whether this is going to be useful, I'm probably not the most orthodox teacher but as I have perfect pitch I find I can have a meaningful communication with most of the students.It would probably be good for you to talk to someone who teaches music in a more regular fashion, have you tried Redhill college?

Do get back to me if there is any more information you require,
all the best with your research, Cara Tivey

Appendix 4 – Initial Developer Contact Email

Example email to software developers

To Whom It May Concern:

We are students at Worcester Polytechnic Institute (WPI) in Worcester, MA conducting a research project evaluating computer music access for the blind. This research is being conducted for the IBS Vocational School in Copenhagen, Denmark. The goal of this project is to find quality Braille music computer programs available for blind students and the best way to integrate these into standard teaching methods.

The Members of our group are Adam Fuller, Arno Hautala, and Sarah Bellfy. We are currently juniors here at WPI, majoring in Computer Science (Fuller and Hautala) and Biology (Bellfy). Our advisors for the project are Professor Scott Jiusto and Professor Holly Ault.

To better review Dancing Dots we would appreciate any documentation you could supply us with about the program. If there is a trial version of your software available then we would also be interested in acquiring that so that we may test it ourselves. If there is someone within your company who would be willing to talk with us and answer some questions we would be greatly appreciative. As we stated above, the final goal of our project is to make a recommendation to IBS Vocational on which software package to use.

Thank you very much for your time.

Sincerely yours,
Adam Fuller
Arno Hautala
Sarah Bellfy

Appendix 5 – Developer Emails Responses

Bill McCann, President of Dancing Dots

Hi, Adam,

Your project sounds quite interesting to me. As you may know, Dancing Dots created the world's first commercial braille music translator. The initial version of GOODFEEL was published in 1997.

Yes, I would be glad to spend some time speaking with you and the other team members. We can certainly send you our latest demo CD and related brochures. I have also written a detailed set of instructions on how to set up and test our demos.

What is the project period for your research? Would you be available to attend one of our training sessions? We have one coming up in April and in June. See www.dancingdots.com/events.htm.

Are there any team members who are musicians and/or that can read printed notation? I am a bit troubled by the idea of integrating our GOODFEEL(R) Braille Music Translator into standard teaching methods. If by that you mean how teachers can use the programs to provide materials in braille to students in a timely manner, that's a worthwhile goal. GOODFEEL is not, per se, a teaching tool for braille music. We are developing other resources for that purpose.

GOODFEEL permits local control of the production of braille music materials. This option is much more preferable to the customary arrangement of sending printed scores off to a braille music specialist, often an unpaid volunteer, who may take many weeks or months to return the transcribed material. Our technology also permits sighted, non-specialists, to function as Braille music transcribers because they do their work in the familiar medium of conventional staff notation. In a few hours, a trained sighted copyist can produce all the braille music materials the typical student will need for the school's spring concert.

Of course, we can discuss at greater length soon. I look forward to further correspondence. BTW, we do have a couple of customers in Denmark and a growing number in Sweden.

Regards,
Bill McCann
President
Dancing Dots

Dancing Dots...Where music meets technology for the blind!
Download the GOODFEEL 2.6 Braille Music Translator demo from:
www.dancingdots.com/democddl.htm
www.dancingdots.com

See the @Freedom Scientific Newsletter for more about our technology and the
people who use it:

www.freedomscientific.com/fs_news/jan2002.asp#story5
[contact information removed]

Terry Kenaghan, Optek Systems

Dear Adam;

Thank you for your email.

There is a demo version of Toccata available to download from our webpage.

This version is limited in the amount of Braille that can be output, and also it is not possible to save pieces, but it will give you a very good idea of the operation and simplicity of Toccata, particularly if used with SharpEye 2, which is also available to download.

Toccata has a very detailed help file which is available with the demo version, and this should be sufficient to assist a user to operate the system.

Magni-CCata the software for vision impaired musicians is also available for download, and is supplied free of charge with full versions of Toccata. In addition to Magni-CCata's uses by vision impaired musicians it can also be used with Toccata to give a magnified interface for a vision impaired
Braille transcriber.

Best regards.

Terry Kenaghan
Optek Systems
[contact information removed]
WEB PAGE www.mpx.com.au/~terryk

Appendix 6 – Bill McCann Interview

Interview Notes
Mr. Bill McCann-President of Dancing Dots
13 February 2003

A. Company background:
   1. How large is your company?

      There are 2 full time and 3 part time employees plus programming and training consultants.

   2. Who does your company market to?

      The main market is for blind musicians and their educators and people with a stake in getting blind musicians employment.

   3. Is your software used mostly in the home or in an educational setting?

      educational

   4. Where does your company market its software? US/Europe?

      Software is marketed worldwide and sold in 26 different countries, mostly English speaking.

   5. You mentioned that you have customers in Sweden. Would that happen to be in Lund?

      There are customers in Sweden but if they are at the school in Lund is unknown. The end users of the product are not always known because the software can be used without being registered.

B. Personal background:
   1. How long have you been a musician?

      35 years. Studied music and made a career in music performance until the start of Dancing Dots about 9 years ago.

   2. How long have you read Braille music?

      Learned Braille music from first trumpet teacher and although no other music teacher ever read Braille, Mr. McCann learned it and used it since then.

   3. Before you had this software did you transcribe your own music?

Transcribed own music and sent it to volunteers for transcription, but the process took a month or 2 so if the music was needed quickly, it could not be done this way.

4. When did you come up with the idea of computerizing the transcription of music and why?

   Had the idea in 1979 when he was studying music and found out that people were using an Apple IIe to print notation and run literary Braille translation software. Mr. McCann thought that if the program could transcribe text then there should be something that is able to transcribe music.

C. GOODFEEL:
   1. Background of program

      GOODFEEL was developed to solve the problem of getting materials in a timely way. This was made to fill in the missing pieces instead of starting over and trying to create the editing software. This Braille music translator accepts music files created in traditional ways so it is made to use MIDI files. When it was made there were known DOS based programs that allowed a blind person to create MIDI files. The MIDI file format was never intended for storage of notation information such as number of bars per staff but as a way to recreate a performance. This means that you can only get notes, pitches, rhythms, key, time, signature information, tempo changes, and lyrics accurately but can't get dynamic marks, fingerings, and accents so in addition to MIDI they needed a music reading notation format. From a professor at the University of Illinois, he found Lime which is a notation editor.

   2. How does it work?

      The Lime or MIDI file is read in. There are different file readers for each. Musical data must be converted into GOODFEEL's internal format, sorted, converted to the equivalent Braille characters, and formatted for the desired Braille page lay-out. Because music scanning has gotten better, it has been incorporated into the transcription process so that Lime and SharpEye can be made. In SharpEye, the music can be saved in a NIFF format (note interchange format). Windows can import directly from SharpEye to Lime. From this you can look at the printed score to see what the scanning left out and add it in such as dynamic marks. It is almost never 100% accurate so there is some manual effort required. If the Lime recognizes that GOODFEEL is on the computer, then it can be launched directly from Lime to create a Braille music score, piano layout, or words and music. In Braille music there are different layouts depending on instrumentation. NIFF never caught on in the mainstream music computer industry so there is an interest to create a MusicXML reader for GOODFEEL because this program has the support of the commercial companies.

3. How easy is it to learn?

   For a sighted user that can read conventional notation and has a PC, GOODFEEL is very easy to learn. Learning of the use of Lime is what takes time. Sometimes people think that Goodfeel isn't working properly because they have not prepared the Lime or MIDI file according to documented guidelines. These formatting requirements are not overly complicated. However, users should read short articles in GOODFEEL's documentation entitled "Preparing Files for GOODFEEL to Transcribe", "Preparing Lime Files for GOODFEEL, and "Preparing MIDI Files for GOODFEEL."

   Blind customers must use the software in a different way. Some music scanning operations are difficult or impossible for them to accomplish independently. There are still the 3 basic steps which are to scan the music, edit the music and transcribe it to Braille but the blind user may or may not complete all of these steps. If the blind user scans the music, it will be done with SharpEye and the file will be taken to Cakewalk as a MIDI file or they could start directly with Cakewalk to create a MIDI file. Scanning for a blind person is not the best option because when SharpEye encounters a rhythm error, it says that there is an error through a program called CakeTalking. Normally the program puts a triangle around it but the blind user can't see either the original or the screen so they can't see where the mistake is. Also the tools to fix the error are graphic. JAWS can't tell what the problem is from reading the screen. If the music is not known, even if it is played back the place of the error is not easily found. Fortunately scanning has gotten better and there is often no errors so the music can be played back and you can be reasonably assured it is correct. When the file is in the computer, it is saved as a MIDI file in SharpEye. The MIDI file is run through Cakewalk editing. Cakewalk is made accessible to the blind through a program called CakeTalking.

   Another possibility is to start directly with Cakewalk if the person wants to take an already existing MIDI file to change or harmonize it. Cakewalk can be used to change notes and edit music. It has a useful feature of being able to be printed for a sighted user and then the music can go to GOODFEEL to be transcribed and embossed in Braille so that the blind user can read the Braille edition.

4. Is this designed for a specific set of instruments or can it be used for all instruments?

   GOODFEEL can transcribe up to 64 parts from a Lime or MIDI file regardless of instrument. GOODFEEL can format one or more parts into a number of different page lay-outs: instrumental solo, instrumental solo with keyboard accompaniment, keyboard format (piano, organ, harpsichord, harp, etc), vocal solo with words and music, or instrumental score (2 or more parts on same page).

5. Other than the software itself, what accessories are needed to make this accessible to the blind and partially sighted musician?

   JAWS screen reader

   Paperless braille display or a braille embosser (printer)

   Low vision users might use some kind of magnification software such as Magic or ZoomText.

6. What advantages do you see this program having over other programs currently available on the market?

   GOODFEEL relies on input from existing music scanning and music editing tools. The developers deliberately designed GOODFEEL to supply the missing link for blind musicians: automatic transcription to music braille.

   GOODFEEL is serving a very small piece of a small market. The Lime music editor, now at version 7, has evolved over decades as a result of tens of thousands of hours of effort. Even so, there are still features its users ask for and other features to correct or improve. As a small company with limited resources, it is best to cooperate with, and leverage the efforts of, third-party developers of programs like Lime and SharpEye and concentrate on creating and improving the GOODFEEL Braille translator.

   Mr. McCann saw the process of making his own music editor as a duplication of effort and a technical challenge that would sidetrack the goal of making the transcription software to automatically transcribe music files into the equivalent braille.

   Dancing Dots has been able to successfully use other's efforts and focus only on creating the Braille music translator. Before this program, no one had been able to commercially release a braille music translator. Since Dancing Dots was founded in 1992, There have been competitors that have come and gone. Dancing Dots is a different company because its founder has a passion for making music available to blind musicians. Dancing Dots is more than just a business to him. McCann's company has competed for and won over 1.2 million in federal funding for Dancing Dots' research and development. He has built a company with a strong international reputation which supplements income from sales of its own products with revenue from distributing complementary assistive technology and music products. Dancing Dots has widened its focus to include the needs of all blind musicians, not just those who read braille by creating or adapting software to allow blind people to independently make sound recordings or printed editions of their creative musical ideas.

Dancing Dots is a thriving, growing concern in its eleventh year of operation that is poised to remain the dominant market force for technology for the blind musician into the new century.

7. Are there multilingual versions available?

   Presently, GOODFEEL has not been localized so it's only available in English. However, significant work has been done to prepare future releases of GOODFEEL for localization and Dancing Dots is actively seeking partners who would commit to the task of localizing and maintaining GOODFEEL in other languages.

   For best results, Lime and SharpEye would also have to be localized. Without funding from government or private sources, localization of Lime or SharpEye is unlikely.

   GOODFEEL has an integrated literary braille translator and can accurately Braille contracted and non-contracted English text and non-contracted non-English text such as titles, lyrics and directions to the player.

8. Is there a new version of the program being released soon?

   A test version of the new program integrating GOODFEEL and Lime is being shown next month at the Sea Sun conference in Los Angeles but the time of the new release is not known exactly. Some time constraints due to the developers of Lime and when there part will be finished. It will hopefully be ready by the summer and definitely within the next year.

9. Are you developing software to aid in the learning of Braille music?

   They have already published a traditional course called Introduction to Music for the Blind Student written by Richard Taesch. This course only needs Perkins Braille writer and a piano. Music Touch Courseware has been developed but will not be released until at least July because hardware contains a mini wave converter that is not ready. The courseware was developed by SAL and marketed by Freedom Scientific. This is a Braille teaching device that allows a student to lay standard Braille paper on a touch screen so that when the student touches a note, the software reads where the screen has been touched and tells the student what to do. If for example the student touches a sol half-note the screen will say what it is and then play the tone. There is also a quiz mode where the student must find the note that the computer asks for.

D. Other:
   1. Where are the conferences that you mentioned you would having in April and June? Would these be conferences that our sponsor would be interested in?

The conferences are at Overbrook School for the Blind in Philadelphia. They are training sessions for the software. Our sponsor may like to come for training. The sessions are all in English.

2. What software is your company currently developing?

   The company is trying to make multimedia solutions to teach Braille. They are working on a version of Lime that runs Lime and GOODFEEL so that when a person navigates through a score they see the measure of music in Braille on the screen. GOODFEEL is translating as Lime is being edited. It would have the appearance of working in Lime but would both programs would be working together. This would be a closer integration of the programs. They are not trying to develop a notation program but just give the customers a well developed editor. They are also working on a new Lime that is able to import Music XML files which would reduce and hopefully eliminate manual effort. Finger marks would be defined and come over and the program would be more highly automated. If source files were available then people who want to use Lime still could but Dancing Dots is trying to make Lime more accessible to the Braille user and make mainstream software more useful to a blind person working independently. Also working on scripting for Sibelius.

3. Has your software been reviewed by any professional journals that we might be able to get a copy of?

   There have been some articles written but it has never been formally reviewed. An article appeared a couple of years ago in Access World which is a newsletter from the American Foundation for the Blind mentioning the use of Goodfeel.

4. We will be sure to send a copy of our final report in May when our project is finished.

Appendix 7 – Leslie Costello Interview

Interview Notes
Ms. Leslie Costello – Florida School for the Deaf and the Blind
13 February 2003

A. Organizational Background

How many students attend the school? 750 students

1. How many students take music classes? 55 students
2. How many teachers are at the school/music classes? 117/ 40 in the blind department/ 3 in music specifically

B. Personal

1. How long have you been at the school? 5 years
2. Did you transcribe your own music before using the software? No
3. Do you teach transcription to students? No
4. How long have you been using GOODFEEL? 3 years
5. How long did it take to learn the software? Couple of days for the basics, still learning new options and features.
6. Have you noticed time savings by using the software? It is much quicker then having it transcribed by hand, and able to make multiple copies at once.

C. Software

1. Do you teach the use of GOODFEEL to your students? No
2. What are some of the difficulties in learning the software? Lots of editing must be done to music when it is scanned in. Prefers using Lime to enter the music.
3. Have you looked at other software? No

D. Other

1. Do you know of other schools that use GOODFEEL, or other Braille music transcription software? School in Alabama.
2. Is there a communication network between the different schools in the US? No
3. Would you like a copy of our final report? Yes

Thank you for your time.

Appendix 8 – Rebecca Lindsey Interview

Interview Notes
Ms. Rebecca Lindsey– Maryland School for the Blind
25 February 2003

Introduction: Thank you.

A. School Background:
   1. How many students are currently attending?

      Around 180 to 200.

   2. How many of those are enrolled in your music program?

      All of them are.

   3. What type of setting are the classes?

      That depends on the group of students, all take a core education in adaptive education or music therapy. Many multiply-handicapped students also attend the school.

   4. How are the groups of students broken up?

      We have 4 program tracts. There are visually impaired students with autism, are in the "structured teach program". Those in the "Life Program" are visually impaired with a lower IQ and possible physically handicapped, "Expanded Academic Program" those who are mainstreamed in public schools, short term or visually impaired with a higher IQ and working towards a competitively employed career. And the "Early Childhood" program consists of students in the early intervention, preschool, and kindergarten programs. Each of these programs are also broken down by age of the students.

   5. Are most students multiply-handicapped?

      Yes, due to IDEA and "No Child Left Behind" most students with only a visual impairment are in mainstreamed education. About 30% of our students are not multiply handicapped. Most of these students are in the expanded academic program.

   6. How many teachers are at the school?

      There are about 32 teachers here.

7. What is the ratio of students and teachers in a typical class?

   The average student/teacher/staff ratio is 3:1

B. Interviewee Background
   1. You are working specifically in the music program?

      Yes.

