Creating an Online Ensemble for Home Based Disabled Musicians: why disabled people must be at the heart of developing technology.

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ABSTRACT

The project takes a Universal Design approach to explore the creation of a software platform to facilitate a networked music ensemble for disabled musicians. In accordance with the 'nothing about us without us' [5] principle, a group of 15 professional musicians, who are also disabled, were interviewed to assess needs and develop design directions. The group gave their perspectives on networked music practices and this data was then analysed to look at how music technology software design could be developed to make it more accessible. Various softwares were explored to assess their potential for adaptation and key messages and recommendations for digital musical instrument makers, performers and event organisers to improve practice for working with, and for, disabled musicians were identified.

Author Keywords

Universal Design, Accessibility, Survey, Network Music

CCS Concepts

•**Applied computing** → **Sound and music computing;**
•**General and reference** → **Surveys and overviews;**

1. INTRODUCTION

The paper is situated in a post-modernist approach, using intersectional feminism as it's basis [6]. This framework understands different groups as having different cultures and perspectives, and does not assume that one dominant group would be able to speak for other groups. Disability [1] is reframed from something negative, which needs to be solved, in order for the disabled person to become more like the non-disabled person (or to become more 'able'), to a radical and positive shift. This understands disabled people's experiences as valuable cultures in themselves, with much to offer a complex and kaleidoscopic postmodern culture.

A networked model of society [2] is used to show how we can design according to the needs of the group, rather than the needs of the leadership or the needs of capital. This offers an opportunity to think about disability as something we deal with together. If each person is a node in the network, then as they communicate and design a process that works for the group the structure is created appropriately. In this networked structure, every person in the structure contributes, and by moving a little this way or that, influences the shape and movement of the structure itself.

When designing a performance, a rehearsal, a workspace, a process or an environment, if we start by thinking 'what do people need?', a process which enables all people to be equally supported and challenged can be built. A disabled woman with three small children to collect from school should be equally able to contribute as a single man with no caring responsibilities or disability. Unless this playing field is levelled, the voices of those with spare time and energy to contribute tend to be heard over the voices of those who do not.

1.1 Disabled Access and Universal Design

The first principle of Universal Design [19], is 'Equitable Use', and is broken down into the following four categories.

1. 'Provide the same means of use for all users: identical whenever possible; equivalent when not.
2. Avoid segregating or stigmatizing any users.
3. Provisions for privacy, security, and safety should be equally available to all users.
4. Make the design appealing to all users.' [4]

An extension of the social model approach is the 'nothing about us without us' [5] concept which holds that those for whom a service, system or environment is designed, must have a contributing say in its design. By incorporating diverse voices in the design process, things can more easily be designed to fit those they will serve. Using Universal Design and the social model of disability we can explore the concept that everything that is made, should be made by a wide range of people for the full range of people. In this way 'made for', is turned into 'made by', and cultural appropriation, perpetuating stereotypes, assumptions, supremacist perspectives, and oppression can be avoided.

For example, the SignAloud gloves [22] — a student project which interprets sign language into spoken text — has been met with a negative reaction from d/Deaf communities [8]. The gloves were criticised as they only interpreted alphabetic spelling, which is a tiny part of sign language which also includes other hand, finger, facial, mouth and eye movements as a part of the language. More importantly, the gloves reinforce that d/Deaf people's communication needs to be 'solved' for the benefit of non signers, and puts the responsibility for that onto the signer, to buy, train, and use

[1] See Appendix A for definitions.

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the gloves. This was seen as cultural appropriation and a colonialist[2] approach to technology and disability [10]. The makers were thinking in a colonial way about how to 'solve the problem of the other'. If d/Deaf people had been interviewed in the conceptualisation of the project, and the makers had read and understood disability theory, something more equitable and useful could have been created.

