Materials in Musical Interaction: Research through a Material Lens under Musical Context

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Research on the design of Digital Musical Instruments (DMIs) emphasize the significance of materiality in the musical gestures and embodied interaction. However, most research on DMI design primarily concentrates on technological aspects and lacks examination of the role of materials in the design process. In this position paper, we present two studies that explored how musicians perceived and explored materials in DMI design. The findings indicate that the characteristics of materials influenced the musicians' creative thinking process, and it is existed a strong connection between the properties of materials and sounds. We discuss the two approaches and how these findings can inform further exploration of material-based design research in HCI.

CCS Concepts: • **Human-centered computing** → **Interaction design theory, concepts and paradigms**; *Activity centered design*; • **Applied computing** → *Sound and music computing*.

Additional Key Words and Phrases: Material, Materiality, Research through Design, Musical Instruments design, Design Methods, HCI

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1 INTRODUCTION

Digital Musical Instruments (DMIs) are musical instruments consisting of a physical interface and computer-based synthesis of sound and other feedback modalities [5, 6, 10–12, 18]. As Human-Computer Interaction (HCI) and computational technology in general become more tangible, research on the materiality of DMI physical interface design has also gained more attention [7, 9, 14]. Previous research shows musicians' expectations of the gestural and sonic interaction of an instrument are fundamentally linked to its material properties [14]. However, the evoked meaning of those materials in DMI design apart from their digital interactivity has been underexplored. Approaches such as design fiction, material speculation, material improvisation, and co-speculation are widely used in HCI research [1, 3, 4, 15–17]. These approaches have been applied in material exploration research and musical instrument design research [2, 8, 13].

2 EXPLORING MATERIALS IN DIGITAL MUSICAL INSTRUMENT DESIGN PRACTICE

In the following sections, two studies related to materials in DMI design are presented. The following content are based on authors' published paper [20] and [21].

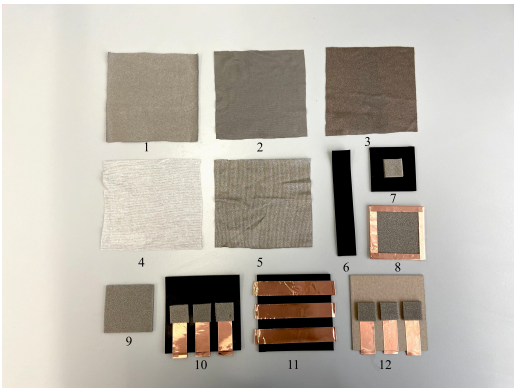

Fig. 1. Material Samples (N1-5: fabric; N6: rubber; N7: rubber and foam; N8,N9: foam in different density; N10: rubber, foam, copper tape; N11: rubber, copper tape; N12: cardboard, foam, copper tape)

2.1 Study 1: Material Inspiring Design Ideas Through Design Fiction

In order to explore how musicians develop musical ideas based on deformable materials, we take a step back from deformable DMI implementation to reflect on their design practice.

2.1.1 Workshop Study. Twenty-three musicians (17 male, 6 female) participaede our study. We ran eight workshops on Zoom (during pandemic), with an average of 3 participants in each workshop.

Following Andersen's methodology in which workshop materials should remain mundane and everyday [2], participants in our workshop were invited to search for everyday objects in their homes. The task of searching available materials became the first source of insights about participants' assumptions about deformable input, which is different to Andersen's approach [2]. There are six main steps in our workshop: Introduction, Open Discussion, Prompt Activities, Design Activity, Demo and Presentation, and Discussion.

2.1.2 Main Findings. We found that in the prompt activity, participants focused on the gestures whereas in the design activity they also thought about the materials and sound. When participants were invited to explain in words their imagined sounds, we found that participants' imagined sonic outcomes came from both an understanding of deformable gestures and also the materials' affordances. Designing non-functional prototypes focused DMI designers' attention on the materials, tangible interaction, deformability, and physical expressiveness. Our data suggests that interaction with materials can also stimulate designers' imagination. Participants mentioned that direct material manipulation and spatial interaction contributed to their designs.

2.2 Study 2: Discovering Gestural Interaction Through Material Probe

In the following part of this section, a study investigating materiality in digital musical instruments design is presented, focusing specifically on deformable materials as they offer opportunities for physical interface design and materiality research.

2.2.1 Study Design. There were 15 participants participated our study. We made five types of non-rigid materials (see Figure 1)for participants to use in this study, which include fabric, foam in low density (softer), foam in high density (more rigid), rubber, and copper. We loosely structured our study following *Material Probe* approach and questions [7].

We guided participants to focus on the wholeness of the material in the first part of the study to explore how people "perceive, value, and articulate material qualities of objects from their memories" [7, 19]. We then invited participants to generate speculative or hypothetical instruments based on the materials after playing with the materials. Finally, participants were then encouraged to talk about their previous DMI design experience in relation to the materials and views on deformable DMIs in general. After each part, a semi-structured interview was followed.

2.2.2 Main Findings. Five themes were identified in the thematic analysis of the interview data and the video observations: From Materials to Sonic Respons; The Patterns of Gestural Interaction, Interaction and Functionality, Affordances and Constraints, and Controllability. When participants were asked to generate speculative or hypothetical instruments, the most frequently mentioned design thinking approach was based on the material properties. As expected, different types of material afforded different types of gestures that corresponded with the material properties. These evidence suggest the materials implied their interaction techniques and functionalities from two aspects: i) the properties of the material, such as foam and fabric, are soft to be squeezed and stretched, ii) the prior expectations of construction of the object, such as the smaller sized square foam suggested a button.

3 MATERIALS IN MUSICAL INTERACTION

Reflecting on our findings from both studies, we suggest that participants generated unique design ideas from everyday objects and materials in three ways: i) rethinking the materials in a specific context (music context); ii) exploring design concepts with concrete objectives (making a non-functional DMI and demo); and iii) encountering unexpected affordances during design exploration. From the results, some participants emphasized their reflections on the interfaces' materiality and how the material properties connect to their design concepts. The constraints and affordances of materials are a significant guide and influence on interactions. In Study 1, the unexpected affordances of the material provided a unique design perspective.

In Study 2, participants' initial perceptions of the materials influence their interpretation of the meaning of materials, thus influencing their design ideas developed with the materials. Our findings indicate that the unfamiliar materials might help DMI designers to focus their thinking on the materials themselves because they do not fall back on previous experiences or focus on technical constraints. We found that participants from engineering and technical backgrounds were less concerned with how a material would look like in the final piece and more concerned with the technical implementation. When DMI designers consider the actual musical activity when interpreting the materials, there is a potential change in their thinking.

4 CONCLUDING REMARKS

This paper presents two studies that explored the evoked meaning of material properties in a musical context beyond their digital interactivity through different approaches. Our results suggest there is a strong connection between the tactility of an instrument and the imagined sound. Also the results suggested the significance of exploring materiality in inspiring musical ideas in the DMI design process. We believe there is great potential for further refining and applying the material exploration approach in digital musical instrument design.

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