   2. How long have you been teaching there?

      5 years.

   3. And you have experience working with Braille music?

      Yes, working with the GOODFEEL software for most of the 5 years I've been here.

C. Software
   1. Before using GOODFEEL, how was music transcribed?

      Our instructional resource center provides Braille for the entire state and provided music for the school until GOODFEEL was brought in.

   2. Do students receive instruction in transcribing music?

      Yes, some of them do receive this.

   3. Does this instruction involve the software?

      Not with students, the software we have is predominantly for sighted users and there is not enough need to purchase the other pieces of software in conjunction with GOODFEEL to achieve this education.

   4. Would a combination of software make this more accessible?

      The software that is available is the best that it can be right now and works well.

   5. Are there other teachers there that use GOODFEEL?

      Not at this school.

   6. How hard is the software to learn?

      The software is easy to learn, the technical support from GOODFEEL is wonderful.

7. What advantages are there to the software?

   The speed of transcription is much faster when using GOODFEEL. A year is no longer needed in order to plan a music lesson.

8. Is a year typical?

   Sometimes, yes. Depending on the type of book you need transcribed

9. What disadvantages are there?

   Currently you must use 3 programs to translate from a piece of music in print to braille. This is time consuming.

10. Is correction an easy process?

    It is fairly easy to correct and support from the company is great.

11. Have you looked into using other packages?

    No, GOODFEEL is easy to get, use, and the support is very good.

12. What attracted you to GOODFEEL?

    It was recommended by our Instructional Resource Center, created close by, recommended by other schools and individuals who were blind, and worked fine.

D. Other

1. How many students there can read Braille music?

   Four students can read it well, and it is being taught to the 40 – 50 expanded academic students.

2. Is Braille music difficult to learn?

   Braille music is difficult because symbols are shared with the Grade I and Grade II Braille, but are completely different. A "D" in grade I braille is a "C" eighth note in braille music. It is totally new code, just like Nemith is a new code for math.

3. IBS Vocational in Denmark is looking to establish a communications network among schools, are there other schools with which you are in contact?

   Overbrook School for the Blind developed and uses GOODFEEL
   Missouri School for the Blind

IBS could utilize the current communications network with others using braille music by using : MENVI: Music Educators Network for the Visually Impaired, the following is a link to the internet listserv

```
Date: Fri, 21 Mar 2003 13:07:04 -0800
From: "Jared Rimer" [contact information removed]
Subject: newsletter 3

Hi all,
newsletter 3 is now online at
http://www.superior-
software.com/menvi/newsletters/news03.html
```

4. Is MENVI helpful?
   It is very helpful to ask questions, receive updated information, newsletters, listserv information, rosters of local membership, and contact information.

Appendix 9 – Janne Hansen Interview

Interview Notes
Janne Hansen-IBS Vocational
11 February 2003

A. Interviewee Background:
   1. What is your position at IBS Vocational?

      Head of the department of Vocational training at the Institute for the Visually Impaired.

   2. What responsibilities do you have?

      It is a department of approximately 50 people where she is in charge of managing the staff. There are several different people in connection with this area. Ms. Hansen supervises how to work with the visually impaired. She helps to develop and get new projects for the facility and offer good educational opportunities.

   3. How long have you been working in this field?

      25 years in the area of visually impaired

   4. How closely do you work with the students at IBS?

      Music students have their main area teacher to help them reach their professional level or next school, depending on the program that they are in. Mr. Morten Schmidt coordinates the educational plan for the music profile. Ms. Hansen meets with the students at the beginning to see how they would view themselves in the program, to establish standards for each student, and if there is help needed with problem solving.

B. Organizational Background:
   1. What is the organization's mission?

      The mission of the vocational training department is to provide an education that will give visually impaired students the possibility to go out and get a job after the completion of the program.

   2. How many students do you typically have, and what ranges of skill do they have?

      There are 76 students in the program currently.

   3. How many different programs are offered at IBS Vocational?

There are 13 different programs.

4. How many teachers are at IBS Vocational?

   There are 50 teachers at the school.

5. What technological resources do you have there?

   Students are initially tested to find their level of visual impairment, their aims or goals for the program, what they will need, and how to compensate for their loss. Most have computers with either screen readers or talking programs depending on their needs and the need for these programs in their education.

6. We'll have access to 1 or 2 computers and will be able to load any software that we may need.

C. Project Goals and Objectives
   1. The project description indicates that you are interested in learning what software exists for changing music script to Braille. What are your goals and expected outcomes for this project?

      The music profile program goes along with an education at the Musical Academy in Jutland. We will be traveling to the Musical Academy to see what software they are using, how much is done on computers. The main goal is to find how visually impaired people can get as much possible access to written notes and how they can use software to do this. The current programs that they have for the visually impaired are Sibelius and Band in a Box. Brussels may have developed software for the blind to transcribe notes. In this software the blind must work along with a sighted person to make the music. They would specifically like to know what type of software is used elsewhere for students to get an education on the same level as a sighted person and in what ways are these developed? They have done some research that will be made available to us when we get there.

   2. What is it that gave you the idea for this project?

      They have been interested in doing this project for many years. About 5-6 years ago there was very low interest in the program with only 1 student enrolled and the decision had to be made to either get rid of the program or expand it. The Institute decided to have a more in depth program and develop an education from an individual's resources that emphasizes the individual's needs. This draws younger people to education. The Institute is interested in finding out what is going on in the world and where in Europe are there similar programs to there's so that they can invite people to a conference.

D. Methodology Ideas
   1. Before we get to Denmark we would like to have a good evaluation of the programs available, so that while there we can survey music teachers, and students, and observe what programs are being used, if any, and evaluate the benefits that it would provide. What areas of research would you suggest focusing on while still in the US?

      They would like to know who has developed software for the visually impaired and get an overview of how different schools' programs work. Is there specific education for the visually impaired in music or are they put into a mainstream education? When companies are developing music software, are they thinking about the blind and visually impaired?

E. Project Specific
   1. How many teachers are in the music program?

      The staff work different hours from 7 hours per week to full time but all together there are 11-12 staff in the music department.

   2. How many students are enrolled in the program?

      12 students

   3. How available will your teachers and students be to us for interviewing, observing, and surveying?

      They should be pretty available. They plan to try to involve students as much as possible in our research although their levels of English are varying. The students are looking forward to meeting with us and speaking with us and they hope that since we are involved in music we will be able to play together.

   4. What portions of the teachers are blind or have low vision?

      The teachers are mostly sighted.

   5. Are there any organizational details which we should be aware of?

      When we get there we will start by being introduced to the departments so that we can understand the set up. There is a shortage of rooms so we may be connected with 2 places instead of 1. Our contact person each day will be Mr. Schmidt. We will be given a tour of the music department so that we can get a good understanding of what vocational training is, what it consists of and we will be able to meet the students. They will find a group to take care of us. After a week of meeting everyone we will find a plan that will work for the rest of the project.

6. After completing their time at IBS, how many students go on to pursue a further education or a career in the music field?

   The people in the organist study go on to have full or part time jobs. The music profile students go to the Music Academy in Jutland. Since this is a new education there is not much experience in this area, but there have been 3 people that have completed the program and have jobs and there are 2 of these that would be possible to speak with while we are there. The students are still in contact with the school

F. Other
   1. In our research we have encountered some sensitivity in what terms are appropriate. What terms are accepted in Denmark: low vision or visually impaired?

      Visually impaired is the most accepted term although the old term partially sighted, which is in the name of the school, is still accepted.

   2. Are there any other suggestions or concerns, which you have which we have not addressed?

      We should be aware that only approximately 1% of the population has an impairment and that of these the majority are older than 67. There are approximately 1200 people per year that are recognized as visually impaired and of these 200 are younger than 67. Approximately 150 in this age group are able to go back to the labor market for new training. The others can't because they have other problems associated with an accident or some other trauma that has caused both visual impairment and a head injury. Because these are small groups of people that are coming and going, the education and technology is connected to small groups of people so it must be specific to the individual's needs.

Appendix 10 – Morten Schmidt, Lars Hansen Interview

Interview Notes
Mr. Morten Schmidt and Mr. Lars Hansen- IBS Vocational
20 February 2003

Introduction: Thank you.

A. Interviewee Background:
   1. What is your position at IBS Vocational?

      Mr. Schmidt: Head of Music Dept & Singing teacher
      Mr. Hansen: Music Teacher & Computer Programs

   2. How long have you been working in this field?
      Mr. Schmidt: 5 years
      Mr. Hansen: 11.5 years

B. Organizational Background:
   1. Are the students in the music program predominately blind, or visually impaired?

      11 students are visually impaired, 3 are blind

   2. What kind of computer experience do the students have? How much access do they have to computers?

      Some use it a lot, some not at all. They all have access, both at the school and at home.

   3. What exactly does the music profile program entail? Kinds of classes?

      A way to shape the education to the talents of the person involved so that they will have employment possibilities when they graduate. Developed for the students to push themselves to their limits, rather than to a specific set of requirements.

C. Project Goals and Objectives
   1. The project description indicates that you are interested in learning what software exists for changing music script to Braille. What are your goals and expected outcomes for this project?

      Find out what possibilities exist for blind musicians in way of computer access. They have used GOODFEEL in the past, and both students and teachers used it.

D. Methodology Ideas

1. Before we get to Denmark we would like to have a good evaluation of the programs available, so that while there we can survey music teachers, and students, and observe what programs are being used, if any, and evaluate the benefits that it would provide. What areas of research would you suggest focusing on while still in the US?

   Focus on GOODFEEL and Braille notes.

E. Project Specific

1. How available will your teachers and students be to us for interviewing, observing, and surveying?

   Very available while we're there.

2. If there is necessary training for the music teachers on the new computer programs, how will this be accommodated?
3. After completing their time at IBS, how many students go on to pursue a further education or a career in the music field?

   There are 3 currently at the music academy in Jutland. You start the music profile at IBS and finish at the academy. Don't know what type of response there will be to the music profile, as this is relatively new. Organ education for the blind and visually impaired has been occurring for hundreds of years so that is well established, although is not as popular anymore.

4. What software is currently in use at IBS Vocational?

   Sibelius

5. How is this software used in the curriculum?

   Used for theory and composing. Have been using it for 3-4 years.

6. How did you find this software?

   It was the best they've tried and the easiest to use.

7. What were the criteria for evaluating it?

   Judged it on simplicity, usability, work with SynText, artificial speech.

8. How did you integrate it into the existing curriculum at the time?

   On a per student basis, as classes are one-on-one between student and teacher.

F. Other

1. How many students from IBS are attending the Music Academy in Jutland?

   Three students attend at Jutland.

2. It has been mentioned that you would like to have a communication between schools. We have contacted several schools in the United States and 1 in the United Kingdom. Are there any schools in particular that you would like us to be contacting?

   Nope

3. Are there any other suggestions or concerns which you have which we have not addressed?

   IBS is a school where people who can't function in normal school go.

Appendix 11 – Lars Pedersen Interview

Interview Notes
Lars Pedersen-IBS Vocational
24 March 2003

A. Interviewee background
   1. What are your position and responsibilities here at IBS?

      Lars teaches Braille notes to students. He uses a Perkins Brailler in the beginning to teach and then moves to computer as the students become more advanced.

      Lars is also an organist at a church.

B. Braille
   1. When did you learn to read Braille?

      As a child when he was very young.

   2. How important do you think it is for people to be able to read braille?

      It is very important to be able to read Braille. It is impossible to work on a professional level without knowing Braille.

   3. What about Braille notes?

      Primarily notes are good to learn although some people can learn notes by ear. There are books for beginners to learn to read the notes and for more advanced students it is good to work with computers.

   4. How do you get Braille music?

      He gets small pieces from software; CakeWalk and GOODFEEL, but music comes primarily from the library in Copenhagen.

   5. What is necessary in a software package for it to be useful?

      The primary feature necessary in software is a speech program to work with it. The notation and output of braille work as well as possible except for the translation of slurs.

   6. Is the music transcribed accurately?

      The accuracy can be a problem if the music is played directly into the computer rather than quantizing or using step recording.

7. How is music normally input?

   Music isn't scanned in. For smaller things he listens to the music and can then form an outline from the basic melody. Using this base, and listening to the piece, he can complete the transcription. Large pieces come from the library.

8. How do you normally play the music?

   Lars learns all the music using notes rather than by ear. He memorizes small sections and plays the music part by part between reading each next section.

C. Contacts
   1. Do you have any contacts at other organizations or schools that you think would be useful for us to speak with?

      Lars does not know of anyone but Hans Rasmussen probably would.

D. Observation of CakeWalk
   1. Playing in via MIDI keyboard (not using step time)
   2. Lars demonstrated using a MIDI keyboard to play directly into CakeWalk. To do this he recorded first one voice (one hand) and then the second voice.
   3. Lars then demonstrated using step time, a way of telling the computer the length value of the notes and then playing them in. This reduces the amount of errors that the program has when determining the length value of notes.
   4. CakeWalk can output the files in a MIDI format, which GOODFEEL will then translate and output into a BRAILLE format.
   5. When JAWS is used in connection with CakeWalk it is called CakeTalk.

Appendix 12 – Hans Rasmussen Interview

Interview Notes
Hans Rassmussen-IBS Vocational
27 March 2003

A. Interviewee background
   1. What is your position here at IBS?

      Data processing consultant used mostly for evaluating programs for the blind or visually impaired. The first blind person in Denmark to be educated as a computer programmer.

   2. What responsibilities do you have?

      Involved in developing synthetic speech, test these devices, train people in using the devices. Hans is 1 of 6 people to evaluate software for the blind or visually impaired at IBS and recommend software that is necessary.

      In 1991, ran a project which was a DOS based solution to transcribing music which made it possible to enter Braille notes and play them as a MIDI file that could be transferred and printed in ink. It could also be reversed so that the MIDI file was transcribed to Braille and then printed on a Braille embosser.

      Hans is now searching for a commercially available solution such as GOODFEEL or CakeTalk. CakeWalk is not for musicians because professional people use Sibelius or Finale so these programs would be better if they too could be used by a professional blind musician. Right now the accessible programs are CakeWalk (Sonar) or Sibelius running with JAWS which sometimes doesn't work well.

B. Braille
   1. When did you learn to read Braille music?

      Hans learned music at a segregated school because he attended a school for the blind for 10 years and was then integrated into a regular school. In grade 8 or 9 Hans took instrumental lessons with 4 different lessons so had to learn 4 different notations.

   2. What was difficult about it?

      For the most part the notation was easy to learn. Hans had to learn notation to be able to make a program to transcribe music. Braille is difficult because there have to be separate notations for soprano and alto (different parts). First you start with the melody and note bars so the blind person must put the music together in his or her head as they read it. There is a separate style for American Braille music and

European Braille music. The European style can be compressed more. All the music that Hans has seen has been arranged for learning so that it was fairly easy to read. The library arranges the music so that it is written in the easiest way to read it.

3. Have you heard of any other software programs?

   Hans was involved in the Play Project which was an EU project done in Milan. They made a program to integrate all the features which could go into a product to produce Braille music. They left the project because of poor results. There was also a Web Delivery of Music which was centralized in Florence. This handles more than music for the blind. It is involved in copyright laws. It could be a virtual library for the blind to have access to music. They wanted to make a transcription model to transcribe music into Braille.

4. What is necessary in a software package for it to be useful?

   Can you use this program without a pointing device (mouse)?
   Can a screen reader identify elements?
   Can elements be clearly defined?
   If these are possible then it could be a usable product.

   The most important thing is that you can handle the program without the mouse if the user is blind. A partially sighted piano teacher can use Finale using a mouse but depending on sight use of a mouse can be limited. The second most important thing is what handicap compensating tool can be used (screen reader or screen enlarger such as JAWS or Zoom Text). When using JAWS, it is a question of how standardized windows elements are. If graphics are not standard then screen readers have difficulties finding elements. Every element is a separate window. Program attributes attached to a windows system must have an adaptation of a screen reader which is related to identifiers. If you have an edit field on the screen then the reader may not be able to identify it unless you tell it that it is an edit field. The further the program is from Microsoft, the more likely it is to need to have the graphics defined. Graphical elements on the screen that have been placed in the toolbar may have a label attached to them. These operations are better with tap key elements. If you can't find the elements you must emulate mouse movements to find which is difficult.

5. Do you think students should be taught to transcribe their own music as part of a music course? Should software be included in this education?

   At the moment, the quality of programs around is not good enough to rely solely on them so it is important to also know how to correct the music yourself. A person can use programs to produce music for use by them but there are things lacking in communication of music using computers because it's hard to correct things and so if the music is written incorrectly it will be communicated wrong.

