FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

The Design of Technology-Mediated Audience Participation in Live Music

DISSERTATION

zur Erlangung des akademischen Grades

Doktor der Technischen Wissenschaften

eingereicht von

Dipl.-Ing. Oliver Hödl
Matrikelnummer 0026051

an der Fakultät für Informatik
der Technischen Universität Wien

Betreuung: o. Univ.-Prof. Dr. Geraldine Fitzpatrick
Zweitbetreuung: Dr. Simon Holland

Diese Dissertation haben begutachtet:

Helmut Hlavacs	Andrew McPherson

Wien, 21. April 2016

Oliver Hödl

FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

The Design of Technology-Mediated Audience Participation in Live Music

DISSERTATION

submitted in partial fulfillment of the requirements for the degree of

Doktor der Technischen Wissenschaften

by

Dipl.-Ing. Oliver Hödl
Registration Number 0026051

to the Faculty of Informatics
at the Vienna University of Technology

Advisor: o. Univ.-Prof. Dr. Geraldine Fitzpatrick
Second advisor: Dr. Simon Holland

The dissertation has been reviewed by:

Helmut Hlavacs

Andrew McPherson

Vienna, 21st April, 2016

Oliver Hödl

Erklärung zur Verfassung der Arbeit

Dipl.-Ing. Oliver Hödl
Singerstraße 30/16
1010 Wien

Hiermit erkläre ich, dass ich diese Arbeit selbständig verfasst habe, dass ich die verwendeten Quellen und Hilfsmittel vollständig angegeben habe und dass ich die Stellen der Arbeit – einschließlich Tabellen, Karten und Abbildungen –, die anderen Werken oder dem Internet im Wortlaut oder dem Sinn nach entnommen sind, auf jeden Fall unter Angabe der Quelle als Entlehnung kenntlich gemacht habe.

Wien, 21. April 2016

Oliver Hödl

Danksagung

An meine liebevollen Eltern und meine großherzige Schwester.

Acknowledgements

The past years focusing on this thesis have been full of exciting work and valuable experiences. The acquired skills and lasting memories will certainly shape my future scientific and personal life.

To achieve all of this, I am deeply indebted and truly grateful to my supervisors. First of all, I want to thank Geraldine Fitzpatrick for making this possible and her enormous support from the beginning. She always knew when I needed to be challenged for my own good and never stopped to be caring when I was lost.

Second, but not least, I want to thank my UK-based supervisor Simon Holland for his engaging inspiration, encouraging passion, and the long discussions we had, whether it was in the Music Computing Lab at the Open University or remotely via Skype.

Special thanks to all my colleagues at the Institute for Design and Assessment of Technology and in particular Fares Kayali, Florian Güldenpfennig, Petr Slovak, Peter Purgathofer, Özge Subasi, Roman Ganhör, Christopher Frauenberger, and Monika Zauner for helping with studies, discussions, advice, writing, and making the work at the HCI group incredibly amazing.

In the context of the Vienna University of Technology my thanks go to all students of the lectures Interface and Interaction Design (winter term 2013 and 2014) and the seminar Gameful Design (summer term 2015) for cooperation and participation in my studies.

Thanks to David Vrtis, Anita Polak, and Tracy Redhead for professional support and advice in their respective areas of expertise. The same thanks go to all colleagues and friends I found during my internships at the Open University in Milton Keynes and the University of Nottingham.

I am thankful for close friends and people who supported my field studies with organisation, performing, and documentation at live concerts: Lukas Amsüss, Franz Löchinger, Georg Hatzl, Magdalena Schindler, Martin Leitner, Thomas Fischer, and Manuel Prutsch. I would particularly like to thank the City of Vienna for funding the event Wiener Musik-Experimente with public means for the promotion of culture.

Finally, I would like to thank my family. My sister Belinda was actively involved in many regards. She was supportive with her organisational skills, her ability to give advice and encouragement, and concerning our common interest in science and academia.

My parents Wolfgang and Marlies deserve my sincere thanks for simply everything, but especially for their sensitive support during my emotional distress in the past year and their love and care during weeks and months of writing in our home in Mürzzuschlag.

Kurzfassung

Durch *Technologie-unterstützte Publikumsbeteiligung* (*TMAP*, Abk. für engl. *Technology-Mediated Audience Participation*) können Zuschauer auf unterschiedliche Weise in eine musikalische Aufführung einbezogen werden. Technische Entwicklungen bieten dabei eine Vielzahl an neuen Möglichkeiten. Die Gestaltung geeigneter Interaktionsformen kann dabei schwierig sein, da Ansichten von Musikern und Publikum unterschiedlich sein können und gleichzeitig die gewünschte musikalische und künstlerische Form gewahrt werden sollte. Eine effiziente Gestaltung von TMAP erfordert daher die *Berücksichtigung verschiedener Blickwinkel und unterschiedlicher Bedürfnisse* aller Beteiligten.

Es gibt wenig Forschung in diesem speziellen Bereich der Interaktionsgestaltung und kaum praktische Orientierungshilfen. Mit dieser Dissertation werden unterschiedliche Aspekte der Gestaltung (engl. Design) von Technologie-unterstützter Publikumsbeteiligung (TMAP) untersucht und systematisch beschrieben um die Gestaltung und Analyse von TMAP zu unterstützen. Diese systematische Beschreibung (engl. Framework) ist praxisorientiert und beschreibt den Gestaltungsspielraum zur *Hilfestellung analytischer und gestalterischer Prozesse* im Bereich TMAP in Live-Musik.

Die Forschungsmethodik basiert vorwiegend auf gestaltungsorientierten sowie verschiedenen qualitativen Methoden und gliedert die Arbeit in zwei Teile: Explorative Feldstudien und systematische Beschreibung.

Der erste explorative Teil beginnt mit *zwei nutzerorientierten Feldstudien.* Mittels Interviews und einer Umfrage werden die Bedürfnisse von Musikern und Zuschauern erhoben sowie Gestaltungsmöglichkeiten von Interaktionssystemen für TMAP-Fallstudien identifiziert. Die *zwei darauffolgenden Fallstudien* im Rahmen von Live-Konzerten, dienen der Umsetzung und Analyse von TMAP in der Praxis.

In der *ersten Fallstudie* konnten die Zuschauer mit ihren Smartphones den Klang der Gitarre gemeinsam beeinflussen. Das technische System wurde im Rahmen der Entwicklung unter Mitwirkung der beteiligten Musiker und einzelner Zuschauer gestaltet. Die *zweite Fallstudie* konzentriert sich auf die Komposition eines Liedes unter der Berücksichtigung von TMAP für die spätere Live-Aufführung. Während dieses Konzerts konnten die Zuschauer mit einem großen Ballon Klangeffekte des Klaviers steuern.

Durch diese explorativen Studien werden relevante Aspekte für die Gestaltung von TMAP in Live-Musik identifiziert. Diese Gestaltungsmerkmale werden benutzt, um *im zweiten Teil* der Arbeit das Feld systematisch zu beschreiben und formal als TMAP Framework zu definieren.

Das *TMAP Framework* verbindet die Erfahrungen des explorativen Teils mit einer systematischen Analyse der vorhandenen Literatur des Forschungsbereichs, um weitere Gestaltungsmerkmale miteinzubeziehen. Das TMAP Framework wurde fortlaufend verbessert und zwei Mal in der Praxis evaluiert. Eine dieser praktischen Anwendungen ist *TMAP Online*, eine web-basierte Version des Frameworks, getestet in einer Lehrveranstaltungsübung, in der Studenten eine Vielzahl existierender TMAP-Beispiele analysierten. Die zweite Anwendung sind *TMAP Design Cards*, bestehend aus 46 Karten, die in Gruppen zur Gestaltung von neuen Ideen für TMAP eingesetzt wurden.

Zusätzlich wurde das TMAP Framework in Zusammenarbeit mit unterschiedlichen Experten fortlaufend analysiert und verbessert. Die finale Version des TMAP Frameworks enthält 180 Begriffe, die in einer baumartigen Struktur auf vier Ebenen sortiert sind.

Diese Dissertation *erweitert das Wissen im Bereich der Gestaltung von Technologie-unterstützter Publikumsbeteiligung in Live-Musik.* Darüber hinaus hat das TMAP Framework praktisches Potential, da es Gestaltungsprozesse unterstützt und insbesondere der Ideenfindung dienen kann.

Abstract

Technology-mediated audience participation (TMAP) offers a wide variety of ways to enhance the involvement of spectators during the performance of live music. Technological change has created rich new opportunities in this area. However, interactions of this kind can be hard to design effectively. Musicians and audiences have distinctive requirements, as does musical coherence, and there can be wide variation among both groups. Thus, the effective design of TMAP generally *requires balancing knowledge from diverse perspectives* and the taking into account requirements of very different roles in live music performance.

Research in this distinctive area of interaction design, and the provision of guidance for designers is at present highly limited. Hence, this thesis identifies and analyses issues in the design of technology-mediated audience participation (TMAP) from a variety of perspectives and synthesises a framework for supporting the design and evaluation of TMAP. This framework describes the design space of TMAP in a practice-oriented way to *support design-related processes* around TMAP in live music.

Methodologically, the overall strategy is based on a research through design approach, using a mixture of mostly qualitative methods in two main research strands: field exploration and framework construction.

The first strand, the field exploration, starts with *two user studies*. These are interviews and a survey to study requirements of musicians and spectators and to identify potential design strategies for case studies. *Two subsequent case studies* focus on live concerts as in-situ studies and explored two contrasting approaches to realising TMAP in practice.

In the *first case study*, smartphones were used to let the audience control the guitar sound collaboratively. This case study was guided by a participatory design approach involving both spectators and the performing musicians during development. The *second case study* focused on the composition of a song crafted with TMAP in mind, and its live performance. During performance, a big balloon in the audience allowed spectators to control piano sound effects.

The field exploration enabled the identification and analysis of issues affecting the design of TMAP in live music. These contributed to framing challenges and potential design strategies for *the second strand* where the TMAP Framework was developed.

The *TMAP Framework* was synthesised using both the experience of the field exploration and a systematic review of related work to identify design characteristics. The framework was then iteratively evaluated and refined through a series of studies testing

its use for analysis and design tasks. To support this, two different presentations of the framework were developed. *TMAP Online* is a web-based tool used for classification exercises within a class of students to describe a range of existing examples for TMAP using the framework. *TMAP Design Cards* (a set of 46 cards) are a tangible instantiation of the TMAP Framework, used in groups to reflect on design sessions.

Finally, the TMAP Framework was improved with feedback from different experts throughout development and evaluation. The final version of the TMAP Framework contains 180 entities in a tree-like sorted structure on four levels.

Alongside the *contribution to knowledge to the design of technology-mediated audience participation in live music*, the TMAP Framework has *practical potential*, making contributions to idea generation as well as guidance during design processes in this innovative and distinctive area of interaction design.

Contents

List of Figures

List of Tables

CHAPTER 1

Introduction

1.1 Preamble

From a personal point of view, audience participation in live music concerns me as a spectator and a musician. From both perspectives I feel that audience participation has to be well considered to create an enriching and desirable experience for everybody involved in a performance.

As a musician I believe that different forms of communication and a degree of audience involvement are essential parts of live music. At some point I started to consider using the technologies I have on stage to try out new forms of communication between all stakeholders of a performance. This raised my personal interest in this goal and in the question of how to design such technology-mediated audience participation to create a desirable experience from two perspectives simultaneously: for me as musician; and for spectators - making full use of my imagination to envision new possible forms of relationship between spectator and performer.

1.2 Motivation

Audience members participate in different ways in live music performances. These can be modest clapping or emotionally dancing in reaction to the music and in dialogue with the performer.

A review of related work demonstrates that approaches to *technology-mediated audience participation (TMAP*[1]*)* are manifold and have implications for art, technology, and science. Among early works is *Radio Net* from 1977 that used the analogue telephone network to involve thousands of people in a networked performance (Neuhaus, 1994).

[1]The acronym TMAP stands for Technology-Mediated Audience Participation. TMAP is a newly coined term of this thesis to address the field of technology-mediated audience participation in live concerts.

More recently, mobile devices, and in particular smartphones, have been used to let spectators participate in performances (Levin, 2001; McAllister and Alcorn, 2004; Lee and Freeman, 2013). While there is always a danger of new technologies being used for their own sakes, much work using new technologies for audience participation places a proper emphasis on the quality of the musical result and on the creative contribution (Levin, 2001; Freeman, 2005). Such works range across musical genres and performance settings. Examples include: DJ-audience interaction (Gates et al., 2006); voting systems for competitive rap performances (Barkhuus, 2008); and orchestral concerts (Thompson, 2006). The review of the literature and relevant practices in Chapter 2 gives further evidence of the diversity of TMAP in live music.

While technology-mediated audience participation (TMAP) poses questions for science, technology, and art, it also raises interesting challenges foo *interaction design*. The design of TMAP involves consideration of interaction within the setting of a *live music performance*. This setting comprises many and diverse aspects including the perspectives of musicians and spectators as primary stakeholders of a performance, issues of musical coherence, and the performance situation itself. Effective design of TMAP requires balancing knowledge from diverse perspectives and taking into account very different characteristics and requirements in live music performance.

However, research in this distinctive area within interaction design is relatively scarce, and the provision of guidance for designers is at present highly limited. Apart from accounts of various specific examples of TMAP in live music, so far there is no comprehensive analysis to guide designers and provide support for design processes. Such work could benefit disciplines in art, technology, and science that are concerned with TMAP. A suitable exploration and analysis should take into account the perspectives of diverse stakeholders, including interaction designers, musicians, media artists, composers, engineers, and, last but not least, spectators as primary participants of interactive performance experiences.

Consequently, this thesis analyses and identifies issues in the design of TMAP from a variety of perspectives. The aim is to *explore and describe the design space* of TMAP in a practice-oriented way to *support processes around the design and analysis* of TMAP in live music. There are two questions motivating this thesis research:

RQ1 What are the principal issues involved in the design of technology-mediated audience participation?

RQ2 How can support for processes of the analysis and design of instances of technology-mediated audience participation be provided?

The studies throughout this thesis will have their own subsidiary or refined research questions to address specific aspects. In the discussion chapter (Chapter 10) we will revisit and answer the overall research questions as raised here taking into consideration all study outcomes. The following thesis overview outlines how these research questions are addressed throughout the chapters of this thesis.

A main outcome of this research is the *TMAP Framework*. It is a descriptive framework mapping the design space of TMAP in live music. The TMAP Framework, the research

it is based upon, and its practical potential for analysis and design is introduced in the following thesis overview.

1.3 Thesis Overview

Two principal strands characterise the research approach to address the questions raised for this thesis. The first strand, a field exploration, contains four empirical field studies (Chapters 4-7) to explore the field and identify issues in the design of TMAP from a variety of perspectives. The second strand focuses on the synthesis of a descriptive framework for supporting the design and evaluation of TMAP (Chapters 8-9). This framework describes the design space of TMAP in an explanatory and practice-oriented way to support design-related processes around TMAP in live music.

The following sections summarise the chapters, their role within the thesis, and how they relate to each other. Figure 1.1 supports this thesis overview with a schematic illustration showing the chapters, the research questions, the two research strands, studies, contributions, and their relation to each other.

1.4 Context and Research Approach

Related Work (Chapter 2) presents and discusses different approaches around audience participation. This chapter focuses primarily on examples of technology-mediated audience participation (TMAP) in live music. Furthermore, I reflect on participatory approaches in other performance-related domains and on non-technical audience participation. In this regard issues of terminology and definitions around TMAP are identified. Issues with terminology concern different terms being used to describe audience participation such as audience interaction, interactive performance, or participatory performance.

This chapter also deals with issues of scope. For example, challenges are discussed in finding a satisfactory characterisation of the term *live music* to help delineate the context in which the research is set. Relevant issues include performance settings, music genres, and aesthetics. I will revisit these issues during the framework development (Chapter 8) and when reflecting on limitations in the discussion (Chapter 10) and conclusion (Chapter 11). Of particular interest for this thesis and the anticipated framework is the reflection on different approaches to formalisation in music interaction design and methodological strategies when studying live performances. Finally, I draw conclusions on the related work and relate these to the research questions as raised above.

The **Research Approach (Chapter 3)** describes the overall *research through design* strategy to address the research questions and outlines the two methodological main strands: the field exploration (Chapters 4-7) and the framework construction (Chapters 8-9). In relation to the design-led research approach and the central role of myself as the author I reflect on the constructivist philosophical background which the overall research agenda assumes. The methodological considerations discuss the mixture of mostly qualitative methods and the related challenges, limitations, and opportunities when combining subjective and objective research methods. In particular, I describe the

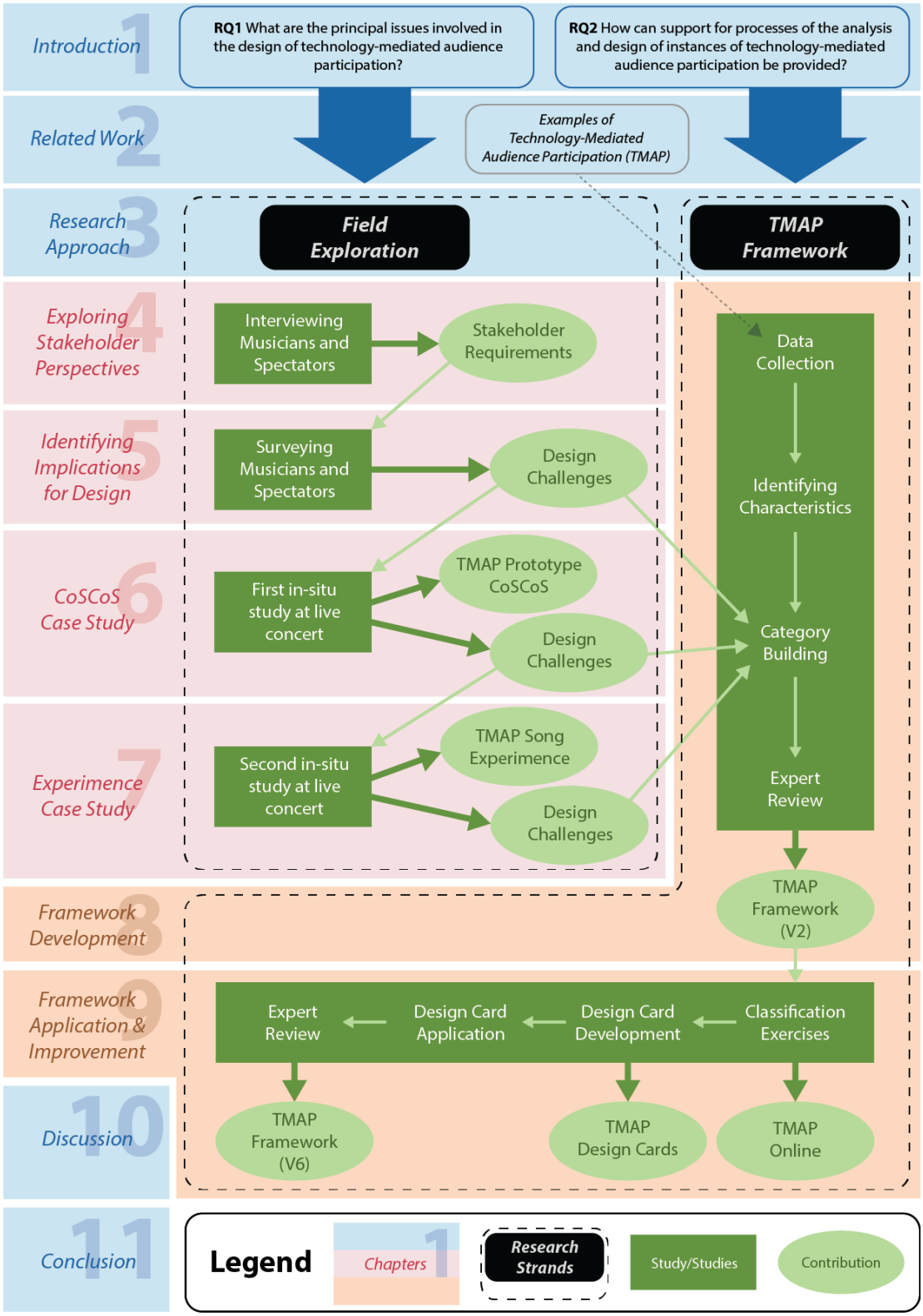


Figure 1.1: Overview of chapters, research questions, studies, and contributions

constraints and potential of first-person research methods such as auto-ethnography and the methodological challenges when studying the complex setting of a live performance. These methodological issues are revisited in the overall discussion (Chapter 10) and conclusion (Chapter 11). Finally, the research approach describes the different forms of data collection and analysis throughout this thesis.

1.5 Field Exploration

The overall aim of the four field studies (Chapters 4-7) is to identify issues involved in the design of technology-mediated audience participation (TMAP).

Exploring Stakeholder Perspectives (Chapter 4) and **Identifying Design Implications (Chapter 5)** are two exploratory field studies. These two field studies describe interviews with musicians and spectators, and an online survey. Both studies explore the perspectives of both groups on live music performances in general and TMAP in particular. The thematic analysis of interviews with four musicians and four spectators concludes with *requirements* concerning their motivation, behaviour, and opinion in relation to live music and TMAP. The analysis and interpretation of 227 online survey responses using descriptive statistics results in *challenges* for the design of TMAP.

The **CoSCoS Case Study (Chapter 6)** is the first of two in-situ case studies at live concerts to explore TMAP in practice. With the *TMAP Prototype CoSCoS* (*Co*llaborative *S*tereo *Co*ntrol with *S*martphones) the audience could use smartphones to control the guitar sound collaboratively. This case study was guided by a participatory design approach involving both spectators and the performing musicians during development. The reflection on the participatory design of CoSCoS and its in-situ evaluation resulted in the identification of further *challenges* for the design of TMAP. In addition, the performance experience with CoSCoS pointed out the need for a more intuitive and expressive interaction as part of a design strategy that informed the second case study.

The **Experimence Case Study (Chapter 7)** focuses on the process of composition, rehearsing and the final live performance of the *TMAP Song Experimence* (*Experim*ent + Experi*ence*), a song I crafted with TMAP in mind. During performance, a big balloon that was visually tracked in three dimensions allowed spectators to control piano sound effects by bouncing the object around the venue. The study describes and reflects on how I composed the song Experimence, followed by the design of the participatory performance, and the actual live concert for evaluation. This case study concludes with another set of *challenges* associated with questions that address certain decisions during the composition of a song having TMAP in mind.

In summary, the field exploration resulted in the identification of issues affecting the design of TMAP in live music. These issues contribute to framing stakeholder requirements, and identifying challenges and potential design strategies for the second strand that focuses on the framework to describe the design space of TMAP.

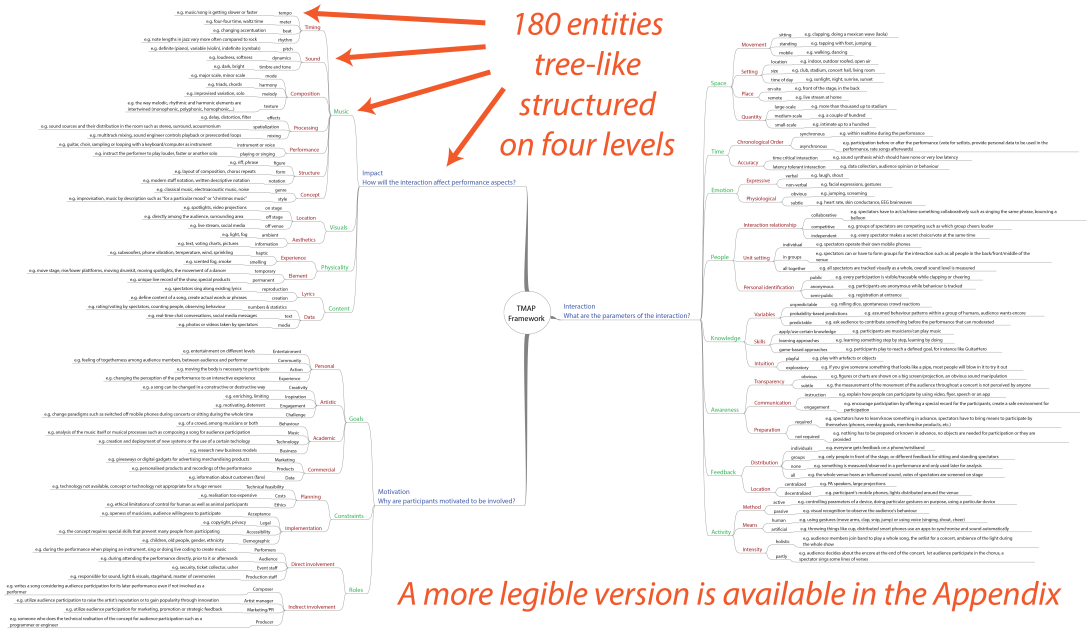


Figure 1.2: Overview of the TMAP Framework

1.6 TMAP Framework and Conclusions

The second research strand (Chapters 8-9) describes the development, application, and improvement of the proposed framework. This descriptive framework is called the *TMAP Framework* as it describes the design space of TMAP and is intended to support design-related processes around TMAP in live music.

The **Framework Development (Chapter 8)** describes the iterative development process using the experience of the field exploration, a systematic review of related work, and expert experience to synthesise a multi-level structured framework.

The **Framework Application and Improvement (Chapter 9)** is the final study-focused chapter of the thesis. In this chapter, the framework is subject to an iterative process of formative evaluation and refinement through a series of studies. These studies test its use for analysis and design tasks specific to TMAP in live music. To support this extended evaluation, two presentations of the framework are developed and applied in practice-oriented settings. Alongside their use as research instruments, these two presentations, *TMAP Online* and the *TMAP Design Cards*, also have implications and applications for TMAP practice.

The current version of the *TMAP Framework* contains 180 entities in a tree-like sorted structure on four levels to describe the design space of TMAP in live music. The majority of these entities are categorised design aspects. Figure 1.2 gives an overview of the TMAP Framework. A full description of the current version can be found in Appendix F.4 (TMAP Framework V6).

The **Discussion (Chapter 10)** reflects on the practical potential of the framework, with particular emphasis on three areas: idea generation and guidance during design processes; provision of a common language; and options for adapting the framework for practical uses. Consideration is given to how the framework might be read and used by different practitioners such as musicians, spectators, composers, interaction designers, engineers, and managers. The discussion concludes with limitations of the thesis in relation to the musical context and the applied methodology.

The **Conclusion (Chapter 11)** revisits and summarises all contributions presented throughout the thesis and considers limitations and future work.

1.7 The Author's Role

The work presented in this thesis uses different research methods and some first-person methods rely mainly on my own perspective as author. The methodological implications using objective as well as subjective research perspectives are discussed as part of the research approach (Chapter 3) and in the discussion (Chapter 10). All practical work such as interviews, surveys, developing prototypes, and conducting case studies was mainly done by myself and so was the analysis of collected data as well as most parts of constructing the TMAP Framework. If other people were involved, either as experts, researchers, students, or assistants for case studies, it is explicitly mentioned as part of explaining the respective study processes.

Nevertheless, the thesis is predominantly written using the authorial *we* to keep a consistent narrative form. Furthermore, the narrative form is intended to align with already published parts of study-focused chapters as we describe next.

1.8 Publications

Parts of the work presented in this thesis were already published in the following four publications which are directly related to the thesis:

1. Hödl, O. Kayali, F. Fitzpatrick, G. Holland, S. 2016. TMAP Design Cards for Technology-Mediated Audience Participation in Live Music. *(peer reviewed and accepted for a workshop at CHI'16 ACM SIGCHI Conference on Human Factors in Computing Systems, San Jose, USA.)*

2. Hödl, O. Fitzpatrick, G. Holland, S. 2014. Experimence: Considerations for Composing a Rock Song for Interactive Audience Participation. In Proceedings of the 40th International Computer Music Conference and the 11th Sound and Music Computing, Athens, Greece. pp. 169-176.

3. Hödl, O. Fitzpatrick, G. 2013. Exploring the Design Space of Hand-Controlled Guitar Effects for Live Music. In Proceedings of the 39th International Computer Music Conference, Perth, Australia. pp. 69-76.

4. Hödl, O. Kayali, F. & Fitzpatrick, G. 2012. Designing interactive audience participation using smart phones in a musical performance. In Proceedings of the 38th International Computer Music Conference, Ljubljana, Slovenia. pp. 236-241.

The *Related Work (Chapter 2)* contains fragments of all four publications. *Exploring Stakeholder Perspectives (Chapter 4)* and *CoSCoS Case Study (Chapter 6)* contain parts of publication 4. Larger parts of publication 2 were integrated in the *Experimence Case Study (Chapter 7)*. The *Framework Application and Improvement (Chapter 9)* contains parts of publications 1.

Three additional publications are associated within the broader context of the thesis. However, none of them is directly related or contains any content used in this thesis.

- Kayali, F. Bartmann, C. Hödl, O. Mateus-Berr, R. Pichlmair, M. 2016: Poème Numérique: Technology-Mediated Audience Participation (TMAP) using Smartphones and High-Frequency Sound IDs. In Proceedings of the INTETAIN 2016 Eight International Conference on Intelligent Technologies for Interactive Entertainment, Utrecht, Netherlands.

- Hödl, O. Fitzpatrick, G. Holland, S. 2014. Exploring the Digital Music Instrument Trombosonic with Extreme Users and at a Participatory Performance. International Journal on Advances in Intelligent Systems, vol 7 no 3 & 4, 2014. pp. 439-449.

- Hödl, O. Fitzpatrick, G. 2014. Trombosonic: Designing and Exploring a New Interface for Musical Expression in Music and Non-Music Domains. In Proceedings of the Seventh International Conference on Advances in Computer-Human Interactions, Barcelona, Spain. pp. 54-59.

CHAPTER 2

Related Work

Given that the aim of this research is to better understand the issues involved in the design of technologically-mediated audience participation (TMAP) and to find ways to better analyse and create such designs, there are various areas of the literature we need to examine. We will look at different forms of participation in performances and uses of technology for audience participation. As central to TMAP we will look at research on the design of musical interfaces and interaction, frameworks for music interaction design, and how research is done in the context of live performances. Finally, we draw conclusions on the literature review.

2.1 Introduction

Live performed music is described by Jordà (2007) as "a highly interactive activity". He explicitly points out that "musicians interact with their instruments, with other musicians, with dancers or with the audience" (2007, p.90). This interaction has been subject to a lot of research over the last decades, which is described throughout the following subsections.

While this certainly touches upon various perspectives, disciplines, all kinds of genres, forms, or settings music happens, we first of all focus on presentational forms of live music, as they are widely used in western music culture. However, we try to elaborate on a broader field of playing music live to inform our studies by the different ways music is made publicly available.

Music in a social context and musical performances have been subject to various studies for evaluating newly developed instruments or interfaces as well as identifying new opportunities to support artists performing music on stage. Rink (2002), in his book "Musical Performance: A Guide to Understanding", collected articles from different authors to address aspects of musical performances including conceptions, preconceptions, learning, music-making, and interpreting.

Describing different ways and forms of musical performances, Turino (2008) provides a good distinction between participatory and presentational performances in the context of musical styles and different cultures. For instance, he studied African cultures in Zimbabwe and wrote, "Until the early twentieth century, group participatory performance was the main type of music making". He further says that before colonial times in Zimbabwe "singing or playing [..] in small informal groups for personal enjoyment was the only other form of music making that existed" (Turino, 2008, p.122).

Looking further beyond traditional presentational forms of music performances, opens up the field of community music (McKay, 2005; Veblen, 2007) and sound installations (Lindborg and Liu, 2015). Lindborg and Liu's *Locust Wrath*, in particular, serves as a good example of a sound installation that can be experienced solely by visiting and participating spectators and played as an instrument in a performance.

As these examples illustrate, participatory approaches in music are not a new phenomenon. Hence, we continue with a review of rather general examples of audience participation in performances.

2.2 Participation in Performances

Among early approaches to audience participation in music are musical dice games (Hoegi, 1763; Kirnberger, 1767). Mozart (1793) was one of the famous composers who tried to make his music interactive for the audience using dices, although not in the sense of an interactive performance but by letting people participate in the composition. In his piece *Das musikalische Würfelspiel* (German for *musical dice game*) spectators roll dice and thereby rearrange parts of the composition (Mozart, 1793; Jones, 1991). This is also interesting because it is an early and good example where spectators, who might not even have any musical knowledge, can somehow create music. The original instruction of Mozart's dice game in Figure 2.1 (left) even says this explicitly with, "To compose without the least knowledge of Music so (sic!) much German Walzer or Schleifer as one pleases, by throwing a certain Number with two Dice". The right image in Figure 2.1 illustrates the original notes showing the numbered measures that are arranged according to the rolled dice.

We referenced Turino (2008) earlier who provides a good distinction between participatory and presentational performance from a historical and ethnomusicological point of view. This clear distinction between participatory and presentational forms of sound and music-related performances becomes blurred when looking at contemporary art in a musical context. Both live performances and interactive installations might have participatory elements in common, although deriving from different directions considering their concept.

Following Rancière (2009) and Wozniak (2015) talking about participation of theatre audiences "spectators are always active", as Wozniak (2015, p.321) postulates. Wilson (2015) goes even a step further by saying not doing anything is already a certain participation in a performance. She approaches participation in performances from a rather philosophical view and says, "not participating (or remaining silent) during the

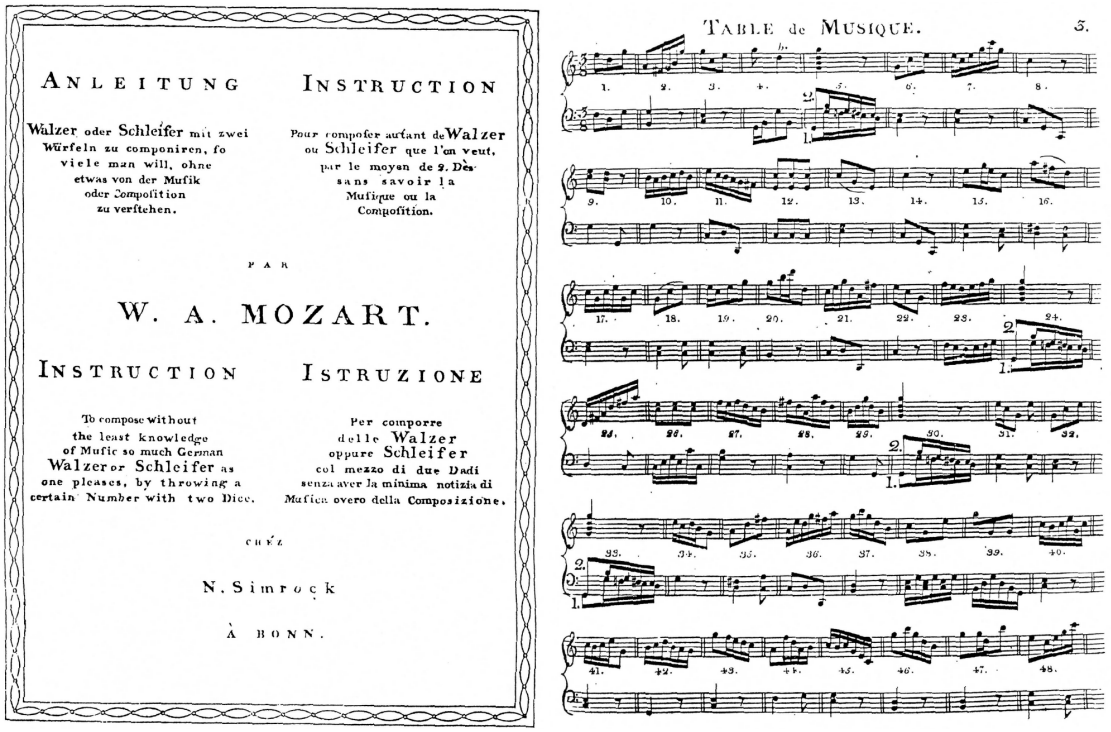


Figure 2.1: Two original pages of Mozart's version of a musical dice game

abusive moment therefore did not signal 'non - participation' but rather complicity in the actions of the performer" (Wilson, 2015, p.345).

Potts (2015) on the other hand, discusses the production and ownership of content in relation to legal issues and asserts, "Fans, entertainers, and copyright holders are renegotiating the terms of participation", and proceeds that "the traditional roles of producer/audience are no longer as clear when fans and artists are co-producing material to share, spread, and celebrate".

Different forms of audience participation and the motivation for it on both sides, the artist and the audience, are manifold. The most popular and natural forms of audience participation are, for instance, singing, dancing, jumping, and clapping along to live played tunes. Often this happens at the audience's initiative, whether it is appreciated by the performer or not. There are countless examples on video platforms on the internet (e.g. youTube) of spectators singing along in live concerts.

The use of personal belongings such as lighters or displays of mobile phones is also widely spread during live concerts. Even big signs with messages are shown towards the stage or personal things are thrown to the artist. One example is the band Madsen (2013) where the singer gets a spectator on stage to let her watch a whole song from the stage after she threw a letter towards him to attract his attention. For the musical *Rocky Horror Picture Show* spectators are even asked to bring particular objects to the play

Figure 2.2: A young boy from the audience performs with the band

(e.g. rice, newspaper, rubber gloves) to use them throughout the performance (O'Brien, 1975).

Likewise, performers also actively encourage their audiences to participate, for example, to keep singing while the band stops playing or instructs them to sing, jump, or clap certain rhythms or tunes. The artists of Pentatonix (2012) make the audience sing a whole song together polyphonically, for example. Some artists even go one step further and let spectators sing in their microphones or play their instruments (Buckethead, 2011). It also happens that they get single audience members onstage to play instruments throughout a whole song or form a complete spontaneous band of spectators (Green-Day, 2008). In Figure 2.2 we can see a still image taken from a video of a performance of the band Green Day (2009) where a young boy was randomly chosen by the singer to play a whole song together with the band live on stage.

Even whole songs have been written with audience participation in mind. A famous example is the song *We will rock you* by the band Queen. Once guitarist Brian Ferry said about their motivation for writing this song, "Both Freddie and I thought it would be an interesting experiment to write a song with audience participation specifically in mind." (Di Perna, 2002)

McLuhan (1994) wrote about participation of the audience in media in general at a very early stage of mass media. He divided media categories into "hot and cool" according to their amount of participation. Corness et al. (2011) mentioned that the "use of media on stage has challenged the audience's traditional relationship to the performer both physically and conceptually" (2011, p.127), also referring to previous work of Auslander (2000) and Dixon (2007).

Audience participation in music can happen in many different settings. Apart from the most obvious one in the western world, which are traditional live concerts with performing artists and listening spectators, Gates (1991) published a "music participation theory based on findings in music education, ethnomusicology, and the sociology of leisure". Of particular interest is the definition that says, "Music participation is distinguished from music audience involvement, but includes the activities of dancer (under some circumstances), producers, instrument makers, and others who contribute the causes for musical events" (Gates, 1991, p.1). What is striking here, is that Gates uses the term *participation* in a broader sense including all sorts of contribution to music, while *involvement* describes the actual participation of an audience in this definition. This points to a terminological issue as well as the matter of perspective how to define audience participation. As we have already seen with other work, participation is indeed used to refer to involvement of an audience in the sense of Gates.

With their essay about representation and social interaction, Braun and Gentès (2005) reflect on "intermedia as it applies to art on Internet". They link from the art movement *Fluxus* where the artists aim on breaking down "the roles traditionally attributed to author, object, and spectator in the production and the reception of works of art", to actual media such as the internet. This brings us to forms of audience participation in live music where technology and technological advances play an important role.

2.3 Technology-Mediated Audience Participation

As already defined in the introduction of this thesis, we abbreviate technology-mediated audience participation as TMAP. Audience participation through getting input from the crowd using technically driven systems has been done in various ways. In an early work in 1977, *Radio Net* used many distributed people, telephones, and radio broadcast for a networked performance to create sounds (Neuhaus, 1994). Neuhaus describes it with "two hours over which ten thousand people found their way into the work and made sounds" (p.13).

Particularly in music, Freeman (2005) wrote a special composition for chamber orchestra and audience. In his piece *Glimmer* the musicians play music based on the audience using light sticks to collaboratively create instructions. Kaiser et al. (2007) presented a system that allows the audience in a dance club to transmit visual material to a VJ (Visual Jockey), who selects and creates live visuals according to the music. Other researchers in nightclubs used biofeedback of the audience for an automated DJ (Cliff, 2006) or carried out studies on DJ-audience interaction (Gates et al., 2006).

Levin (2001) used the audience's mobile phones to collaboratively create the concert *Dialtones*. As the title suggests, he combined ringtones of individual spectator's mobile phones for the performance. Figure 2.3 shows the actual performance. This is important because it illustrates the combination of sound and visuals. During the concert the performer on stage called numbers of phones the spectators registered before the performance. At the same time, the spectators they called were highlighted with a white spotlight from above and could see themselves in a mirror.

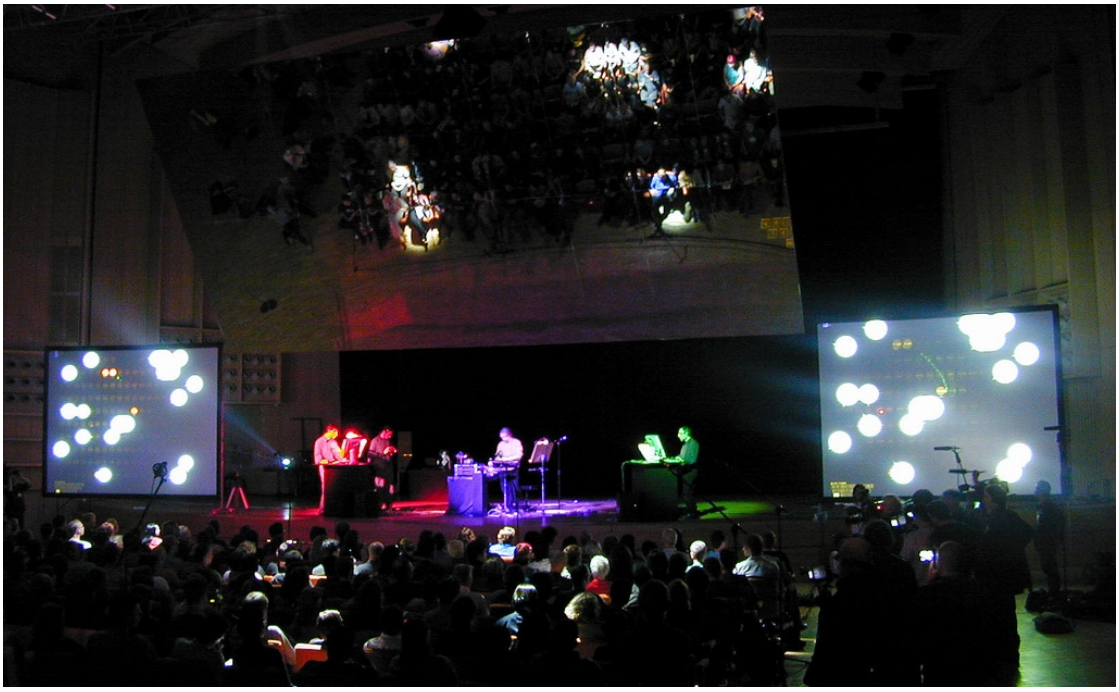


Figure 2.3: The performance of *Dialtones*

Before smartphones became popular, McAllister and Alcorn (2004) designed an interactive performance system with wireless hand-held devices (PDAs, Personal Digital Assistants) to let individual audience members transmit gestures to the performers on stage. The number of people with smartphones is already high and still increasing and modern smartphones combine a wide range of sensor and network technologies in one off-the-shelf device. Hence, studies about audience participation using smartphones (Oh et al., 2010; Lee and Freeman, 2013) and mobile technology (Knapp and Bortz, 2011) rapidly increased during the last couple of years.

In the area of sensor-based systems Knapp et al. (2009) developed a system called BioMuse and used purpose-built chairs to collect physiological data of the audience to control sound generation through emotion and motion. Later, they took advantage of mobile technology and presented MobileMuse, a new approach measuring both physiological and kinematic data via a mobile phone for the purpose of mobile music creation by the audience through emotional states (Knapp and Bortz, 2011). Feldmeier and Paradiso (2007) used wireless sensors that were given to the audience to collect information about the audience's rhythm and activity.

Freeman (2008) worked on real-time notation systems and by exploring these he tried to "create performance paradigms that redistribute the roles of composer, performer, and listener [..] with a collaborative feedback loop" (2008, p.25).

In the field of collaborative and multi-participant musical performances using technology, many approaches have been undertaken using the Internet (Burk, 2000; Young,

2001; Wang, 2009), mobile phones (Rohs and Essl, 2007; Wang, 2009; Fabiani et al., 2011; Oh and Wang, 2011), or other technologies (Kaltenbrunner et al., 2004; Klügel et al., 2011; Bryan and Wang, 2011).

In an early stage, when research on collaborative musical interfaces just began to emerge, Blaine and Fels (2003) studied collaborative musical experiences for novices exploring context and design. Bryan-Kinns et al. (2007) used a collaborative music tool to study mutually engaging interaction between people.

Sheridan and Bryan-Kinns (2008) developed guidelines for public multi-participant performances with tangibles, including a list of well-known tabletop interfaces for creating music or visuals. This is of certain interest for TMAP as Bryan-Kinns et al. underline the need to consider "how the audience and non-performers might understand, respond and interact with a system" (p.289). Furthermore, this points to the importance of the actual design of musical interfaces and interaction, as this interaction is central to what we refer to as *technology-mediated* (TM) in TMAP.

2.4 Design of Musical Interfaces and Interaction

If we revisit Jordà who said, "musicians interact with their instruments, with other musicians, with dancers or with the audience" (2007, p.90), musical instruments appear as an essential part of human interaction in live music. In the context of live music and technology, instruments enable new forms of musical expression for artists, but can also serve as interfaces for multiple participants within a musical context.

In research new instruments are often referred to as new interfaces for musical expression (Dobrian and Koppelman, 2006; Fels and Lyons, 2009). Researchers as well as musicians have been exploring new ways of making music using different custom-built and modified instruments as well as additional devices (Lähdeoja, 2008; Reboursière et al., 2010; Engum, 2011; Overholt, 2011). We consider this knowledge and these approaches as important for TMAP and the use of technology in music or the design of musical interfaces in particular to mediate audience participation.

Even popular artists already use new digital music instruments for their shows. For instance, the Icelandic musician Björk said, "it also allows the audience to experience and understand electronic music and its performance on a whole new level" (Reactable, 2015), when using the *Reactable* (Kaltenbrunner et al., 2004; Jordà, 2010) during her 2007 Volta tour. Although the Reactable did not support audience participation in this setting, Björk's statement informs about the suitability of new digital instruments to be used by professional and popular artists. Apart from new instruments, interactive elements have also been added to performances and whole performances have been digitally mediated and augmented (Johnson et al., 2006; Jessop et al., 2011; Zappi et al., 2011).

Thus, talking about interactive audience participation also means making musical play available to non-specialists, as we can consider a certain amount of spectators in a typical audience without having any musical experience. This opens up the discussion about making music in a more intuitive, passive toy- or game-like sense (Robson, 2002; Kayali and Pichlmair, 2008). In his essay about the *composition-instrument*, Herber

(2006) states that a system designed for this kind of musical play must maintain a delicate balance between *play* (freedom of expression) and *being played* (controlled and musically *safe* results). Talking about whether it is important that the audience understands the interactivity of an artistic work or not, Rokeby (2011) says, "My solution has been to put the audience in the interface. Let the experience of the interface, hybrid phy-gital space, be the content of the work." This underlines the importance of a good, working, and understandable design of participatory performances. Among approaches to support design are different kinds of frameworks (Goffman, 1986; Carroll, 2003; Rogers, 2012). Hence, we continue with a review of formalisations and conceptualisations in the area of music interaction.

2.5 Frameworks for Music Interaction Design

Music interaction design concerns researchers from various perspectives. Especially systematic approaches to describe and classify musical interaction have been researched differently so far. While not primarily for music but using a music exhibit as case study, Borchers (2001) turned this music exhibit into a pattern language to support interdisciplinary interaction design.

Birnbaum et al. (2005) present a dimension space for musical instruments. They propose seven dimensions to describe musical instruments for analytical purposes (e.g. role of sound, required expertise). Magnusson (2010) goes further and builds on these phenomenological dimensions, as he describes them. He proposes an epistemic dimension space for musical devices using again seven axis (e.g. expressive constraints, music theory). While primarily intended to be used for systematic analysis, it also helps with the conceptual design of new instruments. Figure 2.4 shows both dimension spaces as they are published by the corresponding authors.

Wilkie et al. (2010) approach music interaction design using image schemas and conceptual metaphors. They discuss a methodology for the systematic identification of these image schemas and conceptual metaphors and outline areas for improvements with corresponding suggestions.

Reeves (2011) proposes a framework for rather general design of interfaces in public performance settings, which somehow also applies to music to some extent. His framework provides a terminology to describe interaction in a public setting (e.g. centre-stage, behind-the-scenes, front-of-house) and different roles that are involved (e.g. actor, participant, audience, bystander, orchestrator).

