MULTI-TOUCH INTERACTION PRINCIPLES FOR COLLABORATIVE REAL-TIME MUSIC ACTIVITIES: TOWARDS A PATTERN LANGUAGE

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ABSTRACT

In this paper we give an analysis of the literature on a set of problems that can arise when undertaking the interaction design of multi-touch applications for collaborative real-time music activities, which are designed for multi-touch technologies (e.g. smartphones, tablets, interactive tabletops, among others). Each problem is described, and a candidate design pattern (CDP) is suggested in the form of a short sentence and a diagram—an approach inspired by Christopher Alexander's *A Pattern Language*. These solutions relate to the fundamental collaborative principles of democratic relationships, identities and collective interplay. We believe that this approach might disseminate forms of best design practice for collaborative music applications, in order to produce real-time musical systems which are collaborative and expressive.

1. INTRODUCTION

A significant number of multi-touch applications for real-time music currently exist, thanks to three main factors: firstly, the current popularity of personal and shared multi-touch devices (e.g. smartphones, tablets, interactive tabletops, among others); secondly, the existence of facilities to develop creative applications on them; and lastly, consumer interest in these creative products. Some of these musical applications are designed for collaborative activities, although we generally find more support for collaboration in software designed for other fields—e.g. multi-player games or collaborative productivity tools—where a variety of appropriate interaction principles are used. We propose that a study of the most prominent of these principles could be used to provide better support for collaboration by improving the interaction design of real-time multi-touch music applications [1]. Thus, we present an analysis of a set of problems that can arise when undertaking the interaction design of such applications. For each problem we follow the same procedure: we briefly describe the problem and then propose a candidate design pattern (CDP) in the form of a short statement and

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[1]Given the popularity of these devices in recent years, this initial study focuses on multi-touch technologies disregarding interaction with physical objects because of the existence in the market of more samples of the former to look at.

a diagram: the text suggests how to deal with the problem and the diagram illustrates the suggested solution—an approach inspired by Christopher Alexander's *A Pattern Language* [1]. The aim of this paper is to present an analysis of a significant set of CDPs based on the literature. It is out of the scope of this paper to implement and/or evaluate these CDPs.

In the following section, we present an overview of interaction design patterns; we then introduce the methodology undertaken; next, we describe and discuss four relevant CDPs; and, finally, we outline future work towards a pattern language for musical interaction design.

2. RELATED WORK

2.1. Interaction design patterns

In the 70s the architect and mathematician Christopher Alexander proposed a method for designing structures [1], which has strongly influenced computer science practices—e.g. programming or interaction design—because, as with architecture, building complex structures with success requires an engineering perspective. The original method was described as a pattern language consisting of solutions to common design problems which were thought to be modular and interdependent. The 253 solutions proposed were based on empirical evidence of how the same design problem has been solved similarly in different cultures and environments.

In computer science, design patterns are used in object-oriented programming (OOP), with the aim of not reinventing the wheel when designing similar structures—within computer programs or interfaces. Beck and Cunningham [2] presented 5 design patterns for the interface design for object-oriented programs. Alexander's approach also inspired the authors of a classic book of design patterns in OOP [5], which describes 23 software design patterns. Recently—and with the advent of a wide variety of displays apart from the desktop monitor display—the need for multi-platform interaction design patterns has been presented by Tidwell [16].

2.2. Design patterns for interactive musical systems

The literature contains few specific design patterns for interactive musical systems. Tanaka [15] argues that it might be relevant to establish links between interaction patterns in music and technology design. Overholt [12] proposes some design considerations for musical interaction design that mainly deal with musical expressivity, based on a literature review and the author's personal experience with prototypes. Magnusson [11] argues, based on built prototypes, that a musical interface is the visible part of the musical instrument, with the intrinsic constraints and affordances that determine what are the instrument's interaction possibilities. In particular, in the context of collaborative music interfaces, Wang and Cook [17] describe a set of objectives related to collaboration when building these interfaces.

Patten et al. [13] offer some design principles for tangible and multi-touch technologies in the context of the Audiopad system. These principles are basically related to visual feedback and collaboration; and inherit from traditional window, icon, menu, pointing device (WIMP) interfaces. Also, in this category, Jordà [7] enumerates the interaction principles derived from the award-winning musical tabletop Reactable, which deal with collaborative and complex interaction, and which are intentionally unrelated to traditional graphical interfaces. Moreover, there exist several multi-touch frameworks that implement user interface components such as Argos [3]—a multi-touch open-source library for music performance and synthesis—which offers a collection of graphical user interface (GUI) components (e.g. knobs, sliders or buttons), even though it offers no specific tools to support collaboration [2].