6. What is needed for a blind person to use GOODFEEL?

   This depends on what quality of music you want to get. Lime interface can't be used by a blind person. A sighted person can use it but a blind person can only run the music through a MIDI file. Braille notation for music is complicated because complex graphical systems must transform the notation from a 2D solution to a 3D solution.

C. Contacts
   1. Do you have any contacts at other organizations or schools that you think would be useful for us to speak with?

      Lars is a good person to talk to. There is a pianist that was educated at the conservatory that practiced as a music teacher and is interested in using music programs although he now works as a programmer. There is also a girl who was educated as an organist and just installed CakeWalk who works in Jutland. Hans will talk to both of them to see if they would be interested in speaking with us.

Appendix 13 – Leif Haal Interview

Interview Notes
Leif Haal-Retired Braille Music Transcriber
2 April 2003

A. Interviewee Background
   1. What was your job at the library? Did you just transcribe music, or text also?

      Also text is necessary, because you can have to have a full understanding of Braille in order to complete an accurate transcription.

   2. When did you learn to read and write Braille music?

      Learned Braille music upon hearing of the possibility of working as a transcriber of Braille music at the Danish Library for the Blind. Had been educated as a musician and previously had no experience with Braille. Has since been transcribing music for 35 years at the library.

B. Braille Transcription
   1. How does the transcription process work? Do you complete everything manually, or use a computer for any part?

      All work is done manually, although now work is keyed in using a computer instead of using a Perkins Brailler machine. Twenty years ago it was done directly onto a printing plate.

   2. So what did you find to be difficult about learning to transcribe Braille music?

      Mostly, having to think in a different way, because you don't see the entire piece in one picture. But there were Braille musicians, students, and Braille music proofreaders who were able to help out.

   3. What are the differences between the European and English formats of Braille music.

      European is formatted as a series of parts (period for period) of 8 or 16 bars, right and then left hands. UK and US use a series of full bars (bar by/for bar).

   4. Have you worked with both formats or just one?

      Mostly just period for period. Bar over bar is only used in special circumstances.

5. How long does an average piece of music take to transcribe?

   Very long. It's a very long and expensive process.

6. Have you tried any software packages to help in the process?

   Has seen some programs, but with the complex pieces that the school is concerned with the software is insufficient. The software is only effective when used with smaller samples or examples.

7. So if teachers at IBS were to use the software to prepare small examples for use in teaching students to read Braille music, the software would be adequate?

   Yes, but only for smaller pieces. For the most part, no new progress has occurred in the past few years in regard to better music transcription using software.

8. What kind of need for music did you see? Was there a large need for the music?

   Yes, not so much in recent years, there are not as many blind musicians as there have been in the past. There are more careers open to blind people as opposed to the previous case where only blind musician or craft worker were viable options.

9. What is the typical delay seen by a request for a transcription?

   Normally between 3 months to a year.

10. Is the library the only source for Braille music in Denmark?

    Yes.

11. Do requests for music come in from all over the world?

    The museum produces music for all of Denmark and contracts work for other areas of the world. Music is also borrowed from other sources. If a piece is available from another source it is always borrowed rather than transcribing again. Music is also preferred in period by period but accepted in bar by bar format.

12. Are both formats readable by any Braille musician?

    Yes there is no problem, and all the symbols are standard.

13. Is the music translated directly to Braille, or are there intermediate steps?

    The process is direct translation from the sheet notes to the Braille format. The process uses special software to input the six-dot cell notation.

C. Contact

1. Who might we contact for further information?

   Bettye Krolick [collected many documents dealing with Braille notation] and Braille Authorities Northern America (BANA)

2. When visiting the library, what is there that we can see?

   The transcription process.

Appendix 14 – Contact with Edina Hadziselimovic

Request occurring after trip to the Danish Library

Dear Edina,

We want to thank you very much for taking the time today and explaining exactly how the transcription process works. It was very insightful to actually witness a few different pieces being transcribed, and in the different formats. We especially want to thank you for looking at the samples we brought.

After listening to your suggestions about how we could make the sample music a little more difficult this morning, we came back and tried to utilize your suggestions. We have made a few changes to the sample piece that we showed you, and output it again using the Finale Plug-In and also using GOODFEEL. We're sending these along on the chance that you might be able to take a quick look and let us know what you see is missing in the transcriptions?

Thank you for all your help.
Sincerely Yours,
Adam, Arno, Sarah

The mentioned samples are included in Appendix 24.

Edina's response

Dear Adam, Arno and Sarah

It was my pleasure to show you our way of doing things. And, it was a special pleasure to me, that you've come with these fine examples we could look at.

I have now looked at the examples you have sent to me.
- In Goodfeel it's very good transcription! (it is that from Lime!) The only one thing I doubt is the prefixes for right and left hand. Otherwise, everything is there it should be. Very fine!

- in Finale is a few things. In right hand part is missing dot 3 after key sign and after Moderato. In the 1st bar, system chooses to not writing the last note in alto as d and its sixth, but Bb has been moved to upper voice. The dynamic diminuendo is written after Bb on a fourth beat in alto, instead of writing it before Bb. In bar 3, it should be the piano mark on the third beat, it has been written in bass!

(Just for your information: the rules said that all dynamics should be written in upper voice in right hand, and bottom voice in left hand! The system is reading upwards her, therefor is difficult to find out the correct interpretation of the rule...)

In left hand, there is a mistake in articulations, because they have been written for in-accord voice (tenor) instead of bass.

In both hands it should be dot 3 instead of space, after hand sign.

Could you do me a favour and try to se, if it is possible to type into these finished transcriptions. Can you save the files, and can you print the files in the same layout as they are on the screen (I think it is possible, because it was only 39 characters in Finale and 31 in Goodfeel.

I apologise my English skills. If you have more questions just write! I'll be happy to help you.

Sincerely Yours
Edina Hadziselimovic

Appendix 15 – Jørgen Mortensen Interview

Field Trip Report
Vestjysk Musikkonservatorium
28 April 2003

We took a trip to the West Jutland Music Academy with 6 of the students in the music profile program at IBS Vocational and our liaison Morten Schmidt. We first toured the apartments where the students who attend the academy live. The rooms have internet access for personal computers and the building has both a computer room and sound proof practice rooms for the students to use. After the tour of the apartments we visited the recording studio where a teacher talked about different features of the studio. The studio is controlled by computer software which controls the hardware in the studio. This allows the musicians to be more precise in control of the equipment. This, however, makes the process very dependent on sight because all of the software depends upon the graphics making it difficult for a blind or low vision student to complete. This also tends to make the musician look at the screen instead of listen to the music which they are recording. After this we met with Jørgen Mortensen who teaches music history and theory. He explained that the program was started because one low vision student requested an education and Mr. Mortensen developed a plan for an individual education which the government decided not to pay for. Later another low vision student asked for an education and they again requested the money which they were this time given. Mr. Mortensen taught Lars Pedersen, a teacher at IBS, and later they worked on a project looking at music notation editing and Braille transcription software packages that could be used by a blind user. After this introduction with the whole group, we were given time to ask him questions. The interview notes follow this summary. After our interview we sat in on a vocal class. In the class, several students sang a piece of music that each had prepared. There was no comments or discussion after the singing. Finally we toured the concert hall at the academy where there was an organist practicing.

Interview Notes
Mr. Jørgen Mortensen
28 April 2003

The first blind student to complete the individual education at the music academy was Lars Pedersen who is a teacher now at IBS. The most difficult assignment he completed was composing 5 part music and he did this several times. To do this he had to play the music into the computer with a MIDI keyboard. The problem with this was that if he made 1 mistake, he had to play everything again. There was also a problem with quantization. He played in the music and then made it into MIDI files to be corrected by a teacher.

1. How long does a sighted student usually stay in the academy?

   A student stays at the academy for 5 years. Many come from a gymnasium but they don't have to. They must be skilled in playing their instrument and in music theory. There are entrance exams that they must take in both theory and their instrument.

2. What is the average number of classes that a student would take while there?

   A student takes solo classes on his or her instrument for all 5 years, music theory, history, and ear training for 3 years. They also must take a teaching and a performance class and some take a chamber music class.

3. How many different tracks or programs are there?

   There is a music teacher program for a specific instrument and a common music teacher program. There are also programs to become professional musicians, organ players, and rhythmic musicians.

4. Are there specific requirements that must be filled in order to graduate?

   There are classes that must be completed after 2 and 4 years and there are tests throughout the program that must be passed. Students must also attend 80% of their classes.

5. Do you use computer software at the academy?

   Computers are used in music theory classes. There are also projects on the internet where 5 musical works were interpreted. The students have the software that is used for these classes. Sibelius and Finale are the notation editing software packages used. Some students coming from IBS have used Sibelius but these were low vision students and it was not used for the blind students.

6. Do you have specific teachers that work with the students from IBS?

   Sometimes the students go into regular classes but sometimes they have one-on-one training with different teachers.

7. Are they trained to work with a blind or low vision student?

   The teachers are not specifically trained to work with the blind or low vision students. Mr. Mortensen has found that the most important thing is to take your time.

8. Do the students from IBS start in more upper level classes since they've already been in school for 2-3 years?

The students start in the 1st year classes.

9. Do you have any Braille music available for a blind student?

There is one book of Braille music at the academy that has notation examples and text. Lars Pedersen is the only person who has gone to the academy who has been able to read Braille notes so he is the only one to have used the book.

10. Do you use any Braille music transcription software?

There is no Braille music transcription software being used at the academy right now. Mr. Mortensen has used GOODFEEL with Lars Petersen in the past when they were conducting a study on the use of software by blind musicians. They found that the problem with GOODFEEL was in the setup of the notation styles with American versus European. Braille music is very complicated anyway because for a piano a person must read with one hand and play with the other but this sometimes doesn't make sense because the piece of music does not sound correct without both hands. Because of these difficulties, the setup of the music is important to help the student be able to read it.

11. Are there exams that the students coming from IBS must pass?

The education is individualized for each student. Instead of an exam telling what a person can't do, they try to describe and recommend what the individual can and should do.

Appendix 16 – Trip to Perkins School for the Blind

Field Trip Notes
Perkins School for the Blind
19 February 2003

Mike Catarazolo gave us a tour of Perkins. We met him at 2:00 pm to start the tour. We started with a brief overview of the school's history. Perkins was the first school for the blind in the United States, starting in 1827. Helen Keller attended Perkins, and was taught by Anne Sullivan, who was also a student at Perkins. Originally they were located in Boston, MA, and moved to their current location in Watertown, MA, in 1912. An interesting feature of the original layout of the Watertown campus is that it was laid out perfectly symmetrically and everything is in straight lines, making it easier to give directions to a blind or visually impaired person. Perkins owns the United States' oldest topographical globe, which was used to teach Helen Keller geography.

The school is designed to be hands on. It contains a tactile museum. Next to entrances to new areas are tactile representations of the function of the area. Perkins is decorated ornately, most decorations have a specific function. An example of this is in the chapel, the carvings on the pew headers indicate seat divisions. Perkins has an indoor pool, which was the first elevated indoor pool on the east coast. This was designed so that blind and visually impaired students will not fall into the water. Also, it is kept warm so that it can be used for therapy. On the basketball court there is one backboard with a clicker placed behind the basket so that the players know where to shoot the basketball.

During the tour Mike told us that approximately 10% of students at Perkins read Braille, as compared to roughly 50% in the 1970s. He guessed that approximately 15 students in the secondary program read Braille. Part of the reasoning for this is due to fundamental changes in the students at Perkins, and other institutions for the blind and visually impaired. Originally Perkins was a place where blind students could gain an education, as they were not accommodated for at the local level. Since mainstreaming, students at Perkins now generally have multiple disorders, which prevent them from functioning in a public school setting. Perkins' goal is still to help students develop life skills, so that they can live as independently as possible.

After our tour, Mike introduced us to Judi Cannon, who works in the Braille library. Judy is herself visually impaired and transcribes text into Braille, through the use of Duxbury, a Braille translation program for computers. She demonstrated this process to us. She told us that it is not as simple as trusting the transcription program to format the Braille while transcribing it. The programs leave white spaces where none are needed, change the flow of the text, and does not preserve whether letters are capitalized. This leads the user to formatting the output, so that it can be read. One advantage of the software is that after the text is transcribed to Braille, the program provides a toolbar at the bottom of the screen showing a written translation of the Braille word the cursor is currently over, so that a user can double check that it is the correct word.

Although she is not an expert in Braille music, she did know that there is not much music available in a Braille format. Most music that is available through the library must be returned. Only about 3-5% of general print is available in Braille, and Judi speculated that there is an even smaller percentage of music available in Braille notation.

The person in charge of Braille transcription at Perkins is Kim Charlson.

Appendix 17 – Trip to the Danish Braille Library

Field Trip Notes
Danish Braille Library
30 April 2003

We visited the Danish Braille Library in Copenhagen and spoke with the new music transcriptionist Edina. She has been working there for almost 2 years and was trained by Leif Haal whom we spoke with earlier. She uses a DOS based program to transcribe the music but there is a lot of work to do because it is very difficult to interpret music to format it correctly to be read in Braille. When writing the music it is very important to know who the music is being made for because if it is for students and teachers it must be made so that both can understand it and communicate what is being read like key and time signature. This is not necessarily needed by blind musicians because of the way Braille is written but it since it is needed for the sighted, the blind student and teachers must know exactly what is written in the piece.

To write the music, it is usually split into sections that can be read and memorized. It must be split for the individual person so that it is formatted correctly for the person who it is intended. The transcriptionist is responsible for choosing where the best breaking point is and what would be easiest to read. Many times it is difficult to find natural cuts in the music so sometimes the transcriptionist must sometimes play the music on a keyboard to find the best place to switch the sections. Right now, Edina is working for the National Library of Congress which makes the music bar over bar which takes a different kind of format. If you know both systems, however, then it is not very difficult to switch between them. In bar over bar you have to make marks at each measure which takes much longer to write than section by section. The pages are also doubled. A piece of music that was 2 pages in section by section format was 3 pages in bar over bar.

There is no objective way to make music because the transcriber decides where to cut the music into sections. The biggest problem for music transcription software is not simple melodic lines but more complex music with ties, slurs, and phrases. It is important for the transcriptionist to put octave marks into the Braille and to know where they must go and where they aren't needed. It is difficult for a software program to recognize this because there are very complex rules. The instructions with dynamics, articulations, fingerings, slurs, and ties are difficult to recognize. Sometimes the formatting of the software doesn't make sense either. Sometimes the right hand reads down and the left hand reads up. If you read the music down to up you can miss melodic lines. This is a problem for organists who must read foot pedals and fingerings.

When writing in different systems of music, bar over bar is easier to make corrections because the bars are numbered. This is more practical than section by section editing. Everything must be proofread. This is done by the help of a blind organist. Edina plays the music while the organ player reads what has been transcribed. The organist tells her where the mistakes are in either the notes, formatting, or even if it is

difficult to read. The transcriptionist then fixes it. It is the policy of the library to have the highest possible quality so they take the extra time to do the proofreading.

For traditional transcription, she first chooses the format and the program automatically sets up the paper size and formatting. Next the title and text are put in. She must indicate that there is text so that it is not mistaken for notes and all numbers must have a number sign. Capital letters must also be pointed out. The third step is to enter the music. She chooses the sections and has to indicate what length they are such as 8 or 16 bar sections. She then must indicate what hand is being used, how many flats, the time signature, rests, octave, and finally the note. If there is an inner chord it must then the octave marks must be put in. If the line goes longer than across the screen, then the computer automatically formats it. If there is a group of 16^{th} notes, then she can write the notes as a group and put the first note as a 16^{th} and the rest as an 8^{th} as long as more 8^{th} notes do not follow. The keyboard is set up like a piano keyboard as in Lime.

Edina looked at the sample piece of music and what the three different software packages transcribed. Toccata was written section by section. The system reads up to down but when writing she usually writes the other way. The program did not enter ties. GOODFEEL was written bar over bar. It marked the bar numbers. The right hand was written first. It read alto, soprano, bass, then tenor but it is usually read soprano, alto, tenor and then bass. It included all ties. It said at the end that there are 8 bars and then a break with some things missing because it was formatted for a longer section. Finally the Finale plug-in was looked at. It made the hand sign a different color. It was written from the bottom up in the same way as GOODFEEL. It included all the ties.

Appendix 18 – End-User Groups

There are four main groups of users which we tested the software for. The four main groups are partially and fully sighted teachers, blind teachers, partially and fully sighted students, and blind students. For each group we identified different software requirements. The major differences between the four groups are that those producing Braille music will need to use the Braille music translation software, while this is not necessary for the groups not producing Braille music.

