The Disklavier: From Educational Tool To Digital Interspatial Performance Explorations

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Abstract

This paper charts the progression at UCF of the use of the Disklavier both as a learning tool, and a tool for artistic expression. It analyses the potential of the Disklavier to become the platform for knowledge sharing and transfer between educational institutions, and explores the technological and theoretical aspects of a number of ongoing projects related to the instrument. The aim of the authors is to illustrate, as in a progress report, the potential of the instrument - looking at the role of its technological implementations in performance as well as in education, offering new possibilities and efficacies in Music, Creative Music Technology and Internet based Music-making matters.

Introduction

The Disklavier is a motorised grand piano that has Musical Instrument Digital Interfaced (MIDI) technological implementations incorporated in its features. Disklaviers were initially developed as modern versions of player-pianos –also known as pianolas or autopianos- that traditionally have been used in the entertainment as automatic music instruments in cafes and public spaces. However, the features of the modern version of player-piano –the Disklavier- extend its possibilities and its implementations in both educational and performance practices. In a brief description of the instrument, it should be mentioned that combines the advantages of digital pianos – saving and reproducing data, volume control, control over the play back speed and silent practice mode – with

the more desirable aspects of acoustic grand pianos: sound quality and touch sensitivity. Disklavier is basically an extended grand piano incorporating technological qualities. Optical laser sensors are placed in its mechanism to measure and save digitally -in the form of a MIDI file- the sensitivity and the timing of the movement of both its keys and its pedals. Hence, by the use of any commercial notation MIDI software, the performance can be stored and represented as conventional western music notation for further study and analysis. Additionally, the Disklavier incorporates the technology to deliver exactly the opposite process; namely, to reproduce any piece of music stored in a MIDI digital file. This happens when the MIDI data is relayed to default installed servomotors –placed as well on the keys and the pedals of the instrument. Such a feature allows the identical reproduction of the previously digitally recorded performance. Due to its very high digital resolution and accuracy on touch velocity, the reproduced performance, -data playback- becomes indistinguishable from a pianist's live playing.

Even if these are some of the most conventional features of the instrument they still facilitate undercurrent educational approaches and methodologies that we will illustrate in detail further in this paper. Currently, the technology of the new generations of Disklaviers such as the one in the "Mark IV" series (Yamaha, 2011) is based on an innovative Operating System (OS) with features that add new dimensions to music performance and pedagogy. The present OS facilitates the transmission of MIDI data streaming online globally utilising the Internet's User Datagram Protocol (UDP). This offers the real-time online performance of acoustic music in different parts of the world, extending the possibilities of both the concepts of music performance and piano teaching as we currently know them.

Here at University College Falmouth (UCF), a specialist arts institution - we have strong links between Media and Performance, which allows us to collaborate across courses. The addition of the fantastic new Performance Centre created to house Dartington College of Arts (DCA) at the Tremough Campus is a significant time in the history of UCF and arts higher education in the UK. The need for Universities to be entrepreneurial led us to a strong and developing relationship with Yamaha and the Disklavier. Currently we are leading a number of different research projects that explore the features and potential of this particular multifunctional instrument. This paper is to be considered as a progress report on those explorations, the aim of which is the enrichment of the students' learning experience. We are focusing on the development of a supportive environment that encourages the acquisition of transferable skills through different forms of practice-based research. Being aware of the constantly evolving technology, we encourage practices through which the students would define their own prospect professional practices within the economies of the globally networked future.

-The Disklavier: an instrument for reflective learning

A number of research outcomes have already demonstrated the valuable pedagogic significance of the Disklavier.

Kathleen Riley (2005) has shown ways of analysing performed music by the use of the instrument in combination with Digital Audio Workstations (DAW) and their piano-roll function. We have implemented comparable methodologies and approaches at UCF in order to create a reflective learning environment for students who need to improve their dexterity in piano playing expressivity. The main attributes of music expressivity are based on variations in timbre, frequency, timing and intensity (Palmer, 1996). Piano players though, due to the nature of the instrument, can have control only of the last three. Considering that, we created a model that would record both visually –in the form of western notation- and sonically the performance of a given music piano score. Such a multisensory recording will allow the observation of the variations of those attributes, and would be a medium for self-assessment of music expressivity and technical agility. Virtually, the model assists the reflective analysis on one's own piano music performance.

In detail, by connecting the Disklavier to a western notation commercial software –such as Sibelius or Finale- the music can be stored digitally as MIDI and can be represented in traditional notation. Consequently, the performance can be compared to the original music score for further analysis. Moreover, because of the fact that the performance is stored in MIDI, it can be reproduced sonically any number of times. The fact that the combination of instrument and software allows both the visual representation of the students' performance as well as the sonic reproduction of it, can facilitate their reconsideration of the features that they like/dislike in their performance. It allows the performers to listen again and again any desirable amount of times to their own musical interpretation of a piece from the side of the audience rather from their usual position. This feature develops the constructive critical thinking in one's performance practise. It enhances self-reflected originality and personalised practice in a variety of matters related to expressivity, technical dexterity, and interpretation.

