

# **A HARDWARE SOLUTION FOR ACCESS TO CAA FOR STUDENTS WITH REDUCED MANUAL DEXTERITY DUE TO ACUTE NEURODISABILTY – A CASE STUDY**

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# **A Hardware Solution for Access to CAA for Students with Reduced Manual Dexterity due to Acute Neurodisability – A Case Study**

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## **Abstract**

This study was undertaken to assess possible solutions to the issue of acute disability with regard access to Computer Aided Assessment systems. With the vision for the adoption of CAA set out by the Quality and Curriculum Authority approaching reality, it is now increasingly important for inclusion, widening participation and accessibility to be paramount on the agenda of any course team developing assessment strategies. This paper is a review of available solutions for students with extreme mobility differences that can exclude them from mainstream approaches to the control of software interfaces. It describes a bespoke solution utilised in a particular case that has proved to be invaluable in the teaching and assessment of a student with limited manual dexterity due to Cerebral Palsy. The study focuses on editing packages that are used extensively in the assessment of audio media courses, but the solution brokered could be adapted to CAA across many disciplines.

## **Introduction**

The Disability Discrimination Act (DDA) states that, 'It is unlawful for the body responsible for an educational institution to discriminate against a disabled student in the student services it provides, or offers to provide'. Therefore, it is the duty of the educator to design systems and a curriculum that can be accessed by every student regardless of physical difference.

The latest figures available for the Higher Education sector indicate that problems of physical accessibility were experienced by 0.3% of the total cohort of 895,675 students<sup>1</sup>. In the institute where this case study was conducted, the figure is substantially higher with 4% of the student cohort registering some form physical disability that affects mobility. Because of the

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1 HESA Statistics 05/06 - <http://www.hesa.ac.uk/holisdocs/pubinfo/student/disab0506.htm>

generic descriptors used to compile these statistics, accurate data for specific student needs that match this case are not available at this time. As interest grows in the area due to the DDA, it is envisaged that data will become available to enable greater analysis of the present situation.

Reasonable adjustment can be used to redress many problems that can be faced, but this can prove to be difficult for students with acute conditions if the course is designed to be assessed on software packages that require a high level of manual dexterity.

Audio media courses are examples of routes of study that rely heavily on the production of artefacts on a wide range of software platforms as forms of assessment. This case study will focus on a student's journey through the curriculum of a course that requires a high level of expertise in the use and operation of such packages. The student has restricted mobility and manual dexterity due to the symptoms of Cerebral Palsy. The condition resulted in the student's access to computer interfaces being limited to the fingers of one hand with reduced movement in the arm. This was exasperated by fatigue, which was the result of the effort required to position a mouse or the use of a conventional keyboard. Another problem that became apparent at a very early stage was that the accuracy of mouse position was going to be an issue due to the working screen resolutions required in the software packages.

The main resource for existing research into this area in the UK is TechDis, a project supported by the Joint Information Systems Committee (JISC). TechDis have funded many projects to investigate solutions into a broad range of accessibility issues<sup>2</sup>. In the poster presentation 'Techdis Accessibility Pyramid'<sup>3</sup>, they advise;

“When investigating appropriate solutions for individuals it is important to consider the amount of time and effort required for them to begin using the relevant kit.”

Throughout this study, this advice has been paramount to the formulation of the solution to ensure that the student is not disadvantaged by the learning curve of the technology.

The target software package that will be described throughout this paper is an audio editing solution from Sony<sup>®</sup> entitled SoundForge<sup>®</sup>. The package requires the user to operate a graphic user interface that relies heavily on mouse movement for data selection and access to drop down menus for editing functions. Due to the particular limitations of finger dexterity, the interface was proving to be difficult for the student to master to the degree of proficiency required by the learning outcomes of the assessment criteria.

The majority of tools for assistive control are centred on mouse and keyboard alternatives. A suite of these are available as standard in the Windows Xp<sup>®</sup>

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2 <http://new.techdis.ac.uk/>

3 Poster presented at ALT-C 2006 (5-7 September, 2006)

operating system whilst other more esoteric solutions are provided by third party companies. This paper will concentrate on the tools that could be of benefit to the subject of the case study, namely, ones that assist with user interaction and with the selection of data on screen.

## **Standard tools**

Although tools for controlling computer interfaces have been developing rapidly alongside those of the major operating systems, accessibility has been mostly focussed on the major software titles due to the combined effect of market forces and demand. However, the very nature of learning differences due to Neurodisability mean that finding suitable tools to match the software package and the particular needs of this specific individual has proven to be difficult. However, in order to highlight the level of research conducted into this particular solution, the author has included a description of some of the more popular access tools that were discounted due to the students specific learning needs.

### *Sticky Keys*

This is one of the standard tools that form the accessibility suite in Windows Xp<sup>®</sup>. It addresses the problem of a user with limited finger dexterity and allows the user to access keyboard shortcuts that are designed for activation with two or more simultaneous key presses. An example of one of these commands would be the standard Windows<sup>®</sup> shortcut for copying data ('Control' + 'C'). For a user with restricted finger dexterity and the use of only one arm, this command could not be achieved. With sticky keys activated, the user can press a modifier key such as 'Control' and have it remain active until another key is pressed. This could prove useful for simple commands such as the example indicated above, but it would prove to be restrictive from both a time and functionality perspective when applied to complex packages.

### *Filter Keys*

FilterKeys is another member of the Microsoft Xp<sup>®</sup> accessibility suite. It is an option that instructs the keyboard to ignore brief or repeated keystrokes. This offers the advantage to a user with reduced dexterity in that it can aid the input time of data by reducing the error rate associated with inaccurate key presses.