Another example which is not directly related to audience participation in music but interaction design for crowd collaboration is work done by Maynes-Aminzade et al. (2002). They investigated various techniques for participation of a huge audience. Their paper concluded with, "a set of design principles for interactive crowd activities" (2002, p.20). Although their research happened in a non-music domain, the principles of how to design audience participation are also relevant for this thesis.

As we can consider participatory performances as special form of collaborative music making, a framework for interconnected musical networks by Weinberg (2005) is relevant

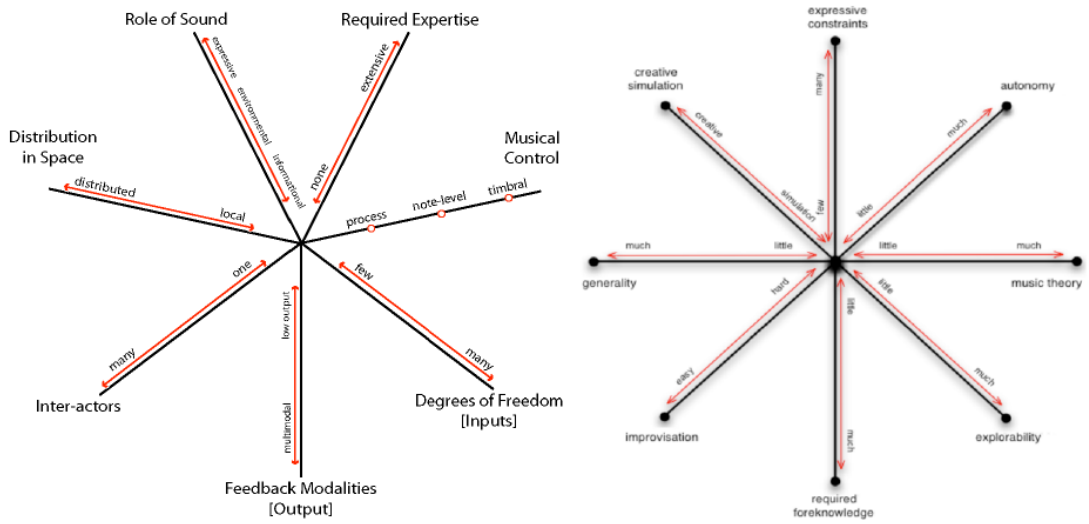


Figure 2.4: Dimension spaces: phenomenological and epistemological (right)

too. He does not come up with a theoretical framework but fundamental aspects, as he says, that form the basis for such a framework. He explicitly suggests, "If the field is to continue to grow, then composers, performers, and audiences will require a solid theoretical framework of reference when composing, designing, participating in, or listening to interconnected musical networks." (Weinberg, 2005, p.38)

The most explicit formal description within the field of TMAP in live music is presented by Mazzanti et al. (2014). They propose *six metrics* to describe and evaluate concepts for participatory performances. By doing so, they directly address aspects of participatory performances conceptually and technically (e.g. system versatility, audience interaction transparency, audience interaction distribution). When talking about design in relation to participatory performances, Mazzanti points out how choices in terms of paradigms and technology "can deeply influence the whole piece experience" (Mazzanti et al., 2014, p.29). However, in the research context of their work, they do not use their metrics for design but to evaluate their own system to mediate audience participation and four others.

The range of the reviewed frameworks addressing different aspects in the context of music and technology shows that there is some agreement that such frameworks can be valuable for various purposes, such as design, description, or evaluation. However, with TMAP in particular, there are only Mazzanti's metrics explicitly dealing with the description and evaluation of systems for audience participation, but have not been used for the design of TMAP.

As with Reeves (2011) and Mazzanti et al. (2014), we think it is necessary to study TMAP in the context of actual live performances. Hence, we conclude this review with existing work about studying musical performances in different ways.

2.6 Studying Live Music Performances

Dogantan-Dack (2012) presents "artistic research on live music performance", which he defines as "under-researched area within contemporary music" (p.34). He discusses common methods such as questionnaires, interviews, and observational studies as appropriate methods for the documentation and analysis of live music. He further underlines the importance of audio-visual documentation to study live performances, but at the same time points out the problems of turning the "live performance into a recorded one" (Dogantan-Dack, 2012, p.40).

When studying a public art installation, an interactive storytelling event, a scientific and artistic performance, and a performance art game, Reeves (2011) conducted a "hybridised form of video analysis" (p.33) combining video-based analysis and questionnaires. He defines the "roles of performer and the spectator" as "setting the two in a simple relationship involving perception of manipulations and effects" (p.158).

A similar approach was taken by Sheridan et al. (2005) when studying performance and technology in "playful arenas, such as nightclubs" (p.1) by observing the interaction between participants, performers, and observers and recording the data on paper and with a video camera. They conclude that "performance and play can be read as basic human functions. They fulfil a need in us for self-expression" (Sheridan et al., 2005, p.14). Live and video-based observations were used by Koleva et al. (2001) when studying a professional touring mixed reality performance.

Ethnographic approaches to study performances were described by Benford et al. (2012) with traditional Irish music sessions in different cultural settings, such as galleries, festivals, and city streets (Benford et al., 2013), and Ahmed et al. (2012) who studied the work of nightclub DJs. Such ethnographic approaches are suitable to document the interaction between promoters, venues, audience, and performers.

From a psychological point of view Gabrielsson (2003) recommends, "we should not only strive to find broad 'lawful' relations in music performance but also study the characteristics of single impressive performances" (2003, p.258). Palmer (1997) describes important aspects and problems that appear when studying musical performances. She explicitly points out that a "methodological problem is determining which performances should be considered representative, given the large variations that can occur among competent performances of the same music" (p.118). This leads us to different approaches to study specific genres, styles, and settings of performances.

Thompson (2006) used questionnaires to quantitatively evaluate the performance experience of the audience of an orchestral live concert. Pedersen and Hornbæk (2009) as well as Zappi et al. (2011) did an after concert evaluation with questionnaires to get an insight on the experience of the audience when using newly developed technology during performances. Knapp et al. (2009) used physiological and kinematic data of performers and audience to monitor the emotions during three different performances.

When thinking about different kinds of music, whether in relation to genres, styles, or settings, it also raises the question of aesthetics. From an art-based research perspective, "science focuses on what can be objectively measured, art emphasizes the unique and

immeasurable aesthetic qualities of a particular work" (McNiff, 2007, p.35).

Laszlo (1967) uses the terms "meaning" and "enjoyment" to discuss the aesthetic quality of music and underlines the subjectivity of the individual in this relation. He says, "music can give rise to such enjoyment only if it has some quality which appeals to the listener and makes for his appreciation" (p.262).

An example how studying participatory performances and the spectator's experience is related to aesthetics, is provided by Breel (2015). In particular, she discusses the aesthetic form of a participatory performance. As part of a case study she presents a mixed method approach that consists of audience observation during the performance, spectator feedback directly after it, and a memory study over a certain period time. She concludes her insights with, "examining the audience experience of participation is therefore essential for a better understanding of participatory performance as an aesthetic form" (Breel, 2015, p.381).

Thus, there are many different approaches to study musical performances. These approaches show the mixture of methods being used to study live performances. Furthermore, we cannot identify a common denominator in terms of how to study live performances *ideally*. Authors rather use methods and critically reflect on their experiences and point out the challenges of studying live performances.

2.7 Conclusion

From reviewing the literature and reports of practitioners, we have identified diverse issues relevant to the design of TMAP. Weinberg (2005) pointed out the need for a theoretical framework in relation to interconnected musical networks.

The only available formalisation in the context of TMAP to the best of our knowledge are six metrics by Mazzanti et al. (2014). These metrics, however, were defined to "describe and evaluate technological and conceptual platforms used by participatory performances" (p.29). According to that, they have not been used for the actual design of systems to mediate audience participation.

Furthermore, there is a growing number of diverse examples for TMAP. Some of these examples stand for themselves as artwork or contribution of creative practice. Other examples are subject to research and reflected on particular issues, such as user experience or interaction design.

However, there is no coherent exploration and overarching analysis of TMAP in live music. None of the existing approaches describe the design space of TMAP in live music in depth or consider different perspectives such as composers, performers, and audience.

In conclusion, we propose to explore the design space of TMAP broadly and to concern different perspectives of potential participants, various approaches towards design, and existing paradigms in this context. On this basis we can construct a framework rich in detail to describe the design space of TMAP in live music and evaluate its potential to support design-related processes.

2.8 Summary

We started this review of related work with a broad view on participation in performances. While mainly focusing on live music, we also looked at interactive (sound) installations or non-music performances and consider them as relevant in parts. The use of technology for audience participation pointed to different examples using mobile devices or sensor-based systems, but also interactive performances combining sound and visuals, or pieces purposely written for TMAP. Overall, there is a wide variety of ways to enhance the involvement of spectators during the performance of live music but no coherent exploration and overarching analysis.

In relation to musical interaction we reviewed research about musical instruments and their design, as they are central elements to facilitate interaction in music. Studying design issues in musical interaction, led to approaches to formally describe musical instruments and interaction in music. This work mostly conceptualises abstracted and theoretical frameworks that consider the design of musical interaction in general. Although there is one approach to formally describe participatory performances, research in this distinctive area of interaction design and the provision of guidance for designers is at present highly limited.

Finally, we reviewed work around research in the context of live performances. These references found in literature are central to this thesis research and will inform the methodology to a large extent as we discuss in the next chapter.

CHAPTER 3

Research Approach

This chapter gives an overview of the applied methods throughout this thesis research. Furthermore, it contains methodological considerations covering challenges, limitations, and opportunities with respect of the constructivist philosophical background the overall research agenda assumes. Finally, it summarises the data collection and analysis methods with a particular focus on how different methods were combined.

3.1 Methods Overview

Following the aim of this research to better understand the issues involved in the design of technologically-mediated audience participation (TMAP), this thesis follows a research through design approach (Barab, 2014; Durrant et al., 2015) and combines different methods to explore and describe this design space. On the one hand, these research methods generated lots of qualitative data (e.g. interview notes, notes from video analysis, notes from students' reflections) as described later in section 3.3. On the other hand, we relied on different kinds of prototypes ranging from technology probes deployed in in-situ studies to drafting and evaluating specially produced design cards (see Figure 3.1).

Two main strands characterise the overall methodology of this thesis research, described as *field exploration* and *framework construction*. The field exploration contains four field studies to explore the design space of TMAP in live music. The second strand serves the construction of the TMAP Framework to describe this design space. We will continue with looking at the rationale behind those two strands, the applied methods, and how they relate to each other. A detailed description of the applied methods of the single studies are motivated in each respective chapter.

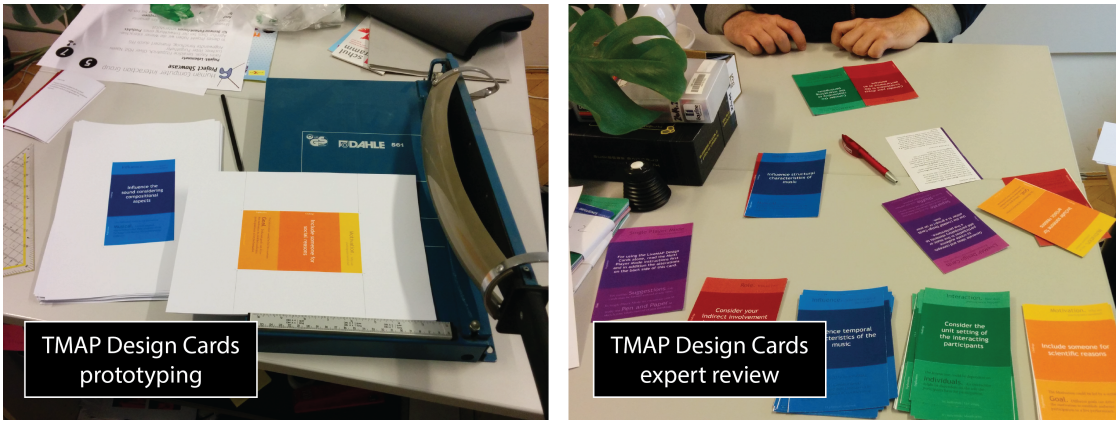


Figure 3.1: Prototyping and reviewing the *TMAP Design Cards*

3.1.1 Field Studies for Bottom-Up Exploration

The primary purpose of the field studies was to explore the domain of TMAP in live music, to use these insights later during the construction of a descriptive framework called *TMAP Framework*. From the review of related work we knew about various examples of TMAP and approaches to deploy and probe new technologies that create a certain artistic impact. For this research, however, we decided to study the design of TMAP using a bottom-up method without looking at particular designs, but to consider the requirements of people and how they are concerned about TMAP in general. The main idea was to start the exploration having a rather broad view on TMAP and stepwise narrow down to study salient issues from particular angles through the field studies.

Hence, the first two studies were planned as sequential mixed methods approach (Creswell, 2009, p.14). A series of in-depth interviews with musicians and spectators were intended to collect qualitative data about particular themes involved people are concerned with (Adams et al., 2008, p.153). To further investigate these themes on a broad basis, a survey of spectators and musicians helped to collect quantitative data. With the interpretation of tendencies and trends within the survey result, we could derive actual implications for the design of TMAP.

Two in-situ case studies characterise the second part of the field exploration research strand. We used them to further explore TMAP in real world scenarios. For the first case study, we continued the user-centred research strategy by using a participatory design approach (Sanders, 2002; Muller and Druin, 2003). From the interviews and the survey we already knew about the requirements of spectators and musicians in terms of the design of TMAP. The rationale for this case study was to shed light on what is desirable "during or after design work itself" (Gaver, 2012, p.942).

According to what was learned from the first case study, we designed another case study to explore TMAP from a different angle. This new angle was to focus on artistic processes around TMAP rather than the actual design, as we did in the previous case study. With the reflection on the composition of a song for TMAP and its performance, we

could round out the exploration of TMAP as anticipated by considering the requirements of people involved and studying the design of TMAP from different angles.

3.1.2 A Framework as Top-Down Construction

The second methodological strand of this thesis was a construction of a descriptive framework for TMAP in live music. Such a framework should serve two purposes. Firstly, it should directly build on our exploration by "rendering what would otherwise be a meaningless aspect of the scene into something that is meaningful", as Goffman describes the purpose of what he calls a primary framework (1986, p.21). Secondly, this descriptive framework is intended to map out and describe the design space of TMAP in live music in such an extensive way that it serves as lingua franca within a highly interdisciplinary field (Rogers, 2012).

Hence, we decided to build the framework in a top-down manner using related work as starting point. For the construction of the framework we wanted to widen and deepen our knowledge about TMAP by systematically reviewing existing works within its broader domain. This should maximise the granularity of the framework, address the interdisciplinary nature of the field, and keep the framework largely scalable considering the field's complexity.

In order to provide a broad basis for the development of the framework, we used a systematic analysis of existing examples of TMAP using a set of ten questions to frame the analysis of concrete design characteristics. Apart from this initial systematic step, we developed the TMAP Framework mainly by iterating over the entities to create a "well-organized system" with a "balance between category size and category specificity". (Levitin, 2015, p.89). The rationale behind using categories to structure the framework is the importance of categories to minimise cognitive effort and provide usable proportions (Rosch, 1978).

The process of categorising was mainly reliant on personal experience gained through the field studies, where we identified various issues, challenges, and strategies that concern the design of TMAP in practice. To complement the subjective task of balancing entities, we additionally reviewed the framework with an expert during development.

To evaluate the framework by applying it in practice and at the same time improving its quality and coherence iteratively, we decided to do this as formative evaluation. As part of this formative evaluation, we reviewed the framework with different experts and applied the framework in practice for a classification exercise and a card-driven design task.

Figure 3.2 gives an exemplary insight of two different stages during the development and evaluation of the TMAP Framework. The left image illustrates annotated printed drafts of the framework as they were continuously used and produced during the development and improvement of the framework. The right image shows a screenshot of the web-based version of the framework as it was used in the classification tool TMAP Online. This tool was specially developed to evaluate the TMAP Framework in practice and further contains functionality to support the analysis of the classification exercises as in detail explained in the respective Chapter 9.

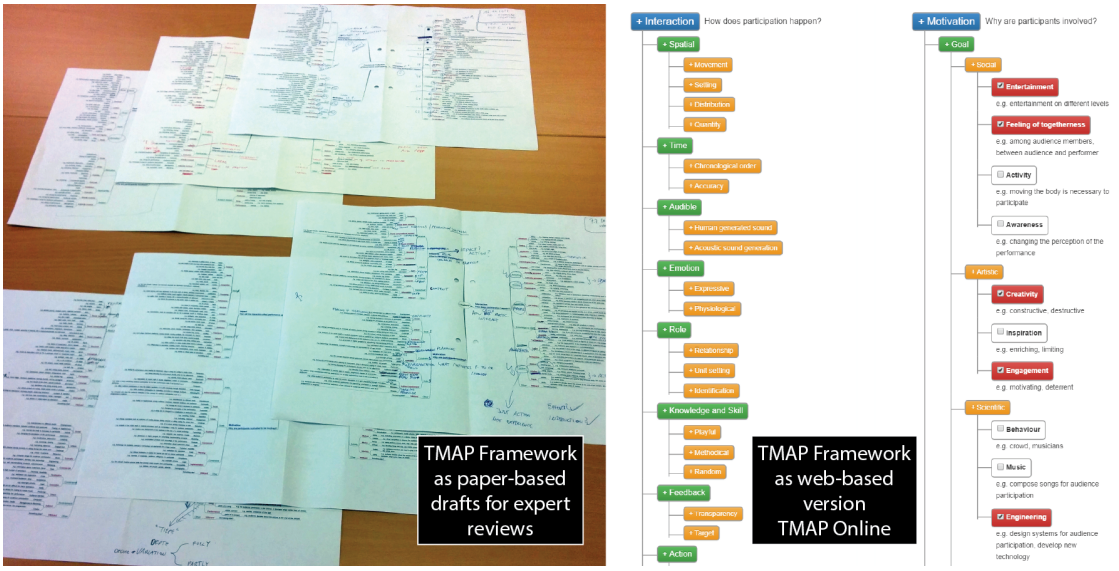


Figure 3.2: Different presentations of the TMAP Framework

3.2 Methodological Considerations

After a brief overview of the methods applied within this thesis research and how they are used throughout the two main strands of exploration and construction, we continue with a closer look on challenges, limitations, but also opportunities that are central to the methodological choices of this thesis research.

3.2.1 Challenges

Epistemologically, this thesis follows a constructivist research paradigm. Most applied methods are qualitatively oriented and those which are quantitative, are somehow combined with the qualitative ones. For instance, the survey, which can be considered a typical quantitative method, was not used to test any hypotheses but rather to find tendencies and trends through a descriptive analysis of the data.

However, this methodological approach and combination of different methods throughout the field studies is not uncommon for the exploratory nature of this research. In addition, this aligns with other approaches evidenced by literature using a mixture of methods to study such a complex field as live performances.

In a recent work about performative experience design (PED), this problem is spelled out explicitly as, “Neither HCI nor performance studies alone provide a satisfactory methodological approach for exploring the possibilities of PED, which embraces and intertwines the methodological premises of both disciplines.” (Spence, 2016, p.99) The author continues with methodological consequence, “The result is a method that resembles the steps of a user-centred design process at the same time as it evokes an overarching approach to practice-led performance research.”

To a large extent this also applies for the methodological approach of this thesis research to a large extent. According to the goal to study the design space of TMAP, it is inevitable to study live performances. To understand how successful or at least meaningful the design of TMAP works, its evaluation in practice within the live setting it is designed for is crucial. Here, we see another parallel to Spence's PED methodology where she says, "Design-oriented research and performance studies share a high regard for the value of practice, as both are fundamentally oriented towards the creation and analysis of novel works in order to advance understanding in their fields. Both value the individual agency of the creator/analyst, and both favour flexibility and novelty in their approach to the research topic."

In the case of this thesis, however, the focus lies more on the creator's side and to understand the motives and rationales behind a certain design. We are indeed aware of the importance to analyse the impact of TMAP on everybody involved, which is without any doubt relevant for the design. Nevertheless, we argue that *successful* design is hard or even impossible to achieve in a domain where technology, art, creative practices, and certain different experiences and expectations come together. As a consequence, we anticipate some limitations we are aware of from the beginning.

3.2.2 Limitations

We consider the limitations of this thesis' methodology as important to mention to guide any claims rather than being constraints or methodological insufficiencies. The methods we chose for the exploration were mainly informed by other research. Except for the auto-ethnographic method to reflect on the creative practice, the methods used during the field studies are common HCI methods to develop and evaluate technology. We used auto-ethnographic approaches in particular during the two case studies and for the construction of the TMAP Framework in combination with other methods. These other methods (e.g. surveys and observation as described earlier during the overview) helped to identify user requirements and experiences in a certain objective way.

Actual limitations concern the two in-situ case studies. They were rather focusing on concrete design issues, specific design-oriented processes, and aside from that they happened in particular genre-specific live settings. As explained earlier, the bottom-up exploration as the first part of this thesis was anticipated to end with studying only certain aspects around the design of TMAP. In this context we also refer to the methodological problem of determining which performances should be considered representative (Palmer, 1997).

Other limitations we want to discuss here, concern the construction of the framework. At no point, we claim the TMAP Framework to be representative for the design of TMAP in live music. Due to the effort of constructing the framework, however, we consider the TMAP Framework as adequate result and outcome of this research.

One particular form of constructivism, the radical constructivism, refers to this as viability, "It merely means that we know one viable way to a goal that we have chosen under specific circumstances in our experiential world. It tells us nothing - and cannot tell us anything - about how many other ways there might be, or how that experience

which we consider the goal might be connected to a world beyond our experience." (von Glasersfeld, 1984, p.5) Thus, the TMAP Framework is indeed limited to the particular boundaries of this research and how exploration of the design space happened here.

Overall, we tried to balance the rather subjective auto-ethnography with other methods to collect more objective data. These methods were the online survey, surveys after concerts, or video observation during the field exploration. For the framework construction we used an extensive analysis of existing examples of TMAP to develop the framework and expert reviews to balance the subjectivity. So, in most studies the researcher is present as per a constructivist approach, but there are a number of ways other perspectives have been explicitly brought into the process.

3.2.3 Opportunities

Parallel to the limitations just discussed from a constructivist point of view, the same epistemological theory can be used to argue opportunities that accompany our chosen methodology. A constructivist does not seek for an image of any reality but considers the researcher as an active and even influencing observer who constructs an adequate reality (Reich, 2001). This thesis makes use of this active influence of the investigator in the research in two ways, during the exploration of the design space and the construction of the framework.

During the exploration of the design space we tried to maximise objectivity by carefully using and combining methods that ensure an objective data collection and analysis, but at the same time support the research agenda to study the domain of TMAP from different perspectives. One of these perspectives was the creative process of composing a musical piece having interactive participation of the audience in mind. Methodologically, we used auto-ethnography as method to systematically analyse personal experience (Ellis et al., 2011). Most obviously this happened during the self-reflective analysis of the song Experimence in the second case study and helped us to get insights in the compositional process and creativity-driven decisions that otherwise remained uncovered.

For the construction of the TMAP Framework, auto-ethnography played a rather subtle role but not less important. Finding, wording, and balancing categories that form the framework was qualitatively driven primarily by iterating through the framework. To ensure objectivity and also increase quality, we used external sources such as expert peer reviews. Nonetheless, the construction of the TMAP Framework remained a mixture of subjective and objective assessment.

In conclusion, throughout this thesis research different and even unconventional methods were applied. We consider this approach as a unique chance to get valuable insights and a necessity given the complexity of the field. At the same time we are aware that it decreases the possibility to generalise results.

Ch.	Study	Data Collection
4	Interview study	semi-structured interviews in person
5	Survey study	structured interviews as online survey
6	In-situ case study 1	video data, after concert interviews with questionnaires
7	In-situ case study 2	video data, after concert interviews with questionnaires, system logs
8	Framework development	systematic analysis of related work, expert reviews
9	Framework application and improvement	classification exercises, documentation and photographs of design sessions, expert reviews

Table 3.1: Overview of the collected data for the studies in this thesis

3.3 Data collection and Analysis

We collected different kinds and amounts of data during the studies of this thesis. Table 3.1 gives an overview of the data collected during the single studies. We proceed with a summarising description of the data collection and analysis of all studies. In addition, each respective study chapter contains detailed information about how we collected and analysed data in particular.

During the field studies, we mainly relied on data we could analyse qualitatively and collected this data by asking and observing people. In terms of interviewing people to collect data, the main difference was that for the first study we conducted semi-structured interviews as we had enough time to let the interviewees talk freely. The intention was to collect as many information as possible about their opinion and requirements in the context of live music and TMAP. In practice, these interviews were audio recorded with additional handwritten notes (see Figure 3.3) and transcribed afterwards for a thematic analysis.

In a different way data collection happened when interviewing people as part of the two case studies at live concerts. Due to time constraints during these in-situ studies and to maximise the number of interviewed people, we conducted these interviews using short one-page questionnaires. Nevertheless, most questions of these guided interviews were open and the questionnaires were transcribed for a thematic analysis. Only with the second case study we could analyse some parts of the data quantitatively. In particular, spectators were asked to additionally rate their experience using scales and collected demographic data.

The survey study described in Chapter 5 was the only completely quantitative oriented study. To analyse the online survey of this study, we used descriptive statistics. We considered these results as important to complement the initial interview study and identify tendencies and trends asking a bigger sample than just eight spectators and musicians. This survey was the only study which was solely quantitatively analysed,

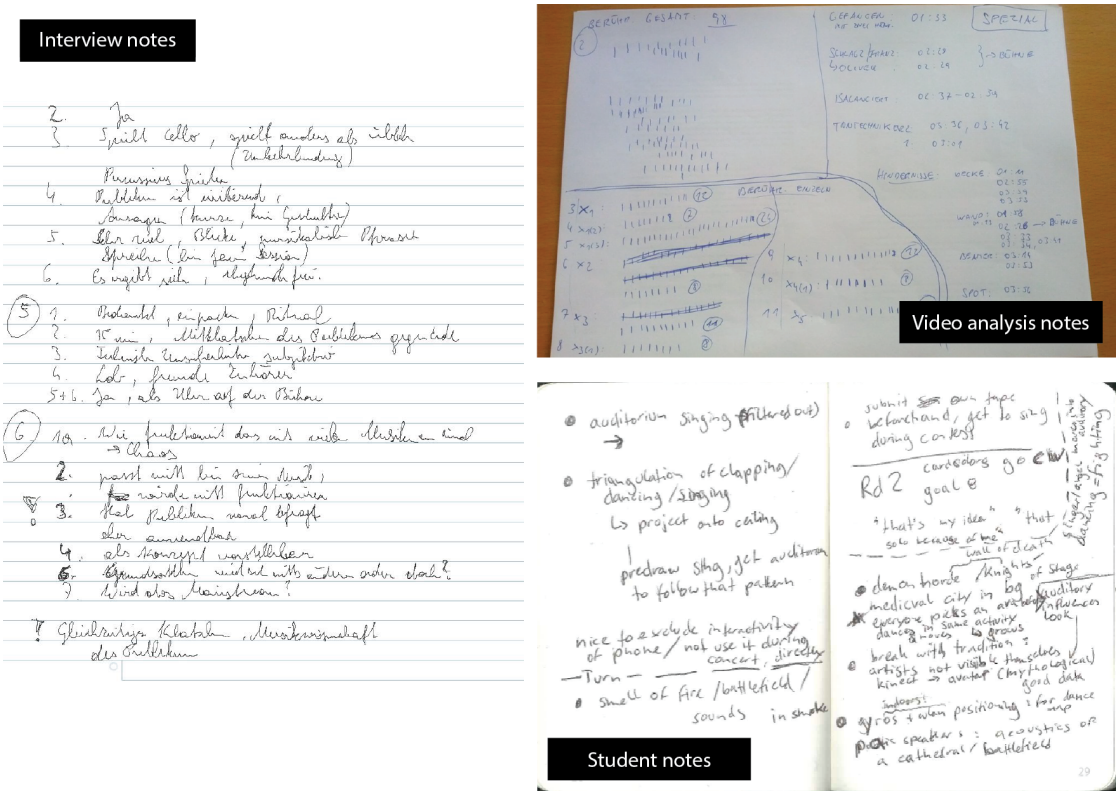


Figure 3.3: Examples of qualitative data collected throughout different studies

while with other studies we used quantitative data (e.g. rating, demographic information) to complement the qualitative content analysis. In consequence of this strategy we used descriptive analysis to make sense of the survey data and did not use comparative statistical methods. The survey study was already designed in a way to analyse its outcomes using descriptive statistics.

Video observation was the most important data source for the two in-situ case studies. According to other research, audio-visual observation combined with questionnaires is a common method when studying live performances (Sheridan et al., 2005; Reeves, 2011; Dogantan-Dack, 2012). For the actual video analysis we did not use any particular analysis tools but video editing software to combine different angles in one video for a better overview of the setting. Exemplary still images are presented in the respective chapters. We watched the videos iteratively for analysis and focused on different kinds of non-verbal interaction of spectators such as body movement, gestures, expressions, and gaze. We documented the results of this analysis taking notes with timestamps (see Figure 3.3).

As we can see in the overview of the collected data in Table 3.1, we used different data sources for the development of the TMAP Framework and its formative evaluation when applying it in practice and improving it. As basis to develop the framework, we

used a systematic review of related work. However, the actual creation of the framework was qualitatively driven. In particular, this was a process of creating, balancing, and extending categories informed by the issues identified throughout the field exploration and the input of an expert.

The first step of the formative evaluation was a classification exercise with students using the TMAP Framework. While we used examples taken from literature to inductively build the framework, we used these and other examples deductively for the first step of the evaluation. As during the development, discussions with different experts reviewing the TMAP Framework remained an important source for improvement.

During the evaluation, qualitative work with experts played another important role for the creation of the *TMAP Design Cards*. The creation of this practice-oriented version of the TMAP Framework was important to use the framework for the actual design of TMAP. In fact, it was important to hand these cards over to students and let them explore the design space of TMAP on their own. The documentation of these design sessions and their written reflections (see Figure 3.3) were a unique chance to review the value of the TMAP Framework and to complement the peer reviews of experts.

3.4 Summary

In this chapter we discussed the overall research through design approach this thesis follows methodologically. At the beginning we presented an overview of all methods as they were used throughout the thesis. As part of this overview, we introduced the two main strands that characterise the research approach: the exploration of TMAP through field studies and the development of the TMAP Framework including its formative evaluation by applying the framework in practice and improving it throughout the evaluation. After this overview, we described the methodological considerations in the context of the philosophical background behind the research methodology of this thesis. We did this by considering the challenges, limitations, but also opportunities of the chosen methodology such as auto-ethnography to reflect on creative processes. Finally, this chapter concludes with the way how data was collected throughout the studies and how this data was analysed using qualitative and quantitative approaches.

All study chapters of this thesis contain a separate explanation of the methods and how they were applied. The purpose of this chapter was to discuss the overall design-based research methodology, to describe the mixture of used methods, and how the methods are related to each other in the context of the whole thesis. We continue with the first field study that explores stakeholder perspectives.

Part I

Field Exploration

CHAPTER 4

Exploring Stakeholder Perspectives

This chapter describes an interview study that qualitatively explores issues around live concerts and technology-mediated audience participation (TMAP) from the perspective of potential stakeholders. The interviews were conducted with four musicians and four spectators. The analysis and discussion of the qualitative data collected in this study exposes stakeholder requirements concerning spectators' and musicians' motivation, behaviour, and opinion in relation to live music in generaland TMAP. Furthermore, it results in potential design issues that need further investigation.

4.1 Motivation

Reviewing related work shows that technology-mediated audience participation (TMAP) has been researched in many ways. Most of these studies present particular systems and deploy them at live performances for evaluation. A primary goal of this research, however, is to explore the design space and gain a deeper understanding of TMAP in live music from different perspectives. One perspective is that of people involved. Among these people are spectators consuming live music and musicians performing it. Both roles are essential for live performed music and are a starting point to explore the phenomenon TMAP.

Our research strategy follows a typical HCI approach and intends to broaden the view on the field of TMAP in live music. By doing in-depth interviews we collect qualitative data to identify and catalogue particular themes the people involved are concerned with (Adams et al., 2008, p.153). The overall questions raised for this study are:

Q1 What is the people's motivation to go to live concerts or play live?

Q2 How do people act during live concerts and react to each other?

Q3 How do people perceive and use mobile technology during live concerts?

Q4 What do people think about technology-mediated audience participation in live music?

Interviewing spectators and musicians will give a good overview of what people think about live music and TMAP and will point out issues we have to further investigate. These interviews are a direct way to get new insights and a connection to what we already know from reviewing related work.

4.2 Interviews with Musicians and Spectators

The interviews were designed to be semi-structured (Preece et al., 2002, p.394). Our interviewees should be able to talk freely about some points instead of just answering given questions. Most important was the qualitative data about their experiences with live concerts and their opinion about TMAP.

4.2.1 Questions

The interview guideline, which is available in Appendix A, included 38 questions divided into five groups. The overall guideline structure and principle questions were the same in all interviews. Only some questions were different or slightly changed with respect to the interviewee being a spectator or a musician (e.g. "How many concert do you play/attend a year?").

The first group of questions was to give an overview of the preferred music styles and live concerts the interviewee usually attends or plays (e.g. "What do you think about music played live?"). Second, interviewees were asked about personal definitions and views on live music in general (e.g. "What is audience feedback for you?"). The third group of questions aimed on the interviewee's typical behaviour and actions during live concerts (e.g. "Describe how you play on stage?" or "Describe on what you focus during the show?"). Through the fourth set of questions they were asked to think of their last concert and tell us particular details including the use of mobile devices (e.g. "Did you use your mobile phone during the concert?" and "For what reason?"). The fifth group of questions was about their personal attitude, about audience feedback and TMAP (e.g. "What do you think about an integration of the audience in the show?").

During the final set of questions exemplary works for interactive and collaborative live music performances were shown to them. It was asked for their reactions and any further ideas these examples generated. The examples were articles or rather pieces of them (see Figure 4.1) to tease some ideas for performances utilising sensor data (Knapp et al., 2009), mobile phones (Rohs and Essl, 2007) and the World-Wide-Web (Young, 2001). These examples were chosen on purpose, because they describe interactive and collaborative systems rather than actual systems for TMAP. This should leave enough room for imagination and not suggest too much to our interviewees.

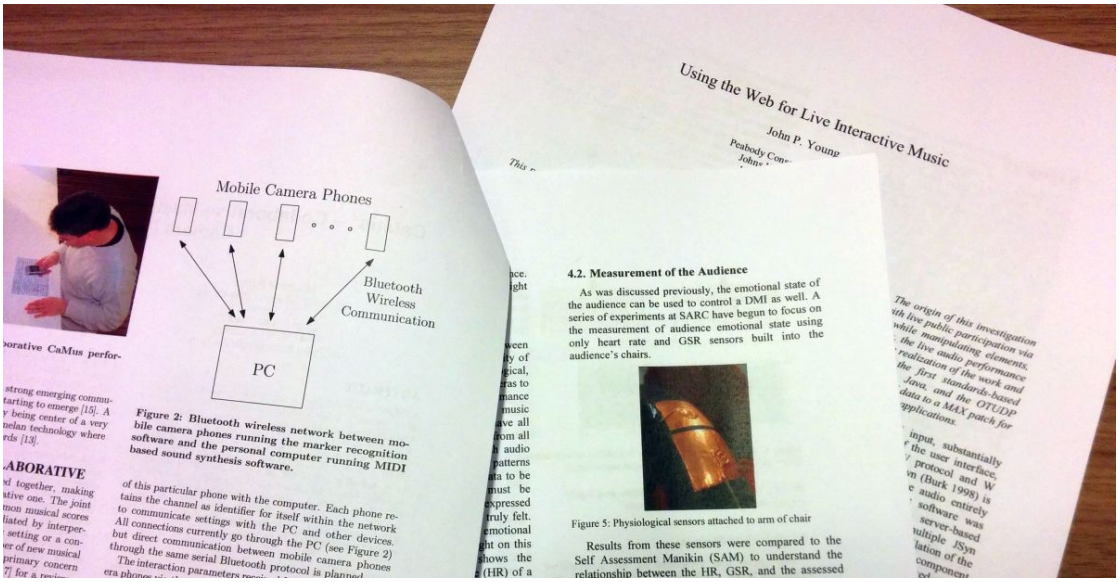


Figure 4.1: Examples as they were shown to interviewees

Code	Occupation	G.	Age	Nationality	Music Styles
S1	Secretary	f	29	UK	mainstream
S2	Student	f	24	Austria	rock, classic
S3	Student	f	20	Germany	pop, alternative, electronic
S4	Student	m	21	Austria	indie rock, electronic
M1	Artist	m	35	Italy	electro-pop
M2	Lawyer	m	33	Austria	alternative rock
M3	Artist	m	20	Austria	jazz
M4	Student	m	23	Austria	pop/rock/punk

Table 4.1: Interview participants, S1-S4 are spectators and M1-M4 musicians

4.2.2 Procedure

Eight participants were interviewed between May and June 2011. Participants were recruited through social media, an online magazine for music and art, a university and two music labels. Table 4.1 gives an overview of all participants and their occupation, gender, age, nationality, and music styles they play or prefer listening to. The codes S1-S4 refer to the spectators and M1-M4 to musicians.

Four of them were spectators attending live concerts regularly, defined as 5 to 15 concerts a year. The age of the interviewees ranged from 20 to 35. The other four persons were musicians who play concerts regularly, defined as about 20 to 30 concerts a year. Two musicians, M1 and M3, make music for their living. The others, M2 and M4, play music regularly live, but as a hobby. M1, M2, and M4 are guitarists and M3 plays cello.

Motivation pattern	Themes
Social	meeting people, having fun, be part of a group, see artist, money
Music	live experience, hear familiar/new music, emotion through music, sound/performance quality
Entertainment	show/performance, special experience/excitement, involvement/interaction with artist, venue

Table 4.2: Spectators' motivation patterns and themes

Each interview took about 45 to 60 minutes and was audio recorded. For the analysis all interview audio records were transcribed. Note that some excerpts quoted below have been translated into English, as six out of eight interviews were held in German. The open source software Weft QDA[1] was used for a thematic and comparative analysis to find out the important as well as controversial themes of both groups in relation to their experience with live concerts.

4.3 Results

The results are presented in three parts guided by the research questions of this study. First, the focus lies on statements referring to the musicians' motivation to play and the audience's motivation to visit live concerts (addressing Q1). Second, it is looked at their behaviour during live concerts (Q2), and third, at their opinion about mobile technology at live concerts (Q3) and TMAP (Q4). Within each part spectators and musicians are treated separately.

4.3.1 Motivation for Live Music

Spectators

The analysis, why spectators go to concerts and what they like or dislike, resulted in three overall motivation patterns: social, music, and entertainment. These three patterns are summarised with their respective themes in Table 4.2.

Statements referring to social patterns were, "meeting friends, having fun with others; choosing concerts I know my friends or family like; when the whole crowd really wants to see the band" (S1), "I want to 'meet' the musician" (S2), or "the feeling of being part of a big crowd and being in the middle of it" (S3). Some also mentioned negative experiences with rude or arrogant people in the audience (S1) or that they do not go to concerts if the entrance fee is to high (S1, S2, S3).

[1] http://www.pressure.to/qda (last access 15.04.2016)

Motivation pattern	Themes
Expression	uniqueness of live stage atmosphere, authenticity, emotional experience
Entertainment	entertain audience, show/performance, impact on audience
Creativity	improvisation, song selection, inspiration
Functionality	money, organisation

Table 4.3: Musicians' motivation patterns and themes

Music is the second pattern that was identified by spectators saying, "live experience of music; pop music I listen to but would not go to concert; I would never go to the concert of soundtrack music but I like this music" (S1), "I want them to play the music like on the record; to see if the band is able to play their music live; to see how music is created; be touched by the music" (S2), "like it when they improvise and do something new, not known from records; the music should be real, not perfect" (S3), or "I want to hear music not party, the show is secondary" (S4). All spectators mentioned, they dislike bad sound quality, either caused by the band (S2, S3, S4) or a bad venue (S1), and when the musicians do not play well because they are badly rehearsed (S1), drunk and wasted (S3, S4), or the band does not care (S2, S4).

The third pattern concerning spectators is entertainment. Important to them is a powerful and entertaining show, interaction with the audience (making jokes, talking to audience), and having a unique experience (S1, S2). S3 likes light effects and the atmosphere, involvement, and feeling excitement and entertainment of the whole crowd. S4 most often ignores the show. Negative experiences of the spectators in relation to their entertainment are, "no interaction with audience; bad venue where I can't see the stage." (S1) or when the musicians seem to be bored or annoyed (S2, S3, S4).

Musicians

The motivation patterns for the musicians to play live concerts and what they like or dislike of them are: expression, entertainment, creativity, and functionality. Table 4.3 summarises these patterns and the related themes emerging from the data.

In terms of expression musicians said, "rock music needs to be live; thrill; we play everything live" (M1), "it's the atmosphere, not perfectly played but authentic; getting excited and enthusiastic on stage is a kick no drug can give you" (M2), or "you can live the music as you can't do during rehearsing; I like to see when our introverted bassist starts to express himself extraordinarily on stage" (M4). M1 said in a negative context, "we could not hear ourselves, the monitoring was very bad".

The second motivation pattern is entertainment. M1 says he wants to electrify the audience and chooses songs for a gig fifty-fifty, half for himself, half for the audience. M2 thinks, "bad gigs happen, but it's in your hand as band - mostly". M3 says, "with live music the audience and musicians have different perspectives on the same thing; it's

Behaviour pattern	Themes
Expressiveness	make noise, movement, communicate with others
Observation	focus on musicians, spectators, show elements
Mobile technology use	communication, documentation

Table 4.4: Spectators' behaviour patterns and themes

great to see excited people; mostly focus on playing" and that entertainment might fail if it is the wrong audience.

Creativity is the third motivation pattern and musicians said they, "have a fixed set list; sound files and effects are predefined, no improvisation" (M1), "we use set list as form of dramaturgy; sometimes we change songs spontaneously live on stage" (M2), "improvise a lot; often no set list, selection of songs spontaneously on stage" (M3), or find "live concerts are inspiring; I like the inspiration of the on-stage-situation and the audience" (M4).

Finally, there is functionality as motivation pattern as musicians mentioned they need to earn money (M1, M3) or they experienced lousy event organisers in relation to bad live concerts (M2).

4.3.2 Behaviour at Live Concerts

Spectators

There are three behaviour patterns: expressiveness, observation, and mobile technology use. They are summarised through the identified themes in Table 4.4.

All spectators said they like dancing and clapping at live concerts. About being expressive and active S2 and S4 added, they only clap, dance or stand up (S2) when others start to do so. Cheering and shouting was mentioned by three spectators (S1, S3, S4). S1 said she most likely cries "encore", tries to make noise, and "I like to be involved in a concert, don't like to stand on the edge". S3 likes to express excitement actively and finds it important that the musicians see people having fun. Even more expressive is, "jumping together" (S1, S4) or "headbanging" (S3). S4 says he is active and does not close his eyes for enjoyment. In terms of communication with direct neighbours S1 prefers smiling at each other or put arm around each other if romantic. S1 and S4 like talking to other friends around them and making small comments.

Statements about a rather observational and passive behaviour were "focus on the singer mostly, never watch the drummer" (S1), "I observe everything, the band, other spectators, the stage design, styling and clothes of musicians, their instruments; I prefer to watch the drummer, drumming fascinates me" (S2), "watch at the instruments to see which ones and how many" (S3), or "mostly focus on singer" (S4). Finally, spectators reported about the use of mobile technology, in particular phones to post on Facebook

Behaviour pattern	Themes
Expressiveness	gestural/verbal communication, embodied interaction
Thoughtfulness	observation, non-verbal communication, concentration

Table 4.5: Musicians' behaviour patterns and themes

(S1), writing messages to others (S2, S3), making pictures (S1, S3, S4), or S4 said he "once recorded a full song".

Musicians

Behaviour patterns among musicians are either expressiveness or rather thoughtfulness. This concerns the communication with other musicians as well as the spectators and what they expect from them. Table 4.5 summarises the musicians' behaviour patterns and themes.

Communication with the audience happens through clapping in time to motivate the audience (M1, M4), "dance, non-verbal; no particular interaction with the audience" (M1), and "beside the usual applause you feel the appreciation of the audience; eye contact with spectators" (M2). M2 and M4 said they step down from the stage with their guitar and M4 added, "let someone off stage strum the last tones". In terms of rather observing the audience instead of communicating with them they said, "audience irritates me sometimes, I can't communicate with them as I would like to, I am too shy" (M3) and M4 likes to observe people if they sing along and stop playing for a moment. Both, M3 and M4, do short announcements between songs and M3 tells even short stories. M1 mentioned he likes to communicating with the audience after a concert by either talking to spectators right after the performance or look on Facebook the days after the performance.

Communication among the band was described with "talking" (M1, M2, M3), keeping eye contact and communicate by playing together (M2, M3, M4), "hand gestures" (M2), and "very intense communication with my colleague; like talking but playing, it has a certain 'flow' between us" (M3). Three musicians addressed what they expect from an audience in terms of communicating with them, "dancing, shouting, whistling" (M1), "don't like when audience is talking, they should listen" (M3), and "applause" (M3, M4).

4.3.3 Opinion about Technology during Live Music

Spectators

Finally, there are opinion patterns about technology. Those of spectators are mobile technology, TMAP in general and its particular impact on visuals, sound, or dramaturgy. Table 4.6 summarises the themes for these opinion patterns.

Regarding the use of mobile technology during live music spectators said, "better atmosphere with real instruments, it has to be done carefully; with laptops music seems pre-recorded and just played back" (S1), laptops on stage are cool, simplify sound

Opinion pattern	Themes
Mobile technology	role/importance of technology, laptop
TMAP	intensity, control, interaction, feedback, problems, imaginability
Impact on visuals	cameras/projections, light, ambience
Impact on sound	volume, tempo, electronic music
Impact on dramaturgy	song selection, emotions

Table 4.6: Spectators' opinion patterns and themes

generation and make equipment smaller (S2, S3), or S4 said a laptop as instrument does not entirely replace a real instrument, maybe with electronic music.

Asking about TMAP, rather general statements were "too much technology for interaction destroys the atmosphere" (S1), "artist must have control to switch on and off; difficult to imagine technically; I don't want to hold a device, I prefer a passive system" (S2), "I would try it and form an opinion afterwards; anonymity in the crowd could be a problem" (S3), or "I would definitely use such a device if I can see that something happens when I press a button; encryption is important to prevent sabotage" (S4).

In a similar way spectators proposed specific aspects that might be a subject of TMAP. They were summarised as impact on visuals, sound, or dramaturgy. Mentioning visuals for audience participation, spectators could imagine, "camera on the audience so that they can see themselves." (S1) or "influence light effects, the whole ambience of light the light show and projections (S3, S4). Two spectators thought that influence on electronic music could be interesting (S3, S4). S4 also said, "an interface for everyone to give feedback on volume; music could be fun but the problem might be eccentric musicians; in electronic music audience could control tempo". Finally, they addressed dramaturgy with, "it could be interesting if the audience could steer the concert but the band should have control; tell the band which songs they should play" (S1), "interactive setlist to choose songs" (S3), or "show mood of audience on flatscreens or projections" (S4).

Musicians

The opinion patterns of musicians are the same as the spectators' ones. They are summarised with their respective themes in Table 4.7.

In terms of mobile technology for live music musicians said, "I use a laptop but it needs to be combined with something, a MIDI keyboard for example" (M1), "interesting, this is our age" (M3), or "enhances creativity, you try out things you would never do, e.g. electronic music" (M4). Rather critical statements were, "technology is not fail-safe, once I had big troubles with a sound interfaces that crashed several times throughout a show" (M1), "I am an 'analogue fan', I am sceptical; technology does not trigger creativity" (M2), and "I miss the feeling" (M4). With regard to mobile phones on stage M1 reported he played snake [a mobile game], filmed this and projected the display while his colleague

Opinion pattern	Themes
Mobile technology	creativity, problems/risk, scepticism
TMAP	control, problems, denial, doubts
Impact on visuals	light, show
Impact on sound	integrity, feedback, audience sound, effects
Impact on dramaturgy	song structure, song selection

Table 4.7: Musicians' opinion patterns and themes

played loops accordingly. M2 and M4 never used mobile phones on stage and M3 only to see the time.

