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# Collaborative music interaction on tabletops: An HCI approach

Anna Xambó  
The Open University  
[a.xambo@open.ac.uk](mailto:a.xambo@open.ac.uk)

Robin Laney  
The Open University  
[r.c.laney@open.ac.uk](mailto:r.c.laney@open.ac.uk)

Chris Dobbyn  
The Open University  
[c.h.dobbyn@open.ac.uk](mailto:c.h.dobbyn@open.ac.uk)

Sergi Jordà  
Universitat Pompeu Fabra  
[sergi.jorda@upf.edu](mailto:sergi.jorda@upf.edu)

With the advent of tabletop interaction, collaborative activities are better supported than they are on single-user PCs because there exists a physical shareable space, and interaction with digital data is more embodied and social. In sound and music computing, collaborative music making has traditionally been done using interconnected networks, but using separated computers. Musical tabletops introduce opportunities of playing in collaboration through sharing physically the same musical interface. However, few tabletop musical interfaces exploit this collaborative potential (e.g. the Reactable). We are interested in looking into how collaboration can be fully supported by means of musical tabletops for music performance in contrast with more traditional settings. We are also looking at whether collective musical engagement can be enhanced by providing more suitable interfaces to collaboration. In HCI and software development, we find an iterative process approach of design and evaluation—where evaluation allows us to identify key issues that can be addressed in the next design iteration of the system. Using a similar iterative approach, we plan to design and evaluate some tabletop musical interfaces. The aim is to understand what design choices can enhance and enrich collaboration and collective musical engagement on these systems. In this paper, we explain the evaluation methodologies we have undertaken in three preliminary pilot studies, and the lessons we have learned. Initial findings indicate that evaluating tabletop musical interfaces is a complex endeavour which requires an approach as close as possible to a real context, with an interdisciplinary approach provided by interaction analysis techniques.

*collaborative music interaction, evaluation, interaction analysis, musical tabletops, real-time music performance*

## 1. INTRODUCTION

Interactive tabletops have become popular beyond computing research in recent years. These display technologies detect either touch or tangible object input, or both. One of their characteristics is that there is direct interaction with the content in comparison with traditional screen-based displays. With the latter, the interaction is much more indirect because we use a pointer—an interaction model generally known as window, icon, menu and pointing device (WIMP). With interactive tabletops, instead, data is more manipulable, as the digital information (bits) become tangible (Ishii and Ullmer 1997), and so more visible and shareable. In other words, representation and control of data are combined in a single unit of meaning. Another characteristic of these interactive tabletops is that the interaction is much more physical, embodied, and so the body becomes more relevant for the interaction if we compare it with traditional screen-based settings (Dourish 2001). Also the environment, and other people, may influence the interaction with these

tabletops, a process which is termed co-located social interaction (Hornecker and Buur 2006).

The characteristics presented above explain why interactive tabletops can be an ideal environment for collaborative activities: First, there exists a physical, visible, shareable space. Second, interaction with digital data is more embodied. Thirdly, there are more opportunities to interact with other people and the environment. Examples of interactive tabletops supporting collaboration can be found across several disciplines such as urban planning, education, gaming or decision making. And, by extension, the discipline known as computer supported cooperative work (CSCW).

We consider tabletop musical interfaces to be any interactive tabletop which allow users to create, play, edit, browse or share music and/or sounds. They are usually designed targeting novices, or experts, or both. Some of these musical tabletops support collaboration, which can be local and/or remote. One example of a collaborative musical tabletop is the Reactable, a digital modular synthesizer that



**Figure 1:** Close-up of the TOUCHtr4ck prototype used in pilot study #2.

allows musicians to play music in collaboration using tangible objects, together with multi-touch interaction for controlling the parameters of the objects (Jordà 2008). However, Reactable is one of the few existing musical tabletops which exploits the collaborative potential that interactive tabletops have—which contrasts with the notion that musical tabletops might be a suitable context for collaboration. In addition, this trend of musical tabletops differs from the consensus idea that music tends to be social and collaborative. Thus, we are looking into how collaboration can be fully supported by means of musical tabletops for music performance<sup>1</sup>, and whether collective musical engagement can be enhanced by providing more suitable musical interfaces for collaboration.