Similarly, the Disklavier is currently used as improvisational tool for the development of music compositions. Music students interested in music composition rather in developing performance skills can use the previously mentioned configuration to record their piano improvisations for compositional purposes, or even to listen back to previously MIDI-notated music compositions. These features enhance compositional creativity in a learning-by-doing mode. Used in this context, the instrument is a tool that does not necessarily require the presence of a tutor but rather a self-reflective learning approach from the students themselves.

The instrument in itself appears to suggest Kolb's (1984) reflective practise model as its natural pedagogic methodology. When a certain *Concrete experience* (the initial piano performance) causes *Observations* and *Reflections* (reflections generated out of the contemplation of the recorded and notated performance), these *Reflections* generate the *Formation of Abstract Concepts and Generalisations* (they get formalised in a set of principles that would assist in the enhancement of music attributes). Then the implications of those *Concepts*, when

tested in *New Situations* (in new enhanced interpretations and performances), will generate *New experiences* (in other words the learning outcome). Therefore, such a tool aids a reflective learning methodology and helps the development of critical thinking, self-awareness and analytical skills in piano playing and music composition practices.

-The Disklavier: an e-learning device.

One of the most important features of the later generations of Disklavier called Remote-Learning (Yamaha Corporation, 2010), is its ability to transmit and receive digital MIDI information through the Internet. In a remote-learning configuration up to four Disklaviers can be connected globally using dedicated Internet Protocol addresses (IP addresses). The model of connection suggests a "master" Disklavier connected to three "slave" Disklaviers. In the example, the "master" Disklavier A can send information to the "slave" instruments B, C, and D and vice versa –instruments B, C, and D can send information to instrument A-. (Unfortunately though, instruments B, C and D cannot yet send data between them) (Picture.1).
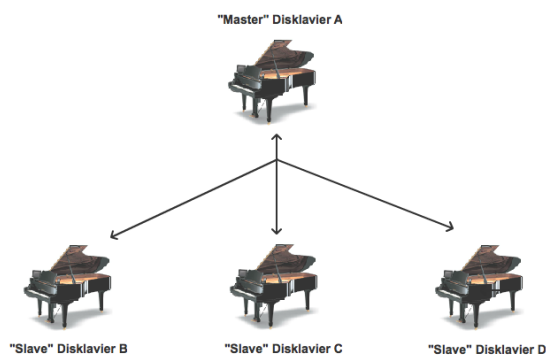
Picture.1 Four Disklavier connected in a Remote-Learning configuration

The communication platform is based on UDP that allows the OS of the Disklavier to send messages –referred as Datagrams- to other hosts on an IP network without the need for a prior set up of dedicated transmission channels and data paths. Such a feature is valuable for various educational purposes. It can be used as an instruction tool for groups or individuals that can be located anywhere in the world. Moreover, with the addition of any commercial videoconference software the tutor and the students can have visual contact between each other. In that case individuals can have access to piano lessons as long as they can access an Internet connected Disklavlier. Such a feature revolutionises the concept of piano master-classes as we know it, and can contribute in the development of sustainable distance learning and Internet based learning methodologies.

Until the recent past, one of the main negative aspects of such technology was, according to James Diamond (2006), the Time Accuracy Issues that could be provoked by the variation in Internet transmission time, a phenomenon known as jitter. That would happen when the MIDI data output by the transmitting piano would arrive at the receiving piano with certain latency. As Diamond mentions, when a pianist plays at the transmitting piano two notes with a time difference of 10 milliseconds, the receiving piano should also reproduce the two notes with exactly the same time difference of 10 milliseconds. Unfortunately though, in most cases, the two notes will be sent through the Internet in separate data network packets. Each of these packets will be transmitted in different lag times depending on the broadband speed. Such

an event would unavoidably have a negative effect on the fidelity of the reproduced music. However, current superfast broadband technologies using optic fiber networks can reduce the problem to a non-perceivable degree to the human ear. Currently at UCF, the Disklavier is linked in a dedicated superfast broadband network, with priority flow over the university's network. In that respect and regarding the previous example, even if the notes are transmitted in separate data network packets the reproduced performance would sound identical to the transmitted one. This feature provides a new range of possibilities for online workshops, performances and master-classes between educational institutions that use networks of similar speed. Additionally, the jitter effect is controlled and very much reduced - to an unperceivable extend - due to the advanced buffering system encoded within the Remote-Learning software. These facts broaden the dimensions in the current online and distance learning practises. They aid the bridging of institutional facilities globally. Fostering the vibrant exchange of pedagogic methods between members of Academic staff around the world. Physically linking educational institutions situated globally in a cross-fertilising mode.

-The Disklavier: a digital research device.