Partially and Fully Sighted Teachers

The following functions of the software packages are necessary for this group:

- Input music via a MIDI keyboard, MIDI file, computer keyboard, mouse, or computer scanner
- Edit music using a computer keyboard or mouse
- Output music into a MIDI file, printed sheet music, or embossed Braille music

Blind Teachers

The following functions of the software packages are necessary for this group:

- Input music via a MIDI keyboard, MIDI file, or a computer keyboard
- Edit music using a computer keyboard
- Output music into a MIDI file, printed sheet music, or embossed Braille music

Partially and Fully Sighted Students

The following functions of the software packages are necessary for this group:

- Input music via a MIDI keyboard, MIDI file, computer keyboard, mouse, or computer scanner
- Edit music using a computer keyboard or mouse
- Output music into a MIDI file, printed sheet music, or embossed Braille music

Blind Students

The following functions of the software packages are necessary for this group:

- Input music via a MIDI keyboard, MIDI file, or a computer keyboard
- Edit music using a computer keyboard
- Output music into a MIDI file, printed sheet music, or embossed Braille music

Group Analysis

By looking at the necessary functions for each group, the differences occur only in the input category of the software. Both the editing and outputting categories for the software are the same across all four groups. Within the input category the differences occur between the partially and fully sighted users and the blind users. Blind users need to be able to input their music using just a MIDI keyboard, MIDI file, or computer keyboard, whereas partially and fully sighted users may also be able to use a computer scanner or mouse. This means that the software must be looked at in terms of its ability

to function without a mouse because these programs were made for a sighted user and are fully functional with a mouse.

Appendix 19 – Software Assessment Rubric

Criteria	Comments	Rating
User Background		
User category		
Advanced/Beginner		
Sighted/Blind		
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		
Braille notes		
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:	Overall ranking of product and user response.	
Use ease/Comprehension		
Total time in trial		
Total steps in trial		

Appendix 20 – Rubric Ranking Criteria

User background

The following categories are not rankings but rather information recorded about the participant.

Category of user

1. Blind student
2. Blind teacher
3. Sighted/Partially sighted student
4. Sighted/ Partially sighted teacher

Advanced / Beginner

1. Advanced computer user who uses a computer more than 15 hours in a week, on average.
2. Intermediate user with an average of 5 hours of computer use in per week.
3. Beginning user with no experience with computers.

Sighted / Blind

1. Fully sighted
2. Visually impaired
3. Blind

All following categories may also be ranked as 0 if the item is not applicable or able to be ranked.

Target audience

Sighted / Blind

1. A screen reader cannot read any content on the screen.
2. Only menu bar items are read.
3. Reads all normally viewable text, but graphics are not interpreted.
4. All text in all windows are read, including popup windows and alerts, but some graphics or other elements are not interpreted.
5. All elements and text in the software are clearly interpreted, including: popup windows and graphics.

Software Requires Knowledge of Braille Notes

2. Yes
4. No

User trials of music software

Steps in Process (opening)

1. Process takes more than 15 actions to complete.
2. Process takes between 15 and 10 actions to complete.

3. Process takes between 9 and 5 actions to complete.
4. Process takes between 4 and 2 actions to complete.
5. Process takes fewer than 2 actions to complete.

Steps in Process (saving)

1. Process takes more than 15 actions to complete.
2. Process takes between 15 and 10 actions to complete.
3. Process takes between 9 and 5 actions to complete.
4. Process takes between 4 and 2 actions to complete.
5. Process takes fewer than 2 actions to complete.

Steps in Process (entering music)

1. Process takes more than 175 actions to complete.
2. Process takes between 150 and 175 actions to complete.
3. Process takes between 125 and 150 actions to complete.
4. Process takes between 100 and 125 actions to complete.
5. Process takes fewer than 100 actions to complete.

User Errors

An error is defined as a missed step, incorrect input, or any other action that requires correction in order to achieve the desired result.

1. Task could not be completed.
2. Task completed with great user difficulty and more than 10 errors.
3. Task completed with moderate ease and between 10 and 5 errors.
4. Task easily completed with less than 5 errors.
5. Task easily completed without error.

Ease of correction

A correction is any action required to achieve the desired result following an error.

1. Cannot be corrected.
2. Correction requires more than 3 steps to correct.
3. Correction requires 2 steps to correct.
4. Correction requires 1 step to correct.
5. Corrected without user intervention.

User comprehension and retention of task

1. No understanding of process logic, unable to reproduce results.
2. Little understanding, would require much help to reproduce.
3. Moderate understanding, could reproduce with some help.
4. Good understanding, could reproduce with minimal help.
5. Full understanding, easily able to reproduce.

Satisfaction

1. Not satisfied with program, would not use again.
2. Little satisfaction with program, would only use if necessary.
3. Somewhat satisfied, would use again on a limited basis.

4. Mostly satisfied, would use again.
5. Totally satisfied with program, would recommend for extensive use.

Total steps

1. Trial takes more than 300 actions to complete.
2. Trial takes between 300 and 250 actions to complete.
3. Trial takes between 250 and 175 actions to complete.
4. Trial takes between 175 and 125 to complete.
5. Trial takes less than 125 actions to complete.

Appendix 21 – Feature List for Reviewed Software

1. Sibelius
    a. Product description
        - Print music notation and composition software.
    b. Feature list
        - Input of music via keyboard and number pad, computer mouse, MIDI instruments, stored music files, scanned sheet music.
        - Notation in multiple instruments.
        - Playback of input music.
        - Professional quality output to printed sheet music.
        - Output to MIDI and other storage formats (Sibelius format, graphical, web page).
    c. Included Software
        - PhotoScore Lite – Music character recognition software.

2. Finale
    a. Product description
        - Print music notation and composition software.
    b. Feature list
        - Input of music via number pad, via computer mouse, MIDI instruments, stored music files, scanned sheet music.
        - Notation in multiple instruments.
        - Playback of input music.
        - Professional quality output to printed sheet music.
        - Output to MIDI and other storage formats (Finale format, Coda notation, Coda template, ENIGMA transportable file, web page).
    c. Included Software
        - none

3. Lime
    a. Product description
        - Print music notation and composition software.
    b. Feature list
        - Input of music via keyboard, MIDI keyboard, and stored music files.
        - Notation in multiple instruments.
        - Playback of input music.
        - Output to printed sheet music.
        - Output to Lime file format and MIDI.
    c. Included Software
        - Included as part of GOODFEEL

4. Toccata
    a. Product description

- Print music notation and composition software.

b. Feature list
   - Input of music via computer mouse, stored music files.
   - Notation in multiple instruments.
   - Playback of input music.
   - Output to printed sheet music.
   - Output to MIDI and other storage formats (Toccata format, NIFF).
   - Transcription to Braille Music (live or as requested).

c. Included Software
   - Magni-CCata – Screen enlarger.
   - SharpEye 2

5. GOODFEEL
   a. Product description
      - Transcribes MIDI or Lime music files into Braille Music.
   b. Feature list
      - Transcription of music from MIDI or Lime file.
      - Output in US, UK, or international Braille formatting.
   c. Included Software
      - Lime
      - SharpEye 2

6. Braille Music Plug-in
   a. Product description
      - A Braille Music transcription plug-in for use with Finale.
   b. Feature list
      - Transcription of input music in Finale.
      - Storage of Braille Music.
      - Editing of Braille Music with the optional Braille Music Kit.
   c. Included Software
      - Braille Music Kit includes an editor for Braille Music

Appendix 22 – Price List for Reviewed Software

All prices in Danish Kroner are estimated with a conversion of 7 Kroner to the Dollar.

1. Sibelius
    a. Cost
        - $600 USD, 4.200 DKK
    b. Other required software
        - GOODFEEL
        - Screen Enlarger (ZoomText) or Reader (JAWS)
    c. Total
        - $ 995 USD, 6.965 DKK : GOODFEEL, ZoomText 1
        - $1,195 USD, 8.365 DKK : GOODFEEL, ZoomText 2
        - $1,495 USD, 10.465 DKK : GOODFEEL, JAWS
        - $1,890 USD, 13.230 DKK : GOODFEEL, ZoomText 1, JAWS

2. Toccata
    a. Cost
        - $795 USD, 5.565 DKK :
        - $595 USD, 4.165 DKK : upgrade from GOODFEEL
    b. Other required software
        - Screen Enlarger (ZoomText) or Reader (JAWS)
    c. Total
        - $1,190 USD, 8.330 DKK : ZoomText 1
        - $1,390 USD, 9.730 DKK : ZoomText 2
        - $1,690 USD, 11.830 DKK : JAWS
        - $2,085 USD, 14.595 DKK : ZoomText 1, JAWS
        - $ 990 USD, 6.930 DKK : from GOODFEEL, ZoomText 1
        - $2,190 USD, 15.330 DKK : from GOODFEEL, ZoomText 2
        - $1,490 USD, 10.430 DKK : from GOODFEEL, JAWS
        - $1,885 USD, 13.195 DKK : from GOODFEEL, ZoomText 1, JAWS

3. Finale
    a. Cost
        - $600 USD, 4.200 DKK
    b. Other required software
        - Braille Music Plug-in (BMP) or Braille Music Kit (BMK includes BMP)
        - Screen Enlarger (ZoomText) or Reader (JAWS)
    c. Total
        - $ 995 USD, 6.965 DKK : BMP, ZoomText 1
        - $1,195 USD, 8.365 DKK : BMP, ZoomText 2
        - $1,890 USD, 13.230 DKK : BMP, ZoomText 1, JAWS
        - $1,315 USD, 9.205 DKK : BMK, ZoomText 1

- $1,515 USD, 10.605 DKK : BMK, ZoomText 2
- $2,210 USD, 15.470 DKK : BMK, ZoomText 1, JAWS

4. GOODFEEL
    a. Cost
        - $800 USD, 5.600 DKK
        - $980 USD, 6.860 DKK : next upgrade free
        - $320 USD, 2.240 DKK : lite version – limited to one music format
    b. Included software
        - Lime – Music Notation editor
        - SharpEye 2 – Optical Character Recognition software for music notation
    c. Used in conjunction with
        - Sibelius
        - Finale
        - MIDI and NIFF file formats

5. Braille Music Plug-in
    a. Cost
        - Free
        - $320 USD, 2.240 DKK : Braille Music Kit
    b. Included software
        - Braille Music Kit includes a Braille Music editor
    c. Used in conjunction with
        - Finale (required for use with the plug-in)

6. Accessibility Packages
    a. JAWS – screen reader
        - $895 USD, 6.265 DKK

    b. ZoomText
        - $395 USD, 2.765 DKK : ZoomText 1 – screen magnifier
        - $595 USD, 4.165 DKK : ZoomText 2 – screen magnifier and reader

Appendix 23 – Assessment Sheets

		Trial #: 1
Criteria	**Comments**	**Rating**
User Background	Finale	
User category	4- Group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ create new document	
Steps in process	21	1
Time to complete	0:52	
Errors	2	4
Ease of correction	1 step to correct each	4
User response:		
Comprehension		5
Feedback		
Satisfaction	Opening a document requires a lot of steps but directions are easy to follow.	4
Task:	Compose	
Steps in process	157	2
Time to complete	8:15	
Errors	16	2
Ease of correction	1 step to correct each	4
User response:		
Comprehension		4
Feedback	It is very easy to make mistakes when entering music and although they are easy corrected they are easy to make.	
Satisfaction		4
Task:	Save	
Steps in process	6	3
Time to complete	0:20	
Errors	0	5
Ease of correction	no errors so no correction required	0
User response:		
Comprehension		5
Feedback	Very easy to save, no problems.	
Satisfaction		5
General product rating:	Overall ranking of product and user response.	
Total time in trial	9:27	
Total steps in trial	184	3

		Trial #: 2
Criteria	**Comments**	**Rating**
User Background	Sibelius	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/create new document	
Steps in process	7	3
Time to complete	0:40	
Errors	0	5
Ease of correction	no errors so no correction needed	0
User response:		
Comprehension		
Feedback		
Satisfaction		
Task:	Compose	
Steps in process	466	1
Time to complete	25:08	
Errors	28 with 7 uncorrected	2
Ease of correction	some easily corrected but some not corrected at all	2
User response:		
Comprehension		
Feedback		
Satisfaction		
Task:	Save	
Steps in process	6	3
Time to complete	0:23	
Errors	1	4
Ease of correction	easily corrected with 1 step	4
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:	Overall ranking of product and user response.	
Total time in trial	26:11	
Total steps in trial	479	1

		Trial #: 3
Criteria	**Comments**	**Rating**
User Background	Finale without mouse and with JAWS	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		3
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/create new document	
Steps in process	33	1
Time to complete	2:24	
Errors	1	4
Ease of correction		4
User response:		
Comprehension	Without using mouse the process requires a lot of steps but is not difficult, just time consuming.	5
Feedback		
Satisfaction		3
Task:	Compose	
Steps in process	264	1
Time to complete	11:20	
Errors	8	3
Ease of correction		4
User response:		
Comprehension	JAWS doesn't read when entering music so if depending on it to use program it would be almost impossible to know if there were errors.	4
Feedback		
Satisfaction		2
Task:	Save	
Steps in process	8	3
Time to complete	0:23	
Errors	0	5
Ease of correction	no errors so no correction needed	0
User response:		
Comprehension	Saving document easy to do even without mouse.	5
Feedback		
Satisfaction		5
General product rating:	Overall ranking of product and user response.	
Total time in trial	14:07	
Total steps in trial	305	1

		Trial #: 4
Criteria	**Comments**	**Rating**
User Background	Sibelius without mouse and with JAWS	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		3
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ create new document	
Steps in process	8	3
Time to complete	0:50	
Errors	0 no errors so no correction needed	5
Ease of correction		0
User response:		
Comprehension		5
Feedback	Opening document without mouse as easy as with mouse.	
Satisfaction		5
Task:	Compose	
Steps in process	177	1
Time to complete	11:00	
Errors	6	3
Ease of correction		4
User response:		
Comprehension		3
Feedback	Some of the steps would be difficult to remember to do and the screen reader did not read everything such as key and time signatures when entering.	
Satisfaction		2
Task:	Save	
Steps in process	6	3
Time to complete	0:25	
Errors	1	4
Ease of correction		4
User response:		
Comprehension		5
Feedback	Saving is easy process without mouse.	
Satisfaction		5
General product rating:	Overall ranking of product and user response.	
Total time in trial	12:15	
Total steps in trial	191	3

		Trial #: 5
Criteria	**Comments**	**Rating**
User Background	Sibelius with JAWS	
User category	1	
Advanced/Beginner	1-2	
Sighted/Blind	3	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		3
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ create new document	
Steps in process	9	3
Time to complete	2:11	
Errors	0	5
Ease of correction		0
User response:		
Comprehension		4
Feedback		
Satisfaction		4
Task:	Open program/new document (total trial not completed)	
Steps in process	60	
Time to complete	10:26	
Errors	3 with 2 uncorrected because screen reader did not read the error	1
Ease of correction		3
User response:		
Comprehension	Entering the notes was made sense using letter keys on keyboard but screen reader didn't read some items	4
Feedback		
Satisfaction		3
Task:	Save	
Steps in process	10	3
Time to complete	1:03	
Errors	0	5
Ease of correction	no errors so no correction needed	0
User response:		
Comprehension		5
Feedback		
Satisfaction		4
General product rating:	Overall ranking of product and user response.	
Total time in trial	13:40	
Total steps in trial	79	5

		Trial #: 6
Criteria	**Comments**	**Rating**
User Background	GOODFEEL w/ mouse	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open Program/Document	
Steps in process	19	1
Time to complete	1:12	
Errors	2	4
Ease of correction		4
User response:	Program very easy to open and transcribe notes to Braille without knowledge of notes.	
Comprehension		5
Feedback		
Satisfaction		5
Task:	Print	
Steps in process	1	5
Time to complete	0:01	
Errors	0	5
Ease of correction	no correction needed because no errors	0
User response:	Printing process very quick and easy	
Comprehension		5
Feedback		
Satisfaction		5
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:	Overall ranking of product and user response.	
Total time in trial	1:13	
Total steps in trial	20	5