It is vital that approaches to disabled technology come from the community, and begin with an equitable approach, rather than with the intention to 'fix' a problem perceived by the non-disabled community. By designing in collaboration with disabled people, we make something which is more flexible, and by default, also works for a broader range of non-disabled people. One example, The Inclusive Design and Research Centre's project, Co-designing Inclusive Cities, '...offers citizens a way to actively participate in the iterative design and growth of communities that meet their needs. Including the most unique and diverse needs—the "edges"—in the co-design process is an effective strategy to ensure our design stretches and responds to a broader range of needs. If we reach the edge, the design will also work better for the centre and will be more flexible and generous' [11]. Co-design can be imported to music technology, to make it more flexible, robust and inclusive. This is basis from which this project commences.

1.2 Motivation

The broad aim of this work is to reach and influence those who are designing and making music technology systems which have the potential to be adaptable to disabled musicians and artists. Much of the technological work in this area could be adapted but makers lack the sector knowledge and skills to make it truly accessible. Through this research, technologists will hear directly from disabled people how their work could be made more accessible. This may be the first opportunity they have had to work with disabled people and to understand design from this perspective. This project also aims to provide information and support to those making music technology systems to encourage them to incorporate disabled access into their work.

The project had a number of desired outcomes:

- To provide access and opportunities for home-based disabled musicians to collaborate and perform live online. There is very little research around housebound people being active musical contributors, with the view often being that housebound people are mainly interested in care and social support rather than in negotiating an artistic practice.

- Reframe disability access from physical access to venues, to contributing from home. This project seeks to move beyond bringing disabled musicians into spaces, and begin to think about how networked technology creates an opportunity for disabled and housebound musicians to create a space for themselves.

- To ensure that work is disabled led and embedded in disabled theory, flipping notions of non-disabled technologists enabling disabled people. It was vital that this project was disabled-led. The first author leading the project helped to undermine notions about non-disabled technologists providing opportunities for disabled people.

- To influence cutting-edge technology with disabled theory. This is important in a field where much of the funding and profile for disabled music work is not disabled-led or grounded in disability theory. This ensures that the structure of the project is not structurally conservative with disability added on as an afterthought.

The 'h0mefile ensemble' project was set up to design flexible music technology performance tools which could be suitable to a range of disabled-musicians with diverse access needs. The project followed the co-design process for developing software tools in collaboration with participants in order to fully describe and meet the needs of a particular group of musicians. In order to reflect the principles of Universal Design, and ensuring that the users had as much influence on the process as possible, disabled musicians were interviewed to find out their requirements and a design process was implemented according to our findings. Part of co-design and universal design principles is the necessity to change course and explore new softwares where an initial route is found to not meet the needs of the participants. This relates to the network society model which prioritises the needs of the group over the needs of leadership or capital. Persevering with any technology that excludes a group member would prioritise the leadership or software developer over the needs of the group.

2. METHODOLOGY

The initial plan for the project had three stages;

1. Establishing the needs of home based disabled musicians through interviews;

2. Using co-design principles to develop one or more pieces of software that could be used by the group to perform together

   (a) The development of a live coding platform which is accessible to home based disabled people **and/or**

   (b) The development of a system to allow live networked performances based on audio streaming.

3. The development of a community of home based disabled musicians who want to perform together.

2.0.1 Stage 1

15 home-based disabled musicians worldwide were contacted using social media and invited to be part of the project. Online interviews with these musicians were undertaken to explore: their approach to making music; their requirements from music making applications (How should it be laid out? What platform works best? What controller adaptations may be useful? etc.); their requirements for learning and workshopping ideas (How long can they concentrate for? How long can they control the software for? How best to communicate during workshops? etc.); and their requirements for performance (Can they do real time? Would they need to pre-record aspects of the work? How long can they perform for? etc.).

The interviewees were disabled musicians, and also included two non-disabled academics who work in the fields of adaptive music technology and live coding [3]. The group of disabled musicians included a range of backgrounds and experiences, from acoustic performers with limited experience of music technology to those who have performed as

[2]We can think of colonialism as an attempt by a dominant group to impose their cultural practices on 'the other' group.