The general statements about TMAP were that musicians want to keep full control and there are always fools among the audience who act destructive (M1). M2 is not interested. He says, "I am the musician and not the audience." M3 could imagine audience participation if technically feasible (M3). Finally, M4 says, "it's worth a try but query whether it works with a huge audience; has to be foolproof; works better for bigger bands when spectators are more respectful and cooperative"

Analogously to the spectators the possible impact of TMAP on either visuals, music, or dramaturgy was summarised. About visuals M4 said that influence on show on stage and light effects are too expensive for an unknown band. Music was mentioned more often by them saying, "songs must be recognisable; do not want someone play my guitar on stage; could be interesting for the sound engineers to get feedback from the audience" (M1), "you could play ringtones from mobiles in the audience" (M2), "could be worth a try how it sounds when 100 people creating sounds; cannot imagine it works for my music" (M3), or "often spectators are drunk, sing along in the group is the only thing that works with them; influencing sound effects could be worth a try if the spectators can do that without musical training, such as with sing star" (M4). Statements about dramaturgy concerned audience participation on selected passages of a song (M1) or let spectators vote about a dynamic set list (M2), although not for his performance, M2 added.

4.4 Discussion

The thematic analysis of the qualitative data collected by doing in-depth interviews with spectators and musicians lead to a set of patterns. These patters concern motivation, behaviour, and opinion in relation to live music in general and TMAP in particular. The spectators' motivation and behaviour are related to live music in general and provide a deeper understanding of the broader context. Their opinion, on the contrary, is focused on the technology in live music and TMAP in particular. These patterns will be discussed and the different themes identified in terms of spectators and musicians will be compared.

4.4.1 Motivation

Several motivation patterns addressing the first research question: What is the people's motivation to go to live concerts or play live? For spectators these motivation patterns are social, music, and entertainment, and for musicians, they are expression, entertainment, creativity, and functionality. Entertainment is important for both groups. This concerns the performance and the show itself as well as the interaction between everybody involved. Musicians want to entertain the audience and create a certain impact. Spectators want to be involved and have a special experience through this interaction with the artists. Even though important, entertainment can play a minor role for some (e.g. S4, "I most often ignore the show" or M3, "mostly focus on playing"). Most likely people feel entertained in different ways and sometimes even external factors influence this experience of everybody involved, e.g. a bad venue.

Another motivation for spectators is music. With musicians it is a priori anticipated that music is central to them. In their case we distinguish between creativity and expression as motivation patterns in relation to music. The atmosphere of live music and the unique experience of this situation is a central theme. Similar is the emotional experience triggered by music, although the view on a balance between improvisation and perfection diverges on both sides. Spectators have a different view on whether music should be played as they are familiar with it, e.g. from records, or if improvisation should strengthen the uniqueness of live music. Among musicians are those who like to improvise on stage to some extent and those who prefer a thoroughly planned performance. Improvisation leads to inspiration, another important theme for musicians and triggered by the live situation (e.g. M2 and M3, "change songs spontaneously live on stage" or M4, "inspiration of the on-stage-situation").

Finally, there is a social pattern for spectators. This summarises important themes like meeting other people and be part of a group. Financial reasons were also mentioned to be decisive for visiting concerts. Money was also mentioned as being a necessity for the two musicians, M1 and M3, who make a living with music. This theme was put under the pattern functionality along with organisational issues that are most likely caused by extraneous circumstances (e.g. M2 "lousy event organiser").

4.4.2 Behaviour

The se

cond research question of this study refers to the behaviour of people during live concerts: How do people act during live concerts and react to each other? The behaviour patterns found for spectators are expressiveness, observation, and mobile technology use. For musicians were identified expressiveness and thoughtfulness. Expressiveness is a pattern both groups have in common. Spectators like to express themselves by making noise (e.g. clap, whistle, cheer) or move the body (e.g. dance, jump). A less obvious but still expressive behaviour is communication with other spectators. Here, we refer to all sorts of communication as spectator S1 said quite clearly with "smiling at each other, small comments and talking, put arm around each other if romantic." Musicians express

themselves in similar ways. To communicate with the band or the audience expressively, they use gestures or simply talk to each other. Body expression does even include to move literally towards the audience from the stage (e.g. M4 “step down from the stage with my guitar”).

On both sides patterns for a rather passive and unobtrusive behaviour can be observed. For spectators this is described as observation pattern, when they focus on various aspects of a live concert (e.g. musicians, instruments, show elements). Regarding musicians the rather passive behaviour can be found under the pattern thoughtfulness. This refers to different ways characterising a less expressive performance. These different patterns were chosen on purpose, although they refer to similar themes. Observation emphasises the rather passive role of the audience listening to the performance. Thoughtfulness of musicians, on the contrary, includes more than just observation, but unobtrusive communication among musicians and sensible concentration on the performance.

Finally, one pattern concerns mobile technology. All spectators mentioned the use of mobile phones during live concerts. Some use their phones for communication with others and some to document the live experience by making pictures or even recording the music.

4.4.3 Opinion

The third and fourth research questions address people’s habits around mobile technology and their opinion about TMAP in live concerts. The first questions was: How do people perceive and use mobile technology during live concerts? The second asked: What do people think about technology-mediated audience participation in live music?

Five opinion patterns were defined, which are the same for both, spectators and musicians. Two patterns, mobile technology and TMAP, are rather general. The other three are more specific and describe a possible impact of TMAP on visuals, sound, or dramaturgy.

With mobile technology, spectators mainly think of laptops and are mostly concerned about a balanced use in a live performance compared to *traditional* instruments. Musicians were rather specific and see the potential for creativity, even if not for their own performances. Nevertheless, they are sceptical and aware of possible problems.

With TMAP both, spectators and musicians, see possible problems and issues, such as a control or intensity of influences. Spectators are mainly concerned about their feedback and how it might work (e.g. S4 “I would definitely use such a device if I can see that something happens when I press a button”). Musicians are rather sceptical remarking their doubts up to complete rejection (e.g. M3 “I am the musician and not the audience”).

Speaking of an impact on visuals, sound, or dramaturgy, there are high similarities. The themes both groups think of mostly are influencing the light show or the song selection. In terms of sound, musicians are reluctant, while spectators pointed out actual musical elements (e.g. volume or tempo) they could think of being influenced by them.

4.4.4 Conclusions on Patterns

In conclusion, we can see certain tendencies and differences among the patterns, which appear to be even more strong in some cases. However, we cannot draw definite conclusions or make generalisations given the small sample and qualitative nature of this study. What we do know are particular requirements of spectators and musician and which issues were identified to investigate deeper in further studies.

Both, musicians and spectators, pointed out the special experience when music is played live and the importance of human elements in live music, most notably when computers are used. The spectator's motivations to go to live concerts are divergent and even widely different in terms of entertainment. Concerning the musicians and their experiences to play live concerts, we can see a tendency to enjoy a unique situation.

The analysis of behaviour and habits during concerts illustrates a strong tendency among all spectators to use a mobile phone for various reasons. Nevertheless, we still do not know at which point or how often this happened during the performance.

Ways and technical means to facilitate audience participation is a controversial issue. The spectators' opinion about TMAP in live concerts in general is more open-minded than the musicians' opinions. Interactive elements during a performance were even seen as a chance and opportunity by the spectators, albeit in different ways. They were mainly concerned about the actual way TMAP is implemented and how they perceive the interaction. This importance for noticeable feedback is also evidenced in other literature as a prerequisite to avoid frustration (Lee and Freeman, 2013).

The musicians on the other side tended to scepticism and refusal. They mainly expressed a certain fear to lose control and a lack of trust in the audience. This scepticism towards letting spectators significantly influence a performance is also evidenced by literature in the field (Breel, 2015).

4.5 Summary

In this chapter we described an interview study to explore the field of live music and TMAP from the perspective of spectators and musicians, who represent two important groups of people involved. The results of this study are *stakeholder requirements* concerning spectators' and musicians' motivation, behaviour, and opinion in relation to live music and TMAP. These requirements are a first step towards a deeper understanding of TMAP in live music and will motivate and guide further studies.

In terms of particular *design issues* we identified, it can be stated that audience members frequently use their mobile phones, particularly smart phones, during a concert. Their opinion in relation to TMAP is ambiguous and distinguished in terms of understanding and getting a clear feedback. The musicians on the other hand are far more sceptical towards new ways of audience participation, even though not categorically rejecting it. They are more concerned about possible problems and technical feasibility. These requirements and design issues will be taken to the next study, which will explore potential issues in more depth.

4.6 Contributions

1. *Stakeholder Requirements*: These requirements describe issues and themes spectators and musicians are concerned with in relation to live concerts and TMAP distinguished into motivation, behaviour, and opinion.

2. *Design Issues*: By discussing the identified requirements, potential design issues could be exposed that need further investigation (e.g. mobile phones, scepticism towards TMAP, possible impact on performance elements, conceptual and technical feasibility of TMAP).

CHAPTER 5

Identifying Design Implications

In this chapter we describe a survey with the goal to collect quantitative data about live music and technology-mediated audience participation (TMAP). We present the results of surveying 169 spectators and 58 musicians by using an online questionnaire. With a descriptive analysis of the data and discussing the results we were able to identify challenges and potential directions for design of TMAP in live music.

5.1 Motivation

The interview study described in the previous chapter led towards potential issues concerning spectators and musicians in relation to live music and technology-mediated audience participation (TMAP). These issues are the use of mobile technology, diverging attitudes towards TMAP and concerns about the actual impact and its technical realisation. Furthermore, there are motivational and behavioural differences in terms of live concerts among spectators and musicians. To further investigate these issues, spectators and musicians will be surveyed to collect quantitative data. By interpreting identified tendencies and trends within these result (Creswell, 2009, pp.12-14), further implications for design of TMAP will be derived.

As part of the results of the qualitative interviews, stakeholder requirements are presented and describe motivation, behaviour, and opinion of spectators and musicians in relation to live music and TMAP. These requirements will guide the questionnaire design and inform the research questions of this study:

Q1 Which musical, motivational, and behavioural tendencies can be identified among spectators and musicians in relation to live concerts?

Q2 How do spectators and musicians use mobile technology during live concerts?

Q3 Which tendencies among spectators and musicians can be identified in terms of particular use of TMAP?

Q4 Which possible implications emerge for the design of TMAP?

Answering these questions on the basis of the survey results will contribute to this research in two ways. First, we can draw conclusions on issues that concern the design of TMAP. Second, we will be able to identify potential design directions that inform further studies. We continue with a description of the survey concept and results.

5.2 Survey

The survey was given the title "Interactivity in Musical Live Performances" and was planned to be conducted online. Not mentioning audience participation beforehand was on purpose to reduce any prejudice. The full catalogue of all questions and exemplary screenshots of the questionnaire are available in Appendix B.

5.2.1 Questionnaire

The questionnaire was designed in a way that basic information was asked at the beginning, followed by questions about music-related information in general and live music in particular, and finally targeting on audience participation in live music. The first part of the survey, mainly demographic and music-related information, can be described in three sections:

Basics: This included demographic information about age, gender and educational qualifications as well as asking if the participant plays any instrument or has vocal training.

Selection: The questionnaire was designed to be filled out from either a musician's or spectator's perspective. After filling out the basic information, participants had to choose in which role they want to continue. They were asked whether they consider themselves more as "visiting concerts and being part of the audience" or "performing live music, being an artist/musician and playing live concerts on stage". The subsequent questions were the same for both groups, although slightly different asked according to the chosen role (e.g. "How often do you attend a live concert approximately?" for spectators and "How often do you play a live concert approximately?" for musicians).

Music: These questions, mainly multiple choice, asked about favourite styles of music and how often and regularly they attend live concerts or play them. Those who are playing instruments were asked, which particular ones.

In the second part of the questionnaire the participants had to rate various statements from their point of view and experience using different scales such as *strongly agree, tend*

to agree, neutral, tend to disagree or strongly disagree or *every time, often, sometimes or never* (Porst, 2011, p.69; Rossi et al., 1983, p.209). These statements were primarily based on the interview results and the identified requirements, but also enriched by literature that investigates experiences of spectators attending musical live performances (Burland and Pitts, 2014). The sections of this part are:

Motivation: To identify any tendencies of motivation in relation to live concerts among spectators and musicians, the following questions were asked: (1) Why do they go to concerts or play them, and (2) What do they expect. 12 statements were formulated, why spectators might go to live concerts or musicians play them, and separated into three categories. These three categories correspond to the three motivation patterns we extracted as part of identifying requirements during the interview analysis. For spectators the categories were social, music and entertainment. For musicians there was used expression, entertainment and creativity. The fourth pattern functionality, found for musicians, was left out. The reasons for this decision was to keep the number of categories between spectators and musicians balanced and because we did not see an additional value for the purpose of this study in asking musicians about necessities of playing live (e.g. earning money).

Behaviour: To find out more about how spectators and musicians feel and act while attending or playing live concerts, they were asked about their behaviour during particular kind of songs. To this end, two particular situations were defined, the participants had to think of when rating the statements: (1) a ballad that touches you deeply, and (2) a fancy song, which really rocks.

Technology: In this section, spectators were asked if, for which purpose, and how often they use a mobile phone during a live concert. All spectators mentioned mobile phones during interviews. Musicians, in contrast, were asked about mobile technologies in general, if they use them for their performances and for which purpose.

Opinion: Finally, both spectators and musicians were asked about TMAP. First, they were asked to what extent they could imagine that particular aspects of a performance can be modified by the audience (e.g. “colour of the light spots”, “order of songs”). Again, the requirements identified during the interview analysis were used to formulate the statements using the categories visuals, sound, and dramaturgy. Second, they had to think of future innovations and how this influence could possibly happen. With the statements of the last questions, participants had to rate diverse approaches towards audience participation, such as moderate ones (e.g. “voting during the concert”), but also more provoking ones (e.g. “my breathing rate”) to get their reaction. According to what was learned about the scepticism towards TMAP from the interviews, there was no intention to confront the musicians especially unprepared with ideas that might offend their artistic integrity. Hence, this statement rating for musicians was introduced with a short explanation, “Imagine the audience could have control of certain parts of a concert

(but you can make the final decision whether to let them or not)". Apart from this difference, the statements for both, spectators and musicians, were the same.

Technically, the web-based survey tool LimeSurvey[1] was used, which was hosted on a web-server of the Vienna University of Technology. Participants could choose between a German or an English version. Different channels, mainly Austrian, were used to distribute the survey link.

Among these channels to distribute the survey were mailing lists of institutions and projects (Vienna University of Technology, University of Music and Performing Arts Vienna, University of Music and Performing Arts Graz, University of Nottingham, The Electroacoustic Project and NIME), personal contacts of researchers, and social media. Furthermore, a distribution by companies in the music business (e.g. labels, concert organiser), music related magazines and broadcasting stations was requested. These inquiries mainly remained unconfirmed, though.

5.3 Results

The survey was carried out online over a period of three weeks in September 2011, resulting in 254 responses. For the analysis, incomplete responses (27) were excluded, which left 227 complete datasets (169 spectators, 58 musicians).

5.3.1 Analysis Approach

For the analysis of the results descriptive statistics and mainly quantitative methods will be used. These descriptive statistical methods include the illustration of frequencies of responses in bar charts showing the percentages of the whole sample. For some questions with many different response possibilities to rate statements, statistical measures of central tendency were calculated for easier interpretation and summarised in tables instead of using separate charts. In particular, mode (Mo)[2], median (Md)[3], and interquartile range (IQR)[4] will be used according to the ordinal-level data of most of the responses (Blaikie, 2003; Jamieson, 2004). The additional bar charts showing the frequencies of these questions are available in Appendix B. Some questions offered the participants to add optional comments in text fields. These comments submitted by participants are presented as part of the statistical data and are considered during the discussion.

5.3.2 Demographics and Music-Related Information

Musicians and spectators were separately analysed, as were the interviews. Table 5.1 gives a demographic overview of the dataset. In both target groups about half was younger

[1] https://www.limesurvey.org (last access 15.04.2016)

[2] Mode is the value occurring with the highest frequency in a dataset. (Blaikie 2003, p.68)

[3] Median is the position in a distribution above and below which half of the frequencies fall. (Blaikie 2003, p.69)

[4] The interquartile range is used in association with the median. It is the most commonly used method for measuring the dispersion of ordinal-level data. (Blaikie 2003, p.78)

Question	Spectators	Musicians
Age (<29)	59%	47%
Gender (male)	57%	80%
Education (college or higher)	43%	70%
Playing an instrument/vocal training (yes)	75%	100%
Attending/Playing concerts (once p. month or more)	52%	21%

Table 5.1: Demographics

than 29 (spectators 57%, musicians 47%). There was a good balance among spectators between male (57%) and female (43%), while the musicians were predominantly male (80%). College education or higher education was chosen by 43% of the spectators and 70% of the musicians. Three quarters of all spectators (75%) played instruments or had vocal training. The musicians were not explicitly asked, whether they had a musical training or not. It was assumed, based on their decision to fill out the survey as a musician.

Choosing particular musical skills, was a question that allowed multiple responses. This is important to mention, because if we now take a closer look on these numbers they obviously do not add up to 100%. Considering all spectators with musical training (75%), about one third (33%) declared to play either a keyboard instrument[5], guitar, bass or some of them. About one fifth (20%) declared to have vocal training or play a brass or woodwind instrument.

In terms of the musicians more than half (55%) play guitar and nearly half of them (41%) have vocal training. Around a quarter chose keyboard instrument (22%) or brass or woodwind (26%). The other instruments mentioned by spectators (3-8%) and musicians (3-16%) were strings, drums, percussion, accordion, electronics or being a DJ. Asking spectators about how often they visit concerts per year, a little more than half (52%) stated to attend live shows at least once a month. Having a look at the musicians, about a fifth (21%) plays concerts in the same regularity.

Finally, musicians and spectators were asked about their preferred music styles. Describing music styles is a difficult endeavour. For this survey, it was attempted to create a list that covers at least those styles mentioned during the interviews. Figure 5.1 illustrates these styles and the percentages of musicians and spectators who chose them as preferred ones. Participants could not prioritise particular styles, but they could choose as many as they wanted. The top five styles musicians of this survey prefer are Jazz (57%), Hip Hop (43%), Pop (40%), Classical (40%), and Traditional/Folk (29%). Spectators primarily like Rock (64%), Classical (51%), Pop (44%), and around a quarter of them prefer Jazz (27%) and Electronic (24%).

[5]piano, keyboard or organ

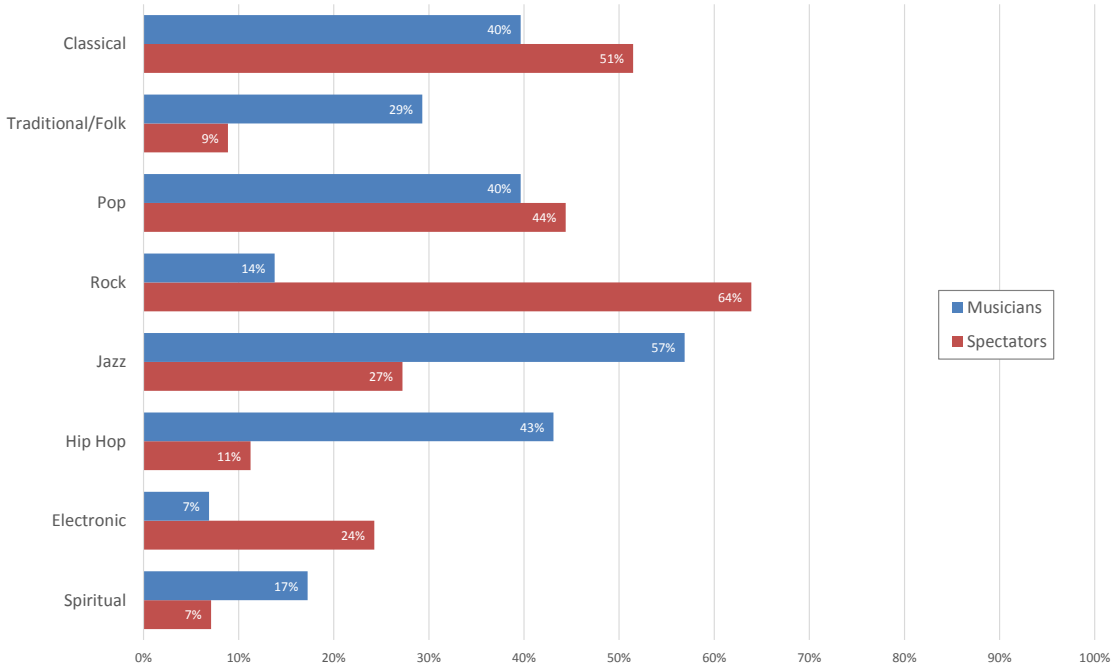


Figure 5.1: Preferred music styles of musicians and spectators

5.3.3 Motivation

Now we have a look on the motivational intentions spectators have to go to concerts and musicians have to play them. Figure 5.2 illustrates all 12 statements (abbreviated) and the positions (positive, neutral, negative) of spectators in percentage. The two agree positions (strongly agree and tend to agree) were combined as *positive* and the two disagree positions (strongly disagree and tend to disagree) as *negative*. Reducing the granularity of the five-step scale in this way for the analysis, should serve a better readability and present the results more clearly (Rossi et al., 1983, p.209). The three categories social, music, and entertainment correspond with the spectators' motivation patterns (see results of the interview study in Chapter 4).

There are three statements more than 80% of all spectators agreed with. To have a unique and special experience, is the strongest motivation why spectators go to concerts (89%) followed by 83% who like to be part of an audience and 81% who think live music is better than listening. The three statements most people disagreed with are "be involved in the show" (49%), "hear the songs I know from records" (38%), and "see a show, not just watching them play" (31%). These three are also amongst the highest neutral positions.

We proceed with how musicians rated the 12 statements about why they play live concerts. These statements are divided into the three categories expression, entertainment, and creativity (Figure 5.3). Very important for musicians are to be on stage (91%) and

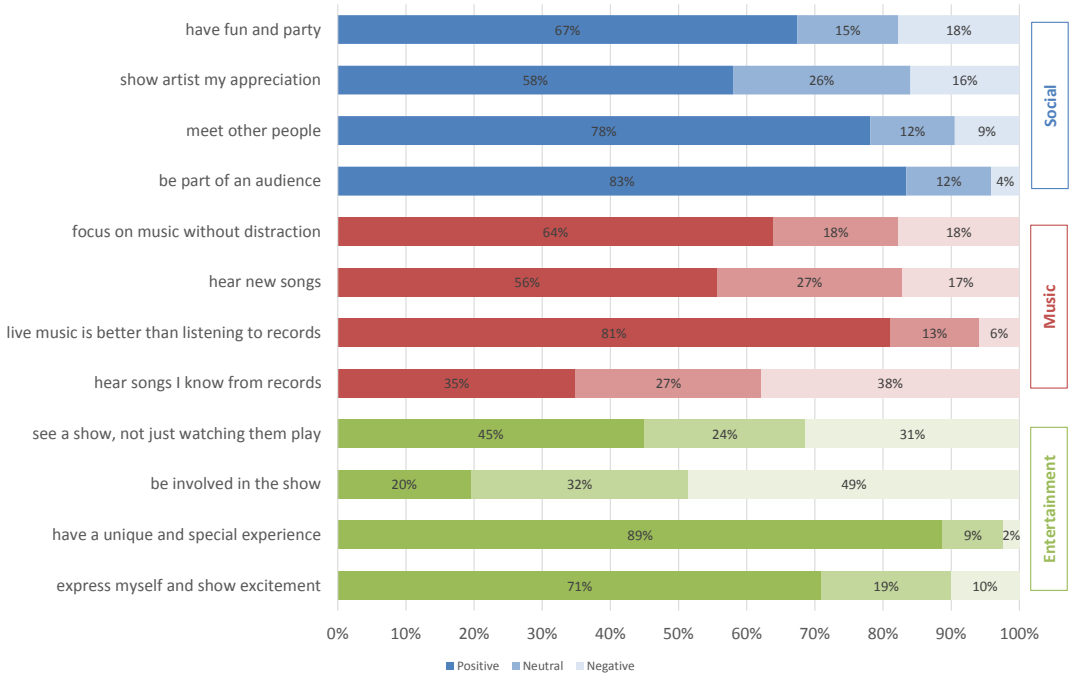


Figure 5.2: Spectators' positions about statements why they go to live concerts

play music publicly (90%). Two statements with positive positions of above 80% are "express myself" (81%) and "create a unique and special experience" (84%). The latter is a statement no musician disagreed with. Amongst the statements, where most musicians have a negative position, are "focus on show" (41%) and "improvise on stage" (29%).

5.3.4 Behaviour

In the next section of the questionnaire participants were asked about their behaviour during songs. In this section survey participants had to rate 14 statements according to how often they see themselves acting alike during a concert. The scale for this rating was *0 = never, 1 = sometimes, 2 = often,* and *3 = every time.* For the analysis median, mode, and interquartile range were calculated for each statement rather than the frequencies (Blaikie, 2003, p.68). This allows a clear view on the central tendencies in the responses given the big amount of data and nature of the ordinal scale, spectators used for rating (Jamieson, 2004). Table 5.2 shows the summary of the spectators' behaviour ratings. Charts presenting the frequencies of all responses for both song types are available in Appendix B.

Behaviour most spectators often show is clapping hands, waving hands in the air, singing along, moving and dancing, and tapping the beat with the foot. All of these statements are done often or every time by most of the spectators (Md=2, Mo>=2). For

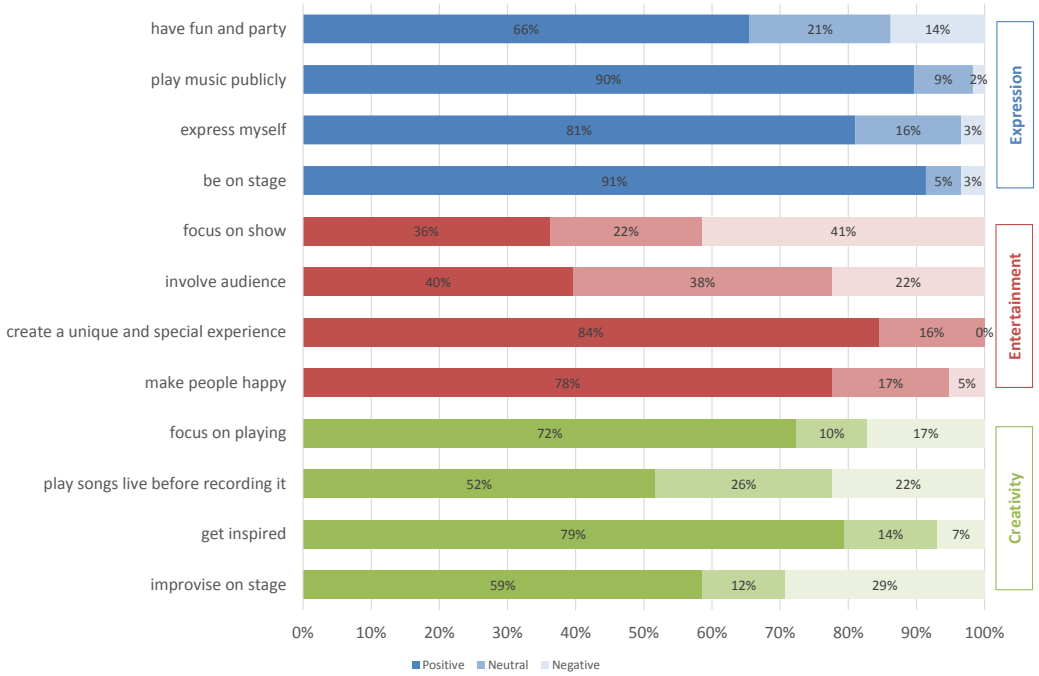


Figure 5.3: Musicians' positions about statements why they play concerts

Spectators' Behaviour (statements abbreviated)	**Ballad**			**Rock Song**		
	Md	**Mo**	**IQR**	**Md**	**Mo**	**IQR**
clap hands	2	2	2	2	3	2
wave hands in the air	1	1	2	2	2	1
sing along	2	3	2	2	3	2
shout/whistle	0	0	1	1	0	2
move	2	2	2	2	3	1
dance	1	1	2	2	2	2
jump	0	0	1	1	0	2
mosh around in the mosh pit	0	0	0	0	0	1
tap the beat on the floor with the foot	2	2	1	2	2	1
stand still, listen to music carefully	1	1	1	0	0	1
close my eyes and enjoying it	1	2	2	0	0	1
grab my lighter and wave it in the air	0	0	1	0	0	0
use my camera	0	0	1	0	0	1
use my phone	0	0	1	0	0	1
Scale for median and mode: 0 = never, 1 = sometimes, 2 = often, 3 = every time						

Table 5.2: Spectators' ratings about behaviour during two song types

the rock song most people even chose *every time* for "clap hands, sing along, and move" according to the mode (Mo=3). "Close my eyes and enjoying it" is done by most people during a ballad, but never during a rock song.

During a rock song some people shout, whistle or jump but most do not (Mo=0). The same counts for the ballad and "stand still, listen to music carefully", although the majority does that *sometimes* (Mo=1). A behaviour that most people never do regarding both song types are moshing around in the mosh pit, grabbing a lighter and wave it in the air, and using a camera or phone (Md=0, Mo=0). Looking at the interquartile range, which is the distribution of the values, most statements rated as *often* or *every time* have a higher distribution (IQR=2). Most of the statements the majority of people never does (Mo=0) have a smaller distribution (IQR=1).

Table 5.3 summarises how musicians have rated seeing themselves playing two different kinds of songs on stage. Charts presenting the frequencies of all responses for both song types are available in Appendix B. A behaviour most musicians often show when playing a ballad-like song is "close my eyes at certain parts of the song", "stand still, enjoy playing", and "make announcements before/after song" (Md=2, Mo=2). For a rock song the behaviour is different. Most musicians often watch the reaction of the audience while playing, smile at certain spectators, and move around on stage (Md=2, Mo=2). Only "make announcements before/after song" was rated as *often* by the majority of musicians for a ballad and even every time for rock songs.

There are 6 statements describing a behaviour most musicians never do (Md=0, Mo=0). Five of them even during neither song type, "jump around, stop playing/singing and listening to audience singing, jump of stage towards audience, move microphone towards audience, and get random spectators on stage".

5.3.5 Mobile Technologies

In this section of the survey it was asked, how spectators use their mobile phones or smartphones. Two thirds (66%) declared to have smartphones and 33% stated to have a mobile phone. Two survey participants (1%) apparently did not have a mobile phone at all. Among all smartphone users 65% are younger than 30. In comparison, 59% of all spectators who filled out the survey are younger than 30. If we take the next age group into consideration, even three quarters (83%) of all spectators having a smartphone are younger than 40.

Table 5.4 summarises the frequency of the use of mobile phones and smartphones. The majority of spectators having a mobile phones (63%) *never* use them during a live concert and 32% use them *1-3 times*. Among smartphone users about half (53%) use their devices *1-3 times* and nearly a third (30%) *never*.

Table 5.5 summarises how often spectators use their phones for particular reasons. The single questions all started with, "During a single concert, how often do you use your phone to...?". In the case of mobile phones we can see that most never use them (Md=0, Mo=0). Only the interquartile range of 1 for "make pictures, call a friend who can't be there, and write a message" indicates that at least some spectators use their mobile phones sometimes for these purposes.

Musicians Behaviour (statements abbreviated)	Ballad			Rock Song		
	Md	Mo	IQR	Md	Mo	IQR
watch reaction of audience while playing	2	1	1	2	2	1
smile at certain spectators	1	1	1	2	2	1
ignore audience at all	1	0	1	0	0	1
close my eyes at certain parts of the song	2	2	1	1	1	1
stand still, enjoy playing	2	2	1	1	0	1
tap the beat on the floor with the foot	1	1	2	2	1	2
move around on stage	1	1	1,75	2	2	1,75
jump around	0	0	0	0	0	1
stop playing/singing and listen to audience singing	0	0	1	0	0	1
jump off stage towards audience	0	0	0	0	0	0
move microphone towards audience	0	0	1	0	0	1
get random spectators on stage	0	0	1	0	0	1
clap hands to motivate audience	0	0	1	1	0	1
make announcements before/after song	2	2	2	1,5	3	2
Scale for median and mode: 0 = never, 1 = sometimes, 2 = often, 3 = every time						

Table 5.3: Musicians' ratings about behaviour during two song types

Frequency	Mobile phone	Smartphone
More than 10 times	2%	4%
4-9 times	2%	8%
1-3 times	32%	53%
never	62%	30%
no answer	2%	5%

Table 5.4: Spectators' phone use during concerts

Regarding smartphones the majority of spectators sometimes make pictures (Md=1, Mo=1). The interquartile range for all statements is 1, except "shorten time". This indicates that spectators do use their smartphones sometimes, even though it is the minority.

Musicians were not only asked about their phones but how often they use them and if they also use other mobile computer devices for their performances. Slightly more than a quarter (28%) already used a smart phone during a performance and 7% does so every concert. Looking at optional comments for this section, musicians mentioned, for instance, "display set list", "to show remaining time", or "play music during break" as rationale for using smart phones during concerts. Even more musicians, more than a third (38%), have used laptops and a tenth (10%) use them for every performance. Tablet computers on stage were used at least once by 12%.

Purpose	Mobile phone			Smartphone		
	Md	Mo	IQR	Md	Mo	IQR
(video-)record a clip	0	0	0	0	0	1
make pictures	0	0	1	1	1	1
call a friend who can't be there	0	0	1	0	0	1
write a message	0	0	1	0	0	1
post something on social media	0	0	0	0	0	1
shorten time	0	0	0	0	0	0
Scale for median and mode: 0 = never, 1 = sometimes, 2 = often, 3 = every time						

Table 5.5: Spectators' ratings about phone use

Purpose	Musician use
recording by yourself	24 %
creating visuals or projections	3 %
displaying something (e.g. lyrics, musical score)	17 %
a device for playback reasons	17 %
an instrument to play with	12 %

Table 5.6: Musicians' use of mobile computer devices on stage

Table 5.6 lists the percentages of musicians that use mobile computer devices during their performances for particular purposes. For every purpose they were asked, "Please check, if you have ever used a device listed in the question above during a live concert for the purpose of...". Nearly a quarter (24%) uses any of the mentioned devices for recording a concert, regardless of whether it is high quality or just a bootleg-like record to document the performance.

5.3.6 Opinion About TMAP

The last survey part asked the participants about their opinion on TMAP. As in previous sections, survey participants again had to rate whether they agree or disagree with different statements using a five-step scale. The first series of statements was formulated as "I would like to influence..." for spectators and "The audience could influence..." for musicians. Table 5.7 lists the statements and summarises the ratings for both spectators and musicians at the same time, to support a better interpretation and to compare spectators and musicians. The frequencies illustrated as bar charts are available in Appendix B.

Most spectators *tend to agree* with having a certain influence on the general volume or the volume of certain instruments referring to sound and the choice of songs in the category dramaturgy (Md=3, Mo=3). The statement "volume of certain instruments" even has an interquartile range of 1, which indicates a lower distribution and a more stable *tend to agree*. For dramaturgy there also was the order of songs and the duration of

Impact of TMAP (statements abbreviated)	**Spectators**			**Musicians**		
	Md	**Mo**	**IQR**	**Md**	**Mo**	**IQR**
Visuals						
colour of the light spots	2	2	1	3	3	2
speed of moving lights	2	2	1	2,5	3	2
intensity of lights	2	2	1	3	3	1,75
projections	2	2	1	2	0	2
ambience	2	2	1	3	3	2
Sound						
general volume	3	3	2	1	1	2
volume of certain instruments	3	3	1	1	0	3
mix	2	2	2	1	0	2
add new sounds	2	2	2	2	0	3
rhythm and tempo	2	2	2	1	0	3
Dramaturgy						
order of songs	2	3	2	3	3	3
choice of songs	3	3	2	3	3	2
duration of songs	2	3	2	2	3	2
unique version of the song	2	2	2	3	3	1,75
Scale for median and mode: 0 = strongly disagree, 1 = tend to disagree, 2 = neutral, 3 = tend to agree, 4 = strongly agree						

Table 5.7: Statements about possible impact of TMAP on elements of a live concert

songs that concerns the majority (Mo=3), but the median is 2 which means the opinion about those two is rather *neutral*. In case of all other statements most spectators have a neutral opinion (Md=2, Mo=2). The ratings of the statements having an interquartile range of 2 (e.g. add new sounds, rhythm and tempo), however, are higher dispersed. This means there are more spectators who have a stronger opinion, whether it is agreeing or disagreeing.

On the musicians' side, most of them tend to agree with being able to influence "colour of the light spots, intensity of lights, and ambience" in the category visuals and "order of songs, choice of songs, and unique version of the song" in dramaturgy (Md=3, Mo=3). Regarding the speed of moving lights and the duration of songs the majority tends to agree as well (Mo=3), but with a little lower median (2,5 and 2). Most musicians strongly disagree with having sound influenced. Except of "general volume" most disagree on all statements within the category sound (Mo=0). The median of 1 and 2 supports their strong attitude towards no impact on sound. The interquartile range for all statements is mostly 2 or 3, which shows a higher distribution of values and indicates that a certain number of musicians tend to agree to some statements.

The last question of the survey asked participants to rate statements about how TMAP could actually work. These statements included general strategies to involve the

Opinion about TMAP	Spectators			Musicians		
	Md	**Mo**	**IQR**	**Md**	**Mo**	**IQR**
It would make a live concert more exciting if						
the audience is really involved in a concert	3	3	2	3	3	1
the audience could make a certain creative contribution	2	3	2	3	3	1
the artist knows what the audience wants	3	3	1	3	4	1
the artist meets the expectations of the audience	4	4	1	3	4	1
the artist is not the only one who performs but involves the whole audience in a suitable way	2	3	2	3	3	1
I like the idea and would try out at a live concert [..] a smartphone app for						
voting during the concert	1	0	3	2	2	2
direct feedback after the show	2	3	2	3	4	2
controlling the light/visuals actively	2	0	3	2	2	3
controlling the sound actively	1	0	3	1	0	2
I like the idea and would try out at a live concert [..] audience participation through						
providing the artist with sensor data of my smartphone	1	0	2	2	0	2
cameras for visual recognition of audience movement	2	3	3	2,5	3	1
floor sensors for recognition of audience movement	2	3	2	2,5	3	1,75
phonometers for noise level	3	3	1	2	2	1
heart rate	1	0	2	1	0	2
breathing rate	1	0	2	1	0	2
Scale for median and mode: 0 = strongly disagree, 1 = tend to disagree, 2 = neutral, 3 = tend to agree, 4 = strongly agree						

Table 5.8: Statements about how TMAP could actually work

audience, concrete examples for participation and actual technologies that might be used. Table 5.7 lists the statements and the central measures of tendency for spectators as well as musicians.

Among the group of spectators is one statement that clearly stands out, “the artist meets the expectations of the audience” as most spectators strongly agree with it (Md=4, Mo=4) and the values are not much distributed (IQR=1). Statements where most spectators tend to agree with are “the audience is really involved in a concert, the artist knows what the audience wants, and phonometers for noise level” (Md=3, Mo=3). The

latter is the only statement among actual ways to realise TMAP with a high agreement (Md=3, Mo=3) and a low distribution (IQR=1).

Some statements spectators rated have a high agreement (Mo=3) but are less confident (Md=2, IQR=2 or 3). These are "the audience could make a certain creative contribution", "the artist is not the only one who performs but involves the whole audience in a suitable", "direct feedback after the show", "cameras for visual recognition of audience movement", and "floor sensors for recognition of audience movement". A disagreement of the majority of spectators applies for statements such as "voting during the concert", "controlling the light/visuals actively", "controlling the sound actively", "providing the artist with sensor data of my smartphone", "my heart rate", and "my breathing rate" (Md=1 or 2, Mo=0).

Musicians strongly agree on "the artist knows what the audience wants", "the artist meets the expectations of the audience", and "direct feedback after the show" (Md=3, Mo=4). The majority tends to agree with "the audience is really involved in a concert", "the audience could make a certain creative contribution", and "the artist is not the only one who performs but involves the whole audience in a suitable way" (Md=3, Mo=3), which is supposed to be a strong opinion with little distribution of values (IQR=1). In a similar way musicians rated "cameras for visual recognition of audience movement" and "floor sensors for recognition of audience movement" (Md=2.5, Mo=3). In the case of "voting during the concert" and "phonometers for noise level" the majority is neutral (Md=2, Mo=2).

Most musicians strongly disagree with "controlling the sound actively", "heart rate", and "breathing rate" (Md=1, Mo=0). Similarly, with "providing the artist with sensor data of my smartphone" the majority strongly disagrees, however, with a median of 2, which indicates a more neutral opinion than with the others. The interquartile range for all these statements, most of the musicians strongly disagree with, is 2 showing a certain distribution among values.

Apart from rating these statements, survey participants could also leave additional comments in this section. A spectator suggested "taking requests from the audience. Often I have heard bands come back for their encore and read signs that fans in the fronts have made requesting certain songs" and "forbid making photographs with camera or mobile". A musician suggested to "combine a play of colours with moving lights and fog for audience participation" and "in classical music nothing of this is wanted at all".

5.4 Discussion

After the presentation of the results, we revisit the four research questions one after another. By answering the first three research questions and discussing notable tendencies of the results, we will identify issues that concern the design of TMAP. In particular, we look step by step at noticeable differences of statistical values in the results and draw conclusions in relation to TMAP. We will finish the discussion by revisiting the fourth research question and take the outcomes of the whole survey into consideration to elaborate and propose implications for design of TMAP. To start the discussion,

we address the first research question: Which musical, motivational, and behavioural tendencies can be identified among spectators and musicians in relation to live concerts?

5.4.1 Music-Related Information

Looking at the musical training of spectators, three quarters (75%) stated to play instruments. This number is relatively high, having in mind that those who filled out the survey as spectators do not consider themselves as musicians. First, the fact that 75% of the spectators have musical training supports the responses' credibility of this survey regarding music-related questions to spectators. Second, these numbers highlight the issue of musically trained spectators among the audience. We call this the *issue of skilfulness* considering possible skills among the audience for the design of TMAP. These skills are not necessarily music-related.

A little more than half (52%) of the surveyed spectators attend live concerts at least once a month, which is a good amount of people regularly experiencing live music. In the case of musicians only a fifth (21%) plays concerts in the same regularity. If we invert this number, it means 79% of the musicians play live concerts less than once a month. This is not as high as one could think of, when asking people who consider themselves as musicians. A possible explanation could be that a certain number of musicians have above-average experiences and regularly play live concerts, but do not make a living out of music. Following this assumption, the aforementioned 21% could be considered as professionals, which seems to be appropriate for someone who plays a concert every month or even more often. In conclusion, we call this an *issue of masterfulness*. For the design of TMAP this means to consider the professional level of musicians and their live performances.

5.4.2 Motivation to Play or Attend Live Concerts

We start with the motivational statements and relate them to each other to identify further issues. For spectators to the strongest motivation visiting concerts is to have a unique and special experience (89%). Similarly, 84% of the musicians want to create a unique and special experience. In relation to another statement rated by the spectators, "live music is better than listening to records" (81%, third highest), this raises the *issue of distinctiveness*. It refers to the distinctive experience TMAP should create in a live concert.

Following this first issue and from the perspective of this research we could anticipate that TMAP always creates such a unique experience. However, at the same time only few spectators agreed to be involved in a show (20%). Regarding musicians, involving the audience has more agreement but is still the second lowest among their ratings (40%). In addition, 64% of the spectators want to focus on music without distraction, which has a relative low rating, but still the second highest within the category music. The musicians agree a little more on focus on playing (72%). This highlights a challenge for the design of TMAP we call *issue of obtrusiveness*. It means utilising TMAP to create a unique live

music experience, but at the same to consider the obtrusiveness of the involvement for both, spectators and musicians.

Two other statements sharing high agreement among the spectators are to be part of an audience (83%) and expressing themselves to show excitement (71%). Again, having TMAP in mind, this indicates the importance of the spectators to act expressively and identify themselves with the whole audience. This leads to the *issue of expressiveness*, which means the design of TMAP needs to consider forms of interaction that enable the spectators to be expressive, whether as individuals, in smaller groups, or as a whole audience.

The high agreement of spectators to meet other people (78%, fourth highest) in relation to the second highest rated to be part of an audience indicates the *issue of sociability*. This issue refers to social aspects in relation to TMAP. For example, there could be a certain social motivation to enable TMAP from the side of the artist or to participate as a spectator. Either way, it allows spectators to socialise to some extent, whether this is with friends or meeting other people.

Most important for musicians is to be on stage and play music publicly. This very high agreement among musicians to be exposed on stage and play in public raises the *issue of exposure*. This not only highlights the importance for musicians to be on stage, but also the need to design TMAP in a way that considers the exposed situation of musicians.

5.4.3 Behaviour at Live Concerts

All behaviour statements the spectators and musicians were asked to rate were more or less about expressive behaviour. Thus, all of them are somehow already covered by the issue of expressiveness. If we compare the two song types, however, we can see certain differences. With "close my eyes and enjoying it" and "stand still, listen to music carefully" most spectators do that often or sometimes during a ballad but never during a rock song. Most musicians often close their eyes during certain parts of a song and stand still to enjoy the playing during a ballad and sometimes during a rock song. Arguing that the spectators' and musicians' behaviour depends on songs and the mood they create among spectators, this raised the *issue of mood*. The challenge for the design of TMAP is to consider the mood and the resulting behaviour of a participating audience as well as the musicians. For instance, some audiences might have a certain mood-driven behaviour a priori (e.g. according to a style of music) and others might change their behaviour according to a particular song that creates a different mood (e.g. the hit of a band versus a new song no one knows).

The interquartile ranges calculated for the rating results show that there is a wider distribution of values with statements of what most spectators do every time (e.g. sing along) or what they never do (e.g. shout/whistle). In addition, the modes do not equal the medians, which supports the assumption of a higher distribution of ratings for these statements. This means, although most spectators always sing along, there is a certain amount of spectators doing that often or only sometimes. We call this anticipated differences regarding the behaviour among spectators the *issue of diversity*.

Among the statements with the lowest ratings of the spectators are "grab my lighter and wave it in the air", "use my phone", and "use my camera". Most spectators never use these devices and even the distribution of values is small. These three statements are among the four lowest rated ones. In addition, these three are the only ones among all behaviours requiring an object or specific thing. This raises the challenge we call *issue of objects*, which means to consider the role of tangible interfaces in the interaction design for TMAP.

Three statements rated by the musicians, "make announcements before/after song", "watch reaction of audience while playing", and "smile at certain spectators", are amongst those rated highest for both song types. The majority of the musicians does most of these actions often. We argue that all of them show some sort of appreciation to the audience. While making announcements has also an informational purpose, the other two show that most musicians care about their spectators, whether by just observing them to see a reaction or actively smiling at them. We call this the *issue of communication*. When TMAP actually happens during a live concert, it most likely needs some sort of communication, whether it is done by the musicians themselves, by a moderator, or it is communicated in a self-explanatory way.

5.4.4 Mobile Technologies during Live Concerts

The second research question was: How do spectators and musicians use mobile technology during live concerts? With the issue of objects we already looked on phone use in relation to the behaviour during songs. Additional survey results show that 66% of all spectators are using smartphones. Taken into account that this survey was carried out in 2011, this number is relatively high. Official statistics say that in 2011 about 33% of the Austrian population were using internet on mobile phones or smartphones[6]. In 2015 this number increased to 72%[7].

Young age and technology affinity could be a possible explanation for the high number of smartphone users. If we consider that among all spectators of this survey 65% are younger than 30, and 59% of all spectators having smartphones are younger than 30 this shows a certain correlation between young age and technology affinity. However, about half (53%) among those having smartphones use their devices 1-3 times and nearly a third (30%) never. Thus, even young people did not use their smartphones frequently during concerts in 2011. In conclusion, we define this as *issue of readiness*. For TMAP this means to consider to what extent an audience is ready for a particular participation. This readiness could be in terms of general availability (e.g. having a device such as a smartphone) or in terms of a certain knowledge or habit (e.g. using the smartphone for a particular purpose).

The only reason why spectators use their phones in particular is to make pictures and even this applies to smartphone users only. Most spectators never use their phones or smartphones for any purpose. We interpret this as another case pointing to the issue

[6]STATISTIK AUSTRIA, Europäische Erhebung über den IKT-Einsatz in Haushalten 2011.
[7]STATISTIK AUSTRIA, Europäische Erhebung über den IKT-Einsatz in Haushalten 2015.

of readiness. The fact that, according to the survey, back in 2011 most spectators never used other features of their smartphone than to make pictures, could also be regarded as an issue of skilfulness as defined earlier.

In general, musicians do not use mobile technology for their performances often. 10% use laptops and 7% smartphones for every concert and mostly for recording, playback, or visualisation purposes. At least 12% use any mobile device as instrument on stage. Looking closer at these 12% and relating them to musical styles, the results show that 9% do electronic music and 3% something else. What we not learn from the results, are the reasons why most of the musicians do not use mobile technologies for their performances. These might be practical reasons because they just do not need them for artistic purposes, but it could also be any kind of refusal. In conclusion, we raise the *issue of openness*. This issue is somehow similar to the issue of readiness but focuses more on the musicians attitude towards technology as an important part of TMAP.