## 2. COLLABORATION ON MUSICAL TABLETOPS

In the context of music computing, supporting collaboration on tabletops contrasts with other collaborative strategies such as remote and or co-located musical networks, where even though musicians are interconnected, they tend to use separated computers (Barbosa 2003). Collaborative music interaction on tabletops bring their own idiosyncrasies such as balancing between shared and personal spaces when sharing physically the same interface (Laney et al. 2010); or supporting multi-threads and multi-players using a single computer, which is described as advanced interaction (Jordà 2005).

We aim to understanding how tabletop musical interfaces for collaborative music performance can be designed in order to improve the collaboration among musicians—both novices and experts. This

<sup>1</sup>It is out of the scope of this paper to approach non real-time music because of its different nature: instead of showing changes on the music composition in real time, it would show them asynchronously.

approach may also facilitate communication, coordination and musical engagement among the performers. With this goal, we propose some evaluation strategies for collaborative music interaction on tabletops as explained next.

## 3. EVALUATION STRATEGIES

In sound and music computing, the evaluation of new digital music interfaces is considered a novel field of research: a review of the NIME conference proceedings (Stowell, Plumbley and Bryan-Kinns 2008) shows that since its beginning in 2001 (Poupyrev et al. 2001) few of the papers have been devoted to the evaluation of new music instruments using HCI methods. However, the benefits of adapting HCI evaluation to these new musical interfaces may range from improving aspects such as the interaction design or the creativity support to identifying their forthcoming influence in both the creative and technological domains. Of those studies which incorporate HCI methods, the majority are focused on how musical tasks are performed. Aspects evaluated might be how precisely musical tasks are performed (Orio, Schnell and Wanderley 2001); the quality of the user experience and the degree of expressiveness obtained (Stowell, Plumbley and Bryan-Kinns 2008; Kiefer, Collins and Fitzpatrick 2008; Bau, Tanaka and Mackay 2008); or the usefulness of the tool (Coughlan and Johnson 2006). Another approach which is less task-oriented stresses the interaction among the participants building on empirical studies of mutual engagement (Bryan-Kinns and Hamilton 2009).

Similarly, evaluating musical tabletops may nurture the HCI community. Supporting music making on tabletops as a collaborative activity generally means providing support to non-verbal actions related to communication and coordination between musicians. These features turn out to be particularly an ideal environment with which to explore the collaborative potential of tabletops—which is a current key area for research in HCI—in the context of non-verbal social interaction (Rogers, Sharp and Preece 2011).

In HCI and software development we find an iterative process approach of design and evaluation, where evaluation allows us to identify key issues that can be addressed in the next design iteration of the system. Using a similar iterative approach, we have started evaluating a number of interactive musical tabletops. The aim is to understand what are the design choices that can enhance and enrich collaboration, as well as can facilitate collective musical engagement on tabletop musical interfaces. Next, we describe and analyse the evaluation

methodologies undertaken in three sequential pilot studies—carried out by interdisciplinary teams.

### **3.1. Pilot study #1**

In this project, the team consisted of Robin Laney, Chris Dobbyn, Anna Xambó, Mattia Schirosa, Dorothy Miell, Karen Littleton and Sheep Dalton. For detailed information, see (Laney et al. 2010).

#### *3.1.1. Aim*

The aim of this pilot study was to design and evaluate a tabletop musical prototype.

#### *3.1.2. Design*

The design of the prototype was minimal. There were four identical areas distributed in each side of a square interface, each with four buttons each of which triggered one different sound, plus a fifth button which switched between speakers and headphones mode. The interface had only discrete parameters, with affordances for up to 4 players given this strict division by the sides of a square. The interaction was multi-touch.