[3]One of these academics has lived experience of being disabled, but they do not currently identify as disabled.

live coders. The interviewees represented a range of impairments, racial identities, genders and sexualities. This intention was to avoid foregrounding a white male perspective, however, as the pool of disabled musicians who are interested in networked performances is a small group of people, the interviewees (although reasonably mixed) were not as demographically diverse as had been hoped. Two interviewees identified as Black British, two as British Asian and the rest as White. Nine interviewees were male and six female. Disabled identities included limb difference, mobility issues, hypermobility, stroke recovery, d/Deaf, M.E., Diabetes, Schizophrenia, Autism, and ADHD.

2.0.2 Stage 2

This data was then taken to the Networked Imagination Lab in Hamilton, Canada during a residency by the first author to develop the project. The aim of the residency was to adapt their platform Estuary [15] to make it accessible to the home-based disabled musicians.

Estuary is 'a browser-based collaborative projectional editing environment built on top of the popular TidalCycles language for the live coding of musical pattern' . It was a target software for this project as it facilitates networked collaborative performance, supports multiple languages in a session and has a flexible interface which can be presented in multiple ways. These aspects fit the criteria for networked and flexible music software tools that could be adapted to be suitable for home-based disabled musicians.

The plan was to create a functioning prototype, and then to connect virtually with the musicians to support them in using and learning the technology. Following their feedback there would be series of workshops, feedback and adaptations the platform which works for the group.

Due to issues in the initial design discussions (which will be discussed further below) we then moved on to stage 2. (b) which was to develop a system to enable the musicians to connect using audio streaming.

2.0.3 Stage 3

The group would be supported in exploring modes of performing with each other using live coding and free improvisation techniques. Once the group had had some rehearsal time, performance opportunities would be explored.

2.1 Why Live Coding and Audio Streaming?

This project began by focussing on live coding as a way of exploring disabled networked performance, building on a recent strand of live coding research that considers diversity from various angles [21, 14, 1, 7]. Coding is design and by engaging with live coding, there was an opportunity to design things from scratch to suit ourselves. This focus on design, coding and re-coding allows multiple levels of engagement with the Universal Design movement, and can support disabled people in making their own technology. Live coding softwares — which are almost universally open source — also give disabled musicians access to the tools to adapt it as they see fit. This shift in power from the 'made for' to the 'made by' that is facilitated by live coding softwares means that engaging with this practice could allow disabled coders to be at the forefront of countering (potentially unintentional) ableist music making.

There are also a number of key connections between the live coding research and disability studies. A focus on open source software responds to a major concern for disabled artists: the costs of software purchase, maintenance and deployment to diverse computing platforms can be prohibitive. Live coding doesn't require specific hardware such as MIDI control surfaces, whose buttons, faders and pots can cause difficulty for disabled people with motor control issues or upper limb difference. Conversely, live coding's use of diverse programming interfaces connects readily with additional custom hardware, such as eyegaze and headmouse controllers, that might be required by some people. Some live coding systems (e.g. Gibber [18]) incorporate lightweight networked options using a shared interface. Coders generate code in online interfaces, which is rendered to sound locally at each participating computer. When networked systems transmit code rather than audio, bandwidth requirements are reduced, making them useful to home-based Disabled artists, and cutting down on latency in the system. Finally, the work of the Live Coding community in breaking down expectations about performance and audience (for example watching someone code is a relatively new progression) can create an opportunity to rethink how performance can be made more Disabled.

Networks and online presence continue to be a powerful and revolutionary tool for the Disabled community [17]. Disabled people with limited time, energy, mobility or income are able to meet, support each other and undertake activism online [3]. Important concerns remain around surveillance, facial recognition technology, racist algorithms, and oppressive regimes [13, 9] and disabled people are still subject to these oppressive technologies, alongside trolling, hate speech and negative representations in social and traditional media. However Networked activity removes many physical barriers and offers a means of collaborating, specifically useful to home-based disabled people.

3. FINDINGS

The findings from the interviews are described in full in [20] and summarised as follows.