5.4.5 Opinion About TMAP

With the third research question we asked: Which tendencies among spectators and musicians can be identified in terms of particular use of TMAP? Overall, most spectators tend to agree more on influencing elements of sound (e.g. volume) or dramaturgy (e.g. song selection) in a live concert. Most musicians tend to agree on letting the audience participate in visuals (e.g. lights) or dramaturgy as well, but strongly disagree on an influence of sound. Interpreting the figures, it is noticeable that most spectators do not care too much about visuals, while most musicians would somehow offer them to participate in light effects, for instance. Regarding sound most spectators would like to have some influence, while most musicians do not. In relation to TMAP we call this the *issue of appropriateness*. This means the actual impact that happens through the participation on some performance element has to be chosen and designed in a way both spectators and musicians can live with.

Following the different views on sound there is another issue. We know that most spectators tend to agree to influence the sound to some extent. When asked, if they could imagine to use a smartphone app to control the sound actively, most spectators strongly disagreed. One could argue they do not want to use a smartphone app, which we do not learn from the results. Nevertheless, there is a certain contradiction comparing these results. Similarly, most spectators tend to agree to influence the choice of songs, but strongly disagree to use a smartphone app for voting. This inconsistency raises the *issue of contradiction*, which describes the challenge to find a compromise to resolve a contradictory situation.

Most spectators and musicians tend to agree that it would make a live concert more exciting if the audience could make a certain creative contribution. Musicians even stronger agree on that. We do not know which form of creativity musicians had in mind when they rated the statements. If we consider sound as one of the most important creativity-related aspects of a live concert, it contradicts the musicians' refusal of an impact on sound, as we already know. In conclusion, we define the *issue of creativity*

Spectators	Musicians	Both
skilfulness	masterfulness	distinctiveness
expressiveness	exposure	obtrusiveness
diversity	communication	sociability
objects	openness	mood
readiness	creativity	appropriateness
		contradiction

Table 5.9: Summary of identified challenges

dealing with the challenge to what extent TMAP is or has to be a creative contribution to a live concert.

5.4.6 Implications for Design of TMAP

The final research question builds up on the previous three to draw conclusions: Which possible implications emerge for the design of TMAP? Answering the previous three research questions and discussing the results of all survey sections step by step served two purposes. First, we identified 16 issues concerning *challenges* for the design of TMAP in live music. Second, we found *possible design directions* for TMAP that will be further investigated in a case study.

We will start to reflect on looking at all challenges. Some of them primarily address either spectators' or musicians' requirements, others concern both. Table 5.9 gives an overview of these challenges as discussed, defined, and described throughout the previous discussion sections.

In some cases we identified these issues by drawing together notable results of the survey questions and sections and by considering spectators' as well as musicians' motivation, behaviour, and opinion. Hence, some challenges might overlap to some extent, e.g. *readiness* and *openness*. Both challenges address attitudes and habits of the spectators and musicians in relation to technology that might have an impact on the design of TMAP. Nonetheless, readiness highlights more the technological availability and habits of spectators, while openness rather bears the principle attitude towards technology and a potential sceptisim in relation to TMAP in mind.

From a structural point of view, this list resembles challenges standing by themselves rather than being a complete set of design strategies. However, theses challenges are an important step from the rather general patterns and requirements towards a more specific description of the design space of TMAP. Furthermore, they serve as well-founded starting point to consider actual design processes. We will study these design processes in case studies to identify further issues concerning the design of TMAP in live music.

The identified concrete design issues are concern the possible impact on performance elements and technological preferences. In general, musicians agree with a creative contribution from the audience. We cannot draw further conclusions on the results about how this creative contribution could look like. Thus, it should be a potential focus for

further studies. According to dramaturgical performance elements, the song selection of a concert is the most desired one. Visuals are somehow offered by musicians to be used for TMAP, but do not concern audience members so much. In the case of sound, audience members mostly wish to control volume aspects of the music, whereas the musicians mostly disagree with any influence on sound. Finally, there are preferences about the actual technology for audience participation. These are recognition systems such as cameras, floor sensors, and phonometers. In terms of smartphones opinions are particularly divided.

5.5 Summary

For this study we took the stakeholder requirements and design issues deriving from the interviews as starting point to collect quantitative data about live music and TMAP. We conducted an online survey targeting on spectators and musicians to identify issues concerning the design of TMAP. The results were 227 complete responses (169 spectators, 58 musicians), analysed through the use of descriptive statistics.

With a step by step discussion of these results across survey sections and target groups, we identified *challenges* for design of TMAP concerning the spectators' and musicians' behaviour, motivation, and opinion in relation to live music and TMAP. In addition, we found *possible design directions* to be investigated in further studies.

5.6 Contributions

1. *Design Challenges concerning the Spectators and Musicians*: These are possible challenges for the design of TMAP. Among them are challenges concerning spectators (skilfulness, expressiveness, diversity, objects, readiness), musicians (masterfulness, exposure, communication, openness, creativity), or both (distinctiveness, obtrusiveness, sociability, mood, appropriateness, contradiction).

2. *Possible Design Directions*: These rather concrete ideas for TMAP are a certain creative contribution from the audience, song selection from the audience, and impact on volume aspects in due consideration of the musicians. Among the preferred technologies are sensing systems, e.g. cameras or floor-sensors.

CHAPTER 6

CoSCoS Case Study

This case study presents CoSCoS[1], a smartphone-based prototype for technology-mediated audience participation (TMAP), in two steps. First, we describe the participatory design process including spectators and musicians. Second, we deploy CoSCoS in a live concert to evaluate the spectators' experience with TMAP. Reflecting on the participatory design of CoSCoS and its in-situ evaluation, we are able to present further challenges and potential strategies towards a more intuitive and expressive design of TMAP.

6.1 Motivation

The field studies described in the previous chapters brought valuable insights about the design of technology-mediated audience participation (TMAP) described as *challenges* and *possible design directions*. However, these results do not include knowledge about the real experience participants will have with TMAP at a live concert. This motivates the necessity to explore TMAP in a real world scenario. Two notable issues identified in both previous studies are central to motivate this case study. First, the scepticism towards TMAP among participants and second, the ambiguous attitudes towards the use of mobile phones and in particular smartphones during live concerts.

To overcome the musicians' scepticism for this case it was decided to use a given song during a band's performance and design TMAP on top of it. With a participatory design approach (Sanders, 2002; Muller and Druin, 2003) it will be continued to consider the requirements of spectators and musicians to let them "directly inspire and shape the technologies that are developed" (Hutchinson et al., 2003, p.18). By choosing smartphones as principle technology for this study, we address the second issue and be able to investigate the potential of these everyday devices in relation to TMAP. The resulting research questions for this study are:

[1] **Co**llaborative **S**tereo **Co**ntrol with **S**martphones

Q1 Which issues can be identified when TMAP is collaboratively designed and deployed in a live concert?

Q2 To what extent are smartphones an acceptable option for TMAP?

Q3 Which practice-based implications emerge for the design of TMAP?

To answer these questions we present a smartphone-based prototype called *CoSCoS* (**Co**llaborative **S**tereo **Co**ntrol with **S**martphones), which was collaboratively designed including involved participants. CoSCoS will then be evaluated during a live concert using methods such as observation, surveying, and auto-ethnography to collect qualitative data.

From previous studies we already know the requirements of spectators and musicians in terms of the design of TMAP, but this study will shed light on what is desirable "during or after design work itself" (Gaver, 2012, p.942). The anticipated outcomes of this reflection on the design process and in-situ evaluation will be further implications for the design of TMAP. These implications will be identified on practice-based experiences and enhance the challenges previously defined. Now the design process of CoSCoS will be described.

6.2 Design process

The actual design of CoSCoS was shaped in two ways. First, my band *Velory Linus* we collaborated with and their scheduled concert framed the musical context and some constraints in relation to the venue. Second, the potential design directions as outcome of the previous survey study combined with the spectators input during the design process led to the final interaction concept for the audience participation.

6.2.1 The Band

The band Velory Linus was a good opportunity for a collaboration. The band had already scheduled a concert in a club in Vienna, Austria, that suited the study's purposes as to time and place. Further, myself as the author of this thesis played guitar in the band. This is important to mention as it includes auto-ethnographic experiences during design and evaluation. However, particularly during the participatory design process, we put emphasis on the input of the involved spectators.

Music-wise, Velory Linus merges rock music with electronic sounds played by a computer but externally triggered by the musicians. Hence, the band already uses a certain amount of technology for their performances. Apart from me as guitarist and singer, the band has a drummer, a bassist, and a computer-based sequencer for all the electronic sounds. For reasons not related to this study, the bassist was not playing at this particular concert.

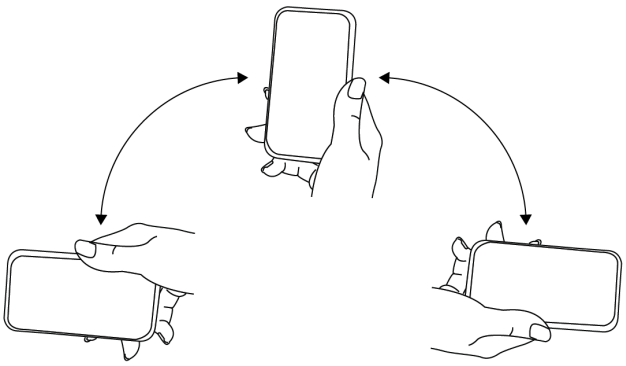


Figure 6.1: Moving the smartphone left and right

6.2.2 Interaction Design

The design process started with some initial considerations based on the potential design directions evolved from the survey study. The use of visuals (e.g. light spots) was no option as the venue's light system was not accessible. Only the projector was available and taken into consideration. Dramaturgy was a potential design idea preferred by spectators and musicians and in particular song selection. We did not follow this idea as there were already examples using this approach (Barkhuus, 2008). Finally, we decided to venture TMAP on sound as favoured by spectators but in due consideration of the musicians.

For the actual design of CoSCoS we recruited two potentially interested fans of the band through social media to take part in this study. Both were invited to two pilot sessions during rehearsals with the band. During the first session we choose a particular song and defined the principle interaction design. We decided the song to use would be *The Last Will*. It has a very noticeable and characteristic guitar track and fits the purpose to build audience participation on top of it.

Considering an unobtrusive but still clear impact on the sound, we came up with a design idea to let the audience collaboratively control a guitar effect. In particular, spectators should be able to control the stereo panorama of the guitar sound coming out of the PA[2] with their smartphones moved left and right (Figure 6.1). This idea was initially inspired by Maynes-Aminzade et al. (2002).

Some additional rationales accompanied this design decision. Focusing on stereo control means that the musician's acoustic distraction is minimized. The artistic freedom is untouched because the actual playing and sound effects are not influenced. Usually the sound of the PA addresses the audience and musicians on stage have their own individual monitor speaker. Even though the musician is aware of the PA sound to some extent as well. This setting allows musicians to be in control of the performance all the time. Considering the audience, we primarily thought about an intuitive interaction and a clear feedback. Understanding and controlling the stereo panorama is very intuitive for

[2]PA (public address) describes the speaker system of the venue providing the sound for the audience.

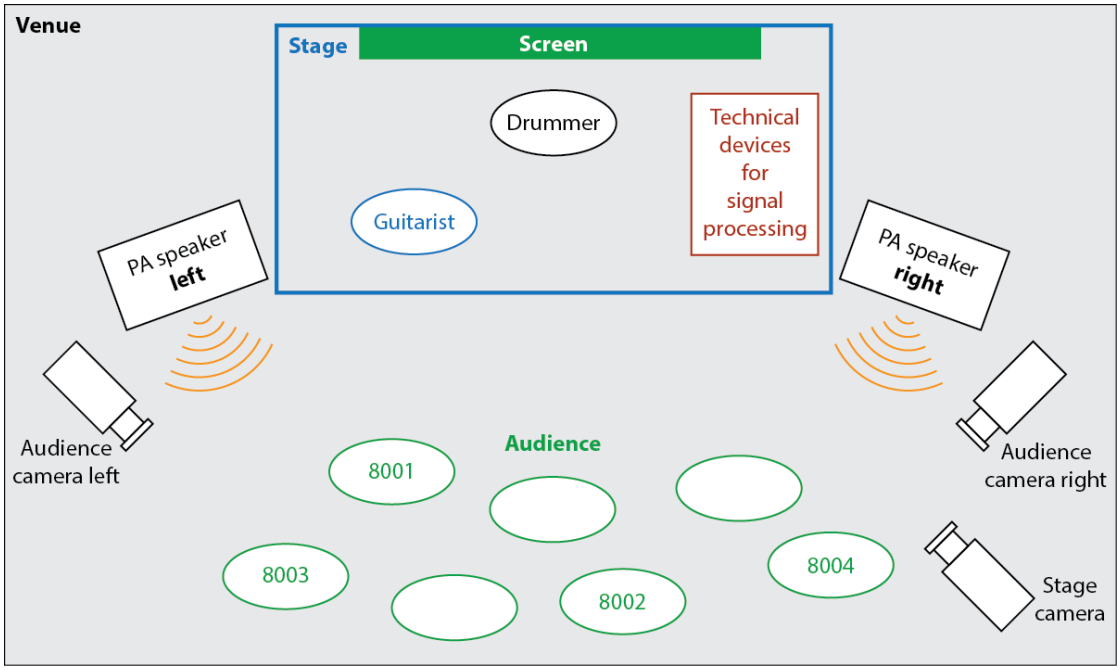


Figure 6.2: The floor plan of the venue for the CoSCoS in-situ study live concert

spectators since acoustic stereo signals are ubiquitous (e.g. mobile music devices with earphones, computer speakers or TVs).

An overview of the whole setting is shown in Figure 6.2. The musicians are on an elevated stage and the audience is standing in front of it. The circles with numbers represent participating audience members with smartphones. Similar to this final setting, a first implementation of CoSCoS was tested during the second rehearsal of the band with the two spectators. This second rehearsal led to the final design of CoSCoS as it is described in the following.

6.3 Technical Implementation

The technical implementation of CoSCoS is shown in Figure 6.3. The major parts *Audience* and *Musician* are the interaction layer including visual and acoustic elements and the *Signal processing* is the technical layer.

Spectators download and install an app (described in the next section) enabling them to interact with the stereo panorama. The audience gets visual feedback through a white dot projected on the screen behind the drummer at the back of the stage. This visual and interactive manifestation of sound or its parameters is called a sound object (Schaeffer, 1966).

Figure 6.4 (left picture) shows the visualization of the left-right-position of one smartphone, which is identified by the unique number 8001. In the right image the white

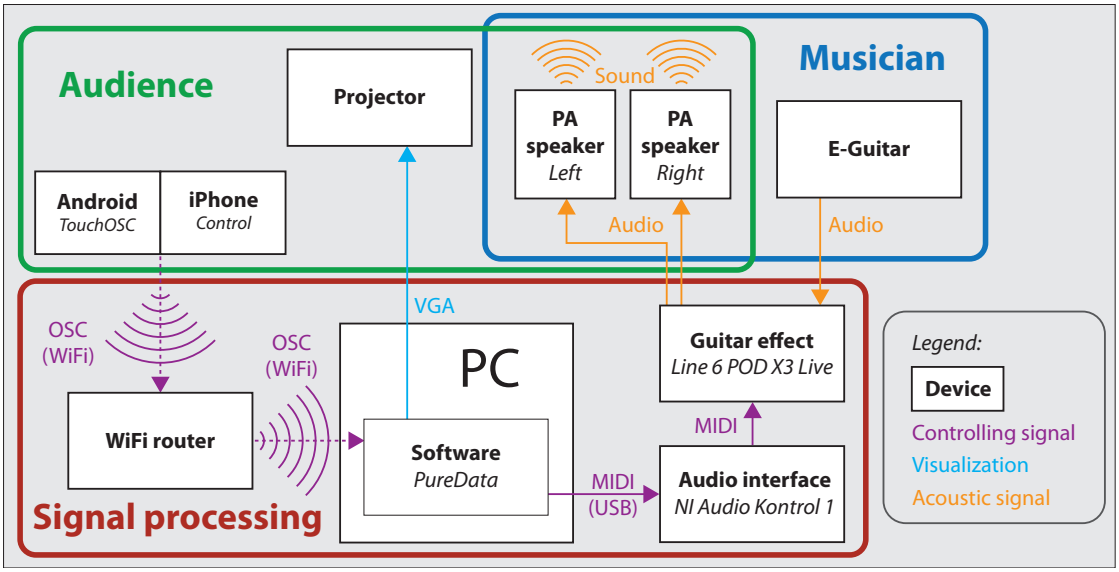


Figure 6.3: Schematic illustration of CoSCoS

Figure 6.4: Two still pictures of the stage camera

dot represents the average left-right-position of all participating smartphones. Thus everybody knows at any time whether their device is active or whether all devices are active and therefore all participants cooperatively control the stereo panorama.

The acoustic feedback comes directly through the PA speakers situated on the left and right side of the stage facing towards the audience as shown in the floor plan (see Figure 6.2).

6.3.1 Smartphone Apps and Signal Flow

To cover the majority of smartphone users and therefore maximize the chance for audience members to take part, we designed CoSCoS for both Android-based phones and iPhones.

There was no need to develop own apps. The free apps *TouchOSC*[3] (Android) and *Control*[4] (iPhone) are fully capable of what CoSCoS needs. For clarification, TouchOSC was only free for Android at the time of this case study in 2011 and subject to charge for iPhone. We decided to use the app Control instead for iPhones.[5]

Technically, both apps are able to send accelerometer data representing the devices' orientation and movement as OSC (Open Sound Control[6]) messages over WiFi. The wireless connection is handled by a WiFi router which transmits the OSC messages over a specified UDP port to a Pure Data (pd) (Puckette, 1996) patch running on a laptop. The pd patch is the core of CoSCoS and does most of the work including the processing of OSC messages and sending out MIDI messages to the guitar effect device where the stereo panorama is applied.

6.3.2 Signal Processing in Pure Data

In pd the accelerometer data is normalised due to the different value ranges of the two apps. In the end, each devices' accelerometer data ranges from -10 for left only to 10 for right only according to the visualization in Figure 6.1. Because of limited capabilities in pd and the general study design, the pd patch is predefined for twelve smartphones to connect and send accelerometer data. All data is summarized and divided through the number of active devices to get an average value, which is then scaled to standardised MIDI values ranging from 0 to 127 and is sent to the guitar effect device.

6.4 Live Performance

The venue for the in-situ study was a public concert of Velory Linus in the club B72 in Vienna, Austria. A team of four people asked guests at the entrance whether they have an Android-based phone or an iPhone and were willing to participate. People who agreed received a one-page manual with a short explanation of the study and how to set up the smartphone. Every participant received the free app, inserted the given IP address to connect to the WiFi router and finally specified a unique UDP port. For testing purposes everyone had to check the correct configuration with the white dot individually as shown in Figure 6.4. The study was anonymous and participants were selected by chance. They were not given any specific instructions about where to stand during the performance. We could only take twelve participants (about an eighth of the audience) due to previously explained technical limitations.

The song chosen was played twice at the end of the show. Everyone was told that the interaction would then take place and there would be an explanation beforehand. The first time the song was played without audience participation followed by a short

[3]http://hexler.net/software/touchosc (last access 15.04.2016)

[4]http://charlie-roberts.com/Control (last access 15.04.2016)

[5]Interestingly, the Android app TouchOSC is now subject to a small charge on Android too and Control is not available any more for iPhone.

[6]http://opensoundcontrol.org (last access 15.04.2016)

Figure 6.5: Still pictures of audience cameras showing participants waving smartphones

explanation of the study and testing the system. Then the actual audience participation was realised while the song was played for the second time. We did this to be able to compare the two versions as explained later during the evaluation section.

The song lasts about five minutes and is divided in two more or less equal parts. During the first part, each participant had the chance to control the stereo panorama individually for 13 seconds to get a feeling for controlling the sound of the guitar. The projection displayed numbers sequentially (e.g. 8001 as in Figure 6.4 left) to show the respective participants that their phones were now active for individual control. With the beginning of the second part the signals of all participants were summarized to cooperatively control the stereo panorama (Figure 6.4 right).

6.5 Evaluation Methods

To answer the research questions, it was important to gain knowledge about the actual behaviour and experience of the spectators involved in a performance with TMAP. Following an approach used by Reeves studying interaction in public settings, we did a "hybridised form of video analysis" (Reeves, 2011, p.33), combining video-based analysis and questionnaires. For this purpose we used three cameras and recorded the stage as well as the audience. Figure 6.2 illustrates the position of the cameras and still pictures of the stage are shown in Figure 6.4. The perspective of one audience camera is illustrated in Figure 6.5. A total of 45 minutes of video footage was taken over a period of 15 minutes.

The video recordings were used to analyse non-verbal social interaction among the audience interpreting body movement, gestures, expressions, and gaze as done previously by Heath, C., Hindmarsh, J., Luff (2010) when studying social settings. Following their outlines, we did a preliminary review for basic structuring, a substantive review to discover and annotate important passages, and finally an analytic review to study specific parts in detail. Each of the three videos was divided into parts to analyse them separately: (1) Five minutes while the song was played originally, (2) five minutes of explanation and testing with the audience, and (3) five minutes while the song was played with audience participation.

Then we analysed the spectators individually according to their behaviour and how they communicated among each other. While repeatedly watching certain occurrences in the video, we focused on particular aspects of bodily interaction (e.g. synchronous moving of smartphones) and compared the three different camera angles (e.g. movement of the white dot compared to the view of the audience cameras). We knew from seeing the phones held and waved by some spectators, which participants were involved in the participation. However, we did not know the numbers of each participating spectator to identify a certain behaviour during the 13 seconds of each individual interaction phase.

To collect data about the opinion and experience of spectators, we conducted a short survey after the concert. Immediately after the second time the song was played, which was also the end of the concert, audience members (no matter if they participated or not) were asked to fill out a short one-page questionnaire. There were five helpers who approached audience members and filled out the questionnaire together with them. The questionnaire had seven short questions and is available in Appendix C. The same method was used by Pedersen and Hornbæk (2009) when evaluating the audience's experience of a new tangible user interface for manipulating audio and music. The survey was focused on their experience with smartphones, the procedure and the understanding of the study and their opinion about this form of audience participation. Finally, we asked them which differences they could figure out between the two performances of the song.

6.6 Results

Overall, about 50 people were attending the live concert. Among them were 12 spectators who participated with their smartphones. We analysed the available data qualitatively and start with the outcomes of the video observation analysis. Then we continue with the results of the thematic analysis of the questionnaires.

6.6.1 Video Observation

As a reference for the results four participating spectators were standing close to the stage and we could clearly see their interaction from two angles (see Figure 6.5). The other eight were distributed over the whole venue mainly standing in the back. In most of the video footage we only saw their smartphones when they waved it up in the air.

We present the video observation results starting with the participating spectators. During the first half of the song, when they had individual control, ten of the twelve participants were carefully waiting, watching the stage and immediately started to wave their phones when their number came up. Two of them in the back started to wave more or less continuously from the beginning of the song although they just had control over the sound for 13 seconds each. Looking at those two, mainly at their phones, during the second half of the song, they reduced their waving activity by waving for a couple of seconds and then stopped again. Nevertheless, there was no particular pattern in terms of their waving behaviour.

During the second half of the song, when all participants were supposed to control the sound together, there was no indication of synchronous behaviour in terms of waving their phones. The only similarity at least among the four participating spectators in front of the stage we could clearly see in the video footage, was that they were mainly facing towards the stage concentrated on the performance or rather the screen with the white dot. Among all individuals who participated, there were essential differences concerning smartphone interaction in relation to speed, range, and height when moving the device. In addition, there was a great disparity regarding stance and how the device was held.

Two participants, a man and a woman standing front row, waved their phones never higher than breast height. The same two held their phones differently in terms of facing the screen towards the stage or towards themselves. The woman was even shaking and moving the phone heavily while the man waved the phone less expressive. Her interaction was also more embodied dancing and moving the phone expressively to the rhythm of the music throughout the whole song. The other three participants in the front stood still and seemed to concentrate on the movement of the smartphone. Only one stopped waving twice to look on his phone. Apparently he tried to check or change settings before continued waving after a couple of seconds of touching the screen. Most of the other participants in the back were waving their phones above their head as far as we could see their phones but there was no synchronous behaviour.

Apart from the interaction with the smartphones, we observed verbal communication among participants. The two participants standing next to each other exchanged small comments five times while continuing waving their phones. The woman also talked twice to a non-participating spectator next to her.

According to non-participants in the audience, during video analysis we concentrated on the behaviour of six women and two men we could clearly see as they were standing in the front rows. All of them observed the study participants regularly throughout the song. They did so at least once up to seven times. All of them were also talking to each other briefly throughout the song. Two non-participating spectators standing in the middle of the front rows even turned around three times; one of them, a man, to watch the audience in the back and the other, a woman, to talk to someone standing behind her.

6.6.2 After Concert Survey

A total of 31 audience members filled out the questionnaire. 12 of them participated with their smartphones and 19 did not. For both groups we looked at their experience and opinion about CoSCoS. For participating members we also extracted music-related statements from the data and for non-participating members smartphone-related statements. A categorised list of all statements is available in Appendix C. We present the results of participating and non-participating spectators separately.

The opinion about CoSCoS among the participating spectators was either positive or negative. There was only one statement we considered as neutral where the participants described the audience participation as “special situation” standing for itself. Positive aspects were annotated as innovative and welcome change, funny experiment, or active and

honourable involvement. The negative ones included distraction and no musical benefit, loss of control for the band, little confidence in the audience, and more performance authenticity without TMAP.

Regarding experience we focused on interaction aspects of CoSCoS. Again, there were positive and negative statements but some we considered as neutral or ambivalent. The individual control was mentioned four times in a positive context and one of them even liked the "power when I had exclusive control." Some participants liked the individual control but not the collaborative one. They were also not completely sure about how the interaction worked (e.g. "I have tried various different ways to control it.") Several participants reported problems with the control or feedback of their interaction. They mentioned little influence on music, a chaotic collaboration, and missed a conductor or extremes in the collaborative interaction.

In relation to music, participating spectators wished to had influence on "other effect that change the sound" or in particular the distortion of the guitar. Music-wise, participants complained about too little change in the sound and that "music suffered."

Those spectators who did not participate think about CoSCoS as innovative, funny, and appreciation of the audience in a positive way. Some criticised a lack of group dynamics, wished for more participants, and saw a certain interruption of the "flow" in the concert.

In terms of experiences of CoSCoS some were positive but overall more spectators mentioned negative aspects and statements that were ambiguous. Among the positive ones very often "good" aspects were mentioned in relation to the performance, atmosphere, and fun. Six non-participating spectators did not experience much difference in terms of the two performances of the song and four said "both versions of the song were good". Two spectators complained that no one asked them to participate and that the guitar and effect was too silent. Smartphone-related, one spectator complained about not having a smartphone to participate. Four others mentioned problems during setup (e.g. "app not found", "setup too complicated").

6.7 Discussion

We will use a reflection on the design of CoSCoS and its in-situ evaluation to answer the three research questions. By addressing the first question, we will identify issues that emerge from this live concert experience with TMAP. These practice-based issues will somehow enhance the issues identified in the previous study. With the second question, we will particularly look at smartphones for TMAP. To answer the third question, we are looking at further implications for the design of TMAP. We will do so by drawing together the practice-based issue to identify further challenges and design directions that inform the next case study.

6.7.1 Design and Evaluation of CoSCoS

The first question motivating this study was: Which issues can be identified when TMAP is collaboratively designed and deployed in a live concert? The principle design of this study determined some aspects from the beginning. This was the band Velory Linus, one of their songs to build TMAP on top of it, a scheduled concert for evaluation, and smartphones as particular technology for audience participation. Having these circumstances defined, we wanted to focus on the participatory design process of CoSCoS and at the same time keep in mind various concerns in terms of TMAP we have identified during previous studies.

This strategy led to some deliberate decisions during the design process. For example, we could not use the venues light system for visual interaction, which would have been a promising option according to what we knew already. To use a given song, helped to focus on the audience during the concert and to minimise any impact on the band. However, being very sensitive about too much impact and various concerns in advance, constrained the design process more than we thought. We call this an *issue of cautiousness*, when many potential concerns about TMAP constrain the design process too much.

Statements of spectators show that this cautiousness during the design also resulted in deficiencies and even disappointment. One spectator said quite clearly, "the movement of all participants together was too average, no extremes." Others also mentioned insufficient feedback, whether it is individual to show participants their impact or in general to make the whole audience aware of any interactive change. We define this important aspect to design TMAP in way that there is enough feedback for participating and non-participating spectators as *issue of meaningfulness*.

From observation results as well as questionnaire statements we can derive a related issue that is more focused on a clear interaction. The problem here is illustrated by differences of how participants held and moved their phones and statements such as, "I have tried various different ways to control it." Also the fact that two spectators waved their phones throughout the first half of the song during individual control, also indicates their misunderstanding of the concept. We call this need for an intuitive or understandable interaction design within TMAP as *issue of clearness*.

The consequence of such an unclear interaction can be unexpected behaviour among spectators. Whether it is due to misunderstanding or frustration, most likely it will ruin or at least disturb the participatory impact. In the same way we see unwanted behaviour among spectators whether unintended (e.g. "Audience is too stupid") or intentional destructive. In any case, the success of TMAP is dependent on the *issue of destructiveness*.

In terms of control, we have already discussed the importance of an intuitive and understandable control with the issues of clearness. With the issue of destructiveness we just discussed potential problems in relation to unclear interaction. One spectator said explicitly, "Funny to control the sound." Four others also described their experience as fun in different ways. Concerning the woman in the front row, we saw a certain behaviour throughout the performance where she expressively shook her device and moved in a rather dancing fashion to the music instead of consciously waving her smartphone as

intended. In the questionnaire one spectator said, “I could hardly move the white dot.” (which could be the woman or someone else which we do not know). We argue that this particular behavioural issue, all other participants who moved their devices differently, and the explicit references to have fun, indicate the *issue of playfulness*.

We could observe certain distraction throughout the video analysis when participating spectators talked to each other and looked at their smartphones or non-participating spectators observed participants. Some spectators explicitly mentioned too much distraction and others indirectly as they were focusing on the white dot of the projection most of the time. We argue that the musicians’ performance should still be the focus of a live concert and that TMAP must not distract the spectators too much. We define this as *issue of awareness* to consider a potential distraction of the spectators caused by TMAP.

Some statements of the spectators indicate a novelty effect in relation to TMAP. Both, participating and non-participating spectators mentioned the innovation or that they liked to be part of an experiment. Another participant said, “Awesome, never experienced something comparable at a concert.” We call this the *issue of newness* and argue that even though CoSCoS did not work properly, the audience also had positive experiences with TMAP in general.

According to the statements, some participating spectators felt honoured to be part of the show or even liked the exclusive individual control during the first half of the song. Some non-participating spectators would clearly have liked to participate but mostly could not due to technical constraints (e.g. “I am so sorry for not having a smartphone” or “Setup was too complicated”). We refer to this as *issue of exclusiveness* which can be positive when spectators appreciate to be part of a performance or negative when they want to participate but are not able to for any reason.

A major problem according to video analysis and questionnaires was little synchronisation among participants than we anticipated during the design. Spectators commented on this with too different movement in the audience or wished more group dynamic and more participating spectators in general. Another one missed a coordinator. Speaking about this audience musician relationship with CoSCoS, the participation and its impact were completely separated from the stage. We, the drummer and myself as the guitarist, did not perceive any sound through the PA speakers the audience controlled. We both had our in-ear monitors that separated us completely sound-wise. We call this the *issue of togetherness* to consider the involvement and relationship of the spectators among each other but also with the musicians. Finally, this also related to the issue of cautiousness. By trying not to interfere with any artistic integrity too much and being too careful with the influence of sound during the design process, the whole interaction happened to be one-sided having very little togetherness between spectators and musicians.

6.7.2 Smartphones for TMAP

With the second research questions we asked: To what extent are smartphones an acceptable option for TMAP? As smartphones were central to CoSCoS, we discussed issues around them already. With the issue of clearness we saw how individual participants used their smartphones in different ways. Statements of participants showed deficiencies

in the system relating to the importance of immediate, transparent, and perceptible feedback. For a clear and unmistakable understanding of the control and functionality people want to have a "proof" that individual influence has a reasonable effect. From a technical perspective in relation to CoSCoS, automatically calibrating the smartphone's movement would have led to more direct results and ensure that small gestures have enough impact on the stereo panorama as well.

The issue of awareness pointed us towards the distraction smartphones can cause when using them for TMAP. In some way the smartphone was too central within CoSCoS. Recalling the preparation on site before the concert started, it certainly took some effort on the side of the spectators, but also the personnel in support to set up and test the system with individuals. Even though, the setup still failed in some cases and the spectators could not participate. In relation to the lack of clearness, some spectators looked for a misconfiguration on the device when they could not see enough impact of their interaction. A specifically tailored app needing a minimum of configuration might help here. Still, it is an important issue to consider especially when audiences get bigger, individual support can rapidly increase.

Finally, spectators were excluded from the participation due to smartphone-related technical constraints as we discussed with the issue of exclusiveness. The problem we see in this case is that more spectators than we thought were excluded from participation against their will. We are talking about the group of spectators wanting to participate but was not able to because they had no smartphone or technical problems. The point here is, that CoSCoS may be technically feasible but the participation is too dependent on the availability of smartphones and personal commitment. Especially with bigger audiences, to reduce technical effort during set up and execution is inevitable. In the worst case, the participation completely fails if low acceptance and technical constraints outbalance.

To summarise, using smartphones for TMAP is a suitable method for engaging and entertaining the audience. However, the strong dependency on technology and individual devices makes it challenging to design an intuitive, transparent, inclusive, and easy-to-use system for at least everybody willing to participate.

6.7.3 Implications for Design of TMAP

With the third research question we draw conclusions on the discussion by asking: Which practice-based implications emerge for the design of TMAP? Through a discussion of the design process and the in-situ evaluation we identified 9 issues. These issues somehow complement the 16 challenges we identified in the previous study. This study, however, focused on designing a concept for TMAP which was then developed and deployed for in-situ evaluation to study the spectator experience. In Table 6.1 we summarise the identified issues for the design of TMAP as *challenges* either related to concept or experience.

Some issues are indeed closer related to each or overlap to some extent. For example, destructiveness, clearness, togetherness, and exclusiveness are all related to the audience as a group. Albeit destructiveness and clearness address the behaviour of the group,

Concept	Experience
cautiousness	meaningfulness
destructiveness	clearness
awareness	playfulness
newness	togetherness
exclusiveness	

Table 6.1: Summary of identified challenges

togetherness refers to the relationship of the audience as a group as well as the musicians, and exclusiveness finally describes rather the inclusion within the group of spectators. Similarly, this applies to destructiveness, clearness, and playfulness. All three aspects are related to control as part of interaction in TMAP. However, clearness refers to misunderstanding, destructiveness describes resulting problems, and playfulness proposes a possible solution.

In addition to these issues we can draw conclusions on the experience with CoSCoS to identify possible design directions for further studies. With CoSCoS we developed a smartphone-based concept for TMAP. The in-situ evaluation showed that technical features in relation to smartphones (e.g. fault tolerance, availability, usability) have to be well considered and implemented as they are crucial to the success of the participation. With CoSCoS some participating spectators were distracted by the devices themselves. Non-participated spectators were distracted by observing participants. Furthermore, some spectators willing to participate were excluded from participation due to technical constraints.

CoSCoS follows a rather careful than provocative approach concerning impact and feedback on sound. From the perspective of the spectators, feedback was hardly recognizable for individuals when they acted in a group. Traceability seems to be an important issue because otherwise participants doubt their contribution, get frustrated and they cannot communicate their interaction within a group. Concerning the musicians, CoSCoS did not include the band on stage apart from a projection behind them they could not really see. We conclude that clear feedback for spectators and a communication between musicians and audience to establish meaningful interaction among everybody involved in the performance is vital to the success of TMAP.

Finally, the given song certainly constrained manipulation possibilities and even the design process was only focused on the interaction as we built CoSCoS on top of this song. Hence, finding the right trade-off between intervening in artistic integrity and designing an intuitive system that engages the audience, is crucial.

6.8 Summary

The purpose of this case study was to design, develop, and evaluate an actual system for TMAP in a real-world scenario. On this basis we presented CoSCoS, a smartphone-

based system for audience participation. We included spectators and musicians during a participatory design process and deployed CoSCoS during a live concert to evaluate the spectators' experience by using video observation and after concert questionnaires.

In summary, with this study we were able to identify further *challenges* concerning the design of TMAP. Furthermore, we present *possible design directions* to inform the next case study derived from the experience with CoSCoS as rather technology-centred form of audience participation.

6.9 Contributions

1. *Design Challenges concerning the Concept and Experience*: Through a reflection on the participatory design process and an in-situ evaluation of CoSCoS, a smartphone-based system for TMAP, we identified 9 challenges. These challenges concern the design of TMAP in relation to concept (cautiousness, destructiveness, awareness, newness, exclusiveness) and experience (meaningfulness, clearness, playfulness, togetherness).

2. *Possible Design Directions*: Too technology-reliant audience participation is distracting and excludes spectators willing to participate. For a meaningful interaction within TMAP it needs an intuitive form of control, clear individual feedback for spectators, and a communication between musicians and audience including an engaging and noticeable impact on elements of the performance.

3. *Participatory Design for TMAP*: Including musicians and spectators in the design, helps to balance constraints and affordances on both sides and to foster the acceptance of such a system, unless the design process is too balanced. Design of TMAP needs to be critical or even provocative to create a final concept that is artistically enriching and satisfying from an interaction point of view.

CHAPTER 7

Experimence Case Study

In this chapter we present the second case study of this thesis research that focuses on the process of composition, rehearsal, and the final live performance of a song, purposely written for technology-mediated audience participation (TMAP). Initially, we describe the composition of the song Experimence[1] *followed by the design of the participatory performance and the actual live concert with the collected data for evaluation and discussion. As outcome we present four design challenges with associated questions driving certain decisions during a composition for TMAP.*

7.1 Motivation

The previous case study pointed out the problem of excluded and distracted spectators with technology-mediated audience participation (TMAP) dependent on smartphones and the importance of clear and individual feedback for meaningful interaction. Furthermore, the use of a given song constrained the design too much in terms of intervening with artistic processes. To further investigate and overcome these issues, we designed another case study exploring TMAP from a different angle.

For this case study, the self-determined goals were to reduce the dependency on technology, to enable intuitive interaction and clear feedback, and to allow as many spectators as possible to participate. In addition, we will focus on artistic processes around TMAP rather than the actual design of technology as we did in the previous case study.

To achieve these goals, we decided the only object being necessary and subject to interaction is a balloon which is bounced around by the spectators as shown in Figure 7.1 and influences the music through its trajectory. This choice was inspired by similar approaches in research (Cutler et al., 2000; Maynes-Aminzade et al., 2002) and art (Muse,

[1] **Experim**ent + Experi**ence**

Figure 7.1: Balloon in the audience

2001; Coldplay, 2012). To include artistic processes in this study, we composed a song called *Experimence* (**Experim**ent + Experi**ence**) specifically with TMAP in mind. To align with the previous case study and according to the primary musical context of this research, the musical piece will be a rock song.

As with the previous case study, we want to learn more about practice-based design processes around TMAP and its impact on a live concert by evaluation methods already being used. With this case study, however, this research also will be informed with new insights. These can arise from a focus on the song itself and its composition in the context of an anticipated audience participation at the live performance. Thus, the questions raised for this study are:

Q1 Which aspects have to be considered when composing a rock song while keeping technology-mediated audience participation in mind during its live performance?

Q2 How can these aspects be classified in terms of variability during their application in the process of the composition?

We start to describe the composition of Experimence, continue with the design of its performance, and then present the evaluation of the spectators' experience at the live concert. The final discussion of the whole process will help to extend our existing knowledge about TMAP and answer the raised questions.

7.2 Composition

The composition of the song, which was given the title *Experimence*, was purpose-written for this particular case study, mainly by myself, the author of this thesis. It follows typical practices regarding song writing as inspired by literature (Tagg, 1982) and the involved musicians' experience. Many different considerations regarding arrangement, form, harmony, and lyrics, just to mention some important ones, shaped the final version as it was played during the live performance. These considerations are described in the following and we return to them in the discussion to reflect on them after the presentation of the results from the live performance. The song analysis is based on self-reflection and notes that were taken during the composition and rehearsals.

In general, the music and lyrics of Experimence were not intended to be just created as a song for the study but represent the main idea and purpose of it. As already mentioned, a core idea for the interactive component of the study was that a balloon is to be collaboratively played with by the audience. The typical wave-like trajectory of a balloon being bounced around was taken up as guiding theme for the music. This particular characteristic of a balloon, to rise up fast when being pushed and to fall down slowly, is reflected figuratively at certain different levels within the whole song as described in each of the following sections.

To get an idea of the song and to support the understanding of the theory behind it, a live recording of the performance at the event *Wiener Musik-Experimente*[2] (Viennese Music-Experiments) is available online, providing a video including the live music as well as different camera angles of the audience and performers[3]. Throughout this chapter references to certain points of the video appear as minutes and seconds (mm:ss). We recommend to watch the video and to listen to the song before proceeding.

7.2.1 Arrangement

The piece was arranged for vocals, piano, guitar, and drums. This instrumentation or parts thereof are widely used throughout popular music. We chose the piano as lead instrument and central element for the audience participation. The main reason for this decision was to provide a clear distinction between the typical piano sound without influence in contrast to significant audible changes when including the crowd of spectators.

While working on initial harmony studies for the verse and according to the main intention of reflecting the balloon's trajectory figuratively in the music, Experimence turned out to become a slower ballad-like song with a 4/4 rhythm at a tempo of 90 beats per minute. However, the chorus did not feel right with a slow tempo (the balloon falling) and so it became the "balloon rises up fast"-part of the song, creating a speedy sung melody along with a tight rhythm in the piano accompaniment.

Apart from the piano, which carries the whole song, the other instruments appear and disappear throughout its progression. The climaxes and full arrangements always

[2] http://www.musikexperimente.at (last access 15.04.2016)

[3] https://www.youtube.com/watch?v=w6i-fsOTASs (last access 15.04.2016)

Time (mm:ss)	**Song part**	**Number of measures** (and references to the harmonies in Table 7.2)
00:00-00:12	Intro	4 mm. (4a)
00:13-00:57	Verse	16 mm. (4a+4a+4b+4c)
00:58-01:22	Interlude 16th	8 mm. (4b+4b)
01:23-01:39	Chorus	6 mm. (6e)
01:40-02:21	Verse	16 mm.
02:22-02:37	Chorus	6 mm.
02:38-02:59	Interlude 16th	8 mm. (4a+4d)
03:00-03:15	Chorus	6 mm.
03:16-03:37	Interlude Solo	8 mm. (4b+4b)
03:38-03:53	Chorus	6 mm.
03:54-04:16	Interlude Outro	8 mm. (4b+4b+I)

Table 7.1: Form of the song Experimence

happen with a chorus, while the verses and interludes are the calming parts, though still with continuous escalations. This leads directly to the actual form of the song which is described in the following.

7.2.2 Form

From an analytic point of view and according to Covach, Experimence has a Verse-Chorus Form (Covach, 2005), though significantly extended. Usually this means the verse is mainly preparing and leading to the chorus, which is clearly the intentional and musical focus in this song form. However, finding the final form presented in Table 7.1, was a key issue and aspect that changed most throughout the composition and the rehearsals.

In the first version of the song, the four *Interludes* were not considered at all and an instrumental solo part was planned instead of the third *Chorus*. At this point it is important to mention that the audience was intended to be included throughout the whole song, influencing the sound of the piano. Hence, the first version represented a typical Verse-Chorus Form (Covach, 2005).

In the first rehearsal of the song with the band, described in detail in section 7.3.2, we included a simulation of the anticipated participation of the audience. However, after a reflection by the band, two important decisions were made. First, it is not expedient to include the audience throughout the whole song, and second, as a consequence it was decided to extend the first form by adding the interludes specially tailored for the inclusion of the spectators.

The final version of Experimence for the live performance was still different from

```
Intro, Verse, and Interlude:
4a: C  G/H   | Am  Am/G  | F     Em  | Dm    G   (chords)
4a: I  V/VII | vi  vi/V  | IV    iii | ii    V   (scale-steps)
4b: C  G/H   | Am  Am/G  | F         | Gsus  G
4b: I  V/VII | vi  vi/V  | IV        | Vsus  V
4c: C  G/H   | Am  Fm/G# | Fmaj7     | Gsus  G
4c: I  V/VII | vi  iv/V# | IVmaj7    | Vsus  V
4d: C  G/H   | Am  Em    | F     C   | G
4d: I  V/VII | vi  iii   | IV    I   | V

Chorus:
6e: F  G | Am | F  G | E   Am G | F  | G
6e: IV V | vi | IV V | III vi V | IV | V
```

Table 7.2: Harmonies of each song part (Table 7.1) in two notations

the actual performance. In particular the *Interlude Solo* and the following last and fourth occurrence of the *Chorus* as shown in Table 7.1 were added by the musicians spontaneously when improvised during the live performance.

7.2.3 Harmony

Creating the harmonic structures of Experimence was more driven by creativity than rationality. Nevertheless there were decisions made for specific reasons.

The harmonies reflect the idea of the balloon's trajectory in two ways. First, in the *Intro*, *Verses*, and *Interludes*, the piano uses step-wise chord progressions. An example is starting from C downwards to Dm following the major scale of C and up again to G as shown in Table 7.2, lines 4a. Slightly different variations of this progression are used throughout the song in all parts except the *Chorus*.

The second occurrence of the harmonic trajectory-imitation appears in the melody of the *Interlude*, which is played instrumentally by the piano. This series of 16^{th} is shown in Figure 7.2 as score and MIDI notes in a piano roll view visualising best the wave-like progression. After the analysis of the music-related elements of Experimence we proceed with the description and interpretation of the textual meaning.

7.2.4 Title and Lyrics

In an early stage it became clear that the lyrics should somehow relate to the purpose of the song rather than addressing something random. At this time the piece was given the title *Experimence*. This artificial word combines the unique *Experience* everyone will have during the *Experiment* of its live performance.

The content of Experimence can be described as what both science and art have in common and try to explore: the quest for something new and to find the unexpected.

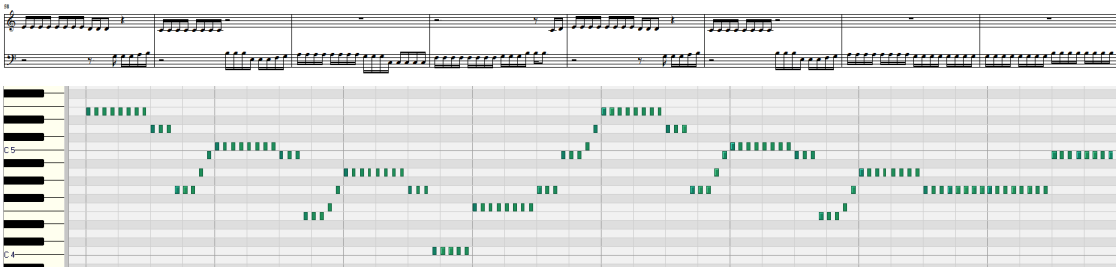


Figure 7.2: The melody of the second *Interlude* showing the wave-like progression

In the song, the *Verse* - as written below - represents the wise and learned voice of a scholar or an experienced person. The *Chorus* though is either the sudden confession of this person's self-criticism or the preceding self-awareness before the conclusion. At the end of each *Chorus* the redefinition of one's own state of mind is presented as possible solution. In either way, the content refers to the purpose of the song itself, which is an art-based and experimental approach to explore something unexpected.

Verse:

Hold on again some ways are fallacious
Find your own lane and mind those of others
Challenge the known will just guide us to new worlds
Life teaches well what happens if you do so

Chorus:

I started to explore the world
To look upon the rationale
And figured out it's endlessly
I started to imagine why
The edge of human knowledge could be
Worth a look beyond the scenery and
Redefined my state of mind

7.3 Design Process

Participatory design characterised the previous case study, while this one focuses on artistic processes. The principle interaction was already defined with the balloon and

Figure 7.3: The band *Oliver Linus* performing the song Experimence live

the composition of the song and we wanted to do the final linking of balloon and song during the rehearsals with the band.

In the end, two rehearsals with the band led to significant changes regarding the form of the song and the final realisation of the interactive audience participation. These modifications and the band's orchestration are described in the following as well as the simulation of the anticipated crowds' behaviour used for a realistic performance rehearsal.

7.3.1 The Band

The case study was planned as a project to be conducted together with a band especially formed by myself, the author of this thesis, whose alias is *Oliver Linus*, the name also given to the band.

To rely on diverse experiences in rock music, a professional drummer aged 35 and a hobby guitarist aged 58 were hired for the live performances. Both were experienced with performing, writing, and recording popular music. None of the musicians had previously played together. The choice was not a coincidence, since the guitarist grew up with rock music starting in the 1960s and the drummer as well as the author are familiar with more recent rock music. Figure 7.3 illustrates the musicians on stage performing Experimence. The singer and pianist is on the left, the guitarist is standing in the centre and the drummer is on the right.