At UCF we are running a number of research projects, the concepts of which have been generated due to the functions of the Disklavier. We are developing an improvisation programme that can be used as computer aided music composition/performance tool. The programme is created in Max/MSP and is based on a number of mathematical functions provided by Karheinz Essl's (1992-2010) RTC-lib. RTC-lib is a real time composition library for algorithmic music composition in Max/MSP/jitter. The programme under development allows the users to make music with the aid of a series of functions and algorithms that control music attributes such as, intensity, note duration, event occurrence and pitch. The software works as follows: a performer/composer would direct the computer to generate and stream digital MIDI data by selecting a set of probability functions; the data is then streamed to the Disklavier, consequently the instrument performs the MIDI data as music. The performers/composers have an overall control about the music's attributes and may change in real time any of the parameters following their own aesthetics using any commercial MIDI controller - slider-box. Hence, the software aids in the conversion of the Disklavier in an improvisation/composition tool for non-piano players. The combination of the two can be the subject of further research on the musicality and expressivity of individuals with no musical education background (Picture. 2).
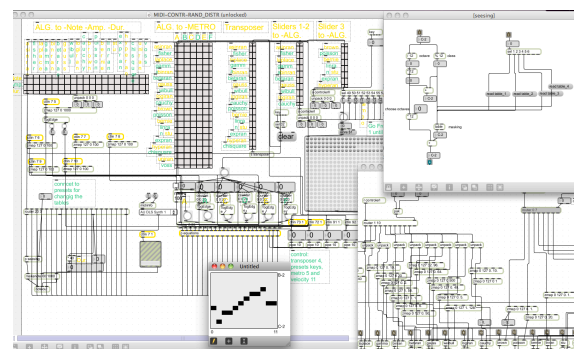
Picture.2 Snapshot of the algorithmic composition software under development

The fact that the Disklavier can perform musically streamed MIDI data implies that any form of digital data mapped in the 8bit MIDI protocol can be interpreted musically from the piano. In that respect, the Disklavier with its technological features permits us to convert it to an instrument that would interpret musically any form of digital information. Currently at UCF we are working on the development of computational programs that would implement algorithms to interpret motion capture information musically. Motion capture systems identify movement data as spatial variations; such information, once digitalised, can be converted to MIDI in order to be interpreted from the Disklavier. The software is currently under development with the intention of implementing it within the context of music, dance and multimedia performance collaborations. Students and staff at UCF are recognising the potential of this technology and interesting projects are starting to form.

-The Disklavier: an Internet based performance instrument.

The last but undoubtedly not least project under current development, concerns the unrevealed potential of the Disklavier as a multimedia performance instrument. This is the establishment of a platform for multimedia real-time remote performances on a global scale. At UCF we are currently in close collaboration with Yamaha Music UK and Yamaha Music Europe in the production of a new work by Jim Aitchison (Aitchison, 2012), Honorary Research Fellow at Royal Academy of Music and Associate Lecturer at UCF. Aitchison's particular composition is inspired both by the work of German Visual Artist Gerhard Richter and JS Bach. Fundamentally, his work explores the concepts related to distance, presence and contemplation; questioning the transformational powers of distance applied over an artwork. Aitchison's composition is exploring perceptual boundaries, identity matters, reality and simultaneity, utilising undercurrent technology and the Internet.

Technically the composition is based on the Remote Learning feature of the Disklavier. More specifically, there will be a pianist performing at UCF on one instrument, which would be linked via the Internet to three remote Disklaviers placed globally. Such a set-up would allow four pianos to be played by a single performer simultaneously at four different places around the world, aiming to offer the same music experience. The composition by conjoining digitally as well as physically remote performance spaces globally, suggests a network of parallel experiences in Telepresence (Dixon, 2007).

Aitchison's project expands the limits of music performance from being a site-specific event to what Johanes Birringer (2008) would call digital inter-spatial experience. The concept for the composition is initially inspired by Richter's work and the creation of multiples or doubles. But in this case the concept manifests itself in the form of a multiple telematic experience (Dixon, 2007) within the context of a digital performance. Furthermore, taking into consideration the technological implications of the carrier medium, the composer is similarly interested in experimenting with the transformational

powers and the aesthetic implications of the Internet as medium over his music; a concept as well derived from the poetics of Richter's work. The composition is under development and is due to be premiered in Autumn 2013.

-Conclusions

Disklavier is a multi-functional instrument that can be incorporated in different types of artistic, educational as well as technically and technologically related research projects. It enhances the student experience in education and facilitates the development of their professional practices.

It aids reflective and experiential pedagogic methodologies, and is a valuable tool for the development of the students' reflective aesthetics and critical thinking in music performance and music composition.

It aids contemporary methodologies in piano learning, facilitating distance and online learning. Conceptually, it advocates the establishment of relationships between different educational institutions globally.

Its technological features and especially the fact that it can interpret any streamed digital data musically, offer new possibilities and open up the dimensions not only in art-based research projects but even further for embodied musicology research projects that could be based on empirical analysis research methodologies.

Furthermore, it is an instrument that, within the general context of the era of the global village, questions the concept of music performance from being a site-specific event and transforms it to a new

innovative experience suggesting the concept of inter-spatiality and it sets new paths for exploration in the era of the global information superhighway.

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