#### *3.1.3. Evaluation*

We gathered 12 participants (novices and experts), in 3 groups of 4 users. The aim was exploratory as an initial step for understanding collaboration and collective musical engagement using this prototype. The evaluation was task-based, with a final individual questionnaire about the experience. There were three main tasks, which were sound exploration, structured composition with a coordinator, and free improvisation. We noted that during the sessions, participants tended to use verbal communication. After the tasks performance, we asked them some open questions about the collaborative musical experience, which engaged discussion. Participants provided us with feedback about improvements on the interface design—close to participatory design practices, where participants get involved in the design process (Schuler and Namioka 1993). All the sessions were videoed.

#### *3.1.4. Results*

In subsequent video analysis, we identified initial themes present in collaborative music making such as awareness of others; or a number of dichotomies such as private vs. shared space, individual vs. shared controls and novices vs. experts' goals. For example, in the case of private vs. shared spaces, participants reported, on the one hand, the need of more features for individual expressivity such as previewing the sounds. On the other hand, participants suggested the addition of global, shareable controls for mutual modifiability—i.e. capability of modifying others—and mutual awareness—i.e. visualisation of what others were doing.

#### *3.1.5. Prototype challenges*

We discovered that a simple (and constrained) prototype can be engaging for novices, but less for expert musicians, who tended to request a wider collection of features for nurturing their personal musical expressivity.

#### *3.1.6. Methodological challenges*

Of the three tasks planned for the evaluation, the structured composition with a coordinator represented with most difficulty a real context of real-time collaborative music performance because time was very constrained. Sound exploration and free improvisation were closer to realistic tasks, “in the wild” (Rogers, Sharp and Preece 2011). We think that, for studying collaboration and collective musical engagement, a step further could be to just evaluate open tasks less tied to time, and in more realistic settings. Furthermore, the final group interview and individual questionnaire provided qualitative and complementary information which can be useful when assessing tabletop musical interfaces.

### **3.2. Pilot study #2**

In this project, the team consisted of Anna Xambó, Robin Laney, Chris Dobbyn, and Sergi Jordà. For detailed information, see (Xambó, Laney and Dobbyn 2011).

#### *3.2.1. Aim*

The aim of this second pilot study was to design and evaluate a tabletop musical prototype, taking into consideration the lessons learned in the first pilot study.

#### *3.2.2. Design*

The design of this prototype was also with a minimal interface (see Fig. 1). It consisted of a 4-track recorder, which allowed musicians to record up to four sounds. It was also possible to manipulate the musical output adding some filters and/or global controls. The tasks of recording/playing and transforming/mixing were visually divided into two main circles. The concept of flexible design was introduced allowing users to show/hide the different tracks and/or filters. The interface had both discrete and continuous parameters, with affordances for 2-4 players—mainly because of the presence of two main circles in a square surface. The interaction was multi-touch.

#### *3.2.3. Evaluation*

We conducted an informal evaluation with 2 groups of 2 people: one novices' group, and one experts' group. The experts' group interacted with an early version of the prototype for 10 minutes using both pre-built sounds and recorded sounds of their choice, and then we informally discussed

the experience—with comments on interface design close to participatory design practices. For example, the expert group suggested the need of more accuracy for the recording controls. Experts also manifested the usefulness of the flexible design approach. The novices' group were first introduced to the concept of recording multiple tracks. Then, they were provided with a Stylophone in order to facilitate the recording of their own sounds with an easy-to-use musical instrument, and let them be concentrated on the tabletop musical interface. They were told to play, and their musical exploration and spontaneous thinking alouds were videoed. This group of novices had the option of comparing between one version with flexible layout vs. one with fixed layout. The feedback provided by novices was also about the interface design. For example, they reported the need of more control with the sounds and their synchronisation. In addition, they expressed preference for the flexible design.

#### *3.2.4. Results*

We informally confirmed some themes present in collaborative music making such as division of tasks, individual vs. shared controls and modifiability of others' actions. For example, during the performance, each one of the two groups tended to be in control of one of the two main circles, so they followed the prototype's division of tasks between recording/playing and transforming/mixing. Thus, they distributed the two main possible tasks without consultation or request, with sporadic modifications to the other's actions, and the use of global controls indistinctly.