3. METHOD

As we argued in Section 2, the current knowledge of design principles for interactive musical systems comes either from the experience of designing a set of interfaces for specific needs, or from the literature. However, no formal set of multi-touch interaction design patterns for collaborative real-time music activities has been established. We aim to identify the main problems that arise in the design of multi-touch systems that support collaborative real-time music activities and to suggest possible solutions. The aim would be to take a step towards more efficient design processes, and more expressive musical instruments of this kind. For that purpose, and inspired by Christopher Alexander's method, we identify a set of problems from the literature [3]. Each problem is described,

and a CDP solution is suggested in the form of a short sentence and a diagram. One issue with the term *pattern* is that traditionally patterns document ways of doing things that have already been used several times in applications; so the term *CDP* is used instead. However, both terms refer to entities which are not necessarily isolated from each other—and so they can be interconnected. In addition, both types of entities have a level of description that is sufficiently abstract to invite varied implementation possibilities.

4. CANDIDATE DESIGN PATTERNS

In this section we identify four main CDPs, which are: shared and personal spaces; learning and fun; map of actions; and, finally, divide and conquer.

4.1. CDP #1: Shared and personal spaces

Having available shared spaces facilitates participants' collaboration. Having available personal spaces offer participants independent control of their contributions.

With interactive tabletops, the concept of personal spaces using shared surfaces is used to improve productivity, security or identity; for example Schmidt et al. [14] present the concept of dynamic personal spaces that appear in response to certain actions performed by the user. In the context of co-located collaborative music with personal computers, Fencott and Bryan-Kinns [4] maintain that, when available, private spaces allow users to contribute pre-prepared ideas to the shared space. However, when only shared spaces are available, the authors report that users interact more, even though their contributions may be fewer. In the particular context of musical tabletops and multi-touch interfaces, Laney et al. [10] point out that whereas personal spaces tend to strengthen personal musical identity, shared spaces facilitate collaboration with others.

Therefore: **Provide two kinds of spaces: shared spaces, and personal spaces. Provide some public space for sharing ideas and modifying contributions; and some private space for developing ideas that can be incorporated into the public space. (see Figure 1).**
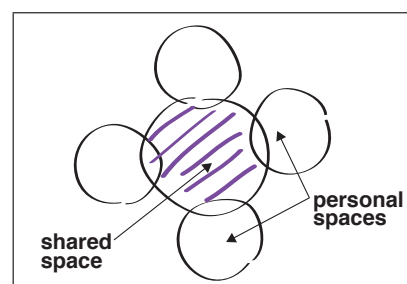

Figure 1. Diagram of shared and personal spaces.

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[2]Similarly, other multi-touch frameworks specifically developed for the iPad, iPhone and iPod-touch devices are MMF-Fantastick http://www.mathieuchamagne.com/mmf-fantastick/ or TouchOSC http://hexler.net/software/touchosc.

[3]The presentation of each CDP is inspired by Alexander's technique: after the title, the description of the problem and the potential solution are both illustrated in bold face type. Between these, the literature evidence is presented.

4.2. CDP #2: Learning and fun

Advanced users can get bored if a music application does not present sufficient cognitive challenge. Novices can be overwhelmed by cognitive challenges.

Koster [9] claims that there are similarities between gaming activities and musical activities, in that they both can be performed either alone or with others. According to the author, in games—as well as in music—players will enjoy (and learn from) the activity if it lives up to their expectations. These expectations are related to the skill levels of the users and the challenges of the game, so there will be fun as long as the skill levels are high enough to be challenging. Otherwise, the user might get bored. Furthermore, Overholt [12] also establishes analogies between interaction design for music and game design theory, in terms of offering enough complexity and unlimited states to keep the performers' interest. With musical tabletops, Jordà [7] suggests that complex interaction is required in order to keep the performer challenged (both experts and novices), but that this should not be an impediment for having fun.

Therefore: **Provide a core of paths to goals for novices, and offer experts the possibility of moving to more goals with at least a second ring of additional paths to more goals. Those paths should be interconnected with each other in order to allow users to create their own way. (see Figure 2).**
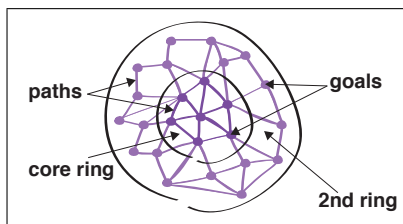

Figure 2. Diagram of rings of learning and fun.