A wide range of preferences, requirements and adaptations were expressed, broadly falling into four categories: physical adaptations; communication preferences; fatigue requirements; and social interaction. Physical adaptations and communication preferences are often foregrounded in disabled access projects, however fatigue requirements in terms of structuring activities, and social interaction are less commonly considered. This demonstrated a need to consider the whole performance ecosystem when engaging in Universal Design and co-design processes. Beyond making small superficial tweaks to software interfaces, ensemble structures and working practices would also need consideration. A consideration of the project became how particular softwares may inform working and creative practices beyond facilitating particular forms of music making.

These responses lead to two specific channels of development: changes that could be made to live coding and audio streaming software, which would support disabled people in becoming part of these communities; and changes to working practices in the music technology sector that could accommodate disabled people in ensembles and performances.

3.1 Software Design Messages

- Flexible layout, design and display, allows people to create a workspace which works for them.
- Software should deliver musical results quickly, but also allow for ongoing progression and development of skills and complexity.
- Well documented, plain language, accessible help files to aid learning.
- Video tutorials should include captioning and scanning option.

- Software should be accessible on both computer and tablet, with the option of using assistive hardware such as eyegaze or Headmouse.
- Disabled access should be fundamentally a part of the main software to reduce issues around updates and versioning.
- Disabled people should be involved in the design and making of their own technology rather than acting as focus groups for non-disabled makers.

3.2 Changes in Working Practices

- Learning and development in the disabled musician community around live coding and audio streaming, and approaches to making music in this way.
- Enabling performers to dip in and out of obligations depending on their circumstances, without this being seen negatively by others.
- Live performances that are flexible and relaxed, with appropriate rest spaces and nutrition available.

4. IMPLEMENTING FINDINGS

As the project moved to the software development phase we explored how these findings could be implemented, both in the Estuary live coding interface, and through adapting audio streaming softwares for our project. The developments and results of these explorations are outlined below.

4.1 Estuary

4.1.1 Technical Issues

At the time of the residency the tutorials in Estuary were not functioning and there were no help files. This meant that even for a non-disabled person it was challenging to engage with the programme and begin making music.

Estuary has additional layers of complexity beyond a standard live coding interface that have been built by various coders. Although this complexity facilitates desirable features to this project such as networked collaboration, editable visual aspects and multilingual performance, it's complexity meant it was not easy to adapt the features for our project. For example, creating a display which was customisable would require going through many pages of code and rebuilding each one.

4.1.2 Conceptual and Political Issues

The technical issues around adapting the display led to a discussion around how accessibility should and could be built into Estuary. The needs of the disabled users that were interviewed were not fully prioritised, and there was concern around how much these needs would cost in terms of time and financially. There was a request that a just few adaptations were chosen that could be easily incorporated or compromised on.

Rather than having a fully customizable display, it was suggested a few presets could be made that took into account the specific needs of our participants. However this did not meet the design requests of the participants which were explored in the interview process. Disabled people are aware that each user will have different needs, and must have control over their display and design. Making a small number of bespoke display presets, would still exclude those who are not currently a part of our project, and would not constitute Universal Design. This does not make the software accessible, merely postpones accessibility issues for another cohort to encounter.

Another suggestion was to make an easy version of Estuary which would work for the duration of this project but wouldn't necessarily be adopted into the main programme, and crucially, would not be updated over time. This was also in direct contradiction to our findings, which told us that disabled access should be at the heart of the main programme and should be easily updated as part of the main programme. Creating a silo which later becomes unusable, is contrary to the aim of the project, as significant learning time would have to be committed to a software which would potentially become obsolete.

The suggestion to tackle a few easy adaptations implied that we can 'half do' disabled access, as long as it is convenient to the programmer. These programmer-led concerns were at odds with the approach of the project, which was to use co-design principles to be disabled-led, inclusive, universal, and to draw on the vast expertise of the disabled community.

Overriding specific issues with the Estuary platform, a fundamental issue was that the disabled musicians were not particularly interested in live coding. This was for a number of reasons, including that they had worked hard to develop their music technology set up and were happy using it. They didn't want to have to learn a whole new skill to take part in the project, and live coding requires typing which some participants found difficult or painful. Others didn't see the musical value in coding, or found the interface too confusing to work with. This was a key driver to shift the focus of the project to audio streaming platforms, which would allow the participants to use their existing hardware/software setups to collaborate from home.