#### *3.2.5. Prototype challenges*

When comparing between a fixed layout with a flexible layout, participants preferred the flexible choice because it allowed them to adapt the musical interface to their needs. Thus, we informally suggest that a flexible design approach might allow a collaborative musical experience for both novices and experts.

#### *3.2.6. Methodological challenges*

As methodological challenges, on the one hand, we need to do a more formal evaluation of this prototype. This would imply, firstly, the implementation of a minimum suggested features such as sound tracks in sync, or better recording control, in order to avoid frustration among participants. However, the addition of new features should be done without losing the experimental context which characterises the current musical interface. Secondly, the prototype should be tested with more participants, and applying similar conditions—e.g. similar open tasks, similar data gathering and similar data analysis. On the other hand, in order to validate the themes identified so

far with pilot studies #1 and #2, evaluating more collaborative musical tabletops will be needed.

### **3.3. Pilot study #3**

In this recently started project, the team consists of Anna Xambó, Sergi Jordà, Robin Laney, Chris Dobbyn, Yvonne Rogers, Eva Hornecker and Paul Marshall.

#### *3.3.1. Aim*

The aim of this pilot study is to conduct a formal evaluation of the Reactable, a well-known tabletop musical system developed in the Universitat Pompeu Fabra-Music Technology Group, in Barcelona (Jordà 2008).

#### *3.3.2. Design*

The Reactable has a sophisticated interface, with both discrete and continuous parameters, and with affordance for 1 to multiple players. The interaction can be both using tangible objects and multi-touch.

#### *3.3.3. Evaluation*

We have adopted an ethnographic approach in two representative settings: a museum (with two days of observations videoed) and a music lab (a "long-study" of 4 sessions videoed, group interview, and prior and post questionnaires for 4 groups of 3 people each on average).

#### *3.3.4. Results (preliminary)*

Preliminary observations point out that the nature of the museum study differs considerably from the nature of the music lab. For example, in the museum context, musical interactions were predominantly ephemeral. In the music lab context, though, more organised musical structures were formed. However, we still have to video-analyse the data in order to define the candidate themes, and then discuss them in group for their validation by adapting video analysis practices (Heath, Hindmarsh and Luff 2010).

#### *3.3.5. Methodological challenges (preliminary)*

This approach is close to a "in the wild" context of real-time collaborative music performance. However, the study's scope should be stated clearly beforehand. At this early stage of the study it is difficult to foresee what are going to be the future research design implications of the undertaken approach.

## **4. CONCLUSION AND FUTURE WORK**

To summarise, we presented a number of features of interactive tabletops (i.e. direct, manipulable, embodied and social interaction) which explain why they can be an ideal environment for collaboration. We then introduced musical tabletops and their

idiosyncrasies when supporting collaboration. Next, we described how supporting collaboration on musical tabletops may be approached as advanced interaction design because it includes aspects such as supporting multi-threads or multi-players; as well as considering personal vs. shared spaces. Afterwards, we contrasted the impact of using HCI methods for evaluating music interaction on the creative and technical domains (of both the HCI and music computing communities), with the general lack of evaluation. After that, we described three pilot studies which have shown that evaluating tabletop musical interfaces is a complex endeavour, which requires an approach as close as possible to a real context. Interaction analysis techniques such as video analysis have proven to be useful.

As future work, a more formal evaluation of musical tabletops should be conducted. So far, the iterative process approach is confirmed to be an agile and effective method for identifying/disregarding idiosyncrasies of collaborative music interaction on tabletops. This approach has yielded valuable participants' feedback about prototype interface design—i.e. discussion of a wide range of possible interface design improvements. Up to now, a qualitative approach has been adopted. Capturing and analysing interaction log files could complement this approach. Logs tend to provide low-level values, so in order to avoid time-consuming analysis, some work has to be done in order to obtain meaningful quantitative data. Finally, we think that a further formal evaluation of collaborative music interaction on tabletops may inform significantly both the music computing and the HCI communities about how to deal with advanced interaction. The former could be informed about a number of reliable HCI methods which would be adapted to digital music interfaces, whereas the latter could be informed about how to deal with non-verbal multi-player activities on interactive tabletops, which is currently a key area for research in HCI.

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