### *Track Balls*

The traditional mouse requires that the user performs three tasks at once. This can prove to be disadvantageous to a user with limited dexterity. The user must grasp the mouse, move the mouse and click a mouse button simultaneously in order to complete a function. By design, a trackball allows the user to perform each of these tasks in a non linear fashion, thus allowing for greater control when movement is restricted. The disadvantage of a trackball for the specific needs of this study is the trade off with regards speed when breaking from the linear approach of standard mouse interaction. Because all control interactions will take between twice and three times that of

the standard mouse function, it will impact upon the fatigue experienced by the user during a session.

### **Expanding the horizons of control**

Because of the limitations of the standard tools, further research was conducted into the type of interaction that could be accepted by the target application. Remote control features for the package are well specified as the software is targeted for use in media production studios as a digital recording platform. The standard control language for this form of operation, due to the environment in which it is designed to operate, is the Musical Instrument Digital Interface. MIDI was developed in the early eighties as a serial communication protocol for the control of musical instruments. In order for this to be effective in this application of the software, a control surface would have to be configured that could communicate the necessary MIDI commands to the host computer. Control surfaces of this type are available commercially and can be configured to send pre-programmed strings of MIDI data. After thorough evaluation, this approach was discounted due to the complexity of the programming of the device and also because this technique would be restricted to the one piece of target software.

### **A bespoke solution**

Whilst researching the control messages required to operate the software remotely, a data sheet was compiled of alternative key presses based on the standard multiple key protocols of the operating system.

It was suggested that a custom built keypad that could send macro commands that were strings of data mirroring the ASCII protocol offered by conventional keyboards, could replace the use of the mouse for the majority of functions required by the user. For indicative purposes, table 1 gives an overview of the basic commands for control of the software package complete with the mouse interaction and shortcut equivalent. It was calculated that for complete control of the package at least sixty distinct keys would be required.

<i>Function</i>	<i>Mouse Interaction</i>	<i>Shortcut alternative</i>
Play	Click GUI Button	Shift + F12
Stop	Click GUI Button	Escape
Record	Click GUI Button	ALT + R
Select all data	Click and drag	Ctrl + A
Increase Magnification	Click GUI Button	Shift + Up Arrow
Decrease Magnification	Click GUI Button	Shift + Down Arrow
Save	Click menu item	Ctrl + S

**Table 1: Comparison of functions, mouse interactions and shortcuts**

It was established that programmable keypads were available that can accept user defined macros per key. These are marketed as components for point of sale interfaces in retail environments. For this project, a keypad with 128 keys was acquired that connected to the computer as a standard PS2 device (Figure 1). The keypad is a flat panel that has a facility for sliding a user defined legend beneath a clear vinyl screen. This allowed the user interface to be bespoke for the application.



**Figure 1: Programmable Keyboard**

The keypad is programmed via a host application called ChangeMe. Once the configuration of the buttons is established in the software, the program is uploaded to the non volatile memory in the keypad itself. The keypad then becomes an autonomous piece of equipment that is dedicated to the software in question.

## **Ergonomic considerations**

For the controller to add enough benefit so as to add extra value to the user, the differential in terms of speed must be measurable. For the increase to affect productivity and to aid with the issue of fatigue, the keys must be grouped into clusters that can be reached in a logical manner determined by the intended function of the individual key. Many of the functions of the software package are already grouped in this manner due to the collections within the drop down menus. The menu collections were utilised in the initial design for the interface, with groups such as the file functions located in strips and coloured via the legend to match the functionality of the cluster. This was repeated with the transport functions, to allow for the complete control of the software from the device.

The size of the keypad enabled its position to be adjusted so that the user did not have to reach excessively in order to access any of its functions. This greatly increased the amount of time the user could participate before the onset of fatigue.

## **Further work**

The keypad has scope for use with other software programs due to the fact that it has four distinct layers that can be applied to each key. This gives the possibility of 512 distinct command strings to be saved in its internal memory. As the Windows<sup>®</sup> operating system dictates that most programs share some shortcut commands, the amount of distinct commands required per program is reduced. The amount of functions required for a particular program would depend upon the complexity of its control interface and the expected level of expertise required to be demonstrated by the user.

The legends that are produced to indicate the functions of the buttons are located beneath a vinyl screen and can be easily changed on a program by program basis. This makes it feasible for the keypad to control numerous software packages without reprogramming.

It is envisaged that a web based depository of pre-programmed macros could be assembled for use as a resource for educators across all sectors. This could make access to numerous software packages a reality to users with severe disability.

This idea could be extended further by the adaptation of Access key protocols by the developers of online assessment materials. Although the Access key attribute in HTML has not reached critical mass due to problems with its implementation, the development of assessment materials could benefit from this technology. The problems that have arisen in the standard HTML protocol have been due to the duplication of command strings with existing shortcuts. Because the keypad can generate strings with the ASCII code for up to four simultaneous key presses, this would not be a problem. Development using other scripting languages could utilise a control surface based upon standard short cut commands in a similar way that the Sony<sup>®</sup> SoundForge<sup>®</sup> example



has been used in this case study. It would be advantageous at this point in the development of the keypad as an access platform to establish a set of Access Key commands specifically for computer aided assessment applications.

## **Conclusion**

The keypad has had a profound effect on the student for whom it was designed. It has reaped benefits that go beyond the initial aim of increased accessibility to the software package. Due to the ability to act independently and in a time frame that allows for a more spontaneous approach to the creation of media artefacts, the student has displayed a vast increase in confidence and self esteem.

The keypad and the methodology from this case study have opened possibilities for the adaptation of more software packages. It has been proved that any computer aided assessment which has options for standard ASCII keyboard shortcuts, can be made accessible to students with acute physical learning differences through devices and strategies of this type.