		Trial #: 7
Criteria	**Comments**	**Rating**
User Background	GOODFEEL without mouse and with JAWS	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		4
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ Document	
Steps in process	25	1
Time to complete	1:39	
Errors	2	4
Ease of correction		4
User response:		
Comprehension	Screen reader read everything except for a warning that came up while creating document although it did alert to the fact that there was a window.	4
Feedback		
Satisfaction		4
Task:	Print	
Steps in process	1	5
Time to complete	0:01.6	
Errors	0	5
Ease of correction	no errors so no correction needed	0
User response:		
Comprehension		
Feedback		
Satisfaction		
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:	Overall ranking of product and user response.	
Total time in trial	1:40.6	
Total steps in trial	26	5

		Trial #: 8
Criteria	**Comments**	**Rating**
User Background	Braille Music Kit Plug-in with mouse	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ Document	
Steps in process	5	
Time to complete	0:20	
Errors	0	5
Ease of correction	no correction needed because no errors	0
User response:		
Comprehension	Very easy process to import MIDI file to Braille.	5
Feedback		
Satisfaction		5
Task:	Print	
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:	Program would not print so this step could not be completed.	
Comprehension		
Feedback		
Satisfaction		
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:	Overall ranking of product and user response.	
Total time in trial	:20	
Total steps in trial	5	5

		Trial #: 9
Criteria	**Comments**	**Rating**
User Background	Toccata as editor- with mouse	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/create new document	
Steps in process	10	2
Time to complete	0:40	
Errors	0 no errors so no correction needed	5
Ease of correction		0
User response:		
Comprehension		5
Feedback	Fairly easy process.	
Satisfaction		4
Task:	Compose	
Steps in process	197	1
Time to complete	18:22	
Errors	19 some errors not corrected	2
Ease of correction		2
User response:		
Comprehension	Process of entering notes very difficult because involves double clicking mouse on staff line and it is difficult to see where the mouse is on the music and what note is being entered.	5
Feedback		
Satisfaction		1
Task:	Save	
Steps in process	3	4
Time to complete	0:11	
Errors	0 no errors so no correction needed	5
Ease of correction		0
User response:		
Comprehension	Easy process to complete.	5
Feedback		
Satisfaction		4
General product rating:	Overall ranking of product and user response.	
Total time in trial	19:13	
Total steps in trial	210	1

		Trial #: 10
Criteria	**Comments**	**Rating**
User Background	Toccata as Braille music transcriber with mouse	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ Document	
Steps in process	5	3
Time to complete	0:19	
Errors	0	5
Ease of correction	no errors so no correction needed	0
User response:		
Comprehension	Very easy process to transcribe the music file into Braille using Toccata file.	5
Feedback		
Satisfaction		4
Task:	Print	
Steps in process	3	4
Time to complete	0:18	
Errors	0	5
Ease of correction	no errors so no correction needed	0
User response:		
Comprehension	Printing process very easy to complete.	5
Feedback		
Satisfaction		5
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:	Overall ranking of product and user response.	
Total time in trial	0:37	
Total steps in trial	8	5

		Trial #: 11
Criteria	**Comments**	**Rating**
User Background	Lime without mouse	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/create new document	
Steps in process	20	2
Time to complete	0:43	
Errors	0	5
Ease of correction	no errors so no need for correction	0
User response:		
Comprehension	Opening of the document was easy to complete	5
Feedback		
Satisfaction		4
Task:	Compose	
Steps in process	181	1
Time to complete	15:41.2	
Errors	18	2
Ease of correction		4
User response:	Process difficult because knowledge of a piano keyboard makes the entering much easier. Hard to navigate through the entering process.	
Comprehension		3
Feedback		
Satisfaction		2
Task:	Save	
Steps in process	7	3
Time to complete	0:35.4	
Errors	0	5
Ease of correction	no errors so need for correction	0
User response:		
Comprehension	Saving is very easy process with very few steps.	5
Feedback		
Satisfaction		4
General product rating:	Overall ranking of product and user response.	
Total time in trial	16:59	
Total steps in trial	208	3

		Trial #: 12
Criteria	**Comments**	**Rating**
User Background	Lime with mouse	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/create new document	
Steps in process	13	2
Time to complete	0:32.1	
Errors	0	5
Ease of correction	no errors so no need for correction	0
User response:		
Comprehension	Opening of the document was easy to complete	5
Feedback		
Satisfaction		4
Task:	Compose	
Steps in process	230	1
Time to complete	22:37	
Errors	58	1
Ease of correction		2
User response:	The entering of notes was very difficult because didn't know a piano keyboard which makes the entering process much easier.	
Comprehension		3
Feedback		
Satisfaction		1
Task:	Save	
Steps in process	5	3
Time to complete	0:19	
Errors	0	5
Ease of correction	no errors so need for correction	0
User response:		
Comprehension	Saving is very easy process.	5
Feedback		
Satisfaction		4
General product rating:	Overall ranking of product and user response.	
Total time in trial	23:28	
Total steps in trial	248	3

		Trial #: 13
Criteria	**Comments**	**Rating**
User Background	Braille music plug-in without mouse	
User category	4- group member	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/create new document	
Steps in process	31	1
Time to complete	1:02	
Errors	1	4
Ease of correction		4
User response:		
Comprehension	Opening of the document and transcription was easy to complete	5
Feedback		
Satisfaction		4
Task:	Print	
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:	Program does not allow printing.	
Comprehension		
Feedback		
Satisfaction		
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:		
Total time in trial	1:02	
Total steps in trial	31	5

	Trial #:	14a
Criteria	**Comments**	**Rating**
User Background	Finale, mostly without mouse	
User category	3 – Former student	
Advanced/Beginner	1	
Sighted/Blind	2	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ Document	
Steps in process	35	1
Time to complete	7:00	
Errors	2 Time signature easily corrected.	4
Ease of correction		4
User response:	Some difficulty in selecting proper time signature.	
Comprehension		3
Feedback		
Satisfaction		4
Task:	Compose (Total trial not completed)	
Steps in process	162	2
Time to complete	10:30	
Errors	5 Initial difficulty with entering notes, easily corrected.	3
Ease of correction		4
User response:	Reports that the process of entering notes is very similar to Sibelius and skills are easily transferable, having used Sibelius before.	
Comprehension		4
Feedback		
Satisfaction		4
Task:	Save	
Steps in process	23	
Time to complete	1:47	
Errors	2 Initially selected open.	4
Ease of correction		4
User response:	Slight delay due to initially selecting “Open” instead of “Save” Easily corrected and saved.	
Comprehension		3
Feedback		
Satisfaction		4
General product rating:	Overall ranking of product and user response.	
Total time in trial	19:17	
Total steps in trial	220	3

	Trial #:	14b
Criteria	**Comments**	**Rating**
User Background	Sibelius, mostly without mouse	
User category	3 – Former student	
Advanced/Beginner	1	
Sighted/Blind	2	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ Document	
Steps in process	53	1
Time to complete	6:20	
Errors	1 Selected "Open Document" instead of "New Document"	4
Ease of correction		4
User response:	Process differs from what user is used to. Easy to adapt to this method.	
Comprehension		3
Feedback		
Satisfaction		4
Task:	Compose (Total trial not completed)	
Steps in process	232	4
Time to complete	8:46	
Errors	7 Initial adjustments to entering process, easily corrected.	3
Ease of correction		3
User response:	Initial adjustment to input process took a small amount of time. Following notes completed with great ease.	
Comprehension		4
Feedback		
Satisfaction		5
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:	Overall ranking of product and user response.	
Total time in trial	15:06	
Total steps in trial	285	2

	Trial #:	15
Criteria	**Comments**	**Rating**
User Background	Sibelius	
User category	3 – Current student	
Advanced/Beginner	1	
Sighted/Blind	2	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ Document	
Steps in process	19	1
Time to complete	1:39	
Errors	1	4
Ease of correction	Only error was in selection of time signature. Correction required removal and reselection of signature.	3
User response:		
Comprehension		5
Feedback		
Satisfaction		5
Task:	Compose	
Steps in process	109	4
Time to complete	3:40, 8:17 total with a pause between entering voices	
Errors	4	4
Ease of correction	all errors were incorrect notes and corrected with 1 step	4
User response:		
Comprehension	Errors were easily corrected.	5
Feedback	Minor aid was required in changing voices.	
Satisfaction	User is experienced using Sibelius and very satisfied with how music is composed using the software.	5
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:		
Total time in trial	9:56	
Total steps in trial	128	4

		Trial #: 16
Criteria	**Comments**	**Rating**
User Background	Sibelius	
User category	4 – Current Teacher	
Advanced/Beginner	1	
Sighted/Blind	1	
Target audience	Targeted users and the how this will affect software use.	
Sighted / Blind		0
Braille notes		4
Trials:	Explanation, feedback, and (1..5) task complexity.	
Task:	Open program/ Document	
Steps in process	10	2
Time to complete	1:40	
Errors	2	4
Ease of correction	Time and key signature were not selected. Not corrected.	0
User response:		
Comprehension		5
Feedback		
Satisfaction		5
Task:	Compose	
Steps in process	90 (43 and 47 steps for the first and second voices)	5
Time to complete	4:13, (2:43 and 1:30 for the first and second voices)	
Errors	3	4
Ease of correction	2 incorrect notes, 1 set of notes needed an octave change	4
User response:		
Comprehension	Errors were easily corrected. Minor aid was required in changing voices. User is experienced using Sibelius and very satisfied with how music is composed using the software.	4
Feedback		
Satisfaction		5
Task:		
Steps in process		
Time to complete		
Errors		
Ease of correction		
User response:		
Comprehension		
Feedback		
Satisfaction		
General product rating:		
Total time in trial	5:53	
Total steps in trial	100	5

Appendix 24 – Trial Interviews

Interview Notes for Trial 5
4 April 2003

A. Pre-trial interview
   1. What is your current job?

      Electronic technician for telecommunications before becoming blind. Not currently employed.

   2. How much do you use computers in your job?

      Uses computers at home to write letters and read the news.

   3. What types of accessibility enhancements do you use?

      Uses synthetic speech- JAWS

   4. What are the problems you notice with them?

      When working with JAWS you can use most of the programs that a sighted person can use, but there are some things that JAWS doesn't read and some things on the internet are impossible to use.

   5. Do you still have musical interests?

      Currently plays the guitar and writes songs for it as a way to spend time but not as a professional. Learning a new song involves listens to it and playing back on the guitar. Music is arranged in memory and then listened to, to find the bass line or to find the tone or chord. Songs are composed and remembered solely in memory, rather than using a computer to write the music.

   6. Do you read Braille? Music?

      Can read Braille but it is difficult because of diabetes and reduced feeling in finger tips.

B. Post-trial interview
   1. What was good about the program?

      Entering the notes was ok. It was different than using a MIDI keyboard but was quite good this way. JAWS reading of the menus was fine and better in the new version of Sibelius.

2. What was particularly difficult to use?

   The hardest part of the trial was that the screen reader didn't read everything on the screen such as the time and key signatures.

3. What do you think could be done to make this more accessible to you?

   Have the screen reader read more of what was happening in the program.

4. If you were doing to use a computer to write music would you look at this program?

   It is difficult to say because it was such a short trial and a good opinion couldn't be formed in that time. There can be some difficulties with this program but a program that would work perfectly well for a blind person may not exist.

5. If you wanted to record professionally, what would your computer need?

   The computer would need to be able to do the same things for a blind person as it does for a sighted user.

6. How easy would it be to repeat a task?

   It would not be difficult because remembering a sequence of steps is not difficult. At home, a Dictaphone is used if remembering may be difficult.

7. Are there any suggestions on how we could make the actual trial easier for you?

   The trial was good and there were not many difficulties so there is not something that we could have done to make it easier. This trial is similar to lessons previously completed with teachers. The only thing we could do is to make it a little longer to get more use of the software and maybe find some shortcuts for things.

8. In regard to a specific task, a note had to be moved down an octave. Did this process of moving it make sense?

   There might be a shortcut that could make it easier but moving with the down arrow made sense.

Interview notes for Trial 14a, 14b
10 April 2003

A. Pre-trial interview
   1. When did you graduate?

Finished at IBS in the summer of 2000 and finished at the conservatory in 2002 for a total of 4 years.

2. What is your current job?

   Right now is working on a book project about film music, a free lance writer for magazines, and is working as a drummer and singer.

3. How much do you use computers in your job?

   Computers are used daily. Is a very experienced computer user.

4. What types of accessibility enhancements do you use?

   Sometimes uses a screen enlarger but some programs have built in zooming, although many people are not aware of this. Can specify 1 bar to zoom in on, with music programs, in order to take a closer look at the music to solve whatever problem is there.

5. Do you read Braille? Music?

   Doesn't read Braille or Braille music. Enough sight is left to read normal music. Is blind in one eye and has 10% sight left for distance, but is able to read notes and sight read music. Limited sight does not allow this too quickly.

   A lot of music reading and writing was required at the Music Academy. This can be difficult unless a screen enlarger is available.

6. Have you used music-editing software before?

   Yes, Sibelius. Uses only sometimes now, but used nearly everyday at the Academy. Sibelius is easy to use and user friendly. A guidebook from a the conservatory lists how to use the keyboard instead of the mouse, which makes it easier for someone with a visual impairment to use.

   Also working with a recording program, Cubase, which takes MIDI and audio tracks for preparation of a demo CD. Has used ProTools but doesn't like it because it makes things sound too perfect. Uses the computer to make demo CD's and loops. The most important thing is to find a program that gives an accurate score.

B. Post-trial interview
   1. Was there something we could have done to make the test run smoother?

      It would have been better to have a full sized Danish keyboard but the actual trial was fine.

2. What did you like about the software?

   It was good that there are different colors for different voices and that there is a voice reader. It's important to have a guidebook that you can read so that everything isn't so technical.

3. How do you think software should be used in the curriculum?

   It's important to teach the software at an early stage of the education because it is used so much at the music conservatory. The students must be really interested in what they're doing and want to learn so that they can move on.

Interview notes for Trial 15
11 April 2003

A. Interview

1. What are you studying here at IBS?

   Is learning to play the piano and sing. Has been here for 2 years and will move on to the Academy when finished.

2. We have seen that you use Sibelius. Where is it used and how long have you been using it?

   Sibelius is only used in the music theory class. It cannot be used to read music because the screen is not close enough to the piano. Music cannot be printed inverted (white on black) so it must be memorized to be played. Has been using Sibelius for 5 months and uses the program 1-2 times per week.

3. What do you think about Sibelius?

   Sibelius is easy to use. It is fast to enter notes and you only need 1 hand. It is easy to build chords.

4. What problems do you find with Sibelius?

   It would be better if it had a feature that allowed you to download a MIDI file into it that came up just as a piano score rather than many different instruments that clutter the score. It also sometimes enters the note in the wrong octave.

5. Would you use Sibelius to write your own music?

   Yes, would use it to write own music and probably at the Academy because they use the program there a lot.

6. Do they teach you how to use the program here?

   Yes, was taught how to use the software by the music theory teacher but they were learning on an older version and now uses the newer version. If there are any questions, the theory teacher can help, but this is not often because it's easy to use.

7. What do you use along with the music editing software?

   Uses ZoomText with only the zoom and contrast features.

8. Are there any problems with these?

   You have to disable all the features that you don't need instead of it just asking which features you would like to use.

9. Do you use a scanner or MIDI keyboard?

   Would use a scanner but this is not currently available. The Lite version of the scanning program that was tried at home didn't work very well. The full version is better here.

Interview notes for Trial 16
23 April 2003

A. Interview

1. What do you teach here at IBS?

   Music theory classes. These involve a combination of piano work and reinforcement using computer software (Sibelius).

2. Is music transcription software something you would be able to use in classes with blind students in the future?

   Yes, basic theory classes should be able to get by with small samples produced with software. More advanced classes would need the dynamics and other notation that is lost in translation to MIDI.

3. Would you be the only one using the software? Or would you use it with students in class?

   Preparation of samples in Braille would most likely not be done with students. If possible, editing music, as is done currently with Sibelius, would include students.

4. What is the largest problem you see in the software?

   The loss of dynamics and other notation elements.

5. How would you use Braille music in teaching with blind students?

   We use a chord symbol system where extra notation on a piece of music is analyzed. The movement of the music is analyzed through looking at the intervals in the music.

   Students are aided in using software, but require other teaching as well. The base formed by music study is needed before software can enhance it.

Appendix 25 – Summary tables of trials

Table A.25.1. Summary table of perfect trials completed without errors.