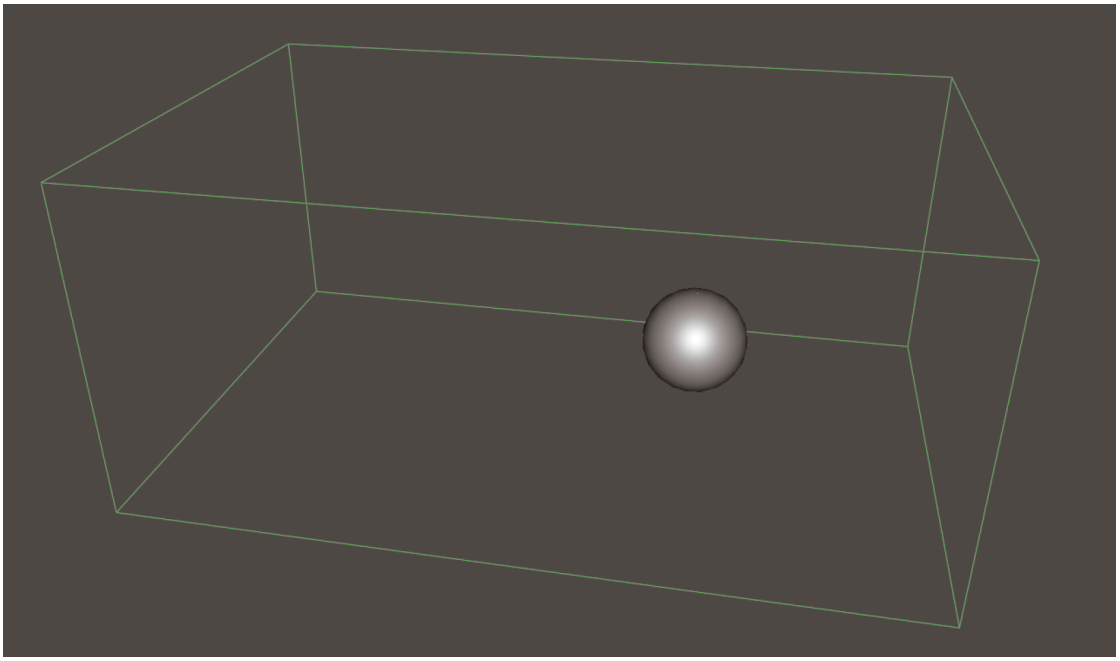


Figure 7.4: The simulation's visualisation of the balloon moving around a room

7.3.2 Simulation

Apart from rehearsing the song Experimence for the purpose of a good live performance, an important issue was the simulation of the anticipated influence of the audience. This was especially important since this idea was new for the hired musicians.

To maximise a realistic practice of the song and to support the imagination of how it could sound in an interactive performance, we developed a simple simulation of a balloon's trajectory in a room. A visualisation of this concept is shown in Figure 7.4. This real-time animation was also used during the rehearsals on a screen for all musicians to at least get a simplified idea of how the balloon might be flung around by the audience during the live performance.

The simulation itself is based on three values for the position of the balloon in the room (x, y, z) and one value for its acceleration (v). These four values are randomly created to describe a changing trajectory. For the purpose of an almost realistic situation during the rehearsal, this random approximation was sufficient.

7.3.3 Audience Influence

The rehearsals proved to be decisive in terms of the final influence of the audience in the song. The original idea was that the audience's interaction with the balloon would collaboratively modulate the sound of the piano by using additional effect devices.

However, when probing this approach in the first rehearsal using the simulation, it

turned out that this alteration was too intense for the whole song and became even distracting and annoying somehow for the musicians. To address this, the interludes were inserted into the song's structure as central elements for audience participation. This has already been described in detail in section 7.2.2.

During the second rehearsal, we tried something else. When we decided to focus the audience participation on the interludes during the first rehearsal, the idea came to link their wave-like melody progression to the balloon's trajectory. By doing so, the audience could not only control the sound but actually play the notes of the melody. When trialling this idea with the simulation, we discarded it soon as it did not sound well. It ended up with the final idea of letting the audience control the sound effects of the piano during the interludes.

Technically, the sound modulation was realised by using the effect device *KaossPad*[4]. To remotely control the KaossPad with the balloon tracking, we used *Max*[5]. In terms of mapping the position of the balloon in the room to effect parameters, we controlled the touch pad of the KaossPad with the balloon's two-dimensional position (left, right, front, back) and the intensity of the applied effect with its height in the room (up, down: the higher the balloon, the more effect was applied to the original piano sound).

Focusing on the sound effect, we used a chorus for the first two interludes and a vocoder for the other two ones. The chorus, which modulates a tone as if it would float in the room, was less intense compared to the vocoder which alienates the piano melody to a larger extent. This makes the influence clearly traceable without changing the piano sound too much.

7.3.4 Balloon Tracking

A technical realisation of the balloon tracking was not the aim of this study. It was rather, to serve as a proof of concept and to study the compositional issues. Hence, we developed a concept for a Wizard-of-Oz-Experiment (Green and Wei-Haas, 1985). By doing so, everything was designed for a real object tracking system with mounted video cameras, except for the manual tracking of the balloon. This was done behind the scenes by another person, the wizard, involved in the study and the only one, apart from me as the author and composer, who was informed about this concept. In fact, even the hired musicians were not aware of the manual tracking. The balloon itself had a diameter of approximately 60 cm when inflated and was made of stronger rubber than a usual balloon product.

Technically, the wizard manually tracked the balloon's position in the room with the right hand and its height with the left. The wizard sitting back stage could not use the KaossPad for tracking because it was needed on stage for playing. Thus, we designed a setting to control the KaossPad remotely from back stage. Figure 7.5 (left) shows the wizard trialling the tracking.

[4]KaossPad KP3: http://www.korg.com/us/products/dj/kaoss_pad_kp3_plus (last access 15.04.2016)

[5]Max 6: http://cycling74.com/products/max (last access 15.04.2016)

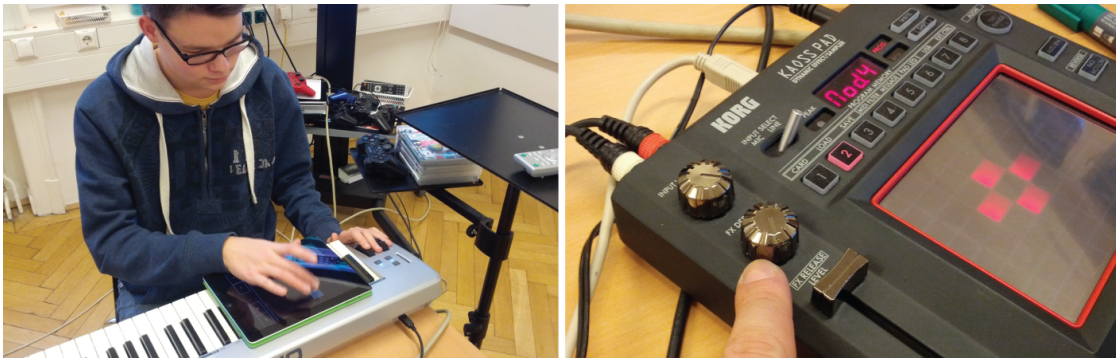


Figure 7.5: The wizard trialling the balloon tracking and the KaossPad (right)

For the position in the room we used a tablet computer with the app *Control*[6]. The touch screen allowed the wizard to trace the position in two dimensions and send OSC messages wirelessly to a computer with Max, which controlled the KaossPad's touch pad (see Figure 7.5 right). The height was controlled with a physical toggle switch of a USB MIDI controller remotely controlling the *FX depth* knob the KaossPad. During testing this set up, it turned out to be more convenient for the wizard instead of just using one tablet computer. Especially for the height control of the balloon, an up and down toggle switch seemed more logical than the rotary knob as used on the KaossPad for FX depth (Figure 7.5).

We will come back to this Wizard-of-Oz approach later for discussion and continue with a description of the it-situ study during performing Experimence live.

7.4 Live Performance

In this section we describe the actual live concert when the purpose-composed song Experimence was first performed publicly and with audience participation.

This central element of the study happened at the event Wiener Musik-Experimente (Viennese Music-Experiments) on 6thFebruary 2014 in Vienna, Austria. The whole event took place at the Vienna University of Technology and the main idea behind this event was to interlink mainstream and experimental approaches in live music in various different ways. The poster to promote the event in public is available in the Appendix D. Overall, there were performances of five bands throughout the evening which were not related to each other. Every band performed for 25 minutes with 10-15 minutes between each performance. Figure 7.6 shows the floor plan of the venue with the general facilities of the event and the particular elements important for our case study.

During the performance of Oliver Linus the song Experimence was played last. Just before the song started I gave a short introduction to the audience to explain what they could do with the balloon. When the song started, the balloon was held back by a helper

[6]http://charlie-roberts.com/Control (last access 15.04.2016)

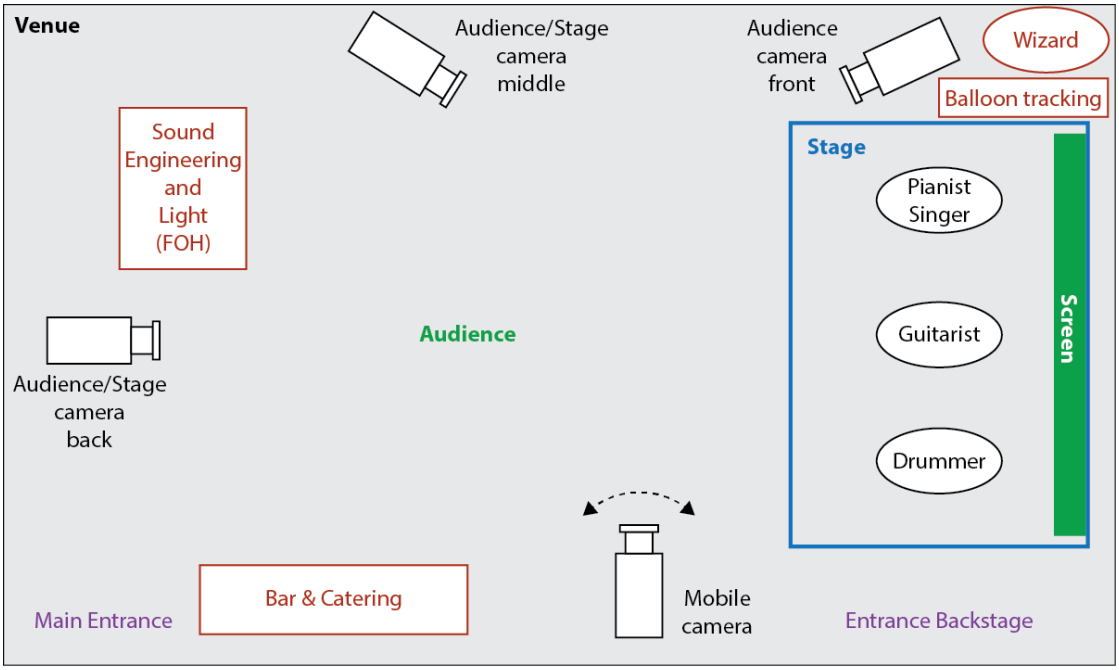


Figure 7.6: The floor plan of the venue for the Experimence in-situ study live concert

in front of the stage until the first interlude. From that moment on, it was introduced into the crowd who then bounced it around over the heads of the audience throughout the whole room.

The balloon tracking was activated during each interlude and its trajectory manually traced by the wizard behind the stage. An additional projection on a big screen showed the words *Ballon aktiviert* (German for *Balloon active*), which was intended to support the awareness of the audience when the influence in the music was activated. The balloon was left in the audience throughout the whole song. However, an influence on the sound of the piano was only audible during the instrumental interludes.

During the live performance, one spontaneous change happened in relation to the song's form. This improvised and mood-driven extension by the pianist can be seen in the live video at 03:28 when the drummer stops playing, puts down the drum sticks, and watches the audience playing the balloon. A few seconds later both the guitarist and the drummer reacted immediately on this prolongation and continued playing. Hence, the final and actual performed version of Experimence had a duration of 4 minutes and 16 seconds, nearly 40 seconds longer than anticipated.

We now proceed with the evaluation of the live performance and present the results based on collected data.

Figure 7.7: Four cameras synchronised in one screen for video-analysis

7.5 Evaluation Methods

We used video observation and conducted an after concert survey for data collection as with the previous case study. In addition, we logged the data of the wizard's tracking and discussed the performance experience within the band retrospectively.

This time we used four cameras to video record the performance from different angles. Two cameras were mounted at the front and back to cover the whole room and to focus on the audience. The other two cameras were oriented towards the stage from opposite angles to record the musicians. For the final analysis we synchronised all videos and edited them to fit in one screen, as shown as a still picture in Figure 7.7. The video is also available online[7].

The camera angle shown in the upper left picture of Figure 7.7 was the main audience camera. We used a fisheye lens to maximize the field of view and to cover the whole audience. The upper right angle shows the view of the camera positioned in the back facing towards the stage. This angle covered half of the audience plus the stage. The lower left camera was mobile hand-operated, focused on close details on stage, and followed the balloon when it was active. The lower right camera was supposed to record the stage. For unknown reasons, most probably by accident, it was misplaced sometimes during the evening. For analysis it did not matter as there were enough angles recorded by the other three cameras. A photographer also did take some pictures of the performance. These pictures were included in the observation analysis too.

[7]Experimence Live: https://www.youtube.com/watch?v=w6i-fsOTASs (last access 15.04.2016)

Immediately after the performance of Experimence, which was played last in the set of Oliver Linus, we used short one-page questionnaires with nine questions to ask spectators about their experience. We had about 15 minutes and six helpers to quickly interview as many spectators as possible during the break after the concert. The full questionnaire is available in Appendix D.

Finally, we logged the manual balloon tracking in Max by saving the three position values with timestamps. We took special care of a fail-safe storage method in Max to minimise the chances of data loss.

7.6 Results

As reference for all results, we start with some basic information about the venue and the event as they are important for the analysis of this case study. According to videos and photographs we counted about 90 people attending the performance of Experimence. The size of the venue was 82m^2 and the height was 5m according to plans provided by the facility management. We proceed with some more details and the video observation results.

7.6.1 Video Observation

We did the video analysis in three steps and were first looking at general issues. According to distribution of people and different roles among them, we identified 76 as spectators. Seven were other musicians and helpers standing next to the stage, one bar tender, two sound and light engineers, and one photographer. Most attendees were standing. However, we could count ten people who were sitting on chairs or on a windowsill. All of them remained seated during the performance and did not stand up for any reason. Overall, there was not much movement among the audience apart from those playing the balloon.

During the second phase of analysis, we divided the whole video into single song parts, including their duration according to the final form of Experimence and if the balloon interaction was active (when the screens showed *balloon active*). For each song part we counted how often the balloon was touched by someone and calculated the average touches per second (Table 7.3).

At the beginning of the song a helper near the stage held the balloon. After one minute, when the Interlude was first played (00:58), the helper threw the balloon in the audience. In total we counted 102 touches of the balloon during the three minutes from the moment the balloon was thrown towards the audience until the end of the song. In average, every 1,9 seconds a spectator touched the balloon (SD=0,2).

For the third step of the analysis, we watched the video iteratively looking for noticeable events and behaviour in relation to the balloon apart from the typical touching and observing single spectators. Among these were spectators who caught the balloon with two hands holding it for a moment (01:33) or balancing it a couple of times (02:37). Others were hurling it rather heavily towards others (four times, e.g. 01:46, and two

Nr	Song part	Begin	Duration	Touches	T. avg.
	* Balloon active	mm:ss	s	#	s/#
1	Intro	00:00	13	-	-
2	Verse	00:13	45	-	-
3	Interlude*	00:58	25	12	2,1
4	Chorus	01:23	17	7	2,4
5	Verse	01:40	42	24	1,8
6	Chorus*	02:22	16	8	2,0
7	Interlude*	02:38	22	11	2,0
8	Chorus	03:00	16	8	2,0
9	Interlude Solo*	03:16	22	12	1,8
10	Chorus	03:38	16	8	2,0
11	Interlude Outro*	03:54	22	12	1,8

Table 7.3: Song parts of Experimence with balloon touches in total and average

times by the same spectator) or ducked their head to prevent being hit (e.g. a woman in the first row at 03:29). Special events noticed were when the balloon was thrown towards the stage one time (02:27) and towards the sound engineers three times (e.g. 03:36). Several times the balloon hit the ceiling, walls, light spots, and even the projector which caused general laughing among the audience (03:54). Once the balloon approached the drummer who threw it further to the pianist and spectators applauded (02:27). Four times the balloon hit spectators and one of them even unexpected from the back which made other spectators laughing (01:57).

To summarise, when observing single spectators throughout the performance, we could see all sorts of behaviour. Most spectators were mainly attracted by the balloon. A group of spectators standing in the middle of the venue followed its movement carefully by turning around completely and ignoring the performance. Spectators in the front rows concentrated more on the performance but turned around sometimes either.

7.6.2 After Concert Questionnaires

Immediately after the performance, six helpers distributed themselves among the audience and started to randomly interview spectators using short questionnaires. In total, they conducted 32 interviews which can be considered a good sample of people, having a total of 76 audience members. 27 of them mentioned their gender and age. Among them were 15 males and 12 females. Age-related, the mean was 31 years (SD=9,6). In other words 16 of 27 spectators were younger than 30. For some questions, participants could give optional comments. Note, all comments were translated from German to English.

For the first four questions participants were asked to answer by ratings or yes-no-decisions and to give optional comments. The average values of the four rating questions are listed in Table 7.4.

Nr	Question	M	SD
1	How often did you manage to play the balloon?	1,9	1,9
2	To what extent did you recognise the acoustic influence of the balloon? (1=weak to 5=strong)	2,4	1,0
3	To what extent have you been distracted from the actual performance? (1=weak to 5=strong)	2,4	1,3
4	To what extent could this balloon interaction play a role at other live concerts? (1=weak to 5=strong)	3,5	1,2

Table 7.4: Answers of questions expecting numbers or rating

In average, every surveyed spectator hit the balloon nearly twice (M=1,9; SD=1,9). The standard deviation of 1,9 indicates that some of the participants never touched the balloon and some more than two times. In fact, two participants stated they played the balloon seven times which was the maximum.

The acoustic perception of how the balloon influenced the sound was middle-rated on the five-step scale (M=2,4; SD=1,0). This indicates that the participants did recognise the acoustic change but not too strongly. Eight spectators gave additional comments for this question that support this assumption, “minimalistic vibration in the sound”, “slight distortion”, “piano but little”, and “short changes in the sound” were some of them.

The distraction spectators experienced by the balloon from the actual performance was also middle-rated (M=2,4; SD=1,3), which indicates a certain distraction through the balloon but not too much. In total, four spectators commented here, “super idea but audience was separated from band”, “I tended to concentrate more on the balloon”, “delightful”, and “the drums were too loud, I could hardly hear the piano”.

The fourth question targeted the opinion of the spectators right after the experience with the balloon and if they could imagine having it at other concerts. Here there was a little higher agreement (M=3,5; SD=1,2) and five spectators left comments. One person who commented on the distraction earlier added here, “yes, if it includes the stage more”. Others said, “depends on audience size and venue” (2x), “could be fun at big festivals”, and “as with Coldplay but interactive.”

The questions number 5 to 7 were open questions. Interviewees were asked about what they liked, disliked, and which intentions they had during the balloon interaction. In terms of what participants liked, the balloon or “balloon game” was mentioned six times and twice the “the idea” and “overall concept”. In relation to a particular positive experience, eight spectators pointed out they liked to observe and watch others having fun playing the balloon and to see the movement of the involved audience. One spectator mentioned the funny moment when the balloon hit a projector mounted on the ceiling.

An issue five participants mentioned as negative, was that they could recognise an influence but it was “too weak” and that they did not like the balloon itself (3 times). Two wished to have more space for an “expressive ball game” and that they could play the balloon more often.

Asking about the thoughts and intentions participants had during the balloon interac-

Nr	Question	Yes	No	Other
8	Do you think TMAP should happen more often at live concerts?	72% (23)	19% (6)	9% (3)
9	Would you like to be involved more often at live concerts?	66% (21)	22% (7)	13% (4)

Table 7.5: Answers of questions expecting yes or no

tion, eight spectators wished to touch the balloon in any way. Two even said, "bounce the balloon as hard as I can" or get "as many balloon contacts as possible". Two spectators also described a certain fear that the balloon approaches them which they would have not appreciated or two other ones were afraid of the balloon hitting fragile things around the venue. Finally, the balloon certainly drew the attention of the spectators as two described their experience as "mesmerised by the balloon". However, one spectator explicitly said she tried to focus on the musicians playing.

The last two questions, 8 and 9, were supposed to be answered by yes or no. Most people did so but some said "maybe" or gave no answer. Some additionally commented on their decision. Table 7.5 summarises the results of these two questions. The full list of comments is available in Appendix D.

First, participants were asked whether they think TMAP should happen more often at live concerts. Most said yes and 18 of the 23 agreeing left general comments or particular suggestions. Among these were, "the mass [audience] should interact together", "let them hand around objects", "sing and clap along", "down-to-earth (sic!) changes in music", "not disturbing and distracting, music has priority, here it was good", "[..] only body movement", and "in a way where the own contribution is recognisable". The three participants who said "maybe" commented with "depends on music [..]".

Second, we asked if they would like to be involved more often at live concerts. Most of the participants agreed (66%). The comments in addition to agreeing were, "If I understand it" (2x), "Acoustically and visually" (4x), and "Only if appropriate, not at an opera and only at selected concerts". One comment of a maybe-respondent was, "Only if the whole audience is involved, focus on one person is not good".

7.6.3 Log Data

Additionally to the video observation and the questionnaires, we logged the wizard's balloon tracking. This log data contained the three coordinates (x, y, z) representing the balloon's position in the room plus timestamps in milliseconds. This resulted in more than 12.000 values from the moment the balloon was released to the audience until the end of the song. To log the x, y, and z coordinates, we stored the MIDI values ranging from 0 to 127 when they were sent from Max to the KaossPad according to the wizard's interface control.

To make sense of this big amount of data, we created a heat map based on x and y values to visualise the balloon's position in the room. Figure 7.8 shows this heat map

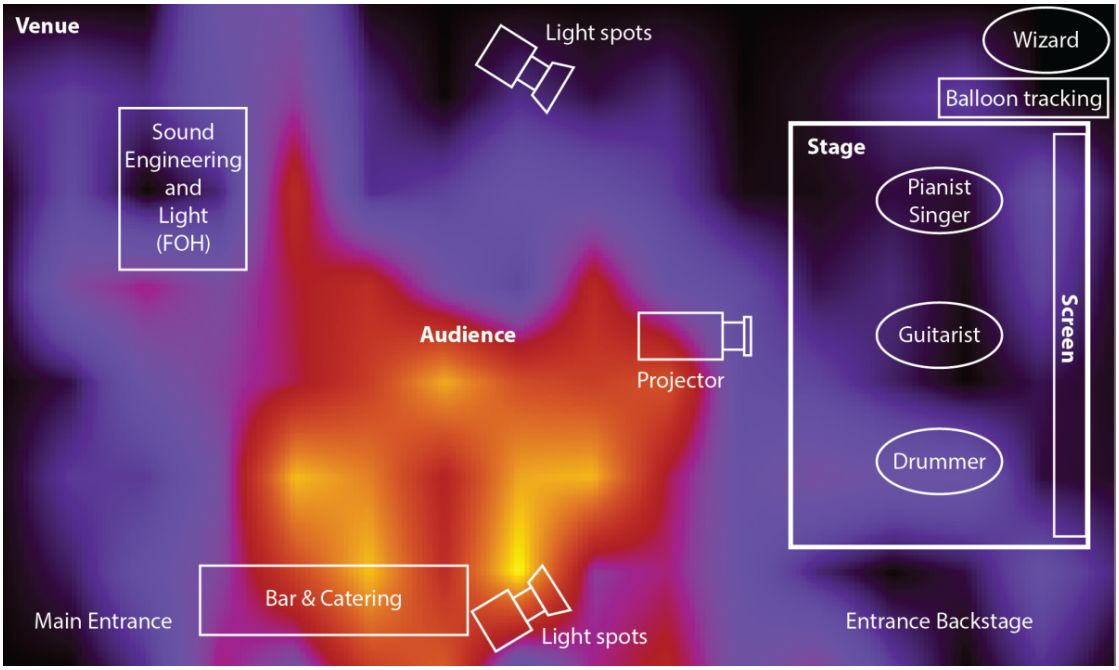


Figure 7.8: The floor plan of the venue with a heat map of the tracked balloon locations

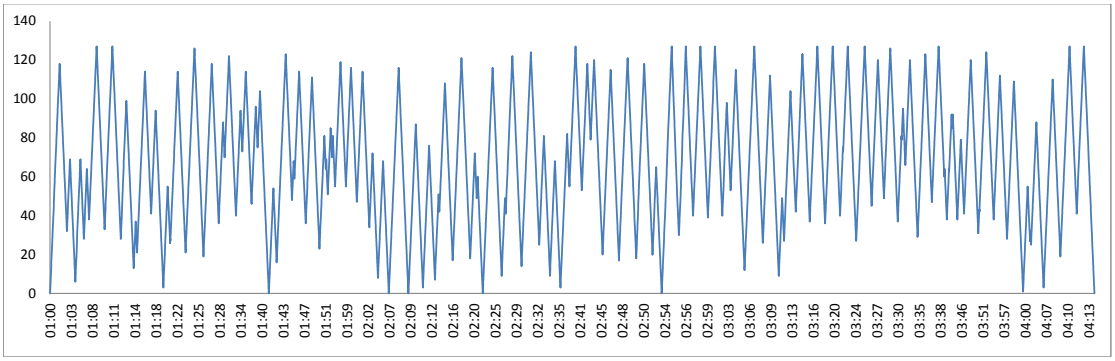


Figure 7.9: Graph showing the up and down movement of the balloon tracking

with an overlay of some elements at the venue.

The brighter and more yellow the colour in the heat map, the more often the balloon happened to be there. Black and very shady areas indicate that the balloon was never tracked there. Compared to what we have seen in the videos, the general tracking by the wizard represents the real situation quite accurately in these two dimensions. Even if we look at the edge areas of the venue, for instance, the shady blue in the upper right corner indicates the moment when the balloon was thrown towards the stage and from the drummer to the pianist.

Figure 7.9 visualises the up and down movement (z coordinate) of the balloon tracking throughout the whole song. Every peak heading downwards represents a touch of the balloon by someone. Some are very close to each other and could be considered as wrongly tracked (e.g. around 01:34). Dependent on skipping these or counting all peaks heading downwards it results in 76 to 82 touches that the wizard tracked. This means about 20 fewer than the 102 identified through video observation. Comparingly, the number of touches of the video observation is more reliable in this regard.

7.6.4 The Band's Reflection of the Performance

The three band members reflected on the concert and discussed the immediate impression after the performance. The results of this reflection is mainly based on notes I, as author and band member, took during the talks and my own experience. Overall, we all agreed that the performance worked out well and that it was a new experience for all of us. The issues being most discussed were the moment the balloon entered the stage and the spontaneous repetition of a chorus at the end.

When the balloon approached the drummer (02:27), he said, he actually did like this inclusion and did not feel very distracted. As he pushed the balloon forward, it ended up at the piano so I had to push it further. For me, it was not the actual physical distraction by using one hand to push the balloon away but the moment right afterwards and the mental distraction when I struggled with singing the right lyrics.

The drummer mentioned he did not immediately recognise the spontaneous repetition of the chorus instead of letting the song end. He rather decided to stop playing (03:28) and let the piano and guitar end the song to enjoy watching the audience and the balloon. That he was not really sure whether another chorus is spontaneously played or not, can be seen at 03:38 when he starts playing again. After the presentation of all results, we proceed with the discussion to draw the different insights of this case study together.

7.7 Discussion

The goal of this case study was to compose a rock song specifically with TMAP in mind and perform it live for evaluation. After the analysis of this purpose written song Experimence and a description of the rehearsals as well as the actual live performance at a event including an extensive data collection, we now reflect on the whole process and the outcome. We will start with a discussion of the composition and a rehearsing of the song that preceded the performance.

7.7.1 Composition

The first research question asked: Which aspects have to be considered when composing a rock song while keeping technology-mediated audience participation in mind during its live performance? To compose a rock song for TMAP means to follow certain standards according to song writing conventions, and at the same time keeping the partly unpredictable behaviour of the participating audience in mind.

First of all, the actual intervention for audience participation, in our case the movement of the balloon, played an important role throughout the whole creative process. Hence, the given technical and data-related possibilities and constraints can be seen as a basis of which different decisions are made. In our particular case, for example, it was the trajectory of the balloon that was used to get real-time data. The three values representing the three dimensions were clearly defined in terms of their range and occurrence. However, the trajectory itself was more or less unpredictable, especially when thinking of different extreme scenarios such as bouncing the balloon very high or keeping it low.

Comparing the initial and the final song structure of Experimence, the form and single parts changed several times throughout the whole process. During the composition these alterations were mostly made deliberately. At the live performance however, a spontaneous repetition at the end of the song happened in a mood-driven way. A consideration during the rehearsal was to leave certain gaps and unfinished parts in the composition (i.e. the melody) which could later be closed and completed by the audience during the performance. Finally four instrumental interludes were created with the intention of letting the sound be collaboratively modulated by the crowd.

After all, what the audience did was rather real-time sound modulation of given tones than actual improvisation. However, it is the spontaneity and unpredictability of such an influence referred to as improvisation in this particular context. Furthermore, the reflection on the whole process we went through during the composition, the rehearsals, and the performance indicates an important trade-off: to provide enough freedom for an unpredictable behaviour as well as distinct feedback for the involved audience and keeping the amount of improvisation at an appropriate level considering the characteristics of a rock song. In relation to the distinct feedback and appropriate level of improvisation, the simulation of the audience participation played and important role. This simulation helped the band to get an actual idea of how the song might sound during the performance and even to try out alternative ways of letting the audience participate.

Another important consideration addresses the actual influence. With Experimence the final decision of which particular influence the audience will have during the performance was the sound of the piano. However, during the rehearsals the ideas varied from applying the modulation during the whole song to letting the audience play the actual notes of the Interlude's melody. From a song writing perspective, applying effects addresses the sound and arrangement while changing notes results in a modified melody. Both approaches are considerable interventions in the song but different in terms of their actual influence.

Finally, there is the actual instrument, that is influenced by the audience, which is in the case of Experimence the piano and it was chosen at a very early and conceptual stage of the composition. The decisive reasons in our case were that the piano is the lead instrument in the song, and that its sound is in general very distinctive and familiar which makes it easier to recognise when it is modulated by effects.

7.7.2 Live Performance

The Wizard-of-Oz approach allowed us to create a realistic scenario for our study at the live concert and to use it as a proof of concept. At the same time we could minimize the technical effort in such a system implicated to be reliable and applicable for a live concert without any loss of plausibility or credibility. Some differences in what actually happened with the balloon and what the wizard was able to track, did show somehow that it could be difficult to simulate such a dynamic interaction. Especially when the balloon was given a faster spin the wizard's tracking seemed to lag behind. Both, the video analysis and the log data support this assumption. A real tracking of the balloon would most likely lead to different changes in the sound. The tracking itself and its functionality, however, was never questioned by anyone, whether spectators or band members.

Overall, the choice to use a balloon as common interface for the audience turned out to be a good one. The results of the interviews indicate that the spectators could see or rather hear the impact of the balloon on the music when it was moved around the venue. The fact, that the balloon was much more playful than smartphones, for example, also seems to be important for the overall experience of everyone. Even non-interacting spectators enjoyed watching others having fun as, again, interviews revealed.

In terms of distraction, which we identified as a challenge to master after the last case study, we could see some issues in this context again. According to comments of both, participating and non-participating spectators, some of them definitely enjoyed watching and touching the balloon rather than being distracted. However, others were obviously afraid of being involved in the interaction. Following their comments they feared that they have to play the balloon when it approaches them or that they get hit by it because they focus on the performance rather than on the balloon.

A different kind of distraction happened when the balloon happened to be on stage, regardless of whether it was thrown there on purpose by someone or just happened to move there by accident. The balloon approached the drummer first who immediately gave it another spin, most likely undirected, which moved it further to the pianist and singer. Both musicians seemed to be certainly distracted for a second when they had to play the balloon. With the drummer we could identify a somehow "controlled distraction" when he was putting down the drum sticks and consciously started to watch the balloon. The moment when the balloon happened to be on stage, however, is also some way to include the musicians in the interaction.

Looking closer at the results in relation to acoustic feedback of the participation, the spectators were aware of it interpreting the average rating. At the same time, however, this rating combined with some interview statements indicate that the actual impact was rather unclear and could be even more intense from the spectator's point of view. From an interaction point of view, the feedback was satisfying and from here on it is rather an aesthetic decision in relation to music and depends on what the musicians want. For instance, a particular musical progression of the song Experimence was already considered during the rehearsals. This possible influence of the audience by collaboratively controlling the actual notes of a melody would lead to different aesthetic results and more obvious feedback presumably compared to the approach to let the audience modulate

the sound.

Finally, the balloon did not always controlled the sound of the piano. Every time it was so, the screen on stage showed *balloon active*. Remembering the rehearsals, this was a deliberate decision by the band to not let the audience participate throughout the whole song. Apparently this was more or less ignored or did not have any impact on how the spectators interacted with the balloon. The problem was that the balloon was still in the audience while it did not influence the sound.

7.7.3 Implications for Design of TMAP

After this analytic summary of the most notable aspects we observed during the composition, rehearsals, and the live performance of the song Experimence, we revisit our second research question: How can these aspects be classified in terms of variability during their application in the process of the composition? This asks for a more general classification of considerations that influence and shape the composition of a rock song for TMAP. An attempt to summarise our experience leads to the following four *design challenges* associated with questions to address certain decisions during the composition of a song having TMAP in mind.

The *subject of influence* is either an instrument or something which creates the music to some extent. It is the crucial point and defines further possibilities regarding to the actual influence. Hence, the following questions are important for this choice: (1) What is it?, (2) Who plays it?, and (3) How is it played?

The *degree of influence* describes what intervention happens to the music in particular and to what extent this is intended. This choice is dependent on the chosen subject of influence and the questions: (1) What is possible? and (2) What is wanted?

The *degree of improvisation* is the amount of participation granted to the influencing audience. This addresses the occurrence in terms of the time and quantity regarding to the whole song. The questions in this case are: (1) When, (2) where, and (3) how long does the influence happen?

The *degree of uncertainty* is mostly dependent on the intervention itself and the ways an audience is actually influencing the performance from an interaction point of view. It describes the anticipated behaviour of the crowd, the circumstances, and the scope of action it has from a technical point of view leading to the questions: (1) How does it work?, (2) Which data is available?, and (3) How predictable is the influence?

To summarise, it is important to mention, that these challenges affect each other and differ in their peculiarity as they are all dependent on the actual intervention for including the audience in the performance. We present these four challenges as results based on the observation and reflection of this particular case study and the previous studies of this thesis. We do not claim these challenges to be complete in this regard but rather see them as an important contribution to the intended descriptive framework for TMAP and as a starting point to its development.

7.8 Summary

In this chapter, we presented the song *Experimence* which was composed for a particular live performance including the audience for interactive participation. From an interaction point of view this was achieved by letting the crowd collaboratively control a balloon to shape the sound of the piano at certain parts of the song.

Overall, at the performance of the song we could observe a good acceptance of both participating people and those who did not. Some audience members still wished a deeper influence, although in general it seemed better recognizable than in the first case study.

Composing a song for TMAP explicitly, turned out to be a promising approach. To combine the interaction design with the composition, generates a more coherent result than putting audience participation on top of an existing song. The playful approach realised by using a balloon, which also resolved any technological issues on the side of the audience, turned out to meet our expectations.

By observation, reflection, and discussion of the whole process of composing, rehearsing, and performing the TMAP song Experimence, we identified and present a set of four *design challenges*. These challenges are associated with questions that drive certain decisions during the composition of a song for TMAP. For this research, we see them as starting point for the framework development.

7.9 Contributions

1. *Challenges concerning the Composition and Design*: We identified four challenges associated with questions that drive certain decisions during the composition of a song having TMAP in mind. These four challenges and their questions are: subject of influence (What is it? Who plays it? How is it played?), degree of influence (What is possible? What is wanted?), degree of improvisation (When, where and how long does the influence happen?), and degree of uncertainty (How does it work? Which data is available? How predictable is the influence?).

2. *Possible Design Directions*: With the visually tracked balloon, we tested an approach for TMAP with less focus on technology than with smartphones. In principle, the balloon was accessible to everyone and provided clear feedback. However, some spectators still want more in terms of touching the balloon more often and really understand what happens with the music. In relation to the balloon as moving object, it is intuitive, playful, and entertaining but also distracting and uncontrollable to some extent.

3. *TMAP Song Experimence*: We present the composition of a song having TMAP in mind that follows typical practices regarding song writing in popular forms of music. Even a structured and largely pre-composed song leaves a certain amount of space for unforeseeable musical events as can happen with an independent crowd and interactive participation. Through the intertwined processes of composition and design, it enables various feedback modalities to influence even the music.

Part II

TMAP Framework

CHAPTER 8

Framework Development

A main goal of this thesis is to describe the design space of technology-mediated audience participation (TMAP). This chapter presents the four steps developing the descriptive TMAP Framework which intends to describe this design space in a practice-oriented way. The framework is synthesised using both the experience of the field exploration and a systematic review of related work to identify design characteristics. After the development the TMAP Framework contains 170 entities in a tree-like structure on four levels. Alongside with the framework itself we discuss challenges that arose from a reflection on its development.

8.1 Motivation

Through the studies of the field exploration we were able to identify a range of issues and challenges concerning the design of technology-mediated audience participation (TMAP) in live music. Furthermore, the field studies investigated the domain of TMAP from various perspectives. This included the spectators' and musicians' experience as involved users as well as the design of technology and creative processes to realise and mediate TMAP as interactive experience. Overall, the field exploration served a better understanding of the design space and revealed important implications for designing TMAP in live music.

However, these issues and implications cannot be considered comprehensive or generalisable as they derive very specifically from our particular field studies. This is a known limitation when studying performances as the methodological problem is to determine which performances should be considered representative (Palmer, 1997).

To this end, we widen and deepen our knowledge about TMAP by systematically reviewing existing works within the broader domain and to form a descriptive framework. The framework is intended to map out and describe the design space of TMAP in live

music and to serve as lingua franca within this highly interdisciplinary field as well as guidance for design-related processes around TMAP (Carroll, 2003; Rogers, 2012). We define this anticipated formalised description of the design space of TMAP in live music as *TMAP Framework* and raise two research questions for its development:

Q1 Which characteristics can be identified from systematically reviewing existing work related to technology-mediated audience participation?

Q2 Which challenges arise from pulling together these characteristics to form a descriptive framework?

By answering the first research question we want to find a common terminology and maximise the granularity of the framework to address the interdisciplinary nature of the field. The second question focuses on the development of the TMAP Framework itself and the intention is to keep it largely scalable, considering the field's complexity. We continue with an overview of the framework development process.

8.2 Development Overview

We developed the TMAP Framework in four steps. To found the TMAP Framework on a broad data basis, we searched for existing examples of TMAP in the first step. With *examples* we refer to related work found in scientific literature (e.g. technical prototypes, artwork) as well as relevant generic sources (e.g. online videos or articles) as described later in detail.

The actual framework construction happened in the next three steps using qualitative approaches to build and extend the framework. These steps were highly informed by the field studies which sensitised the experience about the design of TMAP. Table 8.1 shows a chronological overview of the applied steps to develop the TMAP Framework. We continue with a detailed description of each step's method, the respective procedures we applied, and the results.

8.3 Data Collection

The first goal was to find a wide range of examples for audience participation in a musical context. To maximise the amount and diversity of the collected examples, we conducted this data collection as part of an exercise with a class of interaction design students at the Vienna University of Technology.

8.3.1 Class Exercise Procedure

For the exercise the students were asked to do three tasks: (1) Search for examples dealing with interaction between performer and audience in live music, (2) choose an example which you want to analyse in detail, and (3) analyse your chosen example. The detailed instructions for this exercise are available in Appendix E.1.

Step	Method	Procedure	Results
1	Data collection	Collection of examples for TMAP in live music from online sources within a class of interaction design students	48 examples for TMAP evidenced by scientific literature and art including a written description based on ten analytical questions
2	Identifying characteristics	Qualitative analysis of data collection results to identify design aspects	66 design aspects assorted as list in categories and sub-categories (93 entities in total)
3	Category building	Qualitative consolidation, abstraction and expansion	TMAP Framework V1: 106 design aspects tree-like structured on four levels (167 entities in total)
4	Expert peer review	Qualitative review and improvement with a music computing researcher	TMAP Framework V2: 109 design aspects plus examples in a balanced tree-like structure on four levels (170 entities in total)

Table 8.1: Overview of the framework development methods, procedures, and results

For the first task, we asked them to use different online resources (e.g. scientific search engines) to find examples for performer audience interaction and to consider that this interaction can happen in various ways (e.g. using technology, non-technical, music-related, non-music). We told them that examples may be scientific or non-scientific and that the quality of the examples and the references primarily count.

To fulfil the second task, they had to choose one example and to enter their choice in a shared online spreadsheet to *save* it for themselves for later analysis. They were told that same examples may not be chosen by more than three people. We decided to use this shared spreadsheet for everyone to ensure that we get a variety of different examples as submissions. The reason for letting three people choose the same example was that the exercises of this course were usually done in small groups. Furthermore, it was a class of 122 students and we did not know whether there exist at least 122 different examples of audience participation or not.

For the third task, we asked them to analyse and describe the chosen example using ten questions. These ten questions were formulated to give the students some guidance for the analysis and to keep the exercise effort within reasonable bounds. These ten questions were:

1. Who is participating from the audience's perspective?

2. Which technology is used?

3. How does the interaction happen?
4. Which feedback is provided for the audience?
5. What is the motivation for the audience to participate?
6. Who is participating on the side of the performer?
7. How does the performer perceive the participation?
8. What is the motivation of the performer to let the audience participate?
9. What is the result of the participation?
10. What are possible problems, issues, and constraints?

Furthermore, they had to write a short description to summarise the chosen example and to provide links to resources where at least one should be of scientific origin if available.

8.3.2 Data Basis of Examples for Audience Participation

Overall, 122 students participated in the course and were supposed to do the exercise. We sighted and sorted all 122 submissions checking the completeness and reading the short description to decide if a submission can be considered correct and the presented example is relevant. Furthermore, we merged duplicates as three students at the maximum could choose and analyse the same example.

Four students within the whole class failed to do the exercise. In particular, two of them submitted nothing, one just answered four of the ten questions without a reason, and one submitted an example which had nothing to do with music. The process of sorting and merging the remaining 118 submissions resulted in a list of 48 different examples representing approaches to audience participation.

As part of this process, we assigned each example a category. These categories were not predefined but emerged during sighting. Table 8.2 lists the four categories we found and the number of examples we associated with the respective category. The whole list of examples including their titles is available in Appendix E.2.

Looking at Table 8.2 we can see that most of the examples (33 of 48) were actually dealing with TMAP. We also kept the other 15 examples as we tried to find many diverse examples for a deeper analysis in the next step. Furthermore, all of these examples seemed to be interesting from a conceptual point of view.

Most of the scientific literature, but also generic online resources the students found, were already presented during the discussion of related work. With respect to the information content of the examples, the level of detail varied broadly. Some sources turned out to elaborate interesting issues in detail. Others were very concise in terms of content or short in length. According to the strategy of data collection to get as many examples for audience participation in music as possible, this broad and diverse list of collected examples including the written analysis based on the ten questions, was the starting point for the next step.

Examples	Number
TMAP	33
Collaborative music making	7
Audience participation without technology	4
Art installations	4
Total number of examples	**48**

Table 8.2: Data basis to synthesise the TMAP Framework

8.4 Identifying Characteristics

After collecting examples for audience participation including the written analysis for each example, we had to identify and extract potentially relevant characteristics concerning the design of TMAP.

8.4.1 Extracting Design Aspects

For the purpose of identifying relevant characteristics, we analysed the students' submissions qualitatively and in particular their answers to the ten questions. We did this for all 48 examples and collected a list of design aspects by looking for keywords we considered as relevant to characterise the design of TMAP. During this step, the experience we gained through the preceding field studies was important as we were sensitised for what to consider as relevant in relation to the design of TMAP.

To create this list as a preliminary assorted collection of all identified design aspects, we followed a strategy described in neuropsychology about how the human brain forms categories, "Generally, there are three ways. [..] Gross and fine appearance [..] functional equivalence [..] particular situations." (Levitin, 2015, p.61) For this step we used either of these three ways to extract and categorise design aspects rather than being strict about a particular way of categorisation.

8.4.2 Creating a Tree-Like List

This procedure of identifying and extracting design aspects resulted in a tree-like list of 93 elements sorted in categories and sub-categories. The first level contained of six categories: *music, visuals, haptic, techniques of interaction, kinds of interaction,* and *decision about participation.* These all contain several sub-categories holding specific design aspects. Overall, there were 66 specific design aspects after this step. The whole list is available in Appendix E.3. To give an impression of this sorted list of design aspects and to show its principle structure, we present the category *visuals* in Table 8.3.

As we see through this example about the category *visuals*, among the design aspects on the third level are either general ones (e.g. *light*) or rather specific ones (e.g. *smartphones*). However, some design aspects even appear in more than one sub-category (e.g. *light*, *smartphones*) or have different labels for similar purposes (e.g.

Sub-categories (second level)	**Design aspects (third level)**
• ambient on stage	• light (e.g. colours, moving spots, strobe speed) • video-walls/projections (e.g. sound-generated visualisations, videos, animations)
• ambient off stage	• light (e.g. darker/brighter) • wristbands (e.g. changing colours) • smartphones (e.g. display colours, flash)
• informational on stage	• graphical visualisation (e.g. shapes, drawings) • data visualisation (e.g. charts, bubbles) • light (e.g. pointing laser beams)
• informational off stage	• smartphones (e.g. text, messages, numbers)

Table 8.3: The category *visuals* listing its sub-categories and design aspects

Previous categories	New main categories (this step)	Additional main category questions
music, visual, haptic	Participation	What is the subject of participation?
techniques of interaction, kinds of interaction	Interaction	How does the participation happen?
decision about participation	Impact	Why are participants involved?

Table 8.4: Finding abstract main categories

video-walls/projections compared to *graphical visualisation*). Thus, in this list of design aspects there is a certain redundancy. For instance, *smartphones* appears in four different sub-categories looking at the whole list (see Appendix E.3).

At this point, the list already contained many design aspects but with redundancies and in a particular technology and application oriented way. Thus, we used this list as a starting point for consolidation, abstraction, and expansion in the next step to find meaningful categories.

8.5 Category Building

For this step, again, we followed the neuroscientist Levitin who suggests a balance between category size and category specificity in a well-organized system (Levitin, 2015). To create this balance, we abstracted and generalised the rather specific example-led design aspects. For this qualitatively driven process we inductively built general design aspects originating from particulars (Creswell, 2009, p.4). This process included the supplement of additional aspects and finding new sub-categories. At the same time, we removed redundancies by reorganising the overall tree structure and summarising similar and overlapping categories.

8.5.1 Reorganising Tree Structure

Starting with the first level, we reorganised the six categories to three new main categories - *participation*, *interaction* and *impact* - each represented by a question (see Table 8.4).

Some of the previous categories, such as *music, visual, haptic*, were summarised under a new category *Participation* and became sub-categories. The others were completely turned into the new main categories *Interaction* and *Impact*. For those we created a series of new sub-categories and especially *Impact* increased in terms of new entities compared to the old category *decision about participation*.

To demonstrate what happened during this step and how entities were reorganised, we use the category *visual* as in the previous example in Table 8.5. This time *visual* is a category under the new main category *Participation*. We can see that during this step the

Sub-categories (third level)	Design aspects (fourth level)
• location	• on stage (e.g. spots, video wall) • off stage (e.g. in the audience) • off venue (e.g. live stream)
• type	• ambient (e.g. light) • informational (e.g. text, voting charts)
• subject	• individual (e.g. wrist bands, phones) • general (e.g. big screens, PA speakers)

Table 8.5: The category *visual* under the new main category *Participation*

design aspects *ambient* and *informational* became final entities under the newly inserted *type*. Similarly, *on stage* and *off stage* were drawn together under the new sub-category *location* and complemented by the new entity *off venue*. These examples should illustrate the processes around category building and reorganisation of entities.

8.5.2 Removing Redundancies

In the previous step (8.4), when identifying design characteristics, we mentioned *smartphones* as an example for redundancies and technology-centred aspects (see Table 8.3). As the above example shows, we challenged this by completely replacing design aspect *smartphones* with rather generalised description implying the use of smartphones as one design option. In particular, all three sub-categories of *visual* contain design aspects that can be realised with smartphones.

See Table 8.5 for the following examples. For the sub-category *location*, smartphones may be used for the design aspects *off stage* and *off venue*, if participants use their smartphones for any interaction. In the sub-category *type* it is the design aspect *informational* when information such as text is shown on individual's devices, for example. Finally, *subject* holds *individual* referring to individuals holding phones, for instance. After this third step, the TMAP Framework had 167 entities sorted in a tree-like structure on four levels.