4.2 Audio Streaming

In response to the participants and the lack of viability of continuing to work with Estuary, audio streaming softwares were considered in collaboration with Colin Clark of the Inclusive Design Research Centre.

4.2.1 Icecast

The Icecast audio streaming software[4] is used by network ensembles such as Great International Audio Streaming Orchestra and Orchestra For Females and Laptops [12] who share common philosophical goals with this project such as non-hierarchical performance and ensemble organisation. However the set up used in these ensembles is quite technical and not easily adaptable for our participants.

A typical Icecast setup requires one performer to act as a host managing and mixing the remote participants audio streams using additional software including Icestream, mplayer, SuperCollider, BUTT, etc. Each performer uses the BUTT broadcasting software[5] to configure and send their audio stream to a server accessible from the host computer. Although this is relatively simple, it is not without frustration or error, and can be stressful or confusing to those for whom live streaming and improvisation is a new practice. The setup also requires each player to use a routing software such as Jack or Soundflower to route their audio into BUTT adding an additional layer of complexity.

As Icecast was designed for online radio broadcast it is optimised for stability and has considerable latency (ca. 3-10 seconds) as a result. For live performance, performers need to compensate stylistically, by e.g. avoiding any attempt at temporal synchronisation with other performers.

For these reasons Icecast was not suitable for this project.

4.2.2 LiveLab

[4]https://www.icecast.org/
[5]https://danielnoethen.de/butt/

Olivia Jack's LiveLab[6] is an open source browser-based interface for sharing video, audio and data streams.

In Livelab users create a 'room' in a browser window which all performers can then join. Each performer can then create audio, video and data streams using the GUI. A peer-to-peer mesh network is used meaning no one performer needs to act as a host or manage the audio streams. This is philosophically closer to the non-hierarchical networked society structure than Icecast or other server-client models of audio streaming.

This means that there is considerable reduction in complexity for the performer who is 'hosting' the concert (i.e. the performer who would be present at a performance venue), to the extent that a performance is likely manageable by a venue technician without the physical presence of an ensemble member. This meets the needs of the participants who are largely home-based musicians and for whom attending performances in person may require significant time or financial commitment.

Livelab does require users to download and use routing software (such as Jack, Soundflower, etc) but the routing software is easily selected directly in the browser window, reducing some complexity for the users.

Our users are not the target audience for live streaming software, and do not have the high spec computers of many of those working in this field. Initial testing with LiveLab suggested that the CPU requirements could be too high for computers with outdated hardware and/or low processing power. An option that may facilitate participation for these users is that LiveLab also has the possibility of sharing data via OSC which could then be mapped to sound producing processes on another computer. This option is yet to be explored by the ensemble.

Through exploring Livelab with Colin Clark and a subset of the participants of the project it was felt that there was still some work that could be done to further simplify the LiveLab interface and workflow for our users. For this reason it was decided to fork LiveLab in order to make a version which is more accessible. Work is ongoing in this direction.

5. DISCUSSION

At the heart of this project were some key issues which recur within disabled access discussions.

In capitalist structures building something to be financially viable generally entails choosing a set 'norm' to design for in order to streamline costs and to be able to mass produce commodities. Once we have established the 'norm' for which we design, any deviation from that becomes expensive and time consuming. This reflects the 'problem' back onto disabled people who are seeking an 'adjustment' in order to access the commodity. This mode of thinking, which is so prevalent in society, foregrounds cost (time or financial), even in non-commercial and academic projects where commercially sellable products may not be the aim, but the pressures of funding councils and research results often do not leave room for flexible, dynamic or slower paced thinking and development. Unfortunately, this often implies that disabled people are costing us extra by their existence, and imposes a rigidity that only facilitates minor alterations to our existing structures and processes.

When disabled people are instead considered in the context of non-hierarchical networked organisation, we can begin to imagine flexible systems made by and for those involved. From a software perspective this adds additional layers of complexity into design work and runs counter to the capitalist narrative that we streamline production for maximum efficiency, but in the long run would create better and more universal design.

