Reconsidering process: bringing thoughtfulness to the design of digital musical instruments for disabled users

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Abstract

Digital musical instruments (DMIs) are subject to drastically fewer design constraints than their acoustic predecessors, and the possibility of minimizing physical interaction has inspired numerous interfaces intended for disabled users. However, the potential of DMIs remains only partially fulfilled. Informed by personal experience as a DMI designer and performer with a disability, concepts of affordances and repurposed technologies are used to make a case for the adaptability of users and durability of established instruments. Examples of unconventional performer-instrument fit are identified and a modified design process is proposed. This contemplates the suitability of established instruments before initiating new designs. Finally, the implications of this change are considered.

Keywords: digital musical instruments, instrument design, needfinding, assistive technology.

1 Introduction

Many of the acoustic instruments present today have been subject to hundreds or thousands of years of refinements (Paradiso 1998). If, over this extended period, they appear to have reached highly optimized states, it is significant that many were developed for reasons of acoustical power rather than their fit for the body of the performer. Therein lies the inherent trade off of acoustic instrument design; the performance interface must physically act on the sound generation mechanism. Thus, to ensure their compatibility, these two aspects must be considered simultaneously and some combinations may be mutually exclusive. DMIs, by contrast, can use almost any performance interface and produce any sound imaginable. Moreover, it is possible for a designer to select these elements independently, and then join them in software *ex post facto*. This shift to a virtual connection produces a loss of haptic feedback, but, at the same time, dissolves many traditional design constraints (Marshall 2008). The NIME community has enthusiastically embraced these freedoms. For instance, easy-to-use hardware such as the Arduino, novel sensor technologies, and intuitive software such as MaxMSP have increased the accessibility of DMI-building, particularly for composers and musicians. Concurrently, these technologies have also reduced barriers to performance. This has been particularly relevant to those previously excluded because they lack the physical dexterity required by most conventional instruments. By contrast, the sensor-based interfaces of DMIs can co-opt almost any physical stimuli as input, from a blinking eye to brainwaves.

However, for all their possibilities, the potential of DMIs remains largely unfulfilled. For Jordà (2005) this relates to a tendency to focus on isolated parts of the problem to the detriment of the whole. Elsewhere, Magnusson and Hurtado (2007) found users of digital musical systems to be concerned about the limitations of software environments and the need for constant upgrades. For the pessimistic, this propensity for endless upgrades may imply that novelty is seen as a justification in and of itself. Thus, this paper tries to take a balanced view of DMIs; particularly those intended for disabled users, to consider them objectively, and as part of the same space as their predecessors.

2 Personal Background

The themes of this paper are in many respects highly personal. Born with a rare orthopedic condition, the initial prognosis was that I would not be able to walk at all (or even sit up). Thankfully, after extensive treatment, I took my first steps aged 4 and by age 5 wanted to play a musical instrument. This was complicated by also missing my left arm below the elbow, except for a small "thumb" near the front of the joint. The trumpet was deemed suitable on the basis that it could be played using only the right hand. It was also relatively inexpensive and thus would not matter if it were quickly abandoned. If the first few years of practice, instrumental grades and concerts were enjoyable, by age 13, hours spent listening to the John Peel show on late night radio fuelled a desire to play the guitar. The ostensible mismatch between bodily and instrumental affordance prompted skepticism. However, my body proved unexpectedly adaptable to the instrument. Just as importantly, I had exceedingly little desire to mimic the instrument's most jaded tropes and soon developed an interest in extended techniques (an interest that ultimately led to exploration of digital systems). Even now, after a decade creating DMIs for others and myself, these experiences remain formative.

3 Towards Performer-Instrument Fit

The notion of performer-instrument fit developed here is built from two concepts: affordances (specifically the intersection of bodily and instrument affordances), and repurposed technologies.

While the notion of unexpected (and perhaps largely incidental) fit between established instrument and unconventional physical affordance is of personal significance, it is also more widely relevant and applicable. Of specific interest are so-called unconventional users; in other words, users who would typically be considered unable to reasonably access or exploit the possibilities afforded by conventional instrument designs. This notion of affordance is particularly pertinent. As developed by J. J. Gibson (1979) affordances concerned the action possibilities brought about by the natural relationships between living things and their environment. In a design context, affordances initially referred to the actions made possible by an object's physical form and properties (Norman 1999). In this respect, many traditional musical instruments can be thought of as complex objects that, if highly specialised, offer rich and diverse action possibilities. However, the intangible properties of software quickly limited the tenability of an object-based model. Thus, the concept was revised to emphasize a distinction between "real" affordances (i.e. actions that are *actually* possible) and "perceived" affordances (i.e. actions users *perceive* to be possible) (Norman 1999).

If, in their separation actors from environments and objects (respectively), the notions of affordance proposed by Gibson (1979) and Norman (1999) appear to discount the action possibilities of the human body, bodily affordances have been discussed elsewhere. For instance, Shapiro (2014 p. 289) considers the representation of body parts in terms of their movement possibilities. Thus, while rooted in the notion of affordances developed by Norman (1999), this paper considers instrumental and bodily affordances simultaneously. This departure is necessary. For instance, if several authors have considered the affordances of musical instruments, it must be remembered that in most cases, these instruments were designed around conventional bodily affordances pertaining to stance, motor skills, and breath control (etc.). Thus, in cases of serendipitous fit between specific unconventional bodily affordance and conventional instrument, the resultant affordance combination may be different to those that arise from more conventional (i.e. the intended) performer-instrument relationships. Indeed, these differences can result in distinctive musical features.