8.5.3 First Instantiation of the TMAP Framework

In Figure 8.1 we present the first instantiation of the TMAP Framework at the example of the main category *Participation*. This illustration contains a description of the main structure and the terminology we further use when referring to the framework. The full framework is available as TMAP Framework V1 in Appendix E.4.

From that moment, the TMAP Framework is structured as a four-level tree and in its first version as presented here with 167 entities in total. As illustrated in Figure 8.1 we refer to framework *entities* as all labelled nodes regardless of level. The root of this four-level tree contains the three *main categories* (e.g. *Participation*) including an additional question (e.g. What is the subject of participation). For the sake of a more balanced and clearer structure there are *categories* on the second level (e.g. *Music* or *Visual* under *Participation*) followed by *sub-categories* on the third level (e.g. *Time*, *Sound*). Finally, the fourth level holds possible *design aspects* and most of them hold particular *examples* (e.g. *accents*). This is the first instantiation of the TMAP Framework as it was taken to an expert for review.

8.6 Expert Peer Review

The fourth and last step to develop the TMAP Framework was a review with a music computing expert who is a researcher and lecturer at an English university. This step was important to conclude the framework development with new insights. The construction of the framework was mainly conducted by the author of this thesis through qualitative work. Only the data collection during the first step happened with the support of external input through a class of students. Thus, the expert review is considered as a necessity and opportunity to get an external perspective.

8.6.1 Reviewing Process

For this review we looked at all entities step by step together with the expert. The overall strategy was to reduce and avoid redundancies, to resolve ambiguity when finding new categories, to trace dependencies between single entities, and to find distinctive wording.

In practice, we used a printed version of the TMAP Framework V1 and annotated all entities with a suggested revision according to the expert's input. Figure 8.2 shows an exemplary picture of the printed TMAP Framework with annotations handwritten in red. A digital and readable version including the changes is available as TMAP Framework V2 in Appendix E.4.

8.6.2 Framework Improvement

This expert review led to several revisions including adding, rewording, and removing entities, as well as splitting up entities to new ones or completely reorganising two sub-categories. The Figure 8.3 and 8.4 show an example of two changes that include splitting up entities and rewording them.

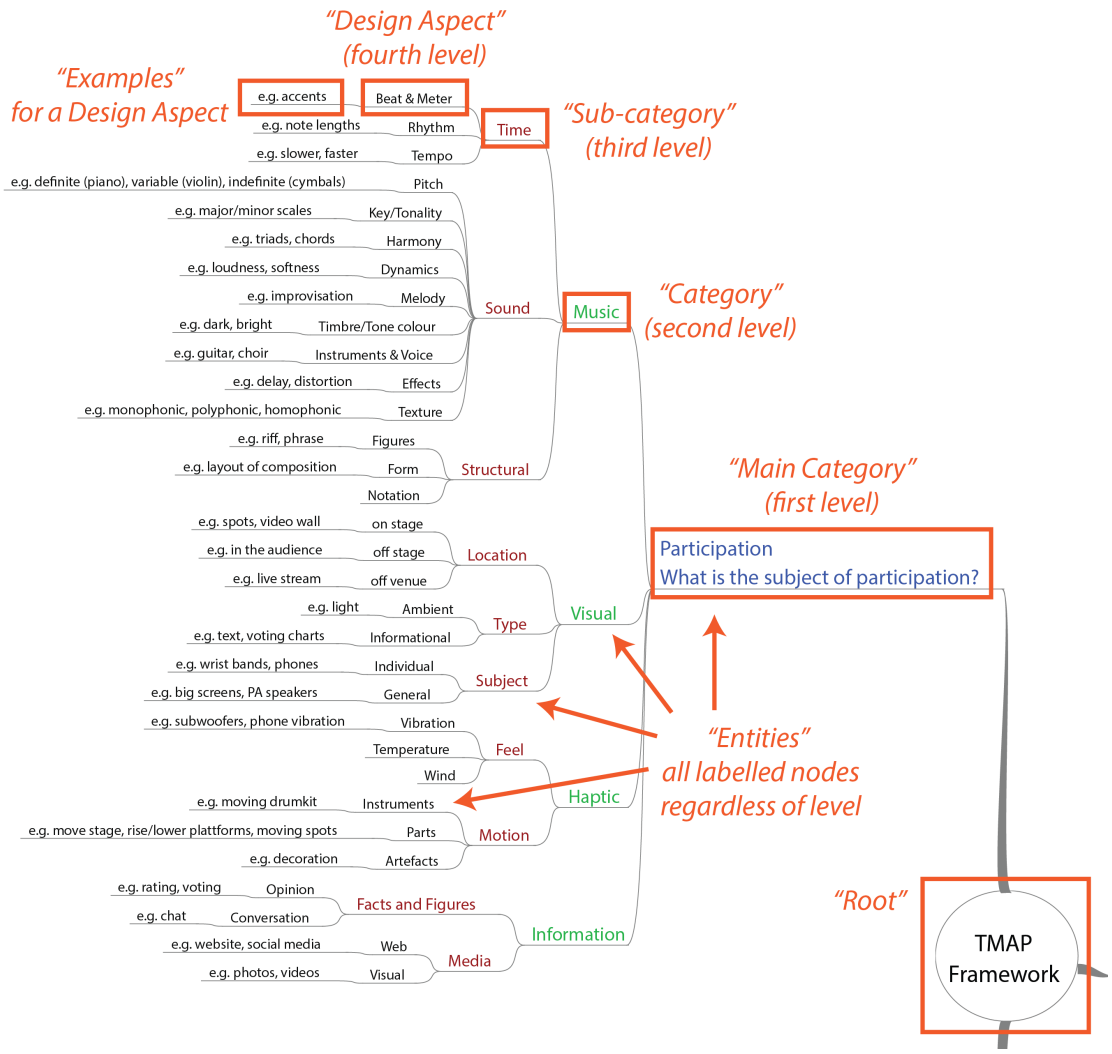


Figure 8.1: Framework structure and terminology at the example of one main category

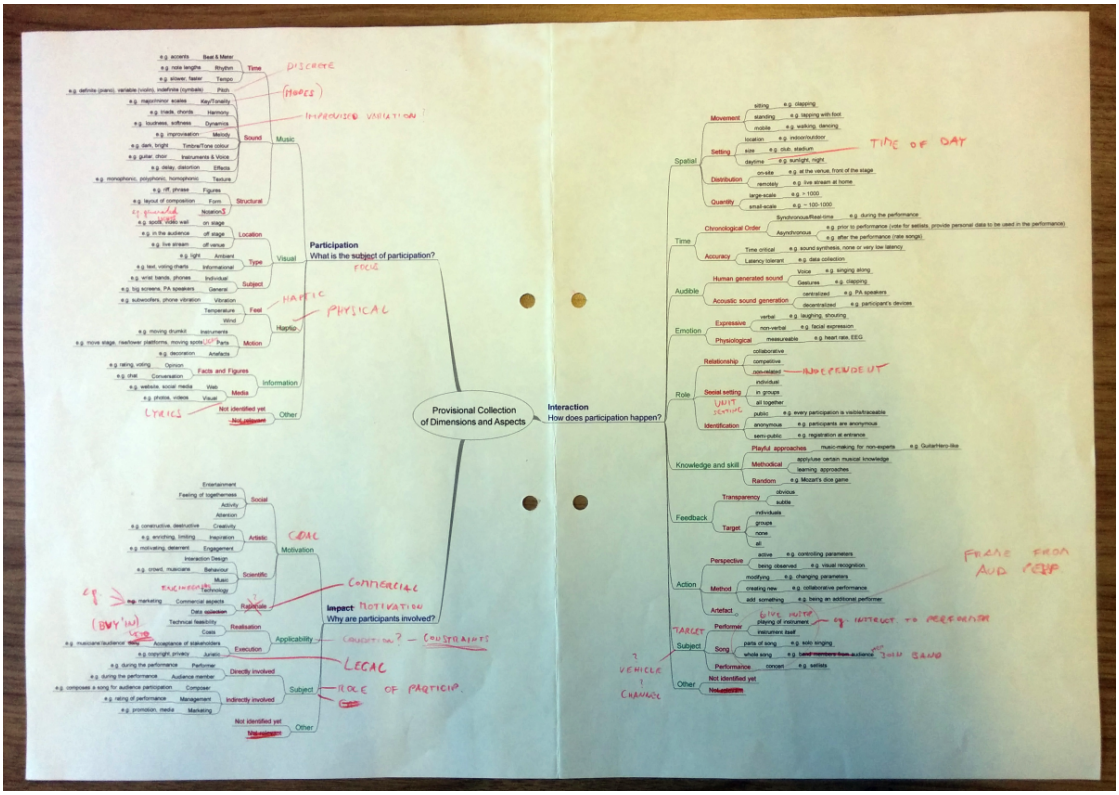


Figure 8.2: The paper-based TMAP Framework as used for the expert review

The whole framework after all revisions with the expert is available as TMAP Framework V2 in Appendix E.4. As in Figures 8.3 and 8.4 all revised sections are highlighted. During the expert review we also added *examples* to all *design aspects* on the fourth level (starting with "e.g.") and reworded existing ones. These changes are not explicitly highlighted as changes for better readability. Changes concerning case sensitivity of words were also not highlighted.

After the expert review the TMAP Framework V2 had 170 entities. 109 of them were design aspects on the fourth, the lowest level and the whole framework was balanced in a tree-like structure throughout all levels.

8.7 Discussion

We now reflect on the process of developing a descriptive framework for TMAP and discuss the current version of it. We will start with the first research question: Which characteristics can be identified from reviewing existing work related to TMAP? To address this question, we revisit the first two steps of the TMAP Framework development, which were data collection and identifying characteristics.

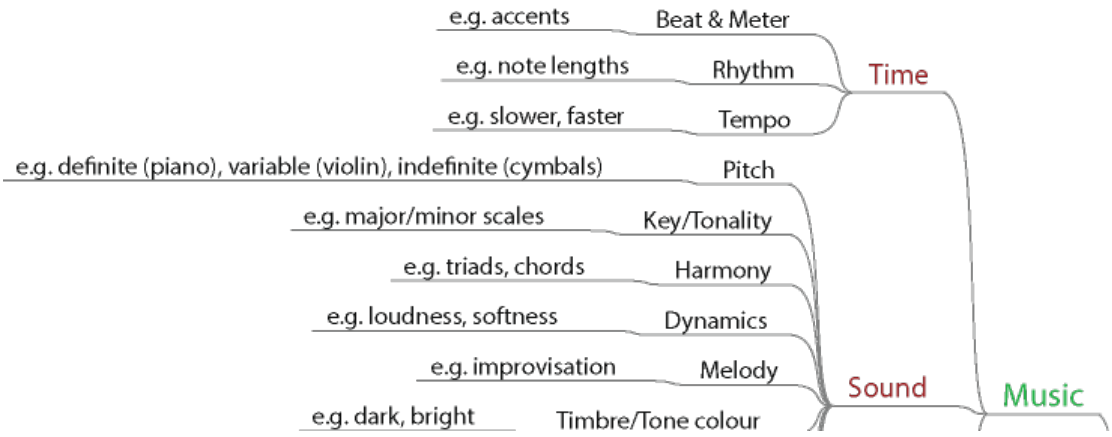


Figure 8.3: TMAP Framework V1 section before expert review

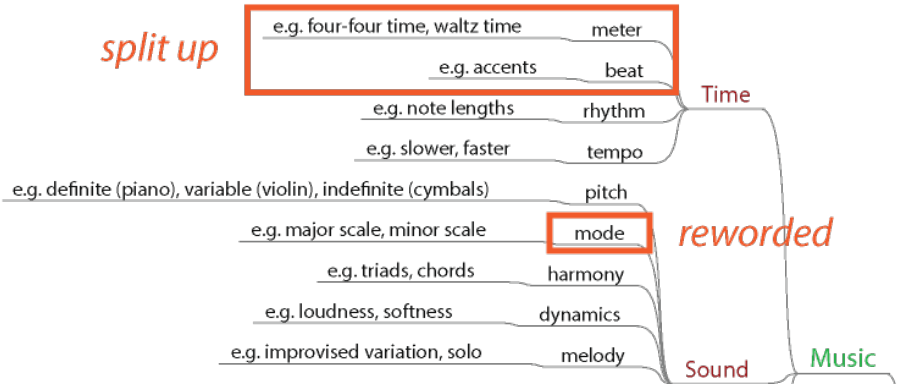


Figure 8.4: TMAP Framework V2 section after expert review with highlighted changes

8.7.1 Data Collection and Identifying Characteristics

To identify characteristics for TMAP, we collected 48 examples of existing work primarily around musical performance. Both, the collection of examples and the actual identification of characteristics, has shown the broad diversity of where and how TMAP in live music can happen. The main challenge during this systematic collection and analysis was to define what to consider as TMAP and where to stop.

For instance, we found ideal examples for TMAP at live concerts describing conceptual, musical, and technical aspects in detail. Others were completely non-technology-mediated but nevertheless relevant for the purposes of the collection. We will explain why, with some particular examples.

Dialtones (Levin, 2001), for instance, is a typical example for TMAP using mobile phones from a technological point of view and needing spectators to bring their own devices. *Engaging the Crowd* (Barkhuus, 2008) uses technology for measuring the

audience's cheering, but no one has to bring some device or has any additional knowledge. Furthermore compared to Dialtones, the audience acts as a group and the participation is not focused on individual spectators with their respective devices. We see that both examples are typical approaches to TMAP in live music although different in the conceptual design of how to apply technology and how to involve spectators.

When Bobby McFerrin (2009) impressively demonstrated how he could conduct a whole audience and make them spontaneously sing a pentatonic scale in tune, there was no technology involved at all. However, this example had one conceptual aspect the others did not have: the performer himself moderates the participation and teaches the audience how to participate. With the *Rocky Horror Picture Show* (O'Brien, 1975) we have audience participation as part of a musical or theatrical performance. Similar to Dialtones, spectators have to bring something by themselves to participate. However, it is not a technical device but everyday objects (e.g. rice, newspaper) they have to bring to the performance. In fact, this allows everyone to participate, even those who do not have an appropriate device as needed for Dialtones.

Remembering the case studies *CoSCoS* and *Experimence* of the field exploration and what we have learned from them for the design of TMAP, there are some conceptual similarities. With CoSCoS one problem was the technology-focused use of individual smartphones which excluded spectators from the participation due to technical constraints. With Experimence a visually tracked balloon enabled participation to everyone in principle, but practically some spectators complained about too few touches, wishing for more chances to participate. Let's say, just hypothetically, that we combine the concept of tracking objects as it happened with Experimence and using every day objects spectators bring along as it happened at the Rocky Horror Picture Show. Following this idea we could think of an imaginary concept for TMAP needing spectators to bring their own objects which are technically tracked during the performance.

A different challenge occurred with *MassMobile* (Weitzner et al., 2012) which is a smartphone application for audience participation. The idea behind MassMobile is a client-server system with a range of features to adapt for participatory performance. While the authors describe particular scenarios where MassMobile was used for voting to change lighting configurations or the collaborative improvisation among spectators, the system can be used for many other purposes in principle. To extract characteristics for TMAP from MassMobile, turned out to be another challenge. The problem was whether we should consider only those design aspects explicitly mentioned in the description of the work or if we should create a longer list of other design aspects that are theoretically possible to address with this system.

With these examples we wanted to illustrate the challenges we had to cope with and why these were useful to include when collecting characteristics for the design of TMAP. On the one hand, it was a way to extract design aspects from particular examples. On the other hand, it was the decision of which examples to consider as relevant. Of course we could have drawn a strict line to just consider TMAP in live music and design aspects explicitly mentioned in the descriptions of the examples. In this case, however, we would have had to exclude Bobby McFerrin and The Rocky Horror Picture Show for

being non-technology-mediated audience participation and the latter even not live music related. Furthermore, we would have had to exclude many music-related design aspects, for instance, that could possibly be controlled with MassMobile although not explicitly mentioned in its description.

In conclusion, the 66 design aspects identified after the first two steps of developing the TMAP Framework were a random sample rather than a comprehensive list, describing the design space for TMAP in a systematic way. How we used this sample in a process to develop a descriptive framework, addresses the second research question: Which challenges arise from pulling together these characteristics to form a descriptive framework? Through discussing step 3 and 4, category building and expert peer review, we are able to answer this question.

8.7.2 Category Building and Expert Peer Review

As we have just discussed the list of design aspects is good enough to be used as a starting point to summarise design aspects in TMAP, but incomplete and unstructured to be used as descriptive framework. The approach of restructuring the whole list and its categories turned out to be a good strategy to continue the framework development.

First, when adding the new main categories and new sub-categories, we also had to fill gaps between the branches of the tree. For instance, *visuals* first had four sub-categories *ambient on stage, ambient off stage, informational on stage,* and *informational off stage* (see Table 8.3). These were split up in the new sub-categories *location* and *type* and the new sub-category *subject* was inserted (see Table 8.5).

Second, to follow Levitin's (2015) suggestion to create a well-organized system, we had to balance out our list of design aspects. This process of balancing out the categories and design aspects through all levels, forced us to rearrange the whole list. For example, *techniques of interaction* and *kinds of interaction* together contained more than half of all design aspects (34 of overall 66) and *decision about participation* only 3. After the whole restructuring process, the new main category *Impact* replaced the former *decision about participation.* Finding new sub-categories led to new design aspects and the new main category *Impact* increased from 3 to 22 design aspects in total.

To create new categories, split up existing ones and find new design aspects in newly created categories during the third step was an iterative process highly driven by trial and error. This process also turned out to be the biggest challenge in building the TMAP Framework. With every new category or design aspect, the granularity of the framework increased and added a new value to describe the design space of TMAP. At the same time, however, the complexity analogously increased to the number of entities.

At some point during this iterative process of rearranging entities it became clear that it is hard if not impossible to find a *perfect* solution. Especially when reviewing the framework with the music computing expert, we identified that changes still improve the quality of the framework but the size of the framework did not change too much at this stage. The version before the expert review had 167 entities and the version afterwards 170 (see V1 and V2 in Appendix E.4). Apart from one complete re-categorisation of two

categories, it were mostly issues of rewording entities for better understanding from the expert's point of view.

In conclusion, with the TMAP Framework in its current version we created a multi-level description of the design space around TMAP with high granularity. With the iterative process of qualitatively constructing and improving the framework (e.g. identifying design aspects, creating and balancing categories) as well as the external input through an expert peer review, we even achieved to increase the framework's coherence (e.g. removing redundancies, filling gaps by adding missing entities). However, we do not know so far how useful such a framework is in practice in terms of describing the design space, support design-related processes, and if there is still room for improvement. Thus, we continue with the application and improvement of the TMAP Framework in the current version.

8.8 Summary

A main goal of this thesis is to describe the design space of technology-mediated audience participation (TMAP). Thus, we developed a descriptive framework presented as TMAP Framework. This framework was synthesised in four steps using both the experience of the field exploration and a systematic review of related work to identify design characteristics. The first step collecting examples of audience participation happened as part of an exercise in a class of interaction design students. The consecutive three steps were qualitatively driven and mainly conducted by the author of this thesis. For these three steps, we took the extracted particular characteristics and iteratively built categories and design aspects on four levels. The fourth step included an expert review to get external input and to improve the coherence of the entities that forming the TMAP Framework. To achieve such a coherence in a framework with high granularity, turned out to be the main challenge of the development process. Furthermore, we could neither assess the actual quality of the TMAP Framework in its current version nor draw any conclusions on its practical usefulness for the design of TMAP. These issues are addressed with the framework evaluation in the next chapter.

8.9 Contributions

1. *TMAP Framework (V2)*: The framework describes the design space of TMAP with 170 entities in a tree-like structure in high granularity. It contains hierarchically sorted categories on three levels and 109 design aspects on the fourth level and is available in Appendix E.4.

2. *Challenges of Framework Development*: We present and discuss an iterative process of building a descriptive framework to describe the design space of TMAP. The main challenges identified concern the difficulties to define the domain of TMAP in live music and to assure the coherence of the framework, given the high number of entities and the increasing complexity during the development.

CHAPTER 9

Framework Application and Improvement

This chapter describes the evaluation of the TMAP Framework which was developed as descriptive framework for technology-mediated audience participation (TMAP). To evaluate the potential of the framework for design-related processes, two different presentations are developed and applied in practice. TMAP Online is a web-based tool used for classification exercises, and TMAP Design Cards are a tangible instantiation of the TMAP Framework. The findings of the evaluation indicate potential support for analysis and design of TMAP in terms of idea generation, guidance, and the provision of a common language.

9.1 Motivation

In the previous chapter we developed and presented the *TMAP Framework* to describe the design space of TMAP in a practice-oriented way to support design-related processes. However, we do not know much about the quality of the TMAP Framework and how it might be used. Thus, we will evaluate the TMAP Framework by applying it in practice. This evaluation was designed to be formative to not only assess the TMAP Framework by using it in practice but to improve it throughout the evaluation. The research questions for this evaluation are:

Q1 How useful is the TMAP Framework when applied in practice?

Q2 How can the TMAP Framework be improved throughout evaluation?

For answering the first question, we study two ways to make the TMAP Framework accessible in practice. The TMAP Framework is intended to map out and describe the

design space of TMAP in live music in depth. Furthermore, the aim is that it serves as shared language within this interdisciplinary field as well as to provide guidance for design-related processes around TMAP. Thus, we applied the framework in practice in two ways, as follows.

First, we used the TMAP Framework to analyse and describe the design space of TMAP. For this purpose, we developed an online instantiation of the TMAP Framework to use it as classification tool with a class of interaction design students. In particular, the students used the framework for exercises to classify and describe existing examples for TMAP.

Second, we studied the usefulness of the TMAP Framework for actual design processes. An approach to support such design tasks in different domains are various sets of cards such as IDEO (2002) that have been developed in the past. Among these are also particular examples where frameworks were transformed into cards (Hornecker, 2010; Lockton, 2013). Thus, we use design cards as method to create a second instantiation of the TMAP Framework to study design processes around TMAP in live music.

Finally, we consulted an expert, and in particular a musician, to review the TMAP Framework from this perspective. Discussing all the steps of using, applying, and improving the framework throughout a formative evaluation will provide help to answer the second research question and to reflect on the improvement of the TMAP Framework throughout the evaluation.

9.2 Evaluation Overview

We describe the three parts of the evaluation in four steps according to the different methods we applied. Table 9.1 summarises the whole evaluation process showing each method, the applied procedure, and the results. As the TMAP Framework is improved throughout the formative evaluation, every step results in a revised version of the framework. In each step we describe all revisions as part of the results and present corresponding versions of the full framework in Appendix F.4.

9.3 Classification Exercises

In this first step of evaluating the TMAP Framework, we applied the framework in practice to use it for understanding and describing the design space of TMAP. For this purpose, we developed a web-based online instantiation of the TMAP Framework, called *TMAP Online*, to use it for classification exercises within a class of interaction design students[1] at the Vienna University of Technology. We consider this group of students qualified to evaluate the TMAP Framework in terms of understandability for two reasons: Firstly, these students have a certain qualification in relation to interaction

[1]This class attended the same lecture series teaching interaction design at the Vienna University of Technology as involved during the TMAP development presented in the previous chapter. However, this evaluation happened during another term and with a different group of students.

Step	Method	Procedure	Results
1	Classification exercises	Development of TMAP Online, a web-based tool to use the framework for classification exercises within an interaction design class	• Insights when the framework is used to understand, analyse, and describe TMAP • TMAP Framework V3
2	Design card development	Development of the TMAP Design Cards with two researchers for game design and interaction design	• 46 TMAP Design Cards and 3 cards with instructions • TMAP Framework V4
3	Design card application	Using the TMAP Design Cards in groups of students for gameful design	• Insights when the framework is used to design TMAP • TMAP Framework V5
4	Expert peer review	Qualitative review and improvement with a musician	• TMAP Framework V6

Table 9.1: Overview of the evaluation methods, the procedures, and the results

design. Secondly, we assume none or scarcely anybody among them as being an expert in TMAP.

9.3.1 The Web-based Tool TMAP Online

We developed a special web-based tool called *TMAP Online* in order to facilitate these exercises. The rationale for a web-based tool was to handle the large number of students in this class and to support the data collection and analysis. Hence, TMAP Online was not only a web-based instantiation of the TMAP Framework but a way to unify the exercises for every student and to support the analysis process for the actual evaluation.

TMAP Online was especially programmed by the author of this thesis for the purpose of this evaluation. Technically, we used the scripting language PHP[2] in combination with the open source database MySQL[3] and hosted TMAP Online on a web-server of the Vienna University of Technology.

[2]http://php.net (last access 15.04.2016)
[3]https://www.mysql.com (last access 15.04.2016)

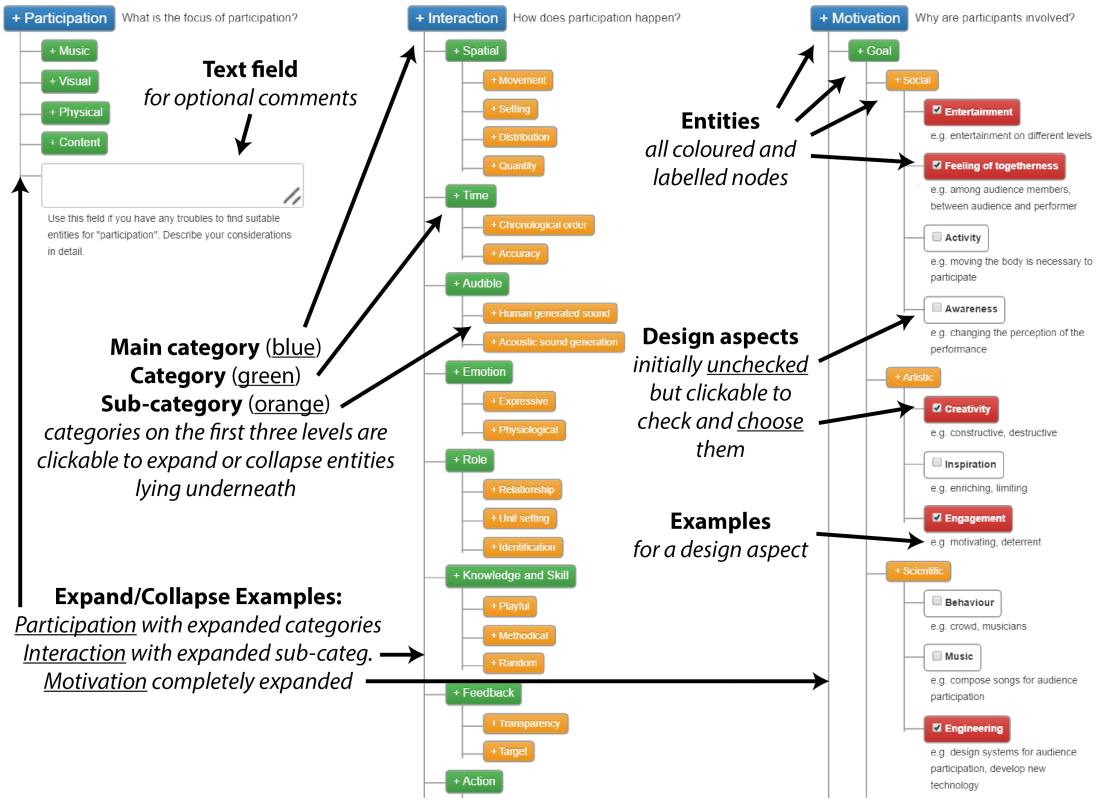


Figure 9.1: Screenshot of the web-based framework as implemented in TMAP Online

TMAP Online contained all information and functionality to do the exercises including a special web-based instantiation of the TMAP Framework. Figure 9.1 shows a screenshot of this web-based TMAP Framework including annotations that describe the basic functionality and terminology as introduced in the previous chapter.

Students could do all exercises just within TMAP Online. They could navigate through the exercises, read the briefings for their tasks, use text fields to enter comments, and save their submissions. The web-based instantiation of the TMAP Framework was designed in a tree-like structure where students could freely expand and collapse entities on all levels (see Figure 9.1). The fourth level contained the design aspects with a checkbox, each to choose during the analysis process. We will present further screenshots and describe the features of TMAP Online in detail throughout the next sections.

9.3.2 Description of the Classification Exercises

Overall 164 interaction design students participated in the course and each one was assigned an individual secret code to access TMAP Online to do the exercises. We designed the exercises as classification tasks where the students had to use TMAP Online to describe existing examples for audience participation.

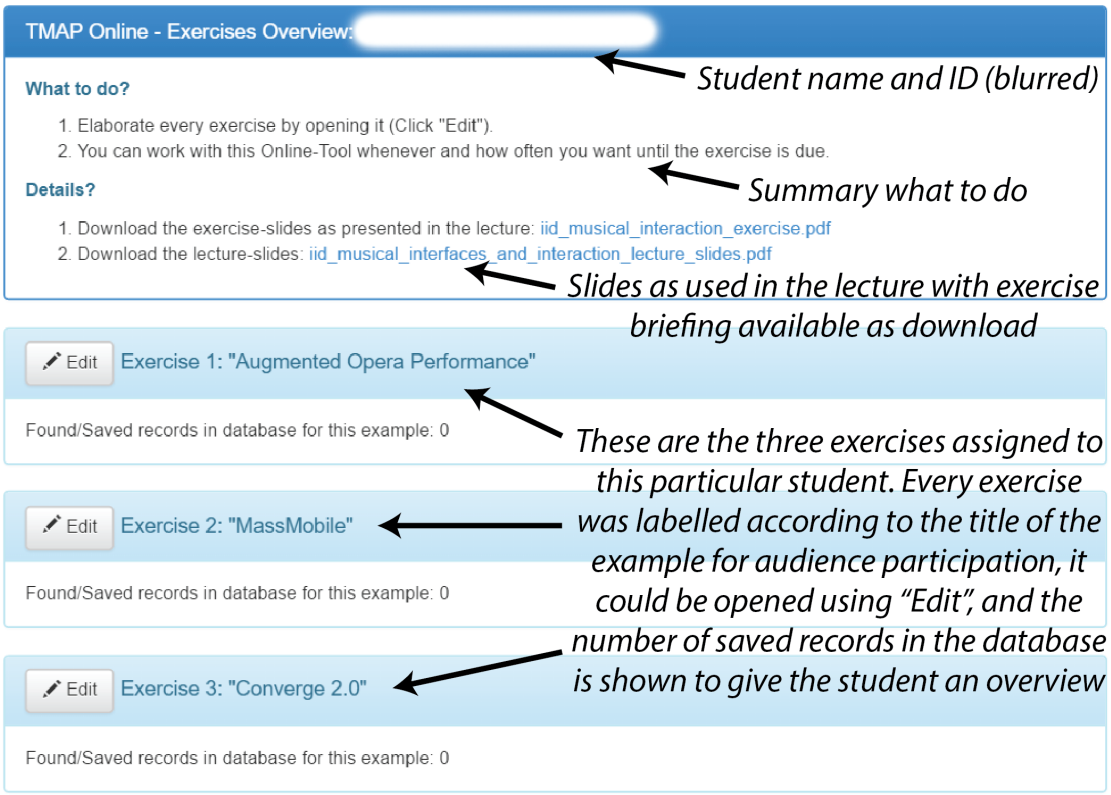


Figure 9.2: The first screen showing the exercises overview for a student

In particular, every student had to analyse three different examples for audience participation. Note, that this approach was contrary to the first step of developing the TMAP Framework. Instead of extracting characteristics from existing examples for audience participation as we did during the development, the students now used the TMAP Framework to classify existing examples for audience participation according to their characteristics.

To do the exercises, TMAP Online offered two screens to the students. The first screen, after accessing TMAP Online using the secret code, was an overview listing the three exercises as shown in Figure 9.2. The upper area of this overview contains the student's name and ID, a short description of what to do next and links to download the slides as used in the lecture. In the lower area there are the three exercises assigned to the student. Each exercise was one specific example for audience participation the student had to classify using the TMAP Framework.

The second screen opened after clicking on *Edit* of one of the three exercises. Figure 9.3 shows this second screen of one exercise. This particular exercise is about the example MassMobile (Weitzner et al., 2012). For each exercise the student had to do three steps: (1) get familiar with the given example, (2) summarise the example with own words, and (3) use the TMAP Framework to describe the example (for simplicity reasons we called

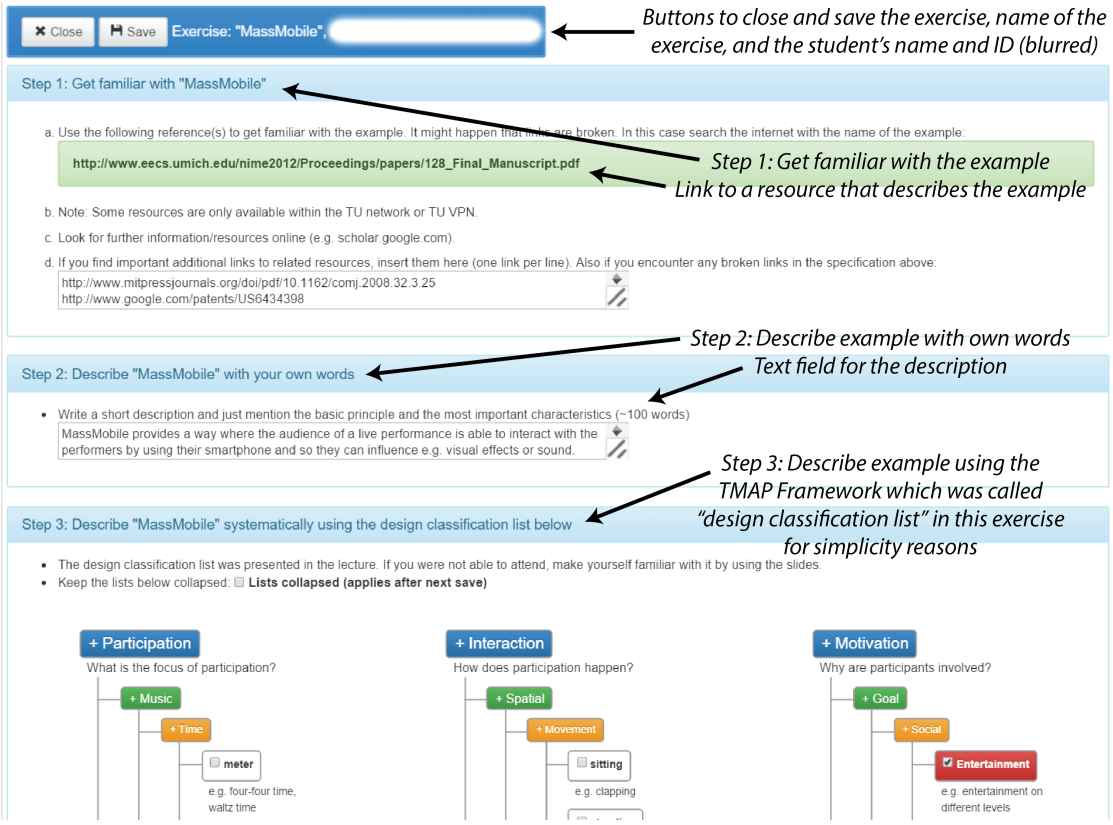


Figure 9.3: The second screen showing one particular exercise as used by a student

the framework *design classification list* for this exercise).

For the first step within the exercise, we provided the name of the example for audience participation which the student was asked to analyse (e.g. MassMobile) and at least one link to a resource (e.g. scientific publication, video) describing or demonstrating the example. We will explain which and how many examples for audience participation we used for this exercise later. The second step was to summarise the example with own words. We used this summary as a quality check to see if the student understood the example correctly when using it for analysis. The third step was to use the instantiation of the TMAP Framework as presented earlier in section 9.3.1 and Figure 9.1 to describe each example by checking design aspects and to additionally comment on any issues they detected when using the framework. This third step was the most important part of this part of the evaluation as it was intended to assess the understandability of the framework and point to required improvements according to missing or misleading design aspects and categories on all levels.

9.3.3 Examples for Classification

The three examples each student had to analyse were randomly assigned from a pool of 69 examples for audience participation in a musical context. The reason for using 69 examples was that overall 164 students participated in the course and we assigned one example to more than one student. By doing so, we could compare different classifications of each example as we will describe later in detail. As each student had to do three exercises, we distributed all 69 examples randomly and equally in a way that each one was assigned to 6-8 students.

The pool of 69 examples was formed by the same 48 examples used to develop the framework extended by 21 new examples for diversification. We found this additional 21 examples by searching online for further and recent examples of TMAP. In particular, the strategy was using online search engines and looking for examples that contain interaction between performer and audience in a musical context. Typical search terms were audience participation, participatory performance, audience interaction, or interactive performance. The list of all 69 examples used for the exercises is available in Appendix F.2.

The information content of the examples and the level of detail varied broadly. We also mentioned this issue during data collection in the previous chapter. To ensure an equal distribution of examples according to the varying level of detail, we used three *effort categories*: easy, medium, and hard. Examples with little information (e.g. video only, short article on the web) and therefore quickly to analyse were considered as *easy*. Examples with much information (e.g. scientific articles) were described as *hard*. Those examples we could not clearly define were attributed as *medium*. This categorisation was important to distribute examples among students and keep the effort for all three exercises equal for everyone. It does not have any other meaning for this evaluation.

9.3.4 Process of Analysing Classification Exercises

Of all 164 students 134 provided meaningful submissions which resulted in a total of 402 classified examples (134 students x 3 exercises). Given the amount of data we had to analyse, we programmed an additional evaluation functionality to summarise the results and to support the analysis by automatically calculating certain values of interest as we will further describe. Figure 9.4 shows the analysis' summary screen of TMAP Online. Two things were important for the analysis: Firstly, how the students used the online instantiation of the TMAP Framework to describe examples for audience participation, and secondly, how they commented on this classification process using the text fields of either of the three main categories.

For the analysis we designed a screen in TMAP Online that summarises all relevant data. This screen, as illustrated in Figure 9.4, lists all the examples for audience participation we used for the exercises and in particular one example per row. The columns on the right side of the list of examples contain the important data for analysis. We will explain the approach how we analysed this data in short but as detailed as necessary to understand the results. A more detailed description of the analysis process with an additional screenshot is available in Appendix F.1.

Figure 9.4: The analysis' summary screen of TMAP Online

The columns *Ex.1* to *Ex.8* in Figure 9.4 list the exercises and in particular the number of the chosen design aspects the students used to classify each example. A first look at these numbers showed that the numbers of chosen design aspects across the exercises for the same example largely varied in some cases. As there were lots of exercises and examples (69 examples with 6-8 exercises each) to compare, we decided to summarise the data and to do the analysis statistically to identify tendencies of how the design aspects were chosen across all exercises for every example.

Most important for this analysis was to calculate *differences*. These differences describe how much the classifications of one example differ. The higher the difference, the more the classification between the exercises diverges. For a comparison of the classifications between the exercises this means, the higher the difference, the more diverging the students used the TMAP Framework to classify an example.

As this was the first test of the TMAP Framework to classify examples for audience participation, there was no reference classification we could use to calculate the differences. Thus, we used the number of *majority checks*, a term we defined by ourselves, as reference. Furthermore, we implemented a feature in TMAP Online, to automatically calculate these majority checks. We describe the concept of using majority checks and what they are in the following.

If a design aspect for one example across all exercises was chosen by more than half of all students, we defined this as a *majority check* as the *majority* of the students *checked* this design aspect. The plural term *majority checks* means to count every majority check of an example to get the sum. The numbers in the rightmost column of Figure 9.4 show these sums. The terms *check* and *choose* when a design aspect is used for classification, mean the same in this regard.

By using the *majority checks* as reference, we further calculated the differences between the number of the checked design aspects for each single exercise and the number of majority checks for the example. We further calculated the arithmetic mean and standard deviation of all differences across one example. By doing so, there were two statistical values for each of the 69 examples.

Finally, for each example we had an arithmetic mean we called *average difference*. The higher the average difference, the more the classifications between the exercises differ. The second value was the standard deviation of the differences to describe the distribution of the average difference. Having these two values for all 69 examples, we could see the actual tendencies and how balanced the classifications across all exercises of these example were. An additional description of how we did the calculation of the majority checks is available in Appendix F.1 followed by a table in Appendix F.2 listing all examples including the two statistical values as just described.

Apart from how students classified the examples statistically, we were interested in the additional comments the students left for the main categories. In Figure 9.4 the abbreviations *Part.*, *Int.*, and *Mot.*[4] indicate that a comment exists for these main categories. We did the qualitative analysis of these comments in two steps. First, we looked at all comments for one example as indicated in the columns *Ex.1* to *Ex.8* and

[4]Refers to the main categories *Participation*, *Interation*, and *Motivation*.

decided whether a comment was relevant or not. We considered a comment as relevant when it was either addressing general issues with using the framework or specific missing or misleading design aspects. Second, we summarised all relevant comments for each example as listed in the column *Summary Comment* next to the title of the examples (see Figure 9.4).

9.3.5 Results of Analysing Classification Exercises

As just explained, we calculated the average differences from the design aspects the majority of students chose for an example. A list of all examples and statistical values we reference in the following presentation of the results, is available in Appendix F.2.

Differences in Classification

The analysis showed significant variations between different student exercises using the same examples. In average across all 69 examples, a little more than two thirds of the examples (42) had an average difference of chosen design aspects smaller than 5. Given there were 109 design aspects available in the TMAP Framework to choose from, a difference of less then 5 design aspects across all classifications of an example can be considered low. However, the average standard deviation of the differences among these 42 examples is 10, which is relatively high given that overall 33 design aspects were chosen on average throughout all 69 examples.

Looking closer at particular examples, shows that the highest difference is 19 with the example *Experio*[5] (Hout et al., 2014). This means some students chose 19 more design aspects on average than some others for this example.

Taking the example Experio in detail we can see that three students chose more design aspects (65; 50; 39) and the other three chose fewer (32; 27; 4). In this particular case the difference between 65 and 4 is enormous. The student who chose 65 design aspects commented, "Everything under Music is focus of participation. It depends on the performer what entities of Time, Sound and Structure he adjusts, but there is a general focus on all of them." This indicates that it is a matter of interpretation or rather *classification strategy* which design aspects to choose and which not. Looking in detail at all 65 design aspects one student chose, showed that the classification was correct according to the comment and the given example Experio. The other student who chose only 4 design aspects, did not comment to justify the classification. In fact, the 4 design aspects were correct as well but there were definitely some design aspects missing, although we cannot actually say how many, as there were no exemplary classifications for the examples as earlier explained.

The other 21 examples have an average distance between 6 to 15 which we consider as moderate. However, the standard deviation is 11 and therefore even a little higher than with the other two thirds of examples. The highest deviation among these 21 examples is 32 with the example MadPad (Kruge and Wang, 2011) which can be considered very

[5] *Experio* describes a design for audience participation in club settings. Multiple participants can influence the musical performance through dancing in several designated areas on the dance floor.

high. Taking the other examples into consideration, these deviations occurred throughout all examples.

Justification of Classification

According to the optional comments students could write for each of the three main categories of the framework, we had 152 comments on *Participation*, 149 on *Interaction*, and 97 on *Motivation*. 63 students commented on all of these three main categories. Most of the comments were justifying their decisions to choose particular design aspects. They were told to do so as part of the exercise, as this was important to see the rationale behind their choices.

For instance, with the example *The Tin Men & the Telephone*[6] (Roe, 2013) one student commented, "The main focus is to communicate with the band and tell them what and/or how to play it. Which could include everything in the music subtask", and chose 23 design aspects in the main category participation. Another one commented for the same example, "There is not really a list of how exactly the audience can influence the music, but at least in theory, every characteristic would be possible", and chose 2 design aspects.

Technically, the strategies of both students to choose design aspects were correct. They both chose the design aspects correctly but interpreted the example or its description differently. We do know according to the comments that the classification was dependent on individual interpretation and some sort of self-imposed strategy. In fact, none of the comments where students justified their classification strategy were wrong in terms of not arguing meaningful for their decisions. This interpretation or strategy concerns how to use the framework in particular and how to decide which design aspects have to be chosen for classification.

However, we do not know consistently based on the results, why the classifications differ as not all students commented on their choices. Hence, for the classifications that diverge but have no comments, we do not know whether the students interpreted or used the framework wrongly or whether they just failed in terms of taking the exercise not seriously enough or any other reason.

Improvement Suggestions

Different kinds of comments were actually addressing issues with the TMAP Framework and in particular the design aspects. For instance, one student commented on the main category participation, explicitly pointing out a missing design aspect by saying, "Missing looping in category music sound", when classifying the example *WanderOnStage*[7] (Lai, 2012). In fact, "triggering the real-time recorded loops", is really part of WanderOnStage (Lai, 2012, p.95) and therefore missing in the TMAP Framework so far.

[6] *The Tin Men & the Telephone* is a jazz trio with their own smartphone app for audience participation (e.g. allows spectators to vote during a song who plays the next solo)

[7] *WanderOnStage* is a live percussion performance with electronics. A wireless device allows the performer to join the audience and to motivate spectators to participate.

In another case, a student commented on the main category *Motivation* when classifying the example *SWARMED*[8] (Hindle, 2013) and suggested, "In this case also the programmer is involved indirectly. Other constraints might be the incompetence of the audience e.g. to connect to a WiFi". Comments such as these two, directly led to changes of the TMAP Framework according to the intention to improve the framework iteratively throughout the evaluation. All original comments like the previous two that implied a need for improvement are available in Appendix F.3. We proceed with the description of how we improved the framework according to the comments of the students.

9.3.6 Framework Improvement

To improve the TMAP Framework V2 based on the results of the classification exercises, we added seven new design aspects and reworded a main category including its associated question as we describe in the following.

During the analysis of the comments, we found out that the words *participation* and *focus* as part of this main category's question confused students and led to misinterpretation. Two comments, for instance, were, "the focus is also the crowd around you: what are they doing, what's the way I can add to the collective experience?", or, "these aren't directly influenced by the audience [..]". Hence, we renamed this main category from *Participation* to *Influence* to emphasise the actual influence of the participation on some performance aspects. Furthermore, we replaced *focus* by *target* in the question. As the whole framework had three occurrences of the word *target* at that moment and two in the main category *Interaction*, we reworded one of them to *focus* to remove this redundancy and prevent ambiguity within *Interaction*.

In some comments of the classification exercises students mentioned particular design aspects they missed in the framework. Based on these comments available in Appendix F.3 we added seven new design aspects to the framework. The revised version after this first step of evaluation and highlighting all changes is available as TMAP Framework V3 in Appendix F.4.

9.4 Design Card Development

As the second step of the evaluation process, we applied the framework in practice to study how we can make it accessible and usable for designing TMAP. In this context, we recalled the importance of ludic design processes for interactive and participative art to support creative processes (Gaver et al., 2004; Morrison et al., 2007). For this purpose, we developed a set of TMAP Design Cards following a series of examples were such cards are used as tools for inspiration, guiding, and shaping during design in different domains. Figure 9.5 shows some of these cards: 1. *IDEO Method Cards* (IDEO, 2002), 2. *kribbeln im kopf creative sessions* (Pricken and Klell, 2006), 3. *Intangibuild* (Keaney, 2003), 4.

[8] *SWARMED* uses smartphones to provide the audience an interface into a computer music instrument of the performer.

Figure 9.5: Different examples of cards to support design

IdeenRausch (Ebertz, 2009), 5. *Innovative Whack Pack* (Von Oech, 2003), and 6. *Design with Intent* (Lockton, 2013).

9.4.1 Development Process

We briefly summarise the process of developing the TMAP Design Cards before explaining each step in detail. The TMAP Design Cards were developed in two steps: First, we reviewed and prepared the TMAP Framework to use it as basis to draft design cards. Second, we drafted a set of 46 TMAP Design Cards plus 3 instruction cards.

Furthermore, we included two experts to support the development of the design cards with their experience. We chose these experts as both of them had experiences with using different design cards within their respective research areas. Both experts were post-doctoral researchers within the author's research group and were asked to help developing the TMAP Design Cards. One had a focus on game design and the other's background was interaction design.

In practice, we conducted one workshop were both experts and the author of this thesis were involved. The goal of this workshop was to review and prepare the TMAP Framework and to draft the design cards. We continue with the first step that describes how we prepared the TMAP Framework for the design cards.