Program	Task	Steps	Total steps
Sibelius	Open	10	
	Compose	100	115
	Save	5	
Finale	Open	16	
	Compose	104	127
	Save	7	
Lime	Open	11	
	Compose	128	143
	Save	4	
Toccata	Open	10	
	Compose	112	128
	Save	6	
Sibelius w/o mouse	Open	16	
	Compose	128	150
	Save	6	
Finale w/o mouse	Open	18	
	Compose	172	172
	Save	7	
Lime w/o mouse	Open	19	
	Compose	140	140
	Save	4	
GOODFEEL	Open	6	
	Print	1	7
Braille music kit plug-in	Open	7	
	Print	1	8
Toccata	Open	8	
	Print	2	10
GOODFEEL w/o mouse	Open	12	
	Print	1	13
Braille music kit plug-in w/o mouse	Open	11	
	Print	1	12

Table A.25.2. Summary table of group trials completed with notation software.

Program	Task	Time to complete	Steps	Errors	Total time	Total steps
Finale	Open	0:52	21	2		
	Compose	8:15	157	16	9:27	184
	Save	0:20	6	0		
Sibelius	Open	0:40	7	0		
	Compose	25:08	466	28	26:11	479
	Save	0:23	6	1		
Toccata (editor)	Open	0:40	10	0		
	Compose	18:22	197	19	19:13	210
	Save	0:11	3	0		
Lime	Open	0:32.1	13	0		
	Compose	22:37	230	58	23:28	248
	Save	0:19	5	0		
Finale w/o mouse	Open	2:24	33	1		
	Compose	11:20	264	8	14:07	305
	Save	0:23	8	0		
Sibelius w/o mouse	Open	0:50	8	0		
	Compose	11:00	177	6	12:15	191
	Save	0:25	6	1		
Lime w/o mouse	Open	0:43	20	0		
	Compose	15:41.2	181	18	16:59	208
	Save	0:35.4	7	0		

NC = could not be completed

Table A.25.3. Summary table of group trials completed with transcription software.

Program	Task	Time to complete	Steps	Errors	Total time	Total steps
GOODFEEL	Open	1:12	19	0		
	Print	0:01	1	0	1:13	20
Braille music kit plug-in	Open	0:20	5	0		
	Print	NC				
Toccata (Braille transcriber)	Open	0:19	5	0		
	Print	0:18	3	0	0:37	8
GOODFEEL w/o mouse	Open	1:39	25	2		
	Print	0:01.6	1	0	1:40.6	26
Braille music kit plug-in w/o mouse	Open	1:02	31	1		
	Print	NC				

NC = could not be completed

Appendix 26 – Details on scanning arrangements

Schumann
Voices: Three staves, soprano and piano stave.
Key Signature: G Major
Time Signature: None, piece is in 6/8.
Notes: Include quarter, 8^{th}, and 16^{th} notes, with sharp and natural signs for accidentals.
Lyrics: Two lines of lyrics, Italian and Danish.
Dynamics and Articulation: One dynamic of piano. Articulations include slurs, ties, staccatos, and fermatas.

Lime w/ SharpEye
Voices: Correctly identified three separate voices: Soprano and Piano
Key Signature: Identified G Major for the bottom Piano voice, and C Major for the other two voices.
Time Signature: No time signature to identify and defaulted to 4/4.
Notes: Unable to recognize 16^{th} notes, and in some instances 8^{th} notes were also misrecognized. Used quarter notes and 8^{th} notes in place of the misrecognized notes.
Lyrics: Identified some vocal text correctly, however many edits would be needed to completely correct the lyrics.
Dynamics: Identified the piano dynamic and also the tempo marking Allegretto. Could not read the fermata. Most staccatos were recognized. Slurs and ties were recognized for the most part, but the software could not recognize slurs when they were over misrecognized 16^{th} notes.

Finale
Voices: Correctly identified the three voices.
Key Signature: Did not recognize G Major, used C Major instead
Time Signature: No time signature to identify so defaulted to 4/4.
Notes: Was able to recognize quarter, 8^{th}, and 16^{th} notes. However, everything was kept in one layer, causing notes to be misinterpreted for their quantities.
Lyrics: Lyrics were not recognized.
Dynamics: Dynamics were not recognized.

Sibelius w/PhotoScore Lite
Voices: Correctly identifies three voices.
Key Signature: Does not recognize G Major, used C Major instead.
Time Signature: No time signature to identify so defaulted to 4/4.
Notes: Was able to recognize quarter, 8^{th}, and 16^{th} notes. Accurately recognized most notes, but added in extra notes. Not all rests were recognized. Recognized some, but not all accidentals.
Lyrics: No lyrics were recognized.
Dynamics: Dynamics were not recognized.

Appendix 27 – Music samples used in scanning

This appendix includes all of the music used in the scanning trials and the results from each software program.

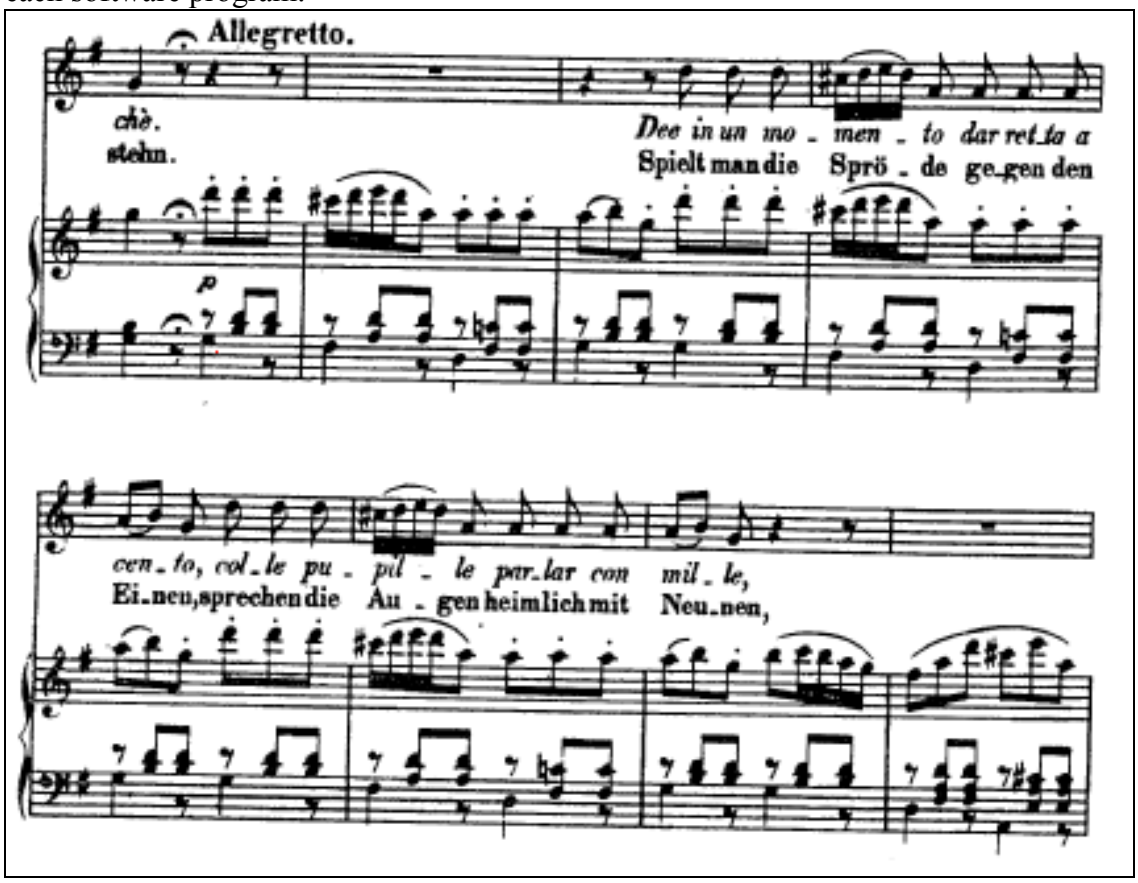

Figure A.27.1. Original Schumann piece used for scanning trials

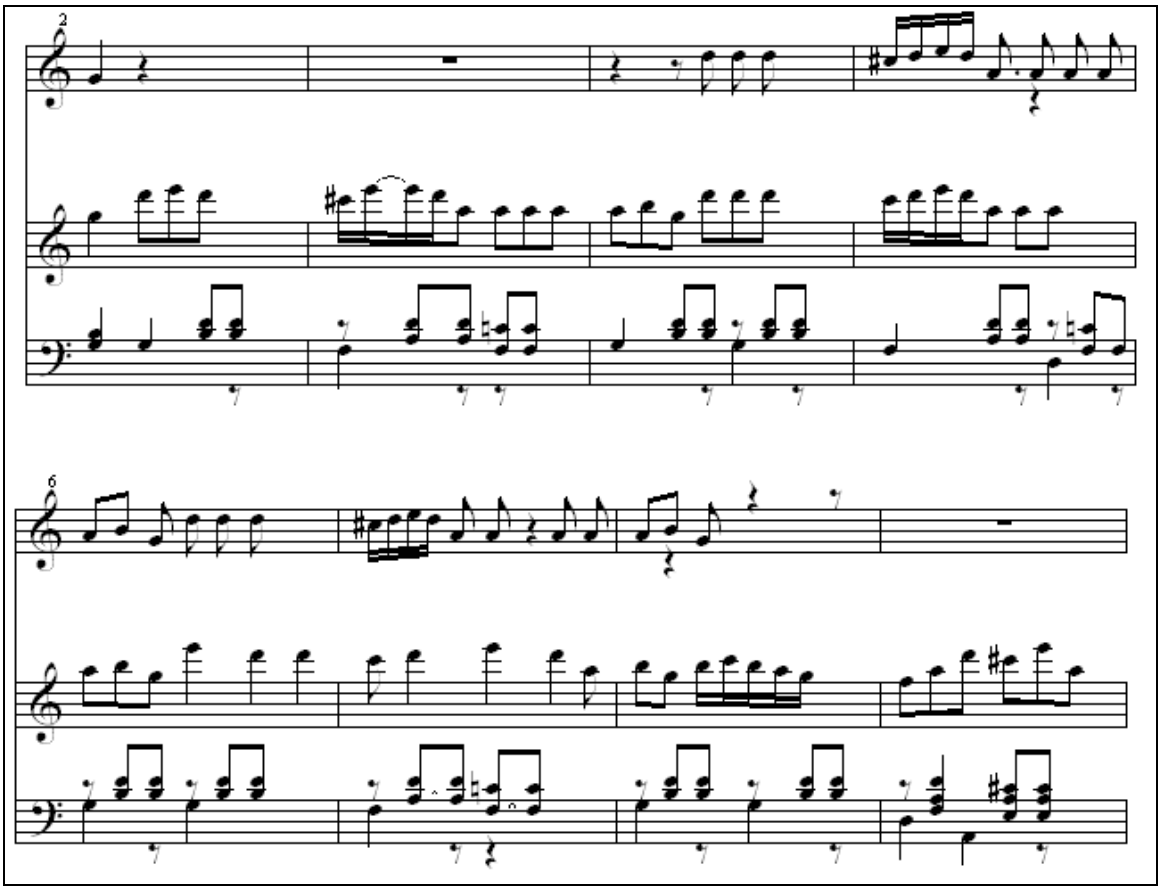

Figure A.27.2. Schumann as scanned and interpreted by Finale.

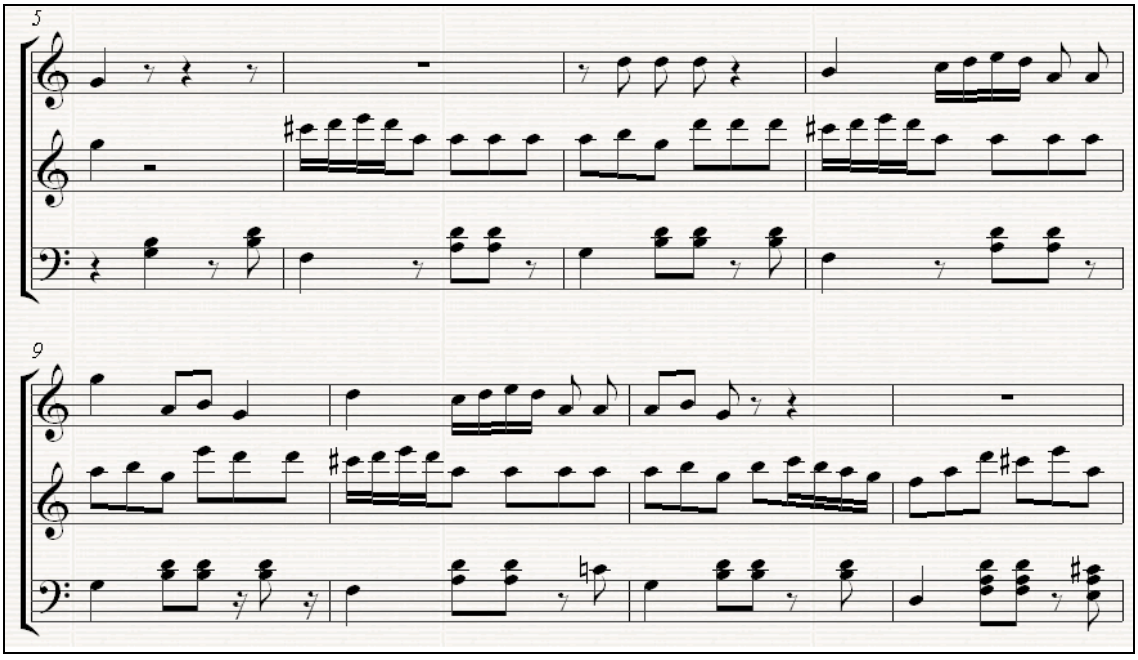

Figure A.27.3. Schumann as scanned and interpreted by Sibelius.

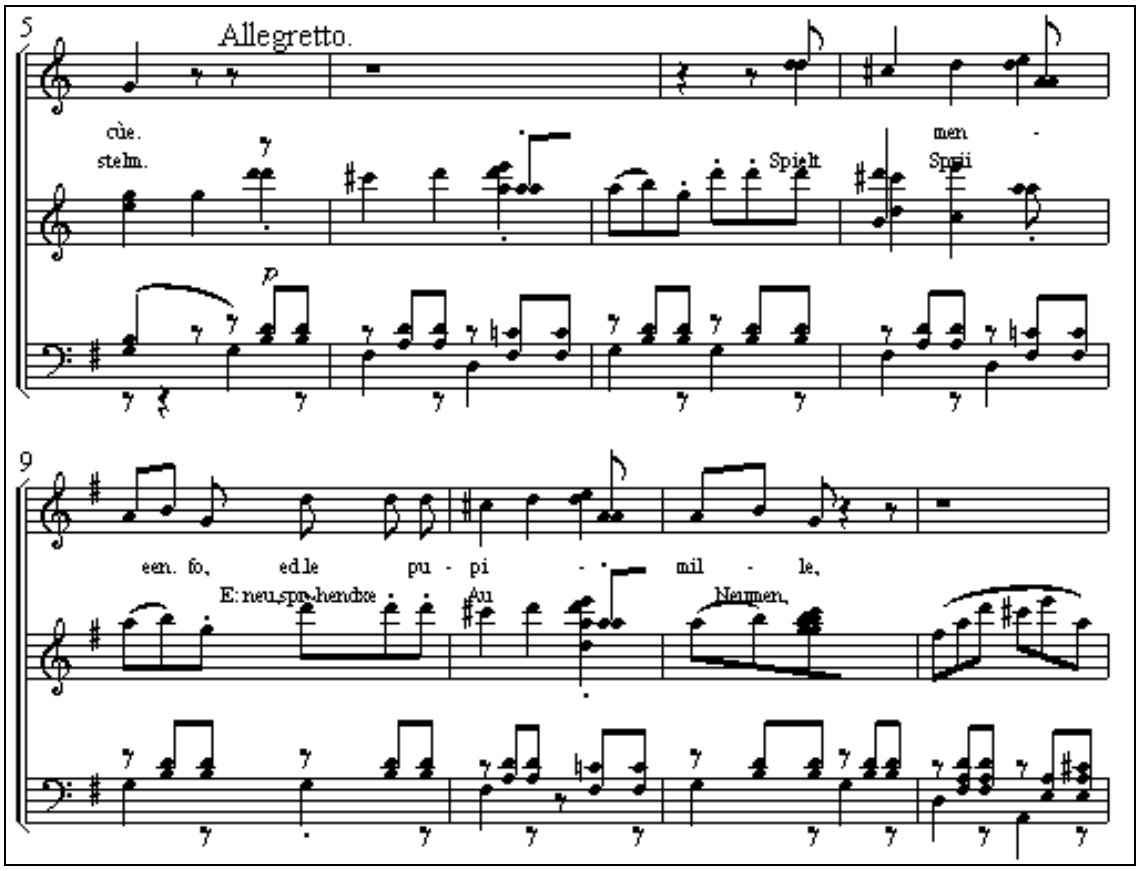

Figure A.27.4. Schumann as scanned and interpreted by Lime.

