A Dimension Space for Evaluating Collaborative Musical Performance Systems

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ABSTRACT

The configurability and networking abilities of digital musical instruments increases the possibilities for collaboration in musical performances. Computer music ensembles such as laptop orchestras are becoming increasingly common and provide laboratories for the exploration of these possibilities. However, much of the literature regarding the creation of DMIs has been focused on individual expressivity, and their potential for collaborative performance has been under-utilized. This paper makes the case for the benefits of an approach to digital musical instrument design that begins with their collaborative potential, examines several frameworks and sets of principles for the creation of digital musical instruments, and proposes a dimension space representation of collaborative approaches which can be used to evaluate and guide future DMI creation. Several examples of DMIs and compositions are then evaluated and discussed in the context of this dimension space.

Keywords

dimension space, collaborative, digital musical instrument, dmi, digital music ensemble, dme

1. INTRODUCTION

Much research has been conducted into the creation of digital musical instruments, defined by Miranda and Wanderley as consisting of an input device and a sound generation device related to each other with mapping strategies [13]. The design goals for a DMI generally revolve around the enabling of personal expressivity [15] [18]. Designs which focuses on collaborative potential present a different approach to DMIs, one which is orthogonal to personal expressivity and can contribute substantially to an instrument's musical potential.

A *digital music ensemble* (DME) can be described as an ensemble whose members all perform with DMIs. This instrumentation allows for the utilization of the capabilities of DMIs to be reconfigured and networked. In Miranda and Wanderley's description above, both mapping and sound synthesis are software configurable. The use of a laptop computer as the primary input device, typically in laptop orchestras, emphasizes that custom hardware is by no means necessary for the creation of new DMIs [19]. These two qualities of networkability and reconfigurability allow DMEs to perform research into approaches to collaborative performance.

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1.1 Collaboration

Mirriam-Webster defines collaborate as "to work jointly with others or together especially in an intellectual endeavor" [14]. Anytime musicians perform together they are said to be collaborating; in a musical context we could say that a meaningful performance is the endeavor. In every collaborative performance there is some kind of structure to the roles of the musicians, whether implicit or explicit. It is very common for ensembles to be divided in terms of frequency range, as in a string quartet. Ensemble performers are often given specific roles such as accompanist and soloist, specific rhythmic patterns in African and Latin-American ensembles, and are often grouped into sections of similar instruments.

These divisions of ensemble are more than incidental, and in fact can be seen as having played an important part in the development of the instruments involved. When designing instruments for a digital music ensemble, the consideration of musical role and sonic space for instruments is highly important. Dan Trueman notes that in a DME it is preferable for instruments "to be designed from the outset knowing that they will be played simultaneously with many other instruments" [19]. Instruments designed to be played by themselves will tend to dominate in terms of frequency spectrum and musical activity, and will ignore the potential of sharing control of important parameters or privileging physical interaction with other musicians such that the experience of playing the instrument is substantially diminished without the participation of others. Without allowing for these possibilities, the collaborative potential of DMIs is diminished. It should be noted that

It should be noted that many DMIs have been used in ensemble performance without being networked or reconfigured, and have utilized traditional approaches to collaboration [9][3]. The approach advocated in this paper are entirely in addition to pre-existing approaches to collaborative music-making.

2. INSTRUMENT AS COMPOSITION

It is frequently the case within a DME that musicians will use different software instruments or patches in order to perform different compositions. This is a striking difference from non-electronic instruments, and allows for the sculpting of musical roles within an ensemble by the composer as well as the instrument designer. In The Hub, "the content of the work is being invented by the composers/performers"

[10]; one of the Princeton Laptop Orchestra's goals is to "develop a performance practice where instrument building itself plays a central role" [19]. Tanaka stresses the need for idiomatic composition for DMIs [18]; this applies equally to composing for collaborative instruments.

However, the concept of instrument as composition comes into conflict with one of the central goals of DMI design: enabling expert performance. Dobrian et al. point out that "[e]xperimental performances by inexperienced musicians or by performers who have incompletely mastered a new interface . . . when done on the concert stage are subject to rigorous musical and aesthetic critique" [8], with the implication that this critique will not be positive. One solution to this is to encourage performers to spend the time on a particular instrument in order to gain this mastery. In The Digital Orchestra Project at McGill University, which had the goal of developing "DMIs with musical potential comparable to that of existing acoustic musical instruments", one performer was given "approximately a year to develop expertise on the instrument before performing in concert" [9]. Approaches such as Trueman's *BoSSa* [20] embody Perry Cook's principle "leveraging expert technique is smart" [6].