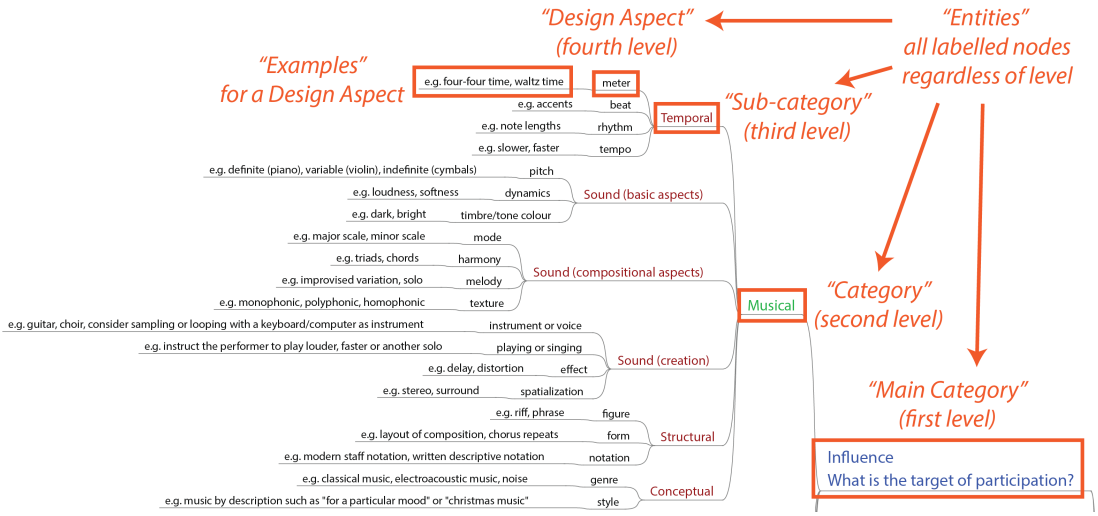


Figure 9.6: Structure and terminology of the framework as used for the design cards

9.4.2 Preparing the TMAP Framework

The starting point for this step was the TMAP Framework V3 as available in Appendix F.4. Similar to the expert review during the development, we went through all entities of the framework step by step and the experts gave immediate feedback. This time, however, the feedback was not only about wording issues, understanding problems, missing aspects, and potential inconsistencies, but also to consider the idea of creating a set of design cards based on the framework.

During this review process, we made four principle decisions before even visually drafting the cards. All these decisions, as we will describe them in the following, were based on discussions with the experts during the workshop. The rationales behind these decisions were to prepare the framework to later draft the design cards on its basis. The outcome of this step was TMAP Framework V4. Figure 9.6 shows an exemplary part of the main category *Influence* to revisit the framework's structure and terminology for the further description of preparing the framework for drafting the design cards.

The first two decisions were based on other sets of design cards as presented in Figure 9.5 earlier. The first decision was, following the concept of other cards, to separate all cards into some main categories. Thus, we decided to use the three main categories influence, motivation, and interaction as main categories for the cards as well.

Second, we took other design cards as example according to the number of single cards (e.g. *IDEO Method Cards* contains 51 cards). Hence, we decided to use a separate card for each sub-category (e.g. *Temporal*) of the TMAP Framework. The rationale for this decision was that using sub-categories resulted in having 46 single cards instead of only 15 with categories.

The third decision was based on an idea of the game design expert to use the concept of different (imaginary) roles when using the design cards. For this purpose we decided

TMAP Framework	TMAP Design Cards
Main category (+question)	Card category (+question)
Category	Explanation
Sub-category	Challenge
Design aspects (+examples)	Suggestions (+what-if-questions)

Table 9.2: Entities of the framework and their use for the design cards

to use the category *Role* of the TMAP Framework (see TMAP Framework V4 lower left in the Appendix F.4). To balance direct and indirect roles that might be involved in a performance and to represent our (imaginary) roles for the design cards, we accordingly added and consolidated underlying design aspects in the framework. Due to this alteration, we changed some other entities to resolve redundancies and wording issues. All these changes are documented in TMAP Framework V4 in Appendix F.4

The fourth decision concerned the actual design aspects of the framework (e.g. *meter*, *beat*, etc.) and which content to put on the front and the back of the cards. The decision made here was to use the front to display the main category, category, and sub category and the back for the actual design aspects. The rationale was to balance the content of the framework according to space on the two sides of a card.

This decision caused the need to revise the sub category *sound* in the TMAP Framework. Before this re-categorisation, *sound* had ten design aspects which would have been too many for a single design card. Hence, we split up *sound* into three new sub-categories. See Figure 9.5 for these particular changes in the TMAP Framework.

Apart from these major revisions of the framework based on the four decisions just described, the process of preparing the TMAP Framework for drafting design cards with the two experts additionally resulted in some minor changes (e.g. rewording entities). All changes are documented in TMAP Framework V4 in Appendix F.4.

9.4.3 Drafting Design Cards

After preparing the TMAP Framework and making some principle decisions how to use it for the design cards, we drafted three possible designs for the cards. For two of these drafts we generated the front and the back side of an exemplary card, for the third we did only the front. Figure 9.7 shows all three drafts and how they influenced the final card design. Table 9.2 supports this description by giving an overview of how the entities of the framework were used for the design cards.

For the header or top section of the final TMAP Design Card, we combined the ideas of draft 1 and 2 to show the card category (e.g. *Influence*) plus a short explaining sentence (i.e. What is the target of participation?). The idea behind this design was to visually emphasise the *Card category* (a) but to support the understanding with an additional *Card category question* displayed in smaller letters (b).

The main section in the middle of the front side of each card shows what we defined as *Challenge* (c). This *Challenge* is unique for each card as it is based on the sub-categories

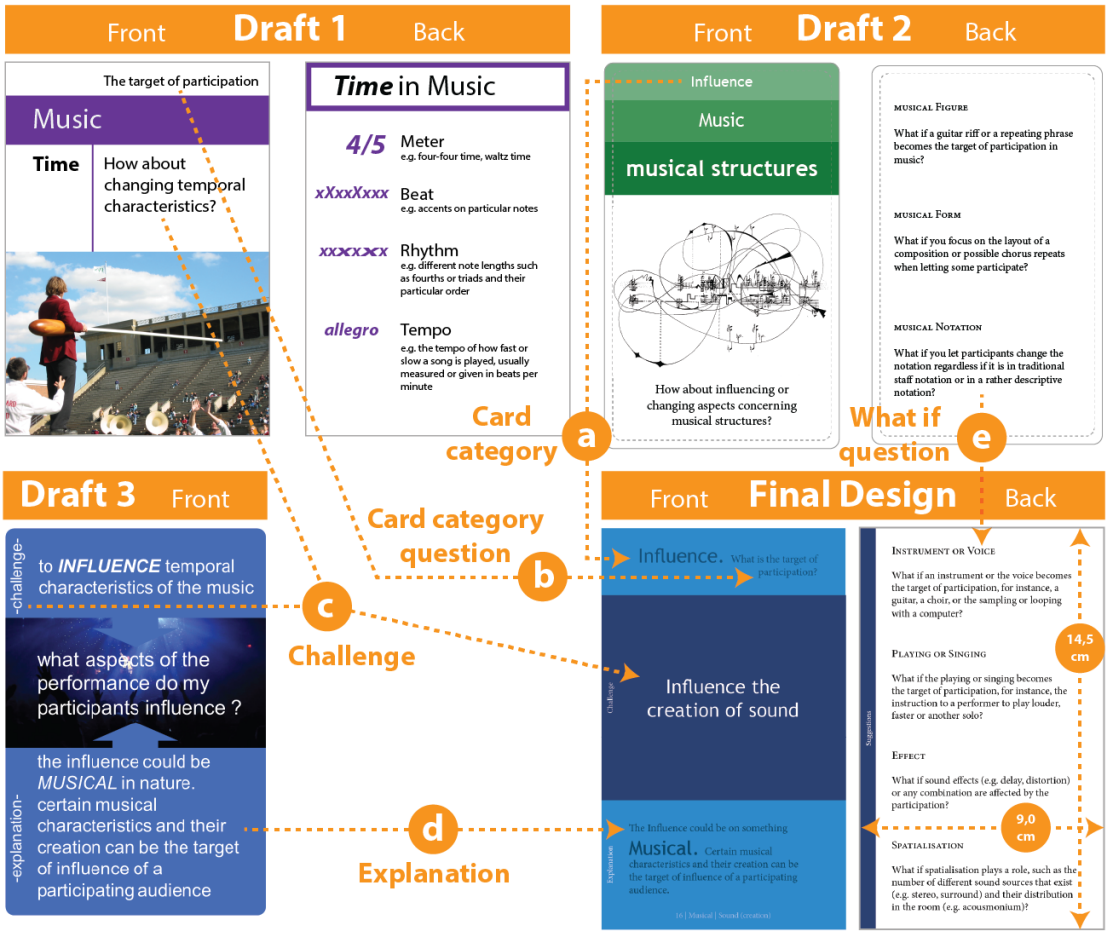


Figure 9.7: The final design of the TMAP Design Cards based on three drafts

of the TMAP Framework. The principle idea to frame this as a challenge came from draft 3. To put this challenge in the main section in the middle of the front side came from draft 1.

The bottom of the front side is inspired by draft 3. Instead of just using the name of a category (e.g. *Music*) to subsume cards of the same category as in draft 1 and 2, we called this the *Explanation* and use a longer description with emphasis on the category (d).

The back of each card was mainly inspired by draft 2 with framing the examples of each design aspect as *What-if-questions* suggesting a possible solution to the challenge on the front side. Following draft 3 and having a challenge and explanation on the front side of each card, we called the content on the back side *Suggestions*. As each sub-category of the TMAP Framework has 2 to 4 design aspects, every card has also 2 to 4 *Suggestions* correlating with the design aspects but formulated as *What-if-questions*.

We decided to create the actual cards bigger than the typical palm-size of playing

Figure 9.8: An exemplary front and back of each design card category

cards and defined the size of the TMAP Design Cards as 9,0 x 14,5 cm. The two reasons for this decision were other design cards with bigger sized cards (IDEO, 2002; Pricken and Klell, 2006; Lockton, 2013) and the amount of text of our cards, especially on the back side showing the *Suggestions*.

For the final set of all cards we added a footer at the bottom of each card showing a continuous number, the category, and the sub-category. Figure 9.8 shows one exemplary front (upper row) and back (lower row) for each category of card. For a better distinction of all cards of the same card category, we chose a different colour for the *role (red)*, *motivation (yellow)*, *influence (blue)*, and *interaction (green)*. The fifth card category in Figure 9.8 (leftmost) is for the *recommendations (purple)* how to use the cards as we will describe next.

9.4.4 Recommendations for Usage

To complete the development of the TMAP Design Card we considered and formulated instructions for their use. We called these instructions *Recommendations for Usage* to emphasise their tentative character as they should rather guide and inspire the design processes around TMAP rather than strictly control them.

The general purpose to use the cards was framed as, "Generate ideas and concepts to create technology-mediated audience participation (TMAP) in live music or add participatory elements to a live performance. Use the TMAP Design Cards either in a

group or on your own." As preparation before a design session we formulated, "Separate the deck and make four piles, one of each colour. The coloured side of a card is its main side and always appears face up. Shuffle each pile and have pens and paper prepared." Finally, we formulated three basic *rules* to use the cards during a design session:

- The cards' main side: The fully coloured side of a card is its main side. Always use the main side first when you draw a card and do not turn around a card immediately.
- Use a card: Read the *Challenge* and the optional *Explanation* on the main side carefully to trigger your imagination. Do not turn around a card immediately after you draw it! Always try to think on the basis of the *Challenge* and the *Explanation* first.
- Turn around a card: You may turn around a card if you need further *Suggestions*.

To make the TMAP Design Cards usable either collaboratively in a group or for a single person, we formulated two modes. The *Multi Person Mode* suggests as preparation, "Every person draws a *Role* card (red) which defines the person's role. Everybody keeps thinking for a moment about the role and refines it quietly.", plus the additional hint, "If the group size extends to six people or more, we recommend to make smaller groups of three or four people each." For the course of a design session we formulated:

- First round: Everybody draws one card in addition to the *Role* card. The person who starts takes an *Influence* card (blue), the second one an *Interaction* card (green), the third one a *Motivation* card (yellow), the fourth an *Influence* card, and so on. Now everyone tries to create an idea based on the *Challenge* written on the card and the further *Explanation* below. Do not turn around a card immediately but do so if you need further *Suggestions* while you create your idea. This is followed by a group discussion where everyone contributes ideas based on their own cards. Use pen and paper to make notes and sketches.
- Further rounds: After the first round, further rounds may follow. At this point cards may be discarded if wanted to draw a new card and even from another colour. Discarded cards may be either fully discarded from the game (of course only for this session) or discarded for later use by dropping it on the related sketches or notes of the finished previous round.

The *Single Person Mode* works similarly, however, with some alterations starting with a different hint, "In *Single Person Mode* we recommend to use pen and paper to sketch your ideas instead of just thinking." The actual alteration for the course of a design session is, "You may draw a *Role* card (red) but you may also define a role on your own. Act as if you were doing a session in a group but draw all cards by yourself. First, draw an *Influence* card (blue), then an *Interaction* card (green), then a *Motivation* card (yellow), then another *Influence* card and so on. However, do not draw more than one card at once. Every time when you draw a card, think thoroughly about the *Challenge*,

read the *Explanation* and finally turn the card to make use of the *Suggestions*. Always make notes and sketches to write down your ideas before you draw another card."

To align these instructions with the other cards, we designed them in the same way but gave them a different colour (purple), as already illustrated earlier showing exemplary cards in Figure 9.8. In total, we created three purple *Recommendation for Usage* cards, one for general instructions and two for the different modes.

In the end we had 3 recommendation cards and 46 design cards: 6 role, 6 motivation, 12 influence, and 22 interaction. All cards are available in Appendix F.5 and a set of printed cards is published together with this thesis.

9.5 Design Card Application

To trial the TMAP Design Cards in practice, we used them in a seminar called *Gameful Design* at the Vienna University of Technology. We chose this particular seminar as its goal was that students learn and understand gameful design methods by trying out different design strategies and challenges. Furthermore, the seminar was dedicated to master students. Thus, we expected the students not only to be qualified but also motivated to test the TMAP Design Cards.

9.5.1 Presenting the TMAP Design Cards to Students

In general, the seminar had different units covering topics around game design in a broader context. Twelve students participated in this seminar throughout a whole term. Every unit topic was presented by an initial lecture, subsequent group work of the students for three weeks, and a final presentation of their results.

In the initial lecture of the unit that concerned the TMAP Design Cards we presented TMAP as a broader context. We tried to avoid giving too particular examples for TMAP and rather described the concept, as we wanted the students to create their own ideas for TMAP during the group work. Furthermore, we introduced the students to the idea of cards for design, showing them different examples (Figure 9.5). Finally, we presented the TMAP Design Cards and explained the process how to use them.

9.5.2 Design Sessions in Groups of Students

For the actual group work, we asked them to form four groups of three people each. The only obligation was that each group had at least one musically trained[9] member. By chance there were enough musically trained students in the course so that we could fulfil this obligation.

We handed out a set of TMAP Design Cards to every group containing the 46 design cards and 3 recommendation cards with instructions. As assignment for the group work, we gave them the following tasks for self-organised workshops within the group:

[9]Not in a professional sense but having learned a musical instrument at a musical school or playing in a band.

Figure 9.9: Idea of the first group: *Rap Battle*

1. Define a particular live music setting. This can be real or fictional (e.g. rock band, DJ set, Hip-Hop performance). Describe this setting according to music style, number and roles of performers, typical performance setting and audience, and what else might be important to know.

2. Conduct design sessions to generate ideas for TMAP for your self-defined live music setting. Use the TMAP Design Cards for these sessions as long as they are useful.

3. Document the design sessions and create a short video sketch (three minutes maximum) to illustrate your idea and concept.

4. Critically reflect on the TMAP Design Cards and the whole process of their application in the group and by yourself and consider the following questions: How did you apply the cards during the session? How useful were the cards for design? What was useful and what did you like? What did not work so well with the cards? When did the cards constrain the design process? Which problems understanding the cards did you have?

After three weeks all four groups presented their results in the seminar. First, every group showed their video sketch and explained their idea for TMAP. Second, everyone reported back about their experiences from the design sessions in a group discussion. In addition, every student had to submit an individual written report containing a critical reflection of the design processes during their self-organised workshops.

9.5.3 Resulting Ideas for TMAP

The ideas for TMAP the groups designed are the actual results of using the design cards in practice. However, the analysis of the students' reflections are the main interest of this study. Nevertheless, we consider these ideas the groups created as relevant to provide a context for the critical reflections on the design process and present them in short.

The first group created a *Rap Battle*. They describe it as a hip hop performance with two competing rappers on stage and the audience decides who wins, based on their physical activity. Figure 9.9 describes the concept in short showing three sketches: 1. two rappers compete on stage; 2. individual technical devices measure the activity of the spectators; 3. the rapper with more active fans wins the battle.

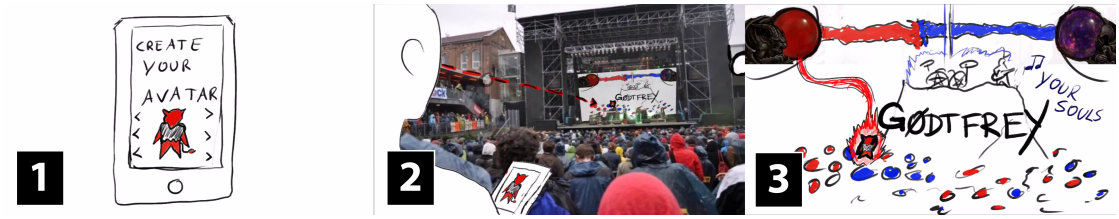


Figure 9.10: Idea of the second group: *Battle for Gødtfrey*

Figure 9.11: Idea of the third group: *Helsinki Rising*

The second group invented the *Battle for Gødtfrey*, an interactive smartphone app to augment the performance of a fictional *Viennese medieval folk/metal band*. See Figure 9.10 for sketches and a brief description of the concept: 1. spectators create an avatar prior to the concert; 2. all avatars appear on a projection on stage; 3. during the performance avatars enter an epic battle between the forces of light and evil that decide which course their concerts take.

The third group presents *Helsinki Rising*, that is an interactive dance floor for DJ performances. The basic idea is to use floor tiles that can change colour and measure the collaborative audience activity. The DJ can either play a normal set or use the interactive dance floor for mini games. Figure 9.11 explains the basic concept using three sketches: 1. at the beginning the interactive dance floor is deactivated (*Bühne* means stage, the tiles are the dance floor); 2. the DJ can start a mini game to encourage audience participation; 3. spectators can go to sections of the dance floor to trigger events.

The fourth group describes *FRLFTMSK* which stands for the German word *Freiluftmusik* without vowels. Freely translatedm it means open air music and uses a smartphone app to record every day sounds later used in a DJ performance. See Figure 9.12 for sketches and a short description that explains this idea: 1. use a smartphone app to record any sound; 2. upload the sound to a DJ's sound collection; 3. the sound may be used in the next performance of the DJ.

9.5.4 Results of Analysing Critical Reflections of Design Sessions

The data we used for the analysis of the group's design processes were the written reports of each student containing a critical reflection and notes from the group discussion at the end of the unit. The written reports were submitted online as digital documents

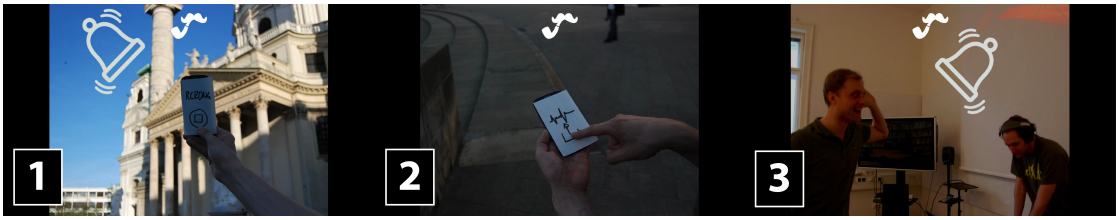


Figure 9.12: Idea of the fourth group: *FRLFTMSK*

including text and pictures documenting how the students used the cards during the sessions and which cards in particular. Figure 9.13 shows an exemplary picture of such a design session submitted by a student as part of the report.

We analysed the text of the reports thematically to identify and categorise issues concerning the design cards or the process itself. We present these results in detail according to four themes we identified. These were issues with terminology and roles, whether they used the cards as recommended or not, how the design cards affected the idea finding and changed their thinking, and finally what could be improved as suggested by the students.

Issues with Terminology

Four students explicitly reported they were confused and could not really understand what the challenge on the front side was inviting them to do. One student suggested formulating the descriptions "more direct and concise".

Another student said the descriptions were complicated and disruptive when thinking about ideas. However, the same student said this should not be a problem for people who are familiar with music and used to the terminology. Similarly another student assumes, "the cards seem to require some musical knowledge in order to be useful." These students had problems because of their lack of expertise, as they assumed by themselves. However, being a non-expert and having troubles to understand a card in a straightforward way, appeared to be helpful as reported by one student, "The cards incentivise thinking about the combinations one gets, instead of skipping over cards that do not seem to make sense".

Issues with Roles

The imaginary roles the students were randomly assigned, were both enriching and challenging. While some students reported the role helped them to get a different view, others saw contradictions with their role and other cards.

Several students discussed the roles and in particular the role card *manager* was mentioned. For instance, the manager card constrained one student in combining it with other cards and thinking of potential ideas, while another student reported he came up with an idea due to thinking of the manager he never had thought of before. One student

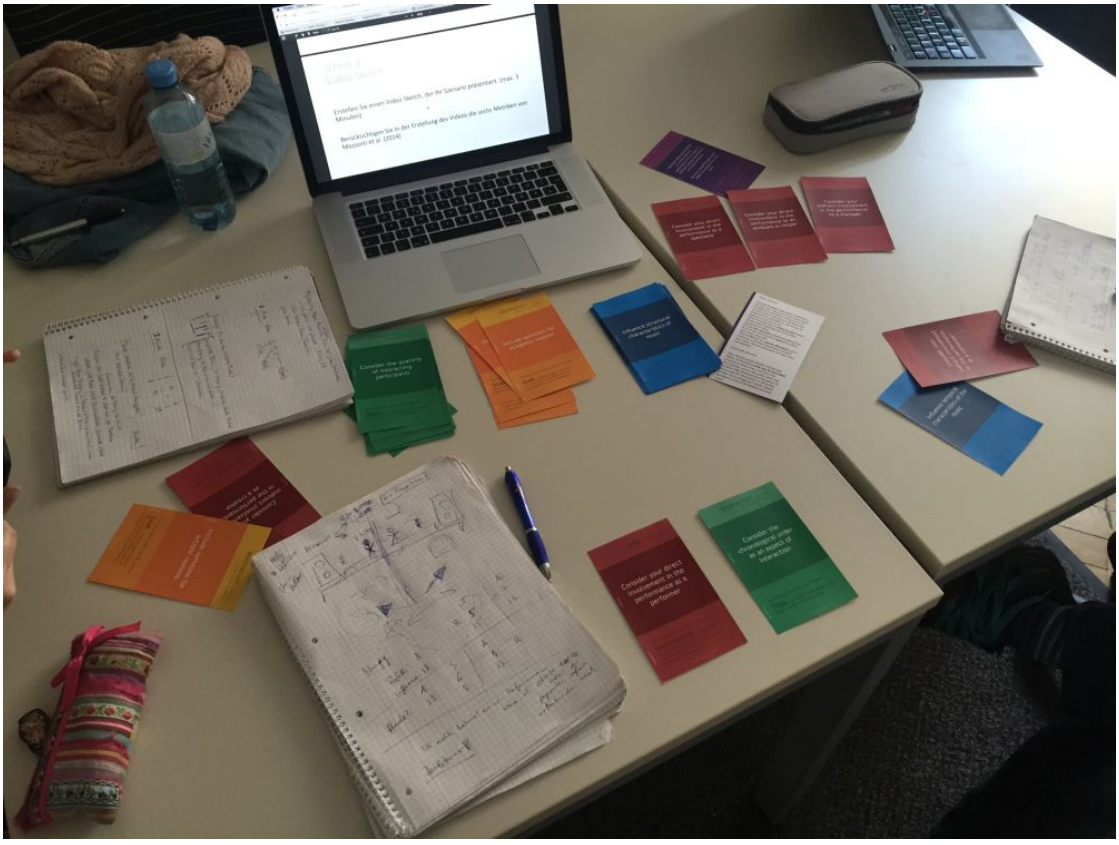


Figure 9.13: An exemplary picture of a group design session

said, “combinations [of cards] seemed a bit confusing, like the manager thinking about spatial movement”.

In two cases students reported, they excluded this card after the first round as they did not know what to do and it even restricted thinking. One group decided to choose roles by themselves in the second round after not being satisfied with the random choice via the card of the first round.

Issues with Recommendations

According to the students’ reflections, they mainly used the cards as recommended. However, in relation to issues with the role cards, they reported that they changed roles on demand when certain roles were too restrictive to find ideas.

Not only for role cards but also other cards, students decided to use the recommendations we gave them in a rather flexible way. They reported that they swapped cards, restarted the design process, or even excluded cards from the set. These self-contained changes helped them during the idea finding process to use the cards rather flexibly.

Concerning the actual use of the cards, some students had enough inspiration with the challenges while others liked to turn around the cards to carefully read all suggestions.

Idea Finding

We identified several aspects, where the cards influenced the idea finding during the design process. According to three statements, the cards helped the students to see design with other people's eyes and to generate an idea forced by a new perspective of a particular role. In contrast to the problems with the manager role card mentioned earlier, this card and the role concept was positively mentioned in the context of idea finding. A student reported that the manager role inspired him to think of using smartphone statistics.

Two students commented on idea finding in relation to the concept of the card to have a challenge on the front side and a suggestion on the back. One said, they rarely had looked at the suggestions as they got already inspired by the challenge. Another one reported that the suggestions on the back were decisive for their design ideas and moved the discussion forward.

In one case, idea finding within the group was overwhelming one individual. This student reported that the distraction of the ideas raised by others made him "subconsciously abandon my role card and just think about the interaction card".

Another student reported that the group had a basic idea, most of the cards did not fit and they decided to completely change the cards and restart a round. The same student also said that especially his new card made the group discuss "the spatial distribution of interacting participants", which was completely new to their idea. He added that they liked how the cards pushed their thinking without suggesting a particular design solution. This example not only illustrates how the cards triggered their ideas but how it changed the thinking, as we describe next.

Change Thinking

Related to idea finding, but more focused on the overall process, were reports about how the design cards changed thinking throughout the design sessions. In particular, students reported that the design cards became later helpful when they already had a basic idea. For instance, two students explicitly said the cards were not helpful at the beginning but were helpful later during the design session when "fleshing out an already existing idea". One student mentioned that the cards were useful when their creative thinking "came to a standstill". Another one reported that "the cards were less helpful when trying to come up with a new idea. However, the cards were useful when filling out details and discovering things about the design that were not apparent at first glance." Finally, one student said, "For what they [cards] also proved to be very useful was viewing an already existing concept through a new facet/point of view." All these reflections indicate that the students most likely changed some aspects later, inspired by using the cards. Unfortunately, we do not know which aspects they changed in particular and at which point during the design.

Other students reported understanding issues with cards as mentioned earlier but added that after a while, they became familiar with these cards. Two students, for instance, said they had troubles at the beginning to use the cards. By reading the texts "carefully and thinking about them, it became more clear what to do, though", said one. Another student reported that the word *temporal* as challenge did not make sense at the beginning but in the end triggered the idea not to do the interaction during the performance but prior to the performance.

There was one case where the cards were mentioned as not helpful in this regard. One group had very early a principle idea, as they said and it was hard to move away from this idea even by using the cards.

Improvement Suggestions

Finally, students made suggestions for an improvement of the cards. Some of these suggestions concerned the recommendations of how to use the cards. Among these suggestions were to define more roles, to specify them more precisely, and to allow changing cards as often as one likes. One student said as it is not a real game where "fair play is important", it should be possible to completely ignore one's own role. The same student said a "wrong role" could prevent members of a group to participate in a discussion when they are not confident about their role. As we have seen earlier, at least one group already changed roles during the process and decided to choose roles by themselves in the second round.

One student mentioned too little time to think as an issue. This should be defined more clearly as sometimes people already came up with an idea when others were still thinking about their challenges as the student reported. We had a related issue that primarily concerned idea finding earlier when a student reported that the distraction of ideas raised by others made him subconsciously forget his own role.

In terms of misunderstanding cards and getting cards that are not useful, one student suggested to remove particular cards from the beginning if they do not fit to a certain setting at all. Concerning missing cards, a student criticised, "they never make you question your social background", and he suggested, "I think cards like these would be a good way to better consider the view of marginalized groups."

The last improvement suggestion concerned the actual design of the cards mentioned by one student. The critique addressed the size of the card as they appeared to be too big to shuffle them and the choice of the colour for some cards as the text was hard to read on the same coloured background.

9.5.5 Framework Improvement

To improve the TMAP Framework based on the results of the design card application, we considered concrete improvement suggestions of the students' critical reflection as just presented. In particular, this improvement mainly affected the roles category to address the comments by students who wished to have more roles and to specify them more precisely. Furthermore, we added the new design aspect *Target group* in *Motivation* to

follow the suggestion of one student to consider different groups of people (e.g. children, old people) during the design.

The revised version TMAP Framework V5, as it looked after the design card application including a description of the changes made as part of this step, is available in Appendix F.4.

9.6 Expert Peer Review with Musician

As with the development of the TMAP Framework, the last step was an expert peer review. This time we did the review together with an Australian musician who says about herself she is "a musician/composer and has been performing, recording and working in the contemporary music industry for over 15 years". Furthermore, she has an academic background in computer science and a special interest in interactive music.

This choice was important for two reasons: First, we needed to include a professional musician to get her perspective on the framework as none of the experts and students included throughout the evaluation process so far provided this experience. The second reason concerned the language. Only the expert we reviewed the framework with during the development was an English native speaker.

Both experts involved during the evaluation so far were German speaking and did not have a professional musical background. Most likely the students of both classes were primarily German speaking as these were held in German at the Vienna University of Technology and did not have a professional background in music as they were computer science students.

9.6.1 Reviewing Process

For this review we neither used TMAP Online nor the TMAP Design Cards. We used a printed version of the TMAP Framework V5 to have the whole framework at a glance and to annotate all entities with suggested revisions according to the expert's input. Similar to the other peer reviews, we went through all entities of the framework together step by step and the expert gave immediate feedback.

9.6.2 Framework Improvement

The suggested revisions by the expert concerned adding, re-wording, and removing entities as well as splitting up entities to new ones or completely reorganise two categories. All of these revisions are documented in the TMAP Framework V6 which is available in Appendix F.4 for details.

Overall, this revision resulted in most changes compared to all other iterations of the TMAP Framework (V1-V5 as available in Appendix F.4). The most noticeable changes made were rewording entities. This rewording concerned 43 entities on all four levels of main categories, categories, sub-categories, and design aspects. All of them were suggested by the expert for a better understanding. Besides that, we added additional design aspects the expert found to be missing in the framework.

In relation to reorganising entities, the expert suggested to remove one category that implied several other changes. In particular, this was the category *Acoustics* in *Interaction*. According to the expert this category did not fit with the other rather abstract character of the categories within interaction (e.g. *space*, *time*). However, we did not remove *Acoustics* completely but moved two of its design aspects to a new sub-category.

9.7 Discussion

For evaluation we applied the TMAP Framework in practice for classification exercises (chapter 9.3), developing design cards (chapter 9.4), and using these cards for design sessions (chapter 9.5). Furthermore, we attempted to iteratively improve the framework throughout the evaluation process with expert reviews. With a reflection on the results of these steps, we identified issues that concern challenges and the potential of the TMAP Framework.

9.7.1 Use Strategies

The results of the classification exercises point to challenges with the fine-grained multi-level structure of the TMAP Framework. We used TMAP Online, an instantiation of the framework, to let students classify examples for TMAP. Through the analysis of the results we saw that this classification was highly influenced by the individual strategy of the students in terms of how to use the design aspects to classify a given example of TMAP.

For instance, some students justified their classification strategy either to choose everything possible or everything explicitly mentioned in a description of an example for TMAP (e.g. using the whole category music versus every single design aspect in music that is mentioned in the example). In terms of the classification both strategies were reasonable and can be considered correct but led to differences in classifications. This points to an issue with the flexibility of TMAP Online. The students had no particular instructions how to use TMAP Online and had to find their own strategy.

However, with TMAP Online we just offered the design aspects to choose for classification. Technically, the categories on all other three levels were just used to structure the design aspects with a possibility to collapse and expand. One option might have been to consider all entities of the TMAP Framework for the actual classification and maybe to provide some additional instructions how to use the different levels. By doing so, the students would have given a choice to apply their strategies (e.g. choosing music and not all particular design aspects within music). Furthermore, we would have taken advantage of the multi-level structure the TMAP Framework offers by using all levels for classification and not only for structuring purposes.

With the TMAP Design Cards, in contrast, we considered this multi-level structure of the TMAP Framework deliberately. When drafting the cards, we used the entities of all four levels on different sides and areas of the cards. For instance, sub-categories became challenges on the front side and design aspects were turned into suggestions on

the back side of a card. The rationale behind this decision was to allow them to think about challenges on their own before turning around a card to read further suggestions. According to the results evaluating the TMAP Design Cards, most students used the cards as intended and it even turned out to be inspiring for them as we will discuss later.

Thus, with the TMAP Design Cards, the fine grained multi-level structure of the framework helped us to design the actual cards in a useful way. Compared to TMAP Online, this means there are different strategies to use the TMAP Framework when used in practice. This makes the TMAP Framework powerful as it is modular and adaptable but complex at the same time as there seems to be no dedicated right or wrong way to use the framework.

9.7.2 Complexity

In both applications, TMAP Online and the TMAP Design Cards, we identified problems with the terminology of the framework. When students used the TMAP Design Cards, they explicitly pointed out wording issues and reported a certain confusion with the complex terminology. With TMAP Online these issues were less obvious but may be partly a reason for the big differences of classifications throughout all exercises.

However, considering some individual classifications with justifying comments, indicate that students understood the terminology of the TMAP Framework and could use it to describe the given concepts of TMAP. The comments addressing the improvement of the framework also underline this assumption. In these comments students pointed towards potentially missing design aspects that turned out to make sense when considering these suggestions during the framework's improvement.

Finally, the complex terminology was an issue when using the TMAP Framework with experts. Both review processes with experts led to several revisions throughout the framework and in both cases these changes concerned the terminology. In particular, the musician at the end reviewed the framework reagrding her professional experience. For the first revision, the experts, both not musicians, had the design cards in mind and had to prepare the framework accordingly. These were two different perspectives the experts looked at the framework for their review.

This means that the challenge is not only the complex terminology of the TMAP Framework concerning its use. It might be even necessary to adapt and revise the terminology for a particular purpose of how and by whom the TMAP Framework is to be used. This challenge with the complex terminology also relates to another issue as we will see when we discuss the potential of the framework to serve as an inspirational tool.

9.7.3 Inspiration

We identified the potential of the TMAP Framework to serve as tool for inspiration when instantiating the framework as TMAP Design Cards. Students reported that the cards helped them with idea finding and that they changed thinking throughout a design session. However, to actually create the cards using the framework took some effort to make changes and prepare the framework in advance.

In terms of inspiration, both the multi-level structure and the terminology bear some potential. We already discussed the multi-level structure being used to distribute the content of the framework on the cards. From an inspirational point of view, this strategy to use two sides having a challenge on the front side and further suggestions on the back was reported as useful. Some students had enough inspiration with the challenges on the front side and others turned around the cards to get more suggestions. Thus, this two-sided structure especially helped those students who did not turn around the card, to concentrate on the challenge and to create their own ideas.

Inspiration through the cards in relation to the complex terminology was differently reported . For some it was disruptive and for others it incentivised thinking (e.g. the manager role). This points back to different perspectives and that it matters on how the framework is perceived and understood. In this context, the fine grained multi-level structure of the framework is a chance to reveal new insights into TMAP but its complex terminology might be obstructive.

9.7.4 Improvement

The fine grained multi-level structure was also a challenge concerning the attempts to improve the TMAP Framework based on experts' input or students' suggestions. We iterated over the framework four times (see TMAP Framework V3-V6 in Appendix F.4). During all iterations there were lots of changes. Entities were added, removed, split up, re-categorised, and finally often reworded.

However, these changes did not affect the number of entities of the framework very much. According to the number of entities, we had 170 entities with TMAP Framework V3 at the beginning of the evaluation and 180 entities with V6 at the end. This is only an increase of 10 entities. Thus, the changes throughout the iterations rather affected the content and in particular refining the entities and the structure on a micro-level.

All these changes were based on input from different perspectives of experts or students (which we consider as *non-experts*). Furthermore, the context was different for each iteration ranging from a large group of students, a small groups of students to individual experts. For instance to draft the design cards, we tried to unify the terminology of the whole framework to avoid confusion with different cards using the same words.

After all these iterations from several perspectives and under different circumstances, we still cannot say that we now have a *final* version of the TMAP Framework. We even postulate that there cannot be a final version of the TMAP Framework as it is dependent on the perspective and the context in which it is used. In some cases, as with the design cases, it is even necessary for a particular purpose to change the framework to meet the requirements.

9.7.5 Revisiting Research Questions

Finally, we revisit the two research questions of this chapter and draw conclusion on all issues identified during the preceding discussion. These issues concern the potential of the

TMAP Framework and some challenges we identified when reflecting on its application and improvement.

The first question asked: How useful is the TMAP Framework when applied in practice? We identified different strategies to use the TMAP Framework in practice as well as its complexity in terms of structure and terminology as challenge and potential. In particular, this concerns how to use the fine grained multi-level structure of the framework in a meaningful way within a dedicated purpose. With the TMAP Design Cards we took advantage of the fine grained multi-level structure. Using the TMAP Framework as design cards, showed also the inspirational potential and for communication during collaborative design sessions. For TMAP Online it turned out, there might be room for improvement how to use the TMAP Framework, especially when using it for analysis. However, in general the students understood the terminology and used it in different ways to describe characteristics of given examples for TMAP.

The second research question was: How can we improve the TMAP Framework throughout evaluation? Attempts to improve the framework turned out to be challenging but also necessary for particular purposes and applications of the framework. As it is dependent on the perspective and the context in which it is used, we conclude that cannot be a final version of the TMAP Framework.

In conclusion, we consider the high granularity the TAMP Framework provides in its current version as a strength and weakness at the same time. Among the strengths of the TMAP Framework are its versatility and adaptability in terms of using the framework for different purposes and describing the design space of TMAP in depth. The two applications of the framework have shown its practical potential concerning idea generation and guidance during design processes as well as to provide a common language for TMAP in live music. The weakness of the framework is that it needs permanent iterations to improve it and to handle this versatility and adaptability.

Based on this knowledge about the practical value of the TMAP Framework and its potential to support design-related processes, we continue with a discussion considering the whole thesis research and the overall research questions raised at the beginning.

9.8 Summary

To evaluate the practical potential of the TMAP Framework, we conducted a formative evaluation in four steps. First, we used the TMAP Framework for classification exercises with students in a class to assess the potential of the framework for analysis and description within the design space of TMAP. Second, we developed a set of 46 TMAP Design Cards together with two experts. We applied these cards in a seminar for gameful design as the third step of the evaluation to identify the practical potential of the framework for actual design of TMAP. Finally, the fourth step was an expert review that concluded the evaluation and primarily aimed on the improvement.

Overall, the TMAP Framework changed in various ways throughout the whole evaluation process which pointed out the challenge but necessity to adapt the framework iteratively for different applications. The potential of the framework concerns its adapt-

ability and versatility to apply it in practice. In particular, we identified its potential to support design-related processes concerning idea generation and guidance during design processes as well as to provide a common language for TMAP in live music. This knowledge about the TMAP Framework is taken further to the overall discussion of this thesis.

9.9 Contributions

1. *TMAP Framework (V6)*: The current and improved version of the TMAP Framework contains 180 entities in a tree-like sorted structure on four levels with 119 design aspects on the fourth level and is available in Appendix F.4.

2. *Practical Potential of the TMAP Framework*: With the evaluation of the TMAP Framework as web-based online tool and as design cards, we could iteratively improve the framework and identify its potential regarding adaptability and versatility for practical applications. The potential to support design-related processes concerns idea generation and guidance during design processes and to provide a common language for TMAP in live music.

3. *TMAP Online*: We developed a web-based instantiation of the TMAP Framework to facilitate classification exercises with a large number of students in an interaction design class. The students used TMAP Online to classify existing examples of TMAP in different ways. The particular features of TMAP Online are the environment to organise the exercises, a web-based version of the framework, and functionality to automatically support the analysis of the classification exercises.

4. *TMAP Design Cards*: We used the TMAP Framework as basis to develop a card-based tool to support design processes around TMAP in live music. The set contains 46 design cards and 3 recommendation cards with instructions. The application of these TMAP Design Cards in group design sessions with students showed their value to use them in different ways to create ideas, guide design, and change thinking.

CHAPTER 10

Discussion

10.1 Introduction

This thesis begun with two research questions, as raised in the introduction. These questions all seek improved understanding of the design space of technology-mediated audience participation (TMAP) in live music. In order to address these research questions, two strands of research were carried out: a set of field explorations, and the development and evaluation of what became the TMAP Framework.

In this chapter, we reflect on the research from the perspective of the various activities of the two research strands. This viewpoint facilitates a critical examination of the diverse ways in which knowledge emerged from the concrete activities of the two strands and a reflection on its potential practical contribution. It also allows an examination of potential practical contributions for stakeholders such as musicians, spectators, composers, interaction designers, engineers, and managers. By contrast, for a summary of the contributions to knowledge organised more directly in terms of the research questions, see the next chapter. For the following discussion, we revisit the research questions raised in the introduction and reflect on the various ways in which the two research strands illuminated these questions:

RQ1 What are the principal issues involved in the design of technology-mediated audience participation?

RQ2 How can support for processes of the analysis and design of instances of technology-mediated audience participation be provided?

We start the discussion with reflecting on the principal issues in the design of TMAP identified during the field exploration.

10.2 Principal Issues in the Design of TMAP

During the field exploration we identified a set of principal issues that concern *stakeholder requirements* and *challenges* for the design of TMAP in live music, as discussed in Chapters 4-7. From these issues we have been able to provide a set of answers to our first research question RQ1 and to make a series of contributions to knowledge about the design space of TMAP, as detailed in those chapters. The identification of issues was effected by studying the field from different angles and using a mixture of methods. The choice of using a combination of methods was deliberate as there is no consensus in the literature on methods for studying live performances.

10.2.1 Methodological Reflections

The field exploration was characterised by a combination of qualitative research methods that included elements of research through design, technology probes and auto-ethnography. All of these methods were used to study and reflect on creative processes and performance experiences.

As there was no consensus in the literature how best to study complex settings such as live music performances, we combined and adapted recommendations from the literature. We found that studying single impressive performances (Gabrielsson, 2003) and using a mixture of methods to study the performance experience (Pedersen and Hornbæk, 2009; Reeves, 2011) led to a rich set of insights.

However, we posit that the use of a participatory design approach for our first case study resulted in an overly cautious design of our CoSCoS prototype (see Chapter 6). With this participatory design approach, we attempted to balance the requirements best concerning musicians and spectators, and additionally use a given song. This process resulted in a rather careful than provocative design concerning impact and feedback on sound.

This outcome contrasts with other work evidenced in literature using participatory design approaches for the design of performance experience (Weitzner et al., 2013; Spence, 2016). We will revisit these methodological issues when reviewing the limitations in the conclusion (Chapter 11).

All field studies highlight both the importance and difficulty of balancing knowledge and requirements from different perspectives. The difficulty to balance requirements during design and anticipate the actual outcome at a performance also demonstrates the challenge of imagining and simulating the interaction and performance experience of TMAP. Regarding the CoSCoS case study the assumed outcome as imagined during design was very different than the actual performance experience. With the Experimence case study we simulated the audience participation on a basic level using random values to anticipate spectators behaviour. In combination with the composition this resulted in an improved interaction and feedback experience during the performance. Nevertheless, there were still spectators complaining about issues with interaction and audible feedback.

With the TMAP Framework, we intend to support such design-related processes, to point to challenges, and to provide guidance. Thus, we continue to reflect on the TMAP

Framework as a practical support for design-related processes for TMAP in live music.

10.3 Support of Design-Related Processes

The TMAP Framework was developed to describe the design space of TMAP in live music in a practice-oriented way to support design-related processes. The final version of the TMAP Framework contains 180 entities in a tree-like sorted structure on four levels. The majority of these entities are categorised design aspects. Full detail of the final version as presented in the previous chapter can be found in Appendix F.4 (TMAP Framework V6).

With the evaluation of the TMAP Framework, we identified its practical value and potential to support design-related processes. This practical potential concerns idea generation and guidance during design processes, provision of a common language, and the potential to adapt the framework for practical uses.

10.3.1 Idea Generation and Guidance during Design Processes

Use of the TMAP Design Cards for group design sessions and TMAP Online for classification exercises helped to identify the practical potential of the TMAP Framework for idea generation and guidance.

Note, that we did not attempt to evaluate the creative output of the design sessions from an aesthetic perspective. However, during the course of the design sessions there were instances where designers appeared to be inspired, changed their thinking, and broadened their perspectives through interacting with the design cards.

Subsequent usage by a different set of interaction design students for analysis rather than design, when the framework was made accessible as TMAP Online, demonstrated uses for analysis within the design space of TMAP. The designers in both of the above studies were interaction design students and thus representative of people concerned with design processes and potential clients for such a framework.

These findings in relation to idea generation and guidance during processes of design and analysis contribute to answering RQ2 by demonstrating refined methods by which the analysis and design of TMAP in live music can be supported. The framework also made a straightforward practical contribution by helping the students in our studies to understand design challenges and characteristics around TMAP in live music.

The six metrics (Mazzanti et al., 2014) are the only other approach to formalise TMAP in live music, to our knowledge. Compared with these metrics, the TMAP Framework is conceptually contrasting and very different in terms of scale and coverage. The TMAP Framework also had instances of practical application to support design processes studied and analysed which does not appear to be the case for the six metrics.

There are commonalities with the outcomes of other research that observed similar practical potential when studying approaches using design cards based on descriptive frameworks (Hornecker, 2010; Lockton, 2013). As with these other approaches we could utilise our descriptive and explanatory TMAP Framework in a way to provoke creative

ideation and to support understanding of concepts and challenges during the design process.

With the TMAP Design Cards and TMAP Online, some issues of ambiguity and confusion with the terminology were observed. However, in both cases the relevant student groups were not generally native English speakers. Thus, with some caution about particular items of terminology, the potential of the TMAP Framework to provide a common language for different stakeholders was demonstrated.

10.3.2 Provision of a Common Language

According to our results, the TMAP Framework supports communication within groups (with TMAP Design Cards) and understanding for individuals (with TMAP Online). Furthermore, it served everyday people (students) as well as experts (e.g. musician and designers) to illuminate the design space of TMAP.

Considering these different perspectives and purposes where the framework provided a useful terminology and supported processes, there is support for the claim that the descriptive framework has the potential to serve as lingua franca for TMAP in live music. Furthermore, the TMAP Framework facilitates communication between diverse stakeholders concerned with design of TMAP in live music - a point generally important for interdisciplinary design (Borchers, 2001).

The potential of the TMAP Framework to provide a common language is in itself a contribution to characterising the design space of TMAP in live music, a main goal of this thesis. Another claim in relation to the design space of TMAP was to provide a practice-oriented description with the TMAP Framework, which we discuss next.

10.4 Describing the Design Space of TMAP in Live Music

At the beginning of this thesis we claimed to build a framework that describes the design space of TMAP in a practice-oriented way to support design-related processes around TMAP in live music. To conclude the present discussion, we argue that the TMAP Framework answers these expectations, as follows. Firstly, the framework fulfils the claim to be a practice-oriented description of the design space of TMAP in live music that serves as a common language and can be used for practical applications (section 10.3.2). Secondly, the TMAP Framework is supportive for design-related processes in terms of idea generation and guidance (section 10.3.1).

Since we claim that the TMAP Framework has potential ongoing uses for different practitioners, we revisit the framework and consider what we have learned about its practical potential. We will look at three exemplary sections of the framework, one from each main category, to demonstrate how the TMAP Framework might be read and used from different perspectives and how it contributes to describe the design space of TMAP in live music (for further details or for reference, see the full framework in Appendix F.4, TMAP Framework V6).

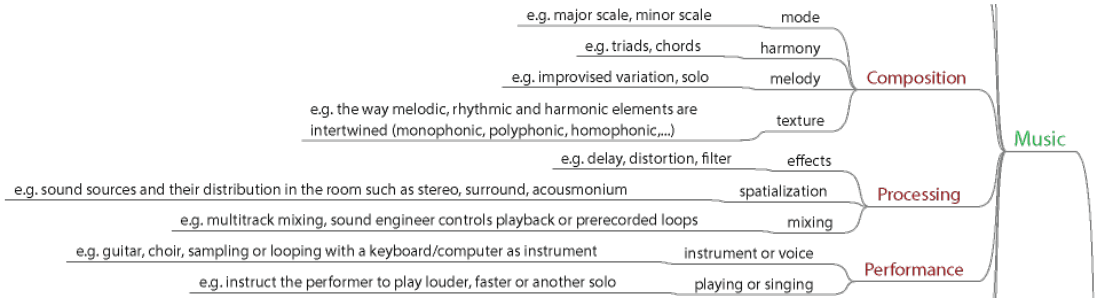


Figure 10.1: Section of the branch *Music* within the main category *Impact*

10.4.1 Perspectives on the TMAP Framework

One main category is *Impact* and asks: How will the interaction affect performance aspects? Figure 10.1 shows example framework entities of the branch Music within this main category. Designer or spectators who are involved in the design process with little or no technical knowledge of music can use the higher level entities to understand that participating spectators might have an influence on the music in general or on the *Composition*, *Processing*, or *Performance* of music in particular. A composer who most likely knows about musical details can directly approach particular aspects such as *mode*, *harmony*, *melody*, etc. The tree-like structure and connections support navigation through the different branches.