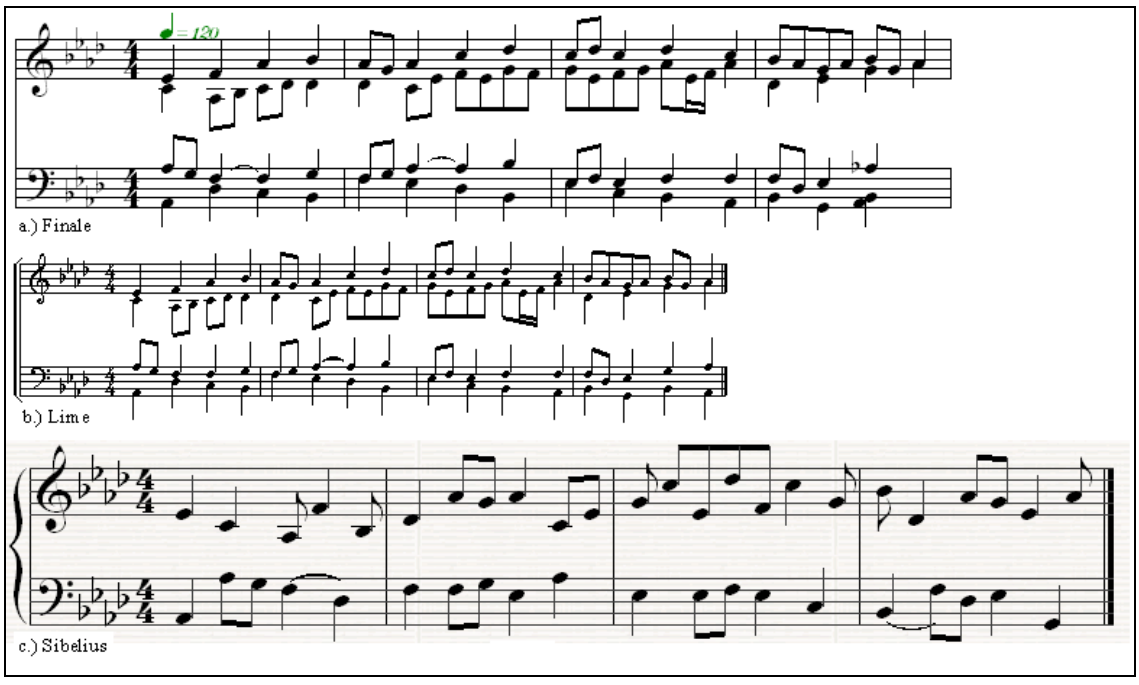

Figure A.27.5. Sample music at original size as interpreted by Finale, Lime, and Sibelius.

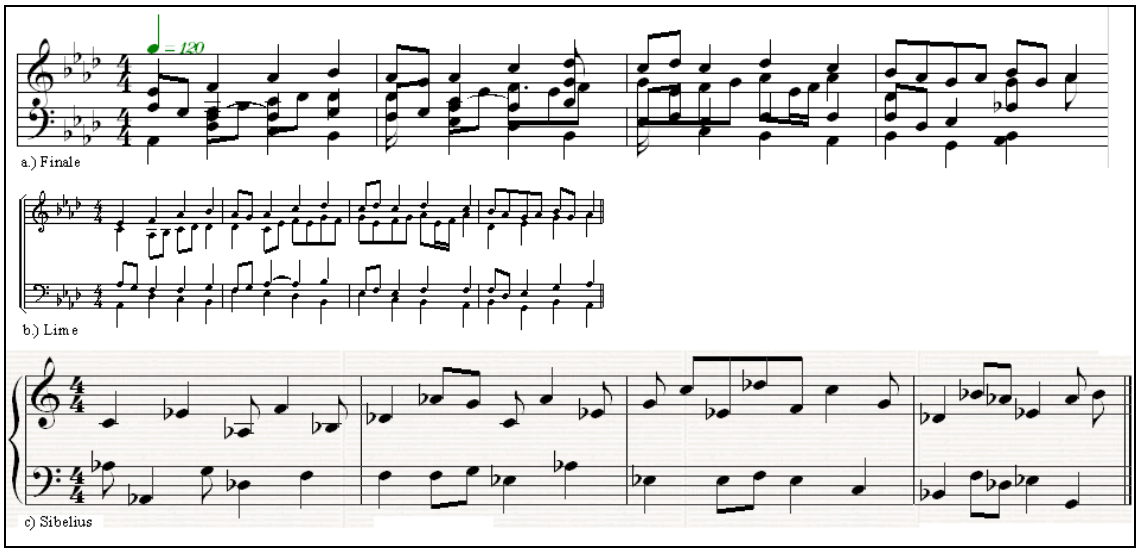

Figure A.27.6. Sample music at one-half original size as interpreted by Finale, Lime, and Sibelius.

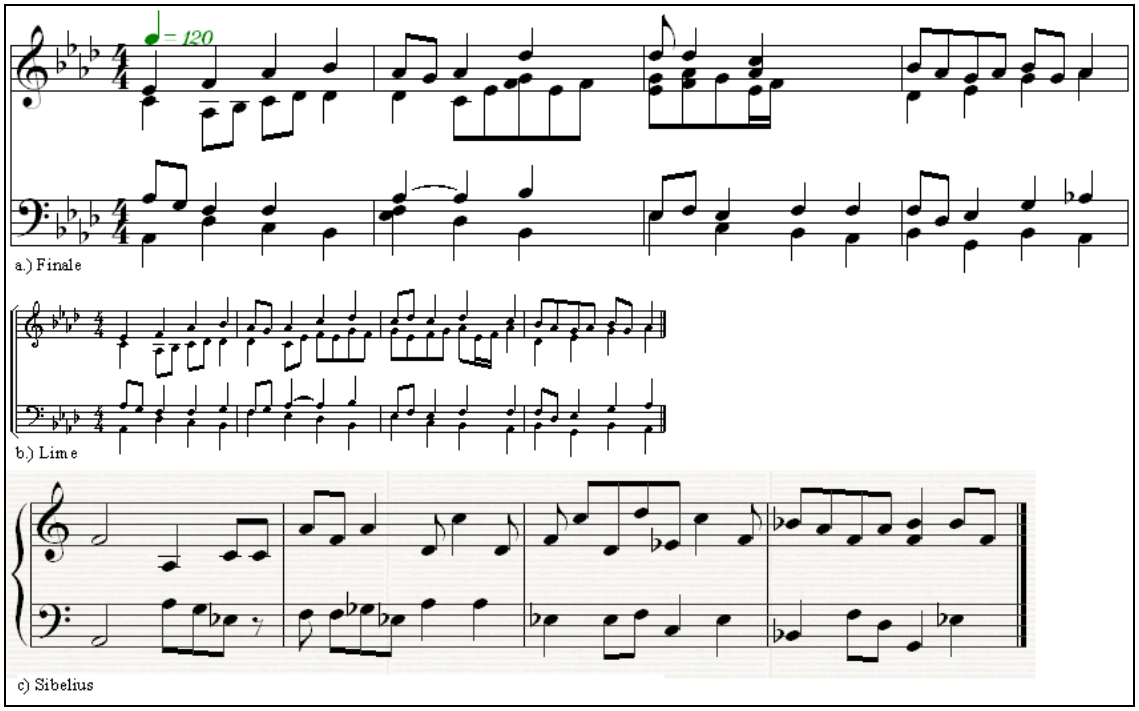

Figure A.27.7. Sample music at double original size as interpreted by Finale, Lime, and Sibelius.

Appendix 28 – Results of MIDI keyboard input

This appendix includes the results of using the MIDI keyboard to input the sample piece in Finale, Lime, and Sibelius. The version of Toccata used by the group did not support MIDI keyboard input.

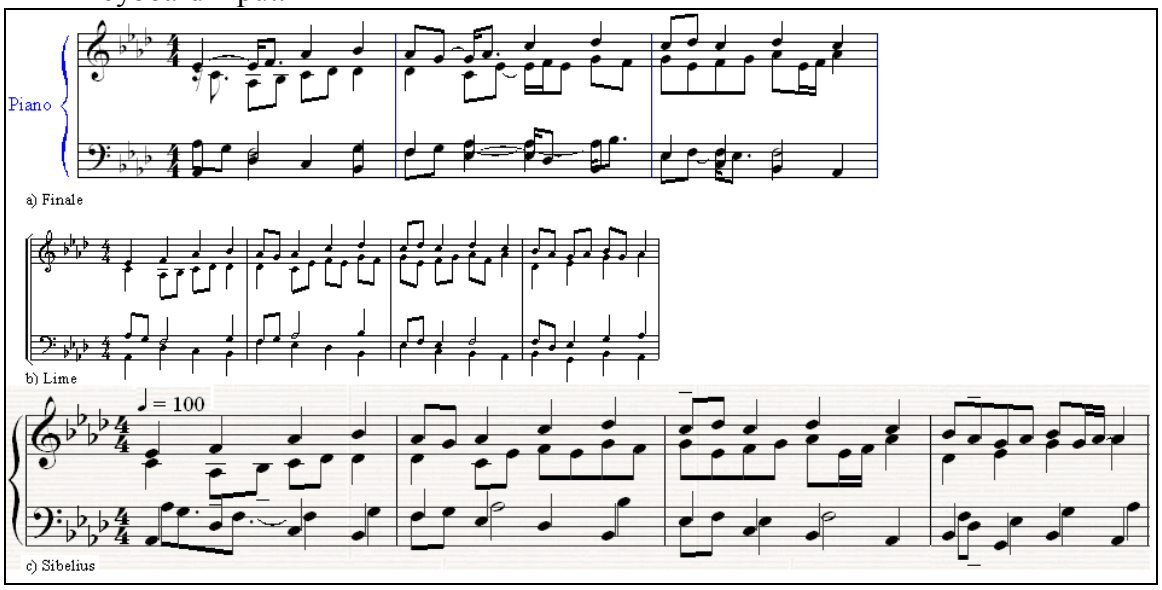

Figure A.28.1. Sample music as played in by voice

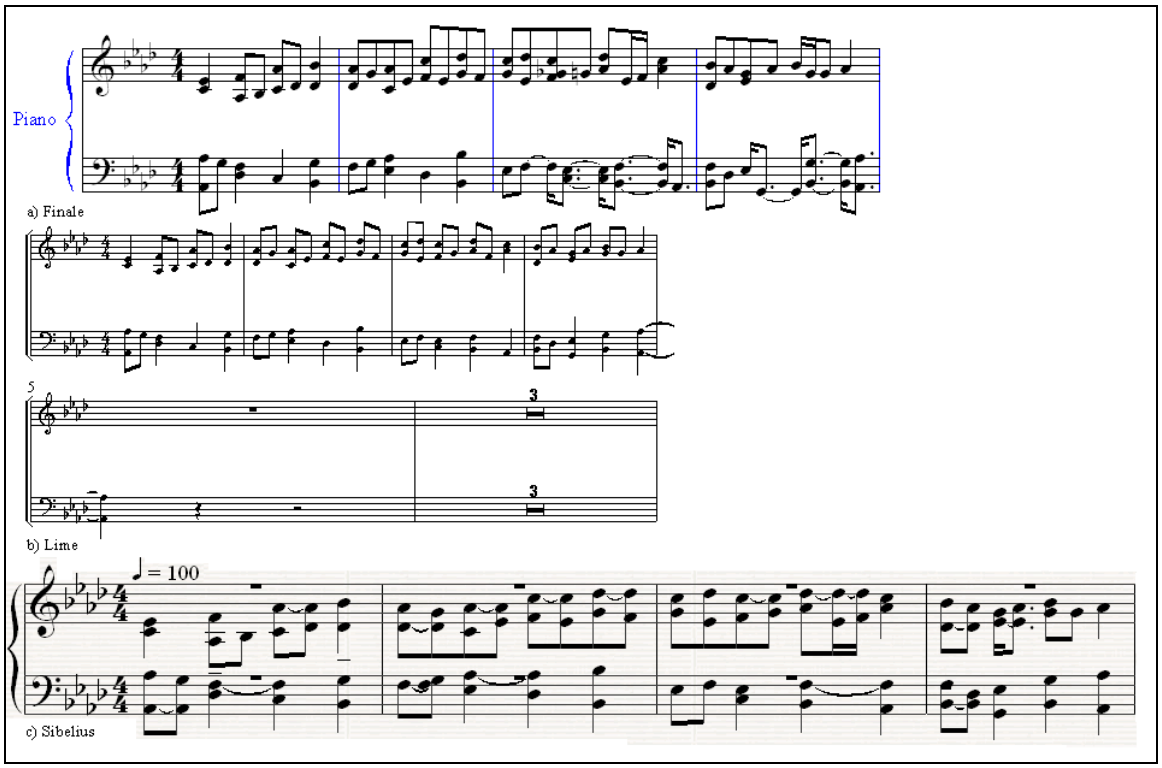

Figure A.28.2. Sample music as played in by staff

Appendix 29 – Transcribed music samples

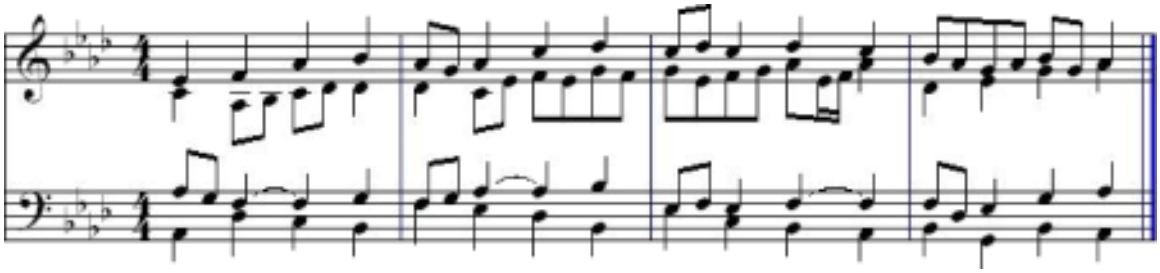

Figure A.29.1. The original notation sample used in accuracy tests.

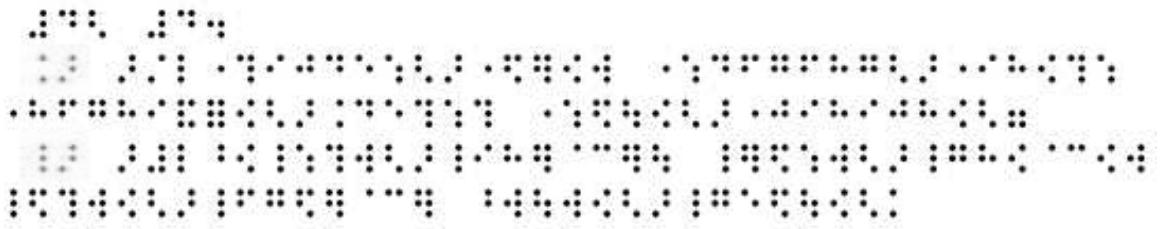

Figure A.29.2. The Braille output by Finale in conjunction with the Braille Music Kit Plug-In.

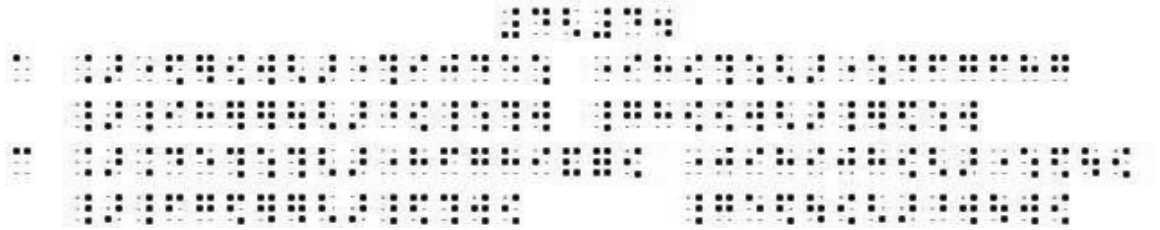

Figure A.29.3. The Braille output by Toccata.