The central issue of performative attention, or the cognitive bandwidth of the performer, comes into play here. A solo performer has multiple needs competing for their attention. An inexpert performer will often need to place focusing on their instrument over issues of musicality. In an ensemble situation they need to be responsive to the musical contributions of the other performers, and aware of their role in the overall texture. One consequence is that in an ensemble setting performers will have even less ability to perform expertly on a new instrument. A positive view is that while instruments designed for collaboration may be technically simpler, and potentially less personally expressive, they may encourage a quality of interaction between performers which highlights the creation and expression of relationships; which may help in the creation of a meaningful performance [17].

3. DIGITAL MUSICAL INSTRUMENT CLASSIFICATIONS

Many different design guidelines and approaches to classifying DMIs have been presented. For the most part these focus on the interaction between performer and instrument. A few, such as Birnbaum et al.'s work on a dimension space for musical devices [1] and Bonger's "Interaction Theory" [4], relate to collaborative performance through analysis of musical installations. The conceptual framework based on the way performers process musical information proposed by Malloch et al. [12] is equally applicable to collaborative instruments. In Perry Cook's revisiting of his principles for designing computer music controllers, he adds the principle "More can be better! (but hard)" [7]. Paine's Taxonomy of Realtime Interfaces for Electronic Musical Performance takes an approach similar to that of Hornbostel and Sachs, and includes a category for collaborative instruments; however, only 1 out of 37 instruments surveyed fell into that category [16].

Weinberg's "Interconnected Musical Networks: Toward a Theoretical Framework" presents several important concepts regarding ensemble structure, balance of power, and collaborative organization [21]. Weinberg describes the difference between large- and small-scale local systems as the degree to which the individual contributions of the performers are discernible. While we can see how difficult it is to discern the contribution of a violinist in an orchestra versus a string trio, in a DME this distinction is fairly arbitrary and depends a great deal on the physical mode of performance. What Weinberg is describing is actually the structure of the ensemble, with homogeneity at one end and heterogeneity at the other. Heterogeneity can be achieved by numerous means: sequential performance of musicians; timbral and registral distinctiveness of individual instruments; independent rhythmic parts; contrasting performance gestures, etc. The way in which heterogeneity is achieved is less important than the fact itself.

The centralization of a network is also a crucially important distinction. Closely tied to this is the concept of equality. Weinberg is correct in describing these as representing social relationships — Scot Gresham-Lancaster of the Hub describes how the structural organization of the Hub grew directly out of the social and political roots of the Bay area [10]. Weinberg describes different combinations of equality and centralization in political terms — a centralized equal network as being a democracy, centralized unequal a monarchy, decentralized unequal as anarchy.

4. COLLABORATIVE DIMENSION SPACE

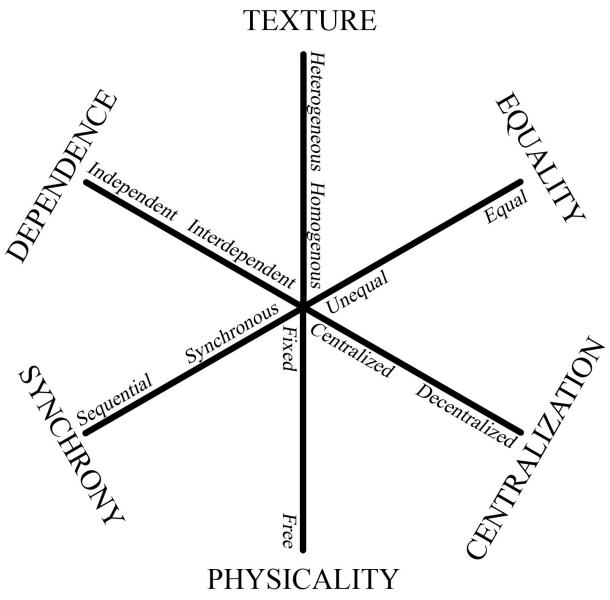

Figure 1: Collaborative Dimension Space

Similar to the dimension space proposed by Birnbaum et al. [1] here we propose a dimension space for evaluating a particular configuration of a Digital Music Ensemble. Many times this configuration will be specific to a composition or installation; however, it is possible for configurations to be re-used. Note that due to the configurability of DMIs a DME may move through different configurations for each composition. In order to determine a configuration's location in the dimension space shown in Figure 1, the following questions are asked:

4.1 Proposed Axes

4.1.1 Texture

Axis limits: Homogenous/ Heterogenous How discernable are individual parts? How individualized are performance styles and instruments? As discussed above, this axis is similar to Weinberg's large- and small-scale networks; it also relates to Blaine & Fels' Player Interaction.

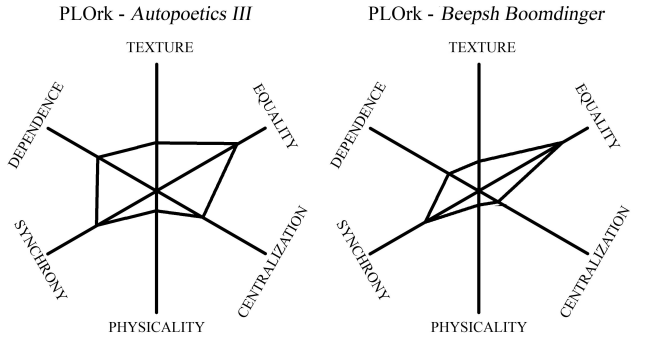

Figure 2: Princeton Laptop Orchestra

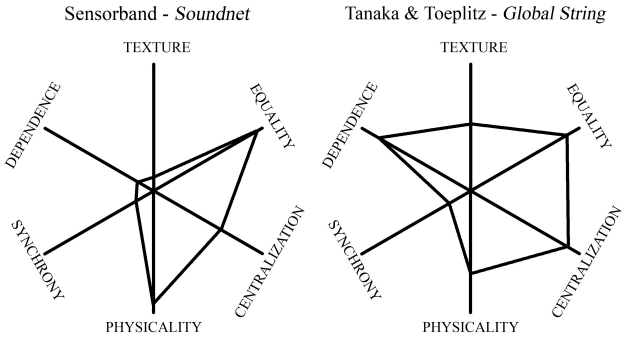

Figure 3: Atau Tanaka

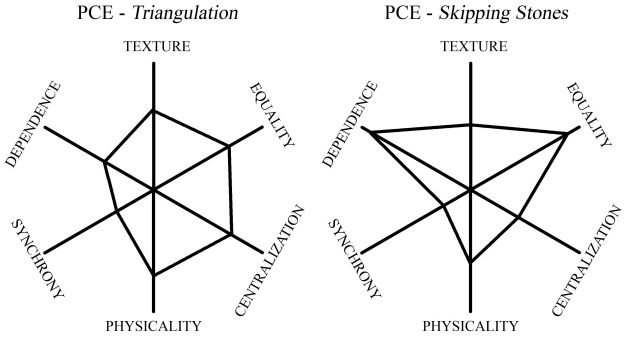

Figure 4: Physical Computing Ensemble

4.1.2 Equality

Axis limits: Equal/ Unequal Is there a conductor/leader? Do performers' actions take place on different levels - Malloch et al.'s Symbols/Signs/Signals? Do performers have access to the same data? Equality and Centralization are drawn directly from Weinberg.

4.1.3 Centralization

Axis limits: Centralized/ Decentralized Is information shared through a central server? How important are global parameters (tempo, form)? Do performers have access to the same collection of data? Is there a conductor, and if so, what role does she play?

4.1.4 Physicality

Axis limits: Fixed/ Free How important are visual connections and physical communication/entrainment between musicians? Are performers located in the same physical space? This axis relates to Birnbaum et al.'s Distribution in Space and Blaine & Fel's Location and Level of Physicality.

4.1.5 Synchrony

Axis limits: Synchronous/ Sequential Is collaboration real-time/signal based? Is information shared in real-time? Is interaction turn based? This axis is drawn from Weinberg's Synchronous and Sequential distinction and has some relation to Blaine & Fel's Directed Interaction.