A cultural level tendency to see disabled people as an 'exception', adds to seeing accessibility from the perspective of seeking 'easy win' solutions that can be implemented efficiently in the short term but may not be fit for purpose in the long term, or for a wider range of people. Often the inconvenience of changing the system (or in our case the software) is considered to out-weigh the inconvenience to a disabled person who is excluded by the system. This is clearly a hierarchical approach that puts power into the hands of those who have the time, resources and 'esteem' to implement changes but may not be motivated to learn from those with lesser societal privilege. On the contrary disability theory views inaccessible design as flawed design, and changing ways of thinking and working as the solution. We should question who's inconvenience is considered more important, and why that might be.

Most fundamentally any resistance to listening to disabled people and acknowledging their wisdom and experience as valid will ultimately prevent accessible design taking place. Lived experience of disability generates an expert knowledge of accessibility, and any attempt to engage with accessibility should seek to draw on this knowledge.

For accessible music making the musical potential of software is not always the crucial issue. Philosophical direction, ensemble structures and ensemble working practices facilitated by or outside of the software can be just as important, as can the collaborative relationship and openness to flexibility and major structural software changes from the programming team.

6. RECOMMENDATIONS

The following recommendations are made for music technology designers to engage with universal and co-design principles for accessible software design:

- Disabled access is not about fitting disabled people into a non-disabled world.
- Ask your disabled colleagues, users, consumers and students about their experience, knowledge and preferred ways of working, and listen. Listen to the needs and concerns of disabled musicians around the making of music, hardware and software platforms. Do not assume that you can bring anything to the table without lived experience of disability.
- This knowledge is valuable and in most cases should be paid for. If your working model includes paying non-disabled colleagues but not disabled ones, revise that model.
- Study disabled theory, to understand how much ableism you may be unconsciously carrying and work to change your approach to disabled issues.
- Half accessibility is no accessibility. Accessibility should be built into the core of music technology software from the very beginning to ensure flexibility and the ability to change things later on if needed.
- Training and supporting disabled people to do the development themselves, may be the best thing you could do for disabled access. Provide opportunities for disabled musicians to learn software development.

[6]https://ojack.github.io/articles/live-lab/index.html

7. CONCLUSIONS

In this project co-design principles were followed to assess needs of home-based disabled musicians and evaluate the suitability of softwares including networked live coding interface Estuary and browser-based audio streaming platform LiveLab. In the process of the research the importance of working practices, workflows and flexibility became apparent in order to prioritise the collective needs of participants. Programmer-led interface design was found to not adequately address the requirements of disabled musicians, whose needs often exist outside the bounds of the capitalist, commodity based society. The project responded to this by reshaping the group structure and taking a flexible approach to time and software development. This put the power back into the hands of the disabled musicians, with whom any resultant interface should be designed, taking full account of their knowledge and expertise.

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9. ETHICAL STANDARDS

This research was granted Ethical Agreement by the University of Plymouth Arts and Humanities Research Ethics Committee, and all data is held in compliance with GDPR, the UK's Data Protection Act (2018).

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APPENDIX

A. DEFINITION OF TERMS

The terms Disabled and Non-Disabled are used in line with the social model of Disability [16], which describes how disabled people are not disabled by their bodies, but by a society which creates environments in which they cannot function. This is the process of society and structures, actively disabling people. For example, a person using a wheelchair is disabled by the decision not to include lifts and ramps to a building. The design of the environment disables them. A person with a fatigue condition is disabled from taking part in a project because of long days scheduled or distance travelled. The design of the project has disabled the person. A non-disabled person is one for whom the structure and design of society broadly works.

The term d/Deaf refers to two differing communities and political positions. Small d refers to those who have partial hearing, or use a spoken language as their first language, and capital D deaf refers to those who use sign language and consider themselves 'culturally deaf' that is, to live in a more visually orientated culture, outside of spoken language [23]

The term Disabled Musicians is used to describe disabled people who have a professional or semi-professional music practice, as distinct to using music as a therapeutic or community building practice with disabled people.