4.3. CDP #3: Map of actions

When approaching the interaction design of multi-touch interfaces for collaborative real-time music activities, there is neither a standard set of hardware— e.g. camera systems, capacitive technologies—nor a single format—e.g. mobile, desktop, tabletops, broad surfaces.

Widgor et al. [18] argue that design patterns and user interaction methods for the emerging multi-touch devices and interfaces should be standardised, with the aim of improving design theories and solutions. The variety of hardware available leads to design according to the capabilities of the devices (e.g. Microsoft Surface tracks over 50 points whereas other devices may track only two points of contact), as well as to the possible formats (e.g. designing for tabletops offers different constraints and affordances than designing for tablets or smartphones).

Therefore: **Provide a system with a tailorable set of actions, and adapt each action according to each**

format depending on the number of points of contact available and/or the available size. (see Figure 3).
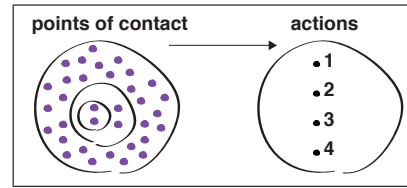

Figure 3. Diagram of map of actions.

4.4. CDP #4: Divide and conquer

Even though the interface design may be intended for collaboration, sometimes lead figures emerge, and members may not participate equally.

In collaborative games for multi-touch tabletop displays, Khaled et al. [8] argue that one strategy to foster collaboration is to offer a division of tasks which can be performed in parallel and which have a single outcome. For instance, the authors present the *Labour of Loaf* game, where the main task of making sandwiches in a virtual restaurant is divided into subtasks on a multi-touch surface.

Therefore: **Allow for a division of tasks which can be executed in parallel towards a single shared goal. (see Figure 4).**
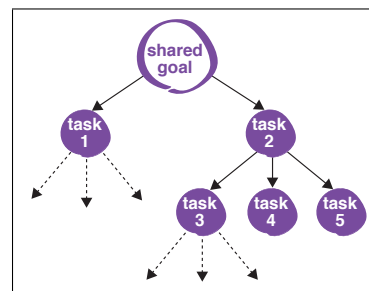

Figure 4. Diagram of divide tasks and conquer.

5. DISCUSSION

In summary, we believe that these four candidate patterns (see Section 4) relate to the fundamental collaborative principles of democratic relationships, identities and collective interplay. In the case of collaborative activities, a common question is whether collaboration can be democratic, and to what extent. Democratic collaborative music is possible, and mostly depends on the affordances offered by the interface design [19]—as with CDP #3. We believe that a democratic collaboration would imply sharing the whole experience of the musical activity—which would include sharing both responsibilities and rights. According to this approach, either dividing and relating the tasks to a single goal—as with CDP #4—or providing a range of complex interaction that could be appropriate for different music knowledge levels—as occurs with CDP #2—are

two strategies that would be likely to facilitate democratic collaborations.

When performing collaborative real-time music activities, there are not only individuals, but a collective identity also arises: in our opinion, these identities should co-exist and interact in order to produce expressive musical results that will satisfy the aims of all. In this aspect, the shared and personal spaces complement each other and each space may nurture the collective and the individual identity respectively (CDP #1). In addition, CDP #4 orchestrates the collective identity.

A system that supports collaborative real-time music activities should allow enough flexibility to achieve the expected collective interplay ([6]). CDP #2 focuses on providing this flexibility through several adaptable and interconnected rings of paths of possible interactions with the interface. The synchronisation of the interrelated tasks described in CDP #4 helps towards this aim.

6. FUTURE WORK

In conclusion, we have provided an insight into how to deal with a set of problems identified in the literature as arising in interaction design of multi-touch applications for collaborative real-time music activities. For that purpose, we have followed the strategy of interaction design patterns by proposing a solution for each identified problem. As a result, we have identified 4 CDPs, which are rooted in general themes of collaborative music: democratic relationships, identities, and collective interplay. For future work, we aim to implement these CDPs, and evaluate the degree of support for collaboration on co-located and shared multi-touch surfaces they provide. Also, we are interested in identifying further CDPs that would deal with themes such as activity awareness or co-located networked processes, among others. Furthermore, we are interested in analysing similarities and differences of interaction design patterns between multi-touch and physical objects. Finally, we aim to establish an initial path towards a pattern language adapted to collaborative real-time music activities using multi-touch technologies, which we consider could be a useful work tool for music interaction design.

7. ACKNOWLEDGEMENTS

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