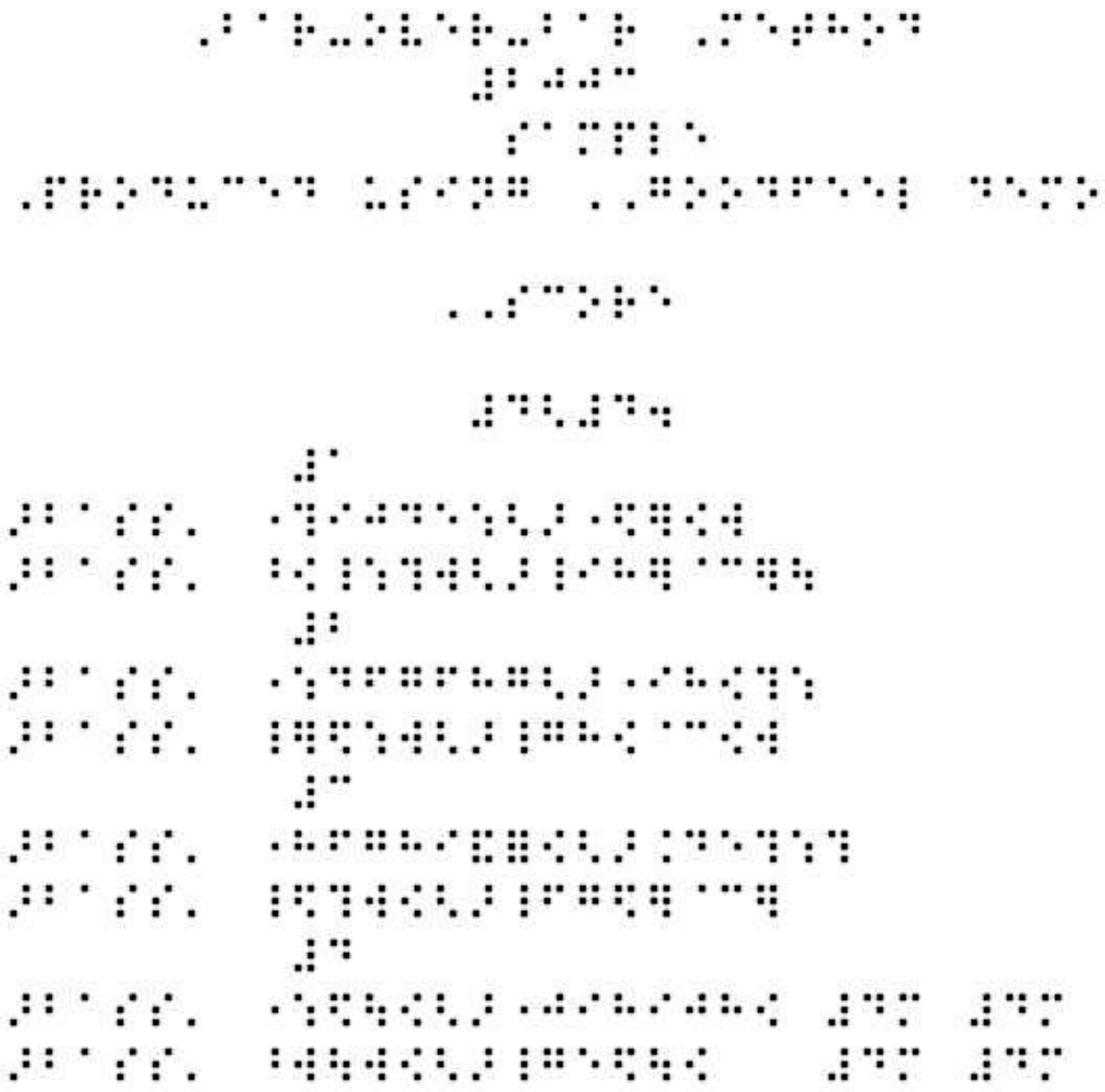

Figure A.29.4. The Braille output by GOODFEEL after processing through Lime and Sibelius.

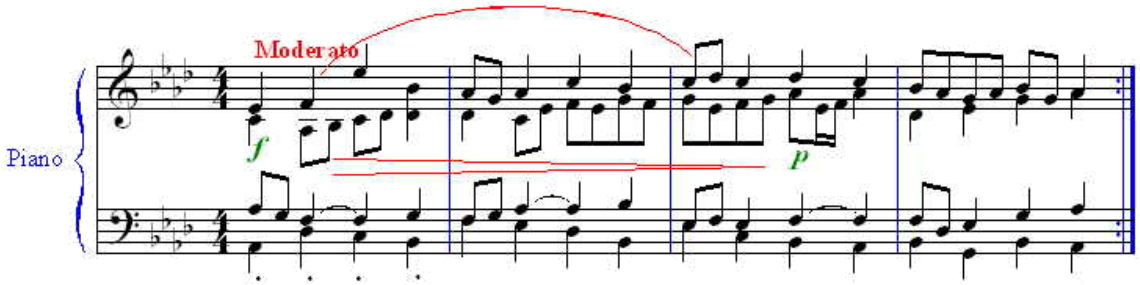

Figure A.29.5. The more advanced piece of music used for transcription as viewed in Finale.

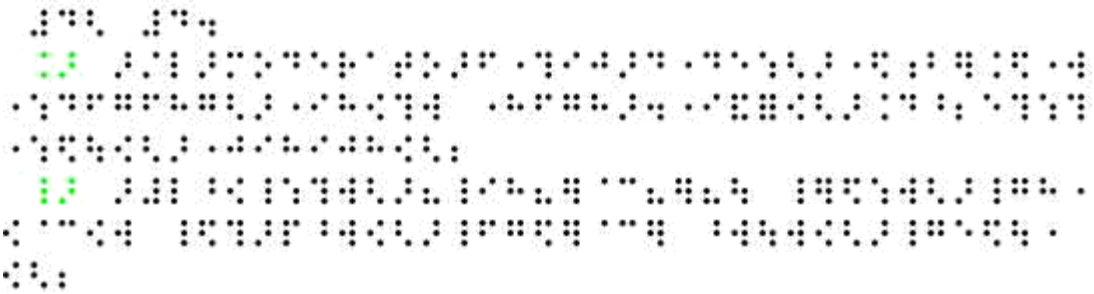

Figure A.29.6. The Braille output produced with the Braille Music Kit Plug-In.

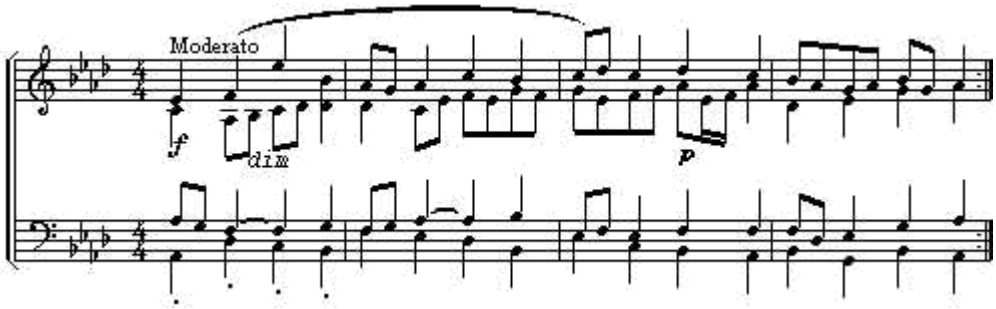

Figure A.29.7. The more advanced piece of music used for transcription as viewed in Lime.

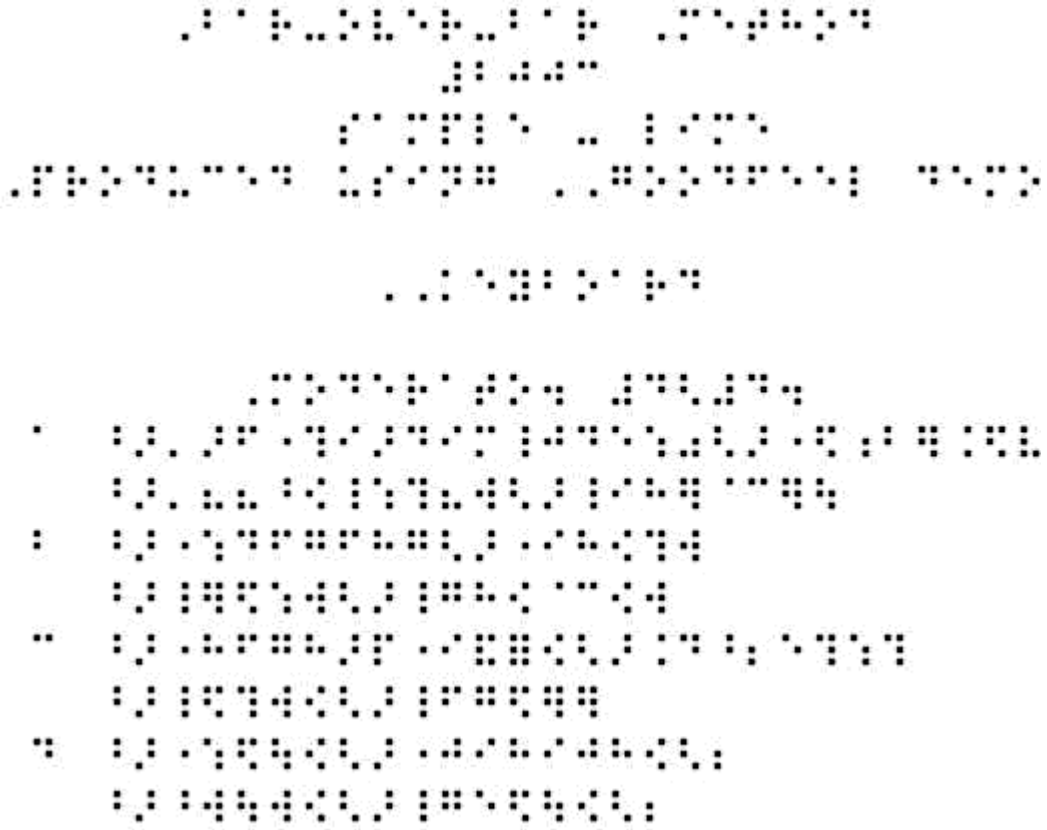

Figure A.29.8. The Braille output produced by GOODFEEL.

Works Cited

Adaptive Technology Resource Center. (2003). Refreshable Braille Displays. Retrieved January 20, 2003, from the World Wide Web: http://www.utoronto.ca/atrc/reference/tech/refbraille.html

American Foundation for the Blind. (2000). Key Definitions of Statistical Terms. Retrieved January 16, 2003, from the World Wide Web: http://www.afb.org/info_document_view.asp?documentid=1280

American Foundation for the Blind. (2001). Quick Facts and Figures on Blindness and Low Vision, Employment Statistics for People Who are Blind or Visually Impaired: U.S. Retrieved January 16, 2003, from the World Wide Web: http://www.afb.org/info_documents.asp?kitid=132&collectionid=15

Boyer, A. S. (1997a). Identification of Characters With Shared Representations: Decoding Musical and Literary Braille. Journal of Visual Impairment & Blindness. 91(1), 77-87.

Boyer, A. S. (1997b). Rehearsal and Recognition of Braille Music Melodies by Skilled and Less Skilled Braille Decoders. Journal of Visual Impairment & Blindness. 91(6), 593-596.

Braille Through Remote Learning. (2002). New International Manual of Braille Music Notation: Basic Signs. Retrieved February 4, 2003 from the World Wide Web: http://www.brl.org/music/manual/basic/index.html

Castan, Gerd. (2002). Music Notation Links: Music Braille. Retrieved February 1, 2003 from the World Wide Web: http://www.musicnotation.info/en/compmus/braille.html#software

Center for Ligebehandling af Handicappede. (2003). No. BSF 43. Retrieved February 10, 2003 from the World Wide Web: http://www.clh.dk/bsf43.htm

Coda Music. (2003). Finale. Retrieved January 23, 2003 From the World Wide Web: http://www.codamusic.com/finale/index.asp

Dancing Dots. (2002). GOODFEEL. Retrieved January 22, 2003 From the World Wide Web: http://www.dancingdots.com/

Danish Disability Council. (2002). Danish disability policy equal opportunities through dialogue. Copenhagen, Denmark: The Equal Opportunities Centre for Disabled Persons. Retrieved January 16, 2003, from the World Wide Web: http://www.clh.dk/pjecer/danskhandicappolitix/disabilitypolicy.doc

Dion, M., Hoffman, K., Matter, A. (2000). Science for Blind and Visually Impaired Students. (Interactive Qualifying Project). Copenhagen, Denmark: Worcester Polytechnic Institute

Dodiesis. (2003). Braille Music Kit Editor. Retrieved March 24, 2003 from the World Wide Web: http://www.dodiesis.com/asp/bmk.asp?language=2

Federal Computer Week (2000). Screen Readers Open Windows For the Blind. Michelle Speir. Retrieved January 20, 2003 from the World Wide Web: http://www.fcw.com/fcw/articles/2000/0807/cov-access3-08-07-00.asp

FNB. (2003). Spoken Music. Retrieved March 18, 2003 from the World Wide Web: http://projects.fnb.nl/SpokenMusic/default.htm

Humphreys, J. (1979). A Computer-based System for Production of Braille Music. In D. W. Croisdale, H. Kamp, & H. Werner (Eds), Computerized Braille Production: Today and Tomorrow. (pp. 241-254). New York: Springer-Verlag.

Institute for the Blind and Partially Sighted in Denmark. English Information. Retrieved January 23, 2003 from the World Wide Web: http://www.ibos.dk/english/

International Braille Research Center. (1997). What is Braille? Retrieved January 17, 2003 from the World Wide Web: http://www.braille.org/#L1S7

International Organization for the Blind. (2002). History of Braille & the Braille System. Retrieved January 17, 2003, from the World Wide Web: http://www.io4b.org/braille.htm

Krolick, B. (1979). Dictionary of Braille Music Signs. Washington, D.C.: National Library Service.

Microsoft (2003). Assistive Technology Catalogue Details. Retrieved January 30, 2003 from the World Wide Web: http://www.microsoft.com/enable/at/search.asp

Napier, G. (1988). Celebrating Braille. Education of the Visually Handicapped, XIX(4). 135-144.

National Foundation for the Blind. (2000). Ray Kurzweil Honored. Retrieved February 3, 2003 from the World Wide Web: http://www.nfb.org/bm/bm00/bm0003/bm000311.htm

NLS Reference Circulars. (2000). Braille Embossers. Retrieved February 4, 2003 from the World Wide Web: http://www.loc.gov/nls/reference/circulars/brailleembossers.html

One Hundred First Congress of the United States of America. (1990). Americans with Disabilities Act of 1990. http://www.usdoj.gov/crt/ada/pubs/ada.txt

Pfanstiehl, M. (1997). Accessible Opera for Blind and Low Vision Audiences. American Music Teacher, 46. 30-31, 93.

PG Music, Inc. (2002). Band in a Box. Retrieved February 22, 2003 From the World Wide Web: http://www.pgmusic.com/bandbox.htm

Royal Danish Ministry of Foreign Affairs. Denmark-Official Denmark-Population. Retrieved January 22, 2003 from the World Wide Web: http://www.um.dk/english/danmark/danmarksbog/kap1/1-7.asp#1-7-1

Sensus Braille. (2002). Multilingual, Bidirectional 6- and 8-dot Braille Translation. Retrieved January 17, 2003 from the World Wide Web: http://www.sensus.dk/braille.htm

Sibelius. (2002). Sibelius 2. Retrieved February 22, 2003 From the World Wide Web: http://www.sibelius.com/products/sibelius/

Siligo, W. (2001). Adaptive Techniques for Teaching Music to Visually Impaired Students. The American Music Teacher, 50 (5). 20-23.

Smaligo, M. (1998). Resources for Helping Blind Music Students. Music Educators Journal, 85 (2). 23-26.

Toccata. (2002). Braille Music Translation Software. Retrieved January 22, 2003 From the World Wide Web: http://members.optusnet.com.au/~terryk/toccata.htm#demo

United Nations General Assembly. (1994). Standard Rules on the Equalization of Opportunities for Persons with Disabilities. gopher://gopher.un.org/00/sec/dpcsd/dspd/disabled/ar48-96.en

Vision World Wide. (2000). Meaning of 20/20 Vision. Retrieved January 22, 2003 From the World Wide Web: http://www.visionww.org/article-what-is-20-20-vision.htm

World Health Organization. (1997). Blindness and Visual Disability. Retrieved January 17, 2003 from the World Wide Web: http://www.who.int/inf-fs/en/fact142.html

World Health Organization. (1999). Blindness as a Public Health Problem in China. Retrieved January 17, 2003 from the World Wide Web: http://www.who.int/inf-fs/en/fact230.html