An obvious distinction can be made between changed bodily affordances (i.e. those that occur after already learning to play an instrument) and unconventional bodily affordances that are present prior to learning to play an instrument. The common assumption is that those who learn to play an instrument before acquiring a disability may be more driven to persist. Notable cases in the first category include pianist Paul Wittgenstein (Howe 2010), jazz guitarist Django Reindhardt (Dregni 2004), and the deaf percussionist Evelyn Glennie. The case of guitarist Tony Iommi is more complex in that, after an industrial accident, rather than relearn the guitar right-handed, he chose to iteratively modify the affordances of both body and instrument (Iommi 2011, pp. 35–43). There are also cases where unconventional bodily affordances are present before learning an instrument. Examples include the visually impaired Moondog, Stevie Wonder and Jeff Healey, one-handed pianist Nicholas McCarthy, and the asthmatic saxophonist Kenneth Gorelick. However, Bogart (2014) warns that there is likely substantial variation in adaptability between individuals, and thus the above distinction between disabilities occurring before and after instrument learning may be too simplistic.

If the above represent cases of apparently serendipitous matches between specific unconventional bodily affordances and conventional instrument designs, the repurposing of existing technologies for new users has been explored elsewhere. Perhaps the most notable example of a repurposed technological in a musical context is the turntable. Originally intended as a sound playback technology, it was subsequently repurposed for performative use by John Cage in the 1930s and the hip-hop turnablists of the 1970s. Particularly in the hands of the latter (and their descendants), the turntable was recast an expressive quasi-instrument (Mudede 2003). Earlier still, the humble washboard experienced an even more radical transformation. Released from its domestic duties as washing apparatus, it provided the rhythmic basis for the Skiffle revival of the 1950s.

4 A Modified Design Process

The cases mentioned above are diverse and no claim is made as to their completeness. Instead, the suggestion is that they at least provide reason to pause or *food for thought*. However, typical DMI methodologies (e.g. Whalley 2010) tend to consider only input, the creation of software elements, the mapping of performer input to output, and user testing. While others have also included assessment of user needs (Farrimond *et al.* 2011), there has been notably little attempt to reflect on the suitability of existing designs, and thus new instruments are produced by default. Thus, this paper proposes that needfinding be followed by systematic evaluation of established instruments to assess if they fit the physical, conceptual, and musical requirements (etc.) of the intended user (Fig. 1). Indeed, if needfinding is to include the identification of untapped opportunities (Patnaik and Becker 1999), it is implicitly necessary to also identify relevant existing solutions.

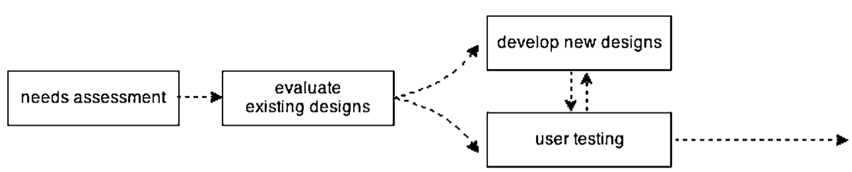

Fig. 1. The modified design process.

The potential benefits of considering DMIs as part of the same design space as their predecessors (and creating new instruments only when established designs can reasonably be ruled out) are numerous. For instance, qualities such as the potential for deep engagement have so far proved elusive in DMIs. Also, if the clamor for uncritical novelty can be tamed, users are less likely to be naively provided with designs that, relatively untested, may be inferior to more tried and tested predecessors. There may also be benefits for DMI identify. For instance, if applications already well served by established instruments can be identified, DMIs, no longer required to cover the duties of their predecessors, would be freed to explore different (and perhaps more distinct) directions.

5 Conclusions and Future Work

The notion of producing fewer, more carefully considered new instruments is not intended to discourage designers, but rather, instill a more balanced mode of production that is simultaneously mindful of the past, and critical and analytical in relation to new developments. Perhaps the most significant advantages relate to testing and evaluation. For example, if DMIs remain poorly understood (at least compared to their predecessors) and thus it is desirable to learn more about their prospects and limitations, a smaller number of designs is much more concertedly tested; especially if a pool of designs were to be openly shared to encourage their reproduction. Moreover, if truly innovative paradigms remain scarce, particularly in DMIs intended for disabled users, there are at least some moves towards more domain-specific DMI models. For instance, some of the most distinctive recent work involves the transparent "show your screens" paradigm developed by the Toplap group. Indeed, their comment that live coding "will develop its own nuances and customs" (Toplap, 2010) is not dissimilar to the ethos of this paper. If this development will take time, a more immediate focus is the creation of a more formal framework for considering the intersection of bodily and instrumental affordances, and, diagrammatically, matching the two together.

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