4.1.6 Dependence

Axis limits: Independent/ Interdependent Is a performer able to create sound without input from other performers? Do performers share control of a musical event? Is an instrument fulfilling to play by itself? This axis has some relation to Blaine & Fel's Directed Interaction.

5. APPLICATIONS OF THE COLLABORATIVE DIMENSION SPACE

One of the uses of the Collaborative Dimension Space is to quickly illustrate similarities between different DME configurations. In Figure 2, an evaluation of two Princeton Laptop Orchestra compositions, the similarity of these compositions' approaches to collaborative performance is revealed [5]. Similarly, those axes which are not identical can be quantitatively evaluated as being subtly different. A tendency towards a consistent approach to collaborative performance is also seen in Figure 3, an evaluation of two works in which Atau Tanaka participated [21][1]. Evaluating a pre-existing configuration serves to clarify the assumptions made during the development of that configuration. Weinberg recognizes that the organization of a musical network may be informed by a "social philosophy" [21]; if that is the case, evaluation in the Collaborative Dimension Space can be a first step in understanding the assumptions within which the configuration was conceived.

Another use of the Collaborative Dimension Space is as a reference during the design of a collaborative performance system. In this sense, configurations which are seen to be under-explored during the evaluation of DME configurations can provide a guideline for future research. In addition, the Dimension Space can provide a focus for those who are interested in designing collaborative systems. Figure 4 demonstrates the evaluation of two Physical Computing Ensemble compositions [11]. The Physical Computing Ensemble is an ensemble created by the first author as a tool for research into collaborative performance. While the systems used in these compositions predate the Collaborative Dimension Space, they illustrate an approach to design experimentation which is consistent with its approach.

6. DISCUSSION AND FUTURE WORK

The axes proposed here are a first approach to a Collaborative Dimension Space. While many additional axes were considered, the goal here is to focus on the fewest number of axes which directly contribute to the character of a collaborative performance. Number of performers was considered as an axis, for example, but was rejected since its effects are reflected onto the other axes, particularly Texture and Centralization. We encourage suggestions for refinement of this dimension space, but also recognize that it is difficult to argue for a definitive categorization of such a complex topic.

One axis that needs particular refinement is Physicality. The use of networks, and in particular the increasing use of wireless networks and interfaces, provides the possibility for the flexibility of the physical location of performers, which can greatly affect the form which collaboration takes. This manifests itself in two ways: music performed by performers

who aren't in the same space, and performances in which the performers are located in the same space but whose relative physical locations are not fixed. Included on this axis are also issues of embodied performance, a complex topic whose effects pervade musical experience.

The positioning and orientation of the axes warrant additional research — in particular, thinking about what organization clearly presents the relevant information. While the tendency is to think about the axes representing more or less collaboration, or better and worse collaboration, in reality each axis merely represents a different quality of collaboration.

An additional consideration for future work is the need for more evaluations in order to give a clearer picture of the trends and assumptions made by composers and system designers. The evaluations included in this paper are our own work; their composers, designers, and performers may evaluate these systems differently.

7. CONCLUSION

The digital music ensemble provide a laboratory which enables research into the collaborative possibilities of digital musical instruments. DMIs present a unique potential for collaborative performance system design due to their configurability and potential for networking. Frequently, these abilities give rise to the idea of instrument design as composition. While this conflicts with the computer music community's call for stable DMIs which allow for the development of expert performance skill, it also allows for the development of collaborative instruments whose success is less dependent upon expert individual performance but instead rely more upon the relationships created within a performance.

This paper presents a Collaborative Dimension Space which can be used to evaluate and guide the creation of performance systems which are used in DME performance. Previous research has mostly focused on evaluation of DMIs performed individually; two exceptions to this are Weinberg's theoretical framework for networked performances [21] and Blaine & Fel's descriptive approach to evaluating collaborative music systems [2]. The dimension space presented here builds upon these previous work to present six axes which reflect varying qualities of collaboration. It can be used both to evaluate DME configurations in order to understand their underlying assumptions, and as a guide for those interested in exploring the collaborative possibilities within a digital music ensemble.

8. ACKNOWLEDGMENTS

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