This example highlights the potential of the TMAP Framework to inspire, as the entities might point to unconsidered aspects or directions. A composer who focuses on composition might be inspired to think of sound processing and different effects as part of the audience participation.

Another main category is *Motivation* and asks: Why are participants motivated to be involved? Figure 10.2 shows example entities of the branch *Constraints* for this main category. Performers who know their audiences best (or designers who focus on effective interaction) might have particular interest in possible constraints of a technology-mediated participation in a live performance. They can get detailed information about how different parameters can affect and potentially constrain the participation such as *Acceptance*, *Accessibility*, or *Demographic* issues in relation to the audience. An engineer who develops the technology to mediate participation, or a person who organises a concert, might focus on and discuss other parameters that possibly constrain participation such as *Technical feasibility*, *Costs*, *Ethics*, or *Legal* issues.

The above example of the *Constraints* illustrates both the guiding potential of the framework and the raising of challenges that can be an issue in the design of TMAP. All aspects within the category *Constraints* have to be considered to some extent for the design of TMAP, depending on the perspective or particular participants, the setting, or other requirements. To follow our example of how the performer and the engineer can share different concerns with constraints, we can see that the TMAP Framework acts as a guiding 'checklist' and a way to address challenges by highlighting certain decisions or

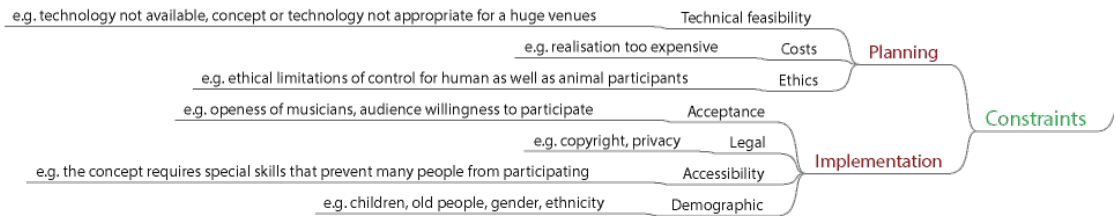


Figure 10.2: Section of the branch *Constraints* within the main category *Motivation*

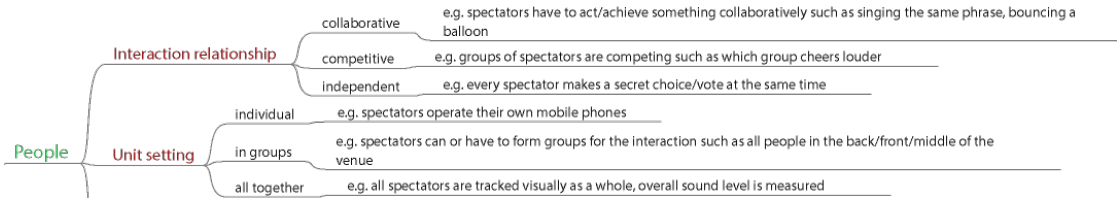


Figure 10.3: Section of the branch *People* within the main category *Interaction*

compromises.

Finally, we look at the main category *Interaction* which asks: What are the parameters of the interaction? Figure 10.3 shows example entities of the branch *People* within the main category *Interaction*. An interaction designer who knows about different forms and the importance of an effective interaction can directly use the details about possible ways to consider the *Unit setting* or *Interaction relationship* of the people involved. Spectators and performers might be interested in how interaction happens as well but can start with superior entities to approach interaction issues from a more general level and can stop before it goes into details they might not be concerned with.

This example uses the potential of the TMAP Framework to serve as common language between different practitioners. It supports practitioners to communicate issues that concern the design of TMAP from their perspectives and their respective level of knowledge such as interaction design between people to follow this example.

We presented these examples having different perspectives and the knowledge about the practical potential of the TMAP Framework for idea generation, guidance, and communication in the design of TMAP in live music. These examples should illustrate how the TMAP Framework might be read and used by different stakeholders and practitioners such as musicians, spectators, composers, interaction designers, engineers, and managers and how it contributes to knowledge to the design of TMAP in live music.

10.5 Summary

In this discussion we revisited the two overall research questions as raised in the introduction. We answered these questions by reflecting on the outcomes of the principal two research strands: the field exploration and the TMAP Framework. Furthermore, we

discussed the practical potential of the TMAP Framework for idea generation, guidance, and communication in the design of TMAP in live music. Finally, we outlined how the framework might be read and used by different stakeholders such as musicians, spectators, composers, interaction designers, engineers, and managers.

CHAPTER 11

Conclusion

11.1 Introduction

The motivating aim for this thesis was to *explore and describe the design space* of technology-mediated audience participation (TMAP) in a practice-oriented way to *support processes around the design and analysis* of TMAP in live music.

Technological advances have created rich opportunities in this area. However, these interactions are challenging to design. Effective design of TMAP requires a combination of knowledge from a variety of perspectives and insights into the needs of diverse stakeholders. Systematic research in the area and guidance for designers have both been very limited.

This thesis has identified and analysed issues in the design of technology-mediated audience participation (TMAP) from a variety of perspectives. A descriptive framework for supporting the design and evaluation of TMAP has been synthesised, refined, and evaluated. This framework describes the design space of TMAP in a practice-oriented way to support design-related processes for TMAP in live music. The research was driven by two principal research questions:

RQ1 What are the principal issues involved in the design of technology-mediated audience participation?

RQ2 How can support for processes of the analysis and design of instances of technology-mediated audience participation be provided?

These questions were addressed using a strategy based on a *research through design* approach, in two main research strands: field exploration and framework construction.

11.2 Summary of Contributions

This thesis explores the design space of TMAP in live music from different perspectives. The field exploration in combination with the development and evaluation of a framework

to describe this design space resulted in a series of contributions.

11.2.1 Contributions in Brief

- **Identification of TMAP Issues**: Numerous issues involved in the design of technology-mediated audience participation (TMAP) have been identified when studying the field from different perspectives to address RQ1. The contributions arising from these field studies are summarised in sections 11.2.4 and 11.2.5 below.
- **Framework for supporting processes of the analysis and design in TMAP**: To address RQ2, the identified issues have been organised in an iteratively revised layered framework that has been evaluated to validate its ability to support processes of analysis and design in TMAP. This framework and its practical applications are presented as contributions in the following sections 11.2.2 and 11.2.3.

11.2.2 The TMAP Framework

The *TMAP Framework* organises the contribution to knowledge of this thesis to the design of TMAP in live music. It is a descriptive framework that contains 180 entities in a tree-like sorted structure on four levels to describe the design space of TMAP in live music. The majority of these entities are categorised design aspects. A full description of the current version can be found in Appendix F.4 (TMAP Framework V6).

As explored and discussed in Chapters 9 and 10, the framework has practical applications in several areas: idea generation and guidance during design processes; provision of a common language; and the potential to adapt the framework for other practical uses. The TMAP Framework addresses various disciplines including HCI, music, performing art, and engineering. The different forms of the framework offer support to stakeholders such as musicians, composers, interaction designers, engineers, managers, and, last but not least, spectators as primary participants of interactive performance experiences.

We explicitly invite researchers and practitioners to adapt, modify, or extend the framework for their particular purposes and needs.

11.2.3 Practical Applications of the TMAP Framework

The practical application of the TMAP Framework during evaluation resulted in two different presentations, namely a set of design cards and a web-based online version of the framework, as summarised below. These validated tangible incarnations of the framework may be viewed as contributions to TMAP practice.

The *TMAP Design Cards* comprise 46 design cards and 3 recommendation cards with instructions. These cards are a tangible instantiation of the TMAP Framework drafted together with two experts and produced as part of the evaluation. A printed set is published together with the thesis and a collection of cards is available in Appendix F.5.

TMAP Online is a web-based tool to facilitate a classification exercise using the TMAP Framework during its evaluation. This tool was developed and used particularly

for evaluation of the framework with a large class of students. TMAP Online contains a front-end for the students to access their exercises and an online version of the TMAP Framework. The back-end allows to manage the exercises and supports the analysis with calculations. TMAP Online is specifically tailored to this classification exercise and not available publicly. Chapter 9 and Appendix F.1 contain screenshots of the tool and descriptions of its functionality.

11.2.4 Musical and Technical Contributions

Two case studies in the context of live concerts, conducted as part of the field exploration and described in Chapters 6 and 7, resulted in musical and technical contributions. These contributions are a song composed for TMAP and a technical prototype using smartphones for audience participation.

The *TMAP Song Experimence* is a song composed as part of the second case study having audience participation in mind. The song follows typical song writing principles for popular music and is available as musical output when performed during evaluation. In the video of the live performance[1] the author sings and plays piano and two other musicians play guitar and drums. Experimence is an artificial word and combines the unique *Experience* everyone will have during the *Experiment* of its live performance.

The *TMAP Prototype CoSCoS* is a technical system for TMAP developed for the first case study. CoSCoS allows the audience to control the sound of the guitar collaboratively using their smartphones. The prototype uses off-the-shelf software and standard protocols to let spectators' smartphones communicate with a guitar effect device on stage. CoSCoS is an acronym that stands for *Collaborative Stereo Control with Smartphones*.

11.2.5 Theoretical Perspectives

The field exploration throughout Chapters 4 to 7 resulted in the identification of a series of issues in the design of TMAP. These identified design issues are *stakeholder requirements* and *challenges* for the design of TMAP in live music. Overall, these requirements and challenges appear in different forms. They describe behaviour, motivations, opinion, and expectations spectators and musicians are concerned with in relation to live concerts in general and TMAP in particular. Other issues concern the actual concept and design of TMAP and the experience during a performance. Finally, there are challenges formulated as questions that drive certain decisions during the design of TMAP.

Among the identified design issues were also several *possible design directions*. These issues concern preferred technologies and ways spectators might influence particular performance aspects. Furthermore, there is a need for a critical or even provocative design to create a TMAP concept that is artistically enriching and satisfying from an interaction point of view. All of these identified issues are presented throughout the studies of the field exploration and summarised at the end of the respective chapters.

[1] https://www.youtube.com/watch?v=w6i-fsOTASs (last access 15.04.2016)

11.3 Limitations

Following the summary of the contributions, in this section, we consider limitations that apply to the work and the outcomes of this thesis in relation to the musical context and the methodology.

11.3.1 Music Genres and Performance Settings

We have discussed the challenge to define *live music* concerning music genre and performance settings as the broader research context in related work (Chapter 2). When interviewing or surveying musicians and spectators about their preferred music genres, we tried to find diverse examples for TMAP to promote generality. When systematically analysing literature to identify design characteristic for the TMAP Framework, we included examples for TMAP such as participatory installations and technology-free but conceptually relevant approaches across different music genres. With the in-situ case studies, we had to choose particular performances to design, deploy, and study. These in-situ case studies focused on particular technologies and happened at club-size live concerts with a couple of dozen spectators. Studying TMAP using other technologies at concerts with different size, audiences might yield different perspectives.

11.3.2 Methodological Limitations

We discussed methodological limitations when reflecting on the research approach (Chapter 3) in relation to the overall constructivist research philosophy and the research through design strategy. The resulting combination of using different research methods proved valuable in studying artistic processes around performances of live music. In particular, using first-person methods such as auto-ethnography to study a composition and to reflect on performance experiences brought valuable insights. However, studying the creative practice of other artists and other performances might lead to different results.

In summary, doing research in the context of technology and live music implies a more or less narrow focus on particular music genres and performance settings when conducting case studies. Furthermore, using first-person methods as research method is a chance to get valuable results other research methods could not provide but at the same time limits the objectivity and reduces the generalisability of outcomes. Following these limitations, we present possibilities for future work to continue research in the field of TMAP in live music.

11.4 Future Work

Future work arising from this research is summarised below, starting with straightforward follow up studies, then moving on to larger projects and perspectives, and finally an existing externally funded follow up project.

11.4.1 Follow Up Studies and Outcomes

The TMAP Framework is well suited to adapting to deal with new design aspects that may emerge from novel artistic and technological challenges.

In the limitations section above we identified issues connected with auto-ethnography as a research method to study the creative practice and artistic experiences. This points to the need for further research around the design of TMAP by *reflecting on different artistic practices* on a broader basis and complementing such approaches with more objective methods. Thus, future studies of TMAP at live concerts might include interviews with performing musicians or focus groups with all involved artists to reflect on their experiences.

Such future studies with different artists might directly continue our case studies. In particular, one option could be an *improved CoSCoS prototype* that considers a larger audience and an interaction design affording more intuitive control and individual feedback. These were all issues identified during the evaluation of CoSCoS.

Following the Experimence case study, possible future work could include an autonomous *visual recognition system for balloon tracking* that enables participation for several spectators at the same time. Such a tracking system could provide musicians with the coordinates of the tracked balloons for further processing of sound effects, for example.

Studying stakeholder requirements in relation to TMAP is a good way to illuminate implications for design. Further studies of requirements could include a *wider sampling of stakeholders' perspectives* in live music to take into account roles such as artist managers, event organisers, and companies such as music labels.

We identified potential for the design of TMAP when using the TMAP Design Cards in group design sessions with students. In further studies the *TMAP Design Cards could be used with experts* and for the design of participatory performances for paying customers. Such experts could be musicians, designers, engineers, or drawn from the previously suggested wider sampling of stakeholders concerned with the business of live music. Using the TMAP Design Cards in different settings might also enable a deeper methodological focus on the design processes and the outcomes when using the cards.

11.4.2 Larger Consequences for the Field of TMAP

Testing and studying TMAP in practice at live concerts requires considerable resources and bears unforeseeable risks. A possible way to ameliorate these problems might be to *develop environments and techniques to simulate TMAP*. Such simulation systems could use knowledge about crowd behaviour, for instance.

A related approach could involve *prototyping platforms to test ideas for TMAP* with minimal effort. With such prototyping platforms it might be easier to test concepts for TMAP from a technical and aesthetical perspective.

From an interaction point of view, particular forms of interaction in TMAP could be the focus of further investigations – tackled similarly to the in-situ case studies of this thesis. This means *focusing on particular forms of interaction* to study how

technology can be used in an unobtrusive, intuitive, and meaningful way to mediate audience participation.

The presented research focused primarily on spectator experience and artistic practice in relation to the design of TMAP. To discuss the aesthetic and social value of TMAP was not part of the research agenda, but it could be relevant to *reflect on TMAP from a fundamental or philosophical perspective*. This might address questions around artistic possibilities and limits of TMAP and conceptual issues that discuss at which point audience participation turns into a collaborative performance.

11.4.3 An Existing Follow Up Project

This thesis contributed to the research proposal of the project *Breaking the Wall*[2], which was accepted for funding by the Austrian Science Fund (FWF) with means of the Programme for Arts-based Research (PEEK). The actual work for Breaking the Wall began while this thesis was being written up and continues until November 2017.

The aim of the project is to study issues around playful interfaces for audience participation in relation to creative practices and artistic expression of involved artists. From this thesis point of view, the project continues the research in terms of the musical genre and performance setting. However, Breaking the Wall also addresses the limitations of this thesis as it considers and studies the creative practices of different involved artists when designing TMAP together with them and for their live music performances.

[2]http://piglab.org/breakingthewall (last access 15.04.2016)

Bibliography

A. Adams, P. Lunt, and P. Cairns. A qualititative approach to HCI research. In P. Cairns and A. Cox, editors, *Research Methods for Human Computer Interaction*, pages 138–157. Cambridge University Press, Cambridge, UK, 2008.

A. Ahmed, S. Benford, and A. Crabtree. Digging in the Crates: An Ethnographic Study of DJs' Work. In *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*, pages 1805–1814, New York, USA, 2012. ACM Press.

P. Auslander. Liveness, Mediatization, and Intermedia Performance. *Degrés: Revue de synthèse à orientation sémiologique*, 101:1–12, 2000.

S. Barab. Design-Based Research: A Methodological Toolkit for Engineering Change. In K. Sawyer, editor, *The Cambridge Handbook of the Learning Sciences*, pages 151–170. Cambridge University Press, 2014.

L. Barkhuus. Engaging the Crowd: Studies of Audience-Performer Interaction. In *CHI '08 Extended Abstracts on Human Factors in Computing Systems*, pages 2925–2930, 2008.

S. Benford, P. Tolmie, A. Y. Ahmed, A. Crabtree, and T. Rodden. Supporting Traditional Music-Making: Designing for Situated Discretion. In *Proceedings of CSCW'12*, pages 127–136, Seattle, Washington, USA, 2012. ACM Press.

S. Benford, C. Greenhalgh, A. Crabtree, M. Flintham, B. Walker, J. Marshall, B. Koleva, S. Rennick-Egglestone, G. Giannachi, M. Adams, N. Tandavanitj, and J. Row Farr. Performance-Led Research in the Wild. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 20(3):1–22, 2013.

D. Birnbaum, R. Fiebrink, J. Malloch, and M. M. Wanderley. Towards a Dimension Space for Musical Devices. In *Proceedings of the 2005 International Conference on New Interfaces for Musical Expression (NIME05)*, pages 192–195, Vancouver, BC, Canada, 2005.

N. Blaikie. *Analyzing Quantitative Data: From Description to Explanation*. Sage Publications Ltd, London, 2003.

T. Blaine and S. Fels. Collaborative Musical Experiences for Novices. *Journal of New Music Research*, 32(4):411–428, 2003. ISSN 0929-8215.

J. Borchers. A Pattern Approach to Interaction Design. *AI & SOCIETY*, 15:359–376, 2001.

C.-A. Braun and A. Gentès. Between representation and social interaction: Fluxus intermedia and dialogic form on the Internet. *Ann Arbor, MI: MPublishing, University of Michigan Library*, 4(2):1–21, 2005.

A. Breel. Audience agency in participatory performance: A methodology for examining aesthetic experience. *Participations - Journal of Audience & Reception Studies*, 12(1): 368–387, 2015.

N. Bryan and G. Wang. Two Turntables and a Mobile Phone. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 1–6, 2011.

N. Bryan-Kinns, P. G. T. Healey, and J. Leach. Exploring Mutual Engagement in Creative Collaborations. In *Proceedings of the 6th ACM SIGCHI conference on Creativity & cognition - C&C '07*, pages 223–232, New York, USA, 2007. ACM Press.

Buckethead. Live Performance Video, 2011. URL `https://www.youtube.com/watch?v=9gpABEdbcqA`.

P. L. Burk. Jammin' on the Web - a new Client/Server Architecture for Multi-User Musical Performance. In *Proceedings of the International Computer Music Conference*, 2000.

K. Burland and S. Pitts. *Coughing and Clapping: Investigating Audience Experience*. Surrey, Ashgate, 2014.

J. M. Carroll. *HCI Models, Theories, and Frameworks: Toward a Multidisciplinary Science*. Elsevier, 2003.

D. Cliff. hpDJ: An Automated DJ with Floorshow Feedback. In K. O'Hara and B. Brown, editors, *Consuming Music Together*, pages 241–264. Springer Netherlands, 2006.

Coldplay. Live 2012. Warner Music Group, 2012.

G. Corness, K. Carlson, and T. Schiphorst. Audience empathy. In *Proceedings of the 8th ACM conference on Creativity and Cognition - C&C '11*, pages 127–136, New York, New York, USA, 2011. ACM Press.

J. Covach. Form in Rock Music: A Primer. In D. Stein, editor, *Engaging Music*, pages 65–76. Oxford University Press, 2005.

J. W. Creswell. *Research Design*. SAGE Publications, 2009.

M. Cutler, G. Robair, and T. B. Blaine. The Outer Limits. *Electronic Musician*, pages 1–12, 2000.

A. Di Perna. Queen are Dead! - Long Live Queen!, 2002. URL `http://www.queenonline.com/en/the-band/interviews/brianmay/reigning-champion/`.

S. Dixon. *Digital Performance*. MIT Press, 2007.

C. Dobrian and D. Koppelman. The 'E' in NIME: Musical Expression with New Computer Interfaces. In *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME06)*, pages 277–282, Paris, France, 2006.

M. Dogantan-Dack. The art of research in live music performance. *Music Performance Research*, 5(including CMPCP/PSN Special Issue):34–48, 2012.

A. C. Durrant, J. Vines, J. Wallace, and J. Yee. Developing a Dialogical Platform for Disseminating Research through Design. *Constructivist Foundations*, 11(1):8–21, 2015. ISSN 1782348X.

A. Ebertz. *IdeenRausch - 111 Impulse für neue Ideen*. Lardon Media, 2009.

C. Ellis, T. E. Adams, and A. P. Bochner. Autoethnography: An Overview. *Forum: Qualitative Social Research*, 12(1):345–357, 2011.

T. Engum. Real-time control and creative convolution. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 519–522, Oslo, Norway, 2011.

M. Fabiani, G. Dubus, and R. Bresin. MoodifierLive: Interactive and collaborative expressive music performance on mobile devices. In *In Proceedings of the Conference on New Interfaces for Musical Expression*, pages 116–119, Oslo, Norway, 2011.

M. Feldmeier and J. Paradiso. An Interactive Music Environment for Large Groups with Giveaway Wireless Motion Sensors. *Computer Music Journal*, 31(1):50–67, 2007.

S. Fels and M. Lyons. Creating new interfaces for musical expression: Introduction to NIME. In *In SIGGRAPH'09 Courses, ACM Press*, pages 1–158, New York, New York, USA, 2009. ACM Press.

J. Freeman. Large Audience Participation, Technology, and Orchestral Performance. In *Proceedings of the International Computer Music Conference*, pages 757–760, 2005.

J. Freeman. Extreme Sight Reading, Mediating Expression and Audience Participation: Real-Time Music Notation in Live Performance. *Computer Music Journal*, 32(3):25–41, 2008.

A. Gabrielsson. Music Performance Research at the Millennium. *Psychology of Music*, 31 (3):221–272, 2003. ISSN 00000000.

C. Gates, S. Subramanian, and C. Gutwin. DJs' Perspectives on Interaction and Awareness in Nightclubs. In *Proceedings of the 6th ACM conference on Designing Interactive systems - DIS '06*, pages 70–79, New York, New York, USA, 2006. ACM Press.

J. Gates. Music Participation: Theory, Research, and Policy. *Bulletin of the Council for Research in Music Education*, 109:1–35, 1991.

W. Gaver. What Should We Expect From Research Through Design? In *Proceedings of the International Conference on Human Factors in Computing Systems CHI'12*, pages 937–946, Austin, Texas, USA, 2012.

W. Gaver, J. Bowers, A. Boucher, H. Gellerson, S. Pennington, A. Schmidt, A. Steed, N. Villars, and B. Walker. The Drift Table: Designing for Ludic Engagement. *In CHI '04 Extended Abstracts on Human Factors in Computing Systems*, 2004.

E. Goffman. *Frame Analysis*. Northeastern University Press, Boston, 1986.

P. Green and L. Wei-Haas. The Wizard of Oz: A Tool for Rapid Development of User Interfaces. Technical Report UMTRI-85-27, University of Michigan, 1985.

Green-Day. Live Performance Video, 2008. URL `https://www.youtube.com/watch?v=gz1y2LWLSjs`.

Green-Day. Live Performance Video, 2009. URL `http://www.youtube.com/watch?v=0UXvV5iS{_}eg`.

P. Heath, C., Hindmarsh, J., Luff. *Video in Qualitative Research*. Sage Publications Ltd, 2010.

N. Herber. The Composition-Instrument: Musical Emergence and Interaction. In *Proceedings of the Audio Mostly Conference - A Conference on Sound in Games*, pages 31–36, 2006.

A. Hindle. SWARMED: Captive Portals, Mobile Devices, and Audience Participation in Multi-User Music Performance. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 174–179, KAIST, Daejeon, Korea, 2013.

P. Hoegi. *A Tabular System Whereby the Art of Composing Minuets is Made So Easy that Any Person: Without the Least Knowledge of Musick, May Compose Ten Thousand, All Different, and in the Most Pleasing and Correct Manner*. Welcker, London, 1763.

E. Hornecker. Creative idea exploration within the structure of a guiding framework: the card brainstorming game. In *Proceedings of the fourth international conference on Tangible embedded and embodied interaction*, volume 10, pages 101–108, 2010.

B. V. Hout, M. Funk, L. Giacolini, J. Frens, and B. Hengeveld. Experio: a Design for Novel Audience Participation in Club Settings. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 46–49, Goldsmith University, London, UK, 2014.

H. Hutchinson, W. Mackay, B. Westerlund, B. Bederson, A. Druin, C. Plaisant, M. Beaudouin-Lafon, S. Conversy, H. Evans, H. Hansen, N. Roussel, B. Eiderbäck, S. Lindquist, and Y. Sundblad. Technology probes: inspiring design for and with families. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '03*, number 5, pages 17–24, Ft. Lauderdale, Florida, USA, 2003. ACM.

IDEO. IDEO method cards: 51 ways to inspire design, 2002.

S. Jamieson. Likert scales: how to (ab) use them. *Medical Education*, 38(12):1217–1218, 2004.

E. Jessop, P. A. Torpey, and B. Bloomberg. Music and Technology in Death and the Powers. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 349–354, Oslo, Norway, 2011.

N. Johnson, S. McKenna, and K. Morrison. G-VISION: Vision-based gesture and motion recognition software for real-time analysis within interactive installation and performance scenarios. In *Proceedings of the International Conference on Digital Live Art*, pages 1–2, 2006.

K. Jones. Dicing with Mozart. *New Scientist*, 132:26–29, 1991.

S. Jordà. Interactivity and live computer music. *The Cambridge Companion to Electronic Music*, pages 89–106, 2007.

S. Jordà. The Reactable: Tangible and Tabletop Music Performance. In *Proceedings of the 28th of the International Conference Extended Abstracts on Human Factors in Computing Systems*, pages 2989–2994, Atlanta, Georgia, USA, 2010. ACM.

G. Kaiser, G. Ekblad, and L. Broling. Audience Participation in a Dance-Club Context: Design of a System For Collaborative Creation of Visuals. In *In Proceedings of Nordes*, 2007.

M. Kaltenbrunner, G. Geiger, and S. Jordà. Dynamic Patches for Live Musical Performance. In *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME04)*, pages 19–22, Hamamatsu, Japan, 2004.

F. Kayali and M. Pichlmair. Playing Music, Playing Games - Simulation vs. Gameplay in Music-based Games. In *Proceedings of the Vienna Games Conference Future and Reality of Gaming (FROG)*, 2008.

S. Keaney. Design Council/Intangible Assets Cards. In K. Cato, editor, *First Choice*. The Images Publishing Group, Australia, 2003.

J. P. Kirnberger. *Der allezeit fertige Polonoisen- und Menuettenkomponist*. George Ludewig Winter, Berlin, Germany, 1767.

N. Klügel, M. R. Frieß, G. Groh, and F. Echtler. An Approach to Collaborative Music Composition. In *Proceedings of the Conference on New Interfaces for Musical Expression*, pages 3–6, Oslo, Norway, 2011.

R. Knapp and B. Bortz. MobileMuse: Integral Music Control Goes Mobile. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, number June, pages 203–206, Oslo, Norway, 2011.

R. B. Knapp, J. Jaimovich, and N. Coghlan. Measurement of motion and emotion during musical performance. In *Proceedings - 2009 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops, ACII 2009*, pages 1–5. IEEE, 2009.

B. Koleva, M. Adams, I. Taylor, S. Benford, M. Fraser, C. Greenhalgh, H. Schnädelbach, D. vom Lehn, C. Heath, and J. Row-Farr. Orchestrating a Mixed Reality Performance. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '01*, pages 38–45, Seattle, Washington, USA, 2001. ACM Press.

N. Kruge and G. Wang. MadPad: A Crowdsourcing System for Audiovisual Sampling. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 185–190, Oslo, Norway, 2011.

O. Lähdeoja. An Approach to Instrument Augmentation: the Electric Guitar. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 1–4, 2008.

C.-H. Lai. WanderOnStage: the Convergence of Percussion Performance and Media Technology. In *Proceedings of the 7th Audio Mostly Conference*, pages 94–97, Corfu, Greece, 2012.

E. Laszlo. Aesthetics of Live Musical Performance. *The British Journal of Aesthetics*, 7 (3):261–273, 1967. ISSN 0007-0904.

S. Lee and J. Freeman. echobo: A Mobile Music Instrument Designed for Audience To Play. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 450–455, KAIST, Daejeon, Korea, 2013.

G. Levin. Dialtones (A Telesymphony), 2001.

D. Levitin. *The Organized Mind: Thinking Straight in the Age of Information Overload.* Penguin UK, 2015.

P. Lindborg and D. Y. Liu. Locust Wrath: an iOS audience participatory auditory display. In *Proceedings of the 21st International Conference on Auditory Display (ICAD 2015)*, pages 125–132, 2015.

D. J. G. Lockton. *Design with Intent: A design pattern toolkit for environmental & social behaviour change.* Phd thesis, Brunel University, 2013.

Madsen. Live Performance Video, 2013. URL http://www.youtube.com/watch?v=W2kqPfCFu5A.

T. Magnusson. An Epistemic Dimension Space for Musical Devices. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 43–46, Sydney, Australia, 2010.

D. Maynes-Aminzade, R. Pausch, and S. Seitz. Techniques for interactive audience participation. In *Proceedings of the 4th IEEE International Conference on Multimodal Interfaces*, number 1, pages 15–20. IEEE Computer Society, 2002.

D. Mazzanti, V. Zappi, D. Caldwell, and A. Brogni. Augmented Stage for Participatory Performances. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 29–34, London, UK, 2014.

G. McAllister and M. Alcorn. Interactive performance with wireless PDAs. In *Proceedings of the International Computer Music Conference*, pages 1–4, 2004.

B. McFerrin. Demonstrates the Power of the Pentatonic Scale, 2009. URL https://www.youtube.com/watch?v=ne6tB2KiZuk.

G. McKay. *Community Music: A Handbook*. Russell House, 2005.

M. McLuhan. *Understanding Media - The Extensions of Man*. The MIT Press, Cambridge, Massachusetts, 1994.

S. McNiff. Art-Based Research. In J. Knowles, editor, *Handbook of the Arts in Qualitative Research: Perspectives, Methodologies, Examples, and Issues*, chapter 3, pages 29–41. SAGE Publications, Inc., 2455 Teller Road, Thousand Oaks California 91320 United States, 2007.

A. Morrison, P. Mitchell, and M. Brereton. The Lens of Ludic Engagement: Evaluating participation in interactive art installations. In *Proceedings of the 15th International Conference on Multimedia*, pages 509–512, Augsburg, Bavaria, Germany, 2007. ACM.

W. A. Mozart. *Anleitung so viel Walzer oder Schleifer mit zwei Würfeln zu componiren so viel man will ohne musikalisch zu seyn noch etwas von der Composition zu verstehen*. N. Simrock, Bonn, Germany, 1793.

M. J. Muller and A. Druin. Participatory design: the third space in HCI. In J. A. Jacko and A. Sears, editors, *The Human-Computer Interaction Handbook*, pages 1051–1068. Lawrence Erlbaum, Hillsdale, NJ, 2003.

Muse. Hullabaloo - Live At Le Zenith. Universal Music, 2001.

M. Neuhaus. The Broadcast Works and Audium. *Zeitgleich: The Symposium, the Seminar, the Exhibition*, pages 1–19, 1994.

R. O'Brien. Rocky Horror Picture Show. 20th Century Fox, 1975.

J. Oh and G. Wang. Audience-Participation Techniques Based on Social Mobile Computing. In *Proceedings of the International Computer Music Conference*, pages 665–672, University of Huddersfield, UK, 2011.

J. Oh, J. Herrera, N. Bryan, and L. Dahl. Evolving The Mobile Phone Orchestra. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 82–87, Sydney, Australia, 2010.

D. Overholt. The Overtone Fiddle: an Actuated Acoustic Instrument. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 30–33, Oslo, Norway, 2011.

C. Palmer. Music performance. *Annual Review of Psychology*, 48:115–138, 1997. ISSN 0066-4308.

E. W. Pedersen and K. Hornbæk. mixiTUI: A Tangible Sequencer for Electronic Live Performances. In *Proceedings of the 3rd International Conference on Tangible and Embedded Interaction - TEI '09*, pages 223–230, New York, New York, USA, 2009. ACM Press.

Pentatonix. Live Performance Video, 2012. URL `https://www.youtube.com/watch?v=mUxlXbHYAQs`.

R. Porst. *Fragebogen - Ein Arbeitsbuch*. VS Verlag für Sozialwissenschaften; Auflage: 3, 2011.

L. Potts. Can't Stop the Fandom: Writing Participation in the Firefly 'Verse. *Kairos Special Issue on Digital Rhetoric and Social Media*, 2015.

J. Preece, Y. Rogers, and H. Sharp. *Interaction Design: Beyond Human-Computer Interaction*. John Wiley & Sons, New York, 2002.

M. Pricken and C. Klell. *Kribbeln im Kopf - Creative Sessions*. Schmidt (Hermann), Mainz, 2006.

M. Puckette. Pure Data. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 224–227, 1996.

J. Rancière. *The Emancipated Spectator*. Verso, London, 2009.

Reactable. BJÖRK / DAMIAN TAYLOR, 2015. URL `http://www.reactable.com/community/artist/3145`.

L. Reboursière, C. Frisson, O. Lähdeoja, J. A. Mills, P. Cècile, and T. Todoroff. Multimodal Guitar: A Toolbox For Augmented Guitar Performances. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 415–418, Sydney, Australia, 2010.

S. Reeves. *Designing Interfaces in Public Settings*. Human-Computer Interaction Series. Springer, London, 2011.

K. Reich. Konstruktivistische Ansatze in den Sozial- und Kulturwissenschaften. In *Einführung in die Wissenschaftstheorie und Wissenschaftsforschung*, pages 356–376. 2001.

J. Rink. *Musical Performance: A Guide to Understanding*. Cambridge University Press, 2002.

D. Robson. Play!: Sound Toys for Non-Musicians. *Computer Music Journal*, 26(3):50–61, 2002.

T. Roe. Tin Men and the Telephone present Interactive Album - Appjenou?!, 2013. URL `https://www.youtube.com/watch?v=CkP-smFvX5I`.

Y. Rogers. HCI Theory: Classical, Modern, and Contemporary. *Synthesis Lectures on Human-Centered Informatics*, 5(2):1–129, 2012. ISSN 1946-7680.

M. Rohs and G. Essl. CaMus2: Collaborative Music Performance with Mobile Camera Phones. *Proceedings of the International Conference on Advances in Computer Entertainment Technology*, pages 190–195, 2007.

D. Rokeby. Adventures in Phy-gital Space. In *Keynote lecture at the 11th International Conference on New Interfaces for Musical Expression*, 2011.

E. Rosch. Principles of Categorization. In E. Rosch and B. Lloyd, editors, *Cognition and Categorization*. Lawrence Erlbaum Associates, Hillsdale, NJ, 1978.

P. H. Rossi, J. D. Wright, and A. B. Anderson. *Handbook of Survey Research*. Academic Press, New York, 1983.

E. B. N. Sanders. From User-Centered to Participatory Design Approaches. In J. Frascara, editor, *Design and the Social Sciences - Making connections*. Taylor & Francis, London and New York, 2002.

P. Schaeffer. Solfege de l'objet Sonore. 1966.

J. G. Sheridan and N. Bryan-Kinns. Designing for performative tangible interaction. *International Journal of Arts and Technology*, 1:288–308, 2008.

J. G. Sheridan, A. Dix, S. Lock, and A. Bayliss. Understanding Interaction in Ubiquitous Guerrilla Performances in Playful Arenas. In *People and Computers XVIII - Design for Life*, pages 3–17. Springer, London, 2005.

J. Spence. *Performative Experience Design*. Springer Series on Cultural Computing. Springer International Publishing, Cham, 2016.

P. Tagg. Analysing Popular Music: Theory, Method and Practice. *Popular Music*, 2: 37–67, 1982.

S. Thompson. Audience responses to a live orchestral concert. *Musicae Scientiae*, 10(2): 215–244, 2006. ISSN 1029-8649.

T. Turino. *Music as social life: the politics of participation*. University of Chicago Press, 2008.

K. Veblen. The many ways of community music. *International Journal of Community Music*, 1(1):5–21, 2007.

E. von Glasersfeld. An Introduction to Radical Constructivism. *The Invented Reality*, pages 17–40, 1984. ISSN 09738606.

R. Von Oech. *Innovative Whack Pack*. United States Games Systems, 2003.

G. Wang. Designing Smule's Ocarina. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, Pittsburgh, PA, 2009.

G. Weinberg. Interconnected Musical Networks: Toward a Theoretical Framework. *Computer Music Journal*, 29(2):23–39, 2005. ISSN 0148-9267.

N. Weitzner, J. Freeman, S. Garrett, and Y.-L. Chen. massMobile - an Audience Participation Framework. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 1–4, University of Michigan, Ann Arbor, 2012.

N. Weitzner, J. Freeman, Y.-L. Chen, and S. Garrett. massMobile: towards a flexible framework for large-scale participatory collaborations in live performances. *Organised Sound*, 18(01):30–42, 2013. ISSN 1355-7718.

K. Wilkie, S. Holland, and P. Mulholland. What Can the Language of Musicians Tell Us about Music Interaction Design? *Computer Music Journal*, 34(4):34–48, 2010. ISSN 0148-9267.

A. Wilson. 'Playing the Game': Authenticity and invitation in Ontroerend Goed's Audience. *Participations - Journal of Audience & Reception Studies*, 12(1):333–348, 2015.

J. Wozniak. The value of being together? Audiences in Punchdrunk's The Drowned Man. *Participations - Journal of Audience & Reception Studies*, 12(1):318–332, 2015.

J. Young. Using the Web for live interactive music. In *Proceedings of the International Computer Music Conference*, pages 302–305, 2001.

V. Zappi, D. Mazzanti, A. Brogni, and D. Caldwell. Design and Evaluation of a Hybrid Reality Performance. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, pages 355–360, Oslo, Norway, 2011.

Glossary

CoSCoS Collaborative Stereo Control with Smartphones.

DJ Disc Jockey.

Experimence Experim(ent) + (Experi)ence.

FOH Front of house.

HCI Human Computer Interaction.

IP Internet Protocol.

IRQ Interquartile Range (statistical value).

M Mean, arithmetic mean (statistical value).

Md Median (statistical value).

MIDI Musical Instrument Digital Interface.

Mo Mode (statistical value).

NIME New Interfaces for Musical Expression.

OSC Open Sound Control.

PA Public address.

Pd Pure Data.

SD Standard deviation (statistical value).

TMAP Technology-mediated audience participation.

UDP User Datagram Protocol.

Appendix A

Interview Study

This Appendix contains additional information related to the interview study described in Chapter 4.

1. Interview guideline including the full catalogue of all questions.
2. Information and consent form as handed out to the interviewees.

Interview Guideline

Introduction for interviewees

This pilot study is conducted to find out more about live-music and the use of technology. The purpose is an insight in the current situation.

How to read this guideline?

There are two target groups listet in columns. The rows show the questions for both target groups or either of them. If there is a "NONE" that means that this question is not used for this group.

	Musician	Audience
Personal information		
1	Age	
2	Gender	
1. General overview		
1	How would you define your profession/occupation?	What is your profession/occupation?
2	How would you describe your style/music?	Which music do you like?
3	How long have you been in that "business"?	NONE
4	What do you think about music played live?	
5	Why do you play live concert?	Why do you go to a concert?
6	What do you like at playing/attending live concerts?	
7	What do you dislike at concerts?	
8	How many concert do you play/attend in a year?	
9	How does a typical concert/dj-set look like? (e.g. preparation/setup, show, After-show)	How do you choose to which concert you will go? (e.g. price, size, artist, style, show-factor) What outweighs?
10	Do you have a specified predefined setlist?	NONE
11	How do you choose your songs/create setlist?	How do you decide if you go to a concert of a specific band?
12	NONE	Do you listen to music of bands you would never go to concert? Why?
2. Definition		
1	How would you define a great concert? (e.g. aspects, criteria)	
2	How would you define an awful concert? (e.g. aspects, criteria)	
3	What is "audience feedback" for you?	
4	How would you define an instrument?	
5	What do you think about a Laptop on stage that is used as an instrument?	

3. Specific details		
1	Can you tell me something about your last concert/gig? (e.g. venue, audience (size), feeling, length, expected/unexpected occurrences)	
2	Was that a typical concert you play/attend?	
3	Describe how you play on stage? (e.g. instruments, dj-mixer, computer, devices)	Describe on what you focus during the show? (e.g. music, visuals, technical gear, venue)
4	How is your audience structured? (e.g. fans vs. anonymous)	NONE
5	How did you interact/communicate with your audience? (e.g. observing, non-verbal, talking)	How did you communicate with the artist? (e.g. applause, scream, moving, throw things on stage)
6	How did you interact/communicate with the other artists on stage?	How did you communicate with the other listeners? (e.g. ignoring, talking, moving together)
7	How did you coordinate your playing with other artists on stage? (e.g.	How and to what extent did you synchronise your concert experience

4. Specific examples: Think of your last concert.		
1	What did you think straight after your last show?	
2	What was the highlight? What worked well?	
3	What did not went so well? (e.g. technical issues, emotional level, playing out of time)	… (e.g. boring setlist)
4	What did an individual spectator said right after the show?	What did you say right after a concert to someone near you? Who was this?
5	Did you use your mobile phone during the concert?	
6	NONE	How often? (e.g. X times, 10 minutes)
7	For what reason? (e.g. part of the show)	For what reason? (e.g. taking a picture, movie, writing text-messages, call sb.)

5. Personal attitude		
1	What is the "role" of the audience in a live concert?	
2	What would you like to change in a live concert?	
3	Did you heard about social or collaborative music? (e.g. Telemusic) What do	
4	What do you think about an integration of the audience in the show?	
5	Could you imagine getting other feedback than mentioned before?	…to give other feedback…?
6	Could you imagine that your audience/that you as spectator take part in your show (inter)actively? (e.g. using sensors, mobile phones, direct manipulation)	
7	Which changes took place in live-music during the last decade?	
8	How do you think a live-concert in 10 years will look like?	
9	Whould you like this idea?	

Information & Consent Form

Introduction

This guided interview is about your personal experience and opinion on live musical performances. Our goal is to find out which technical improvements can be done in this area. As an employee of the Vienna University of Technology I appreciate your honesty and frankness.

Information about the consent form

Consent forms are standard within the context of interviews for research purposes. Please note:

- There is nothing you can do wrong, your opinion counts.
- You can act and talk totally freely.
- The interview is audio-recorded. All data is treated confidentially and is not forwarded to any third party.
- You can stop or interrupt the interview at any time.
- You can abort the interview at any time.
- You can contact us at any time after the interview for further information by telephone, e-mail or post.

This interview is carried out by the following person:

Oliver Hödl, MSc
Vienna University of Technology
Institut für Gestaltungs- und Wirkungsforschung
Human Computer Interaction Group

Favoritenstraße 9-11
1040 Wien
Austria

Phone: 0043-1-58801-18757
E-mail: oliver@igw.tuwien.ac.at

Consent Form

Name (in capital letters): _____

I have read and understood everything and fully agree with the interview.

☐ Yes ☐ No

I agree that the interview is audio-recorded.

☐ Yes ☐ No

I agree that anonymised quotes maybe used in scientific publications.

☐ Yes ☐ No

I understand that I do not receive any payment for participating in this interview.

☐ Yes ☐ No

_____ _____

Place, Date Signature of the interviewer

_____

Signature of the interviewee

Appendix B

Online Survey

This Appendix contains additional information related to the online survey described in Chapter 5.

1. Survey guideline including the full catalogue of all questions.
2. Bar charts showing the frequencies of statement ratings. All frequencies are presented in percentages and separately for spectators (158 in total) and musicians (58 in total).

Survey Introduction

Title
Interactivity in Musical Live Performances

Welcome note
This survey is for my PhD thesis at the Vienna University of Technology, Institute for Design and Assessment of Technology. Your input will be important for my further studies which will be based on the outcome of this survey.

About the survey
The purpose of this anonymous survey is to find out more about your personal experience and opinion as an audience member or artist in musical live concerts. It will only take 5-10 minutes to fill it out. It is your opinion that will help me to develop new innovative technologies to enhance the live concert experience. Within this study a musical live concert is defined as a performance of a single artist or group of artists (e.g. band) that play music in front of an audience.

Thank you for your precious time! I really appreciate your honesty and frankness.

Something you should know before filling out the questionnaire
Within this study a musical live concert is defined as a performance of a single artist or group of artists (e.g. band) that play music in front of an audience.

Your consent
By proceeding you agree, that you

- take part in a study of the Vienna University of Technology.
- have read and understood the study description above.
- know that this survey is anonymous.
- are older than 16.
- know that there are no wrong answers and only your opinion counts.
- understand that all data is treated confidentially and is not forwarded to any third party.
- know that anonymised quotes maybe used in scientific publications.
- can stop and withdraw at any time without being disadvantaged in any way.
- can contact me at any time after the survey for further information.

Contact and responsible for this study
Oliver Hödl
Vienna University of Technology
Institut für Gestaltungs- und Wirkungsforschung
Human Computer Interaction Group
Argentinierstraße 8/187
1040 Wien
Austria
E-Mail: oliver@igw.tuwien.ac.at
Web: http://igw.tuwien.ac.at/hci

Survey Questions

Demographics

Introduction: Here are a few short questions for statistical purposes.
(*Note: Italic written text is a draft comment only and will be cleared out in the final questionnaire.)*

Q1: Are you male or female?

(Single choice)

A: Male / Female / No answer

Q2: What age group are you in?

(Single choice)

A: 16-19 / 20-24 / 25-29 / 30-39 / 40-49 / 50-59 / 60+

Q3: What is the highest level of educational qualifications you have reached? (Either in your current study or in qualifications already achieved)

(Single choice)

A: Compulsory school / Apprenticeship / Higher School Certificate / College/University

Q4: Do you play an instrument or have a vocal training?

(Single choice)

A: Yes / No / No answer

Target group selection

The survey aims two groups: (1) musicians who perform live music on stage and (2) people in the audience who attend live concerts. The following question is only shown if the answer of the previous question is "Yes" or "I don't know".

Q: The following questions depend on your point of view whether you perform music on stage or you attend live concerts as a member of audience. In which role do you want to proceed?

(Single choice)

A: performing live music, being an artist/musician, playing live concerts on stage / visiting concerts, being part of the audience

Target group specific questions

The following questions aim the same topic but from the perspective of (1) the audience and (2) the artist (which stands for musicians, bands, musical performers). Therefore, it depends on the selection the participant made above which questions are shown from now on.

General questions

Q *(audience and artist if "Do you play an instrument or do you sing" was answered with "yes"):* Please rate your skills playing an instrument in the given categories?

(Multiple choice: Yes / No)

A1: Singing (e.g. Solo, Choir)
A2: Piano/Keyboard/Organ
A3: Guitar/E-Guitar/E-Bass
A4: Strings (e.g. Violin, Double Bass)
A5: Brass or Woodwind (e.g. Trumpet, Flute)
A6: Drums/Percussion

A7: DJ/Loops/Electronics
A8: Other, please describe: _____

Q: How would you describe the style of music you like *(for audience)* / play *(for artist)*?

(Multiple choice: Yes / No)

A1: Classical
A2: Folk
A3: Pop
A4: Rock
A5: Jazz
A6: Hip Hop
A7: Electronic
A8: Spiritual

Q: How often do you attend *(for audience)* / play *(for artist)* a live concert approximately?

(Single choice)

A: more than once a week / weekly / monthly / every 2-3 months / once a year or less

Questions about your behavior and mood during a concert

Q *(audience)*: Please rate the following statements about yourself attending a live concert?

(Scale: Strongly agree / tend to agree / neutral / tend to disagree / strongly disagree)

A1: I like to be part of an audience
A2: I like to express and show my appreciation and excitement at a concert actively
A3: I like to meet other people at concerts
A4: I want the artist to know my appreciation and excitement
A5: I want to hear the songs as I know them from records
A6: I want to experience a unique and special concert
A7: I want to have fun and make party
A8: I like the live music experience instead of just listening to the music
A9: I like to be involved in the show
A10: I want to hear new songs which are not (yet) available on records
A11: I like to focus on the music without being distracted
A12: I like to see a show instead of just listening and watching them playing

Q *(artist)*: Please rate the following statements about yourself playing a live concert?

A1: I like to be on stage
A2: I like to express myself in front of an audience
A3: I like to play my music in public
A4: I want to make people happy
A5: I like to improvise on stage or vary the way I play songs
A6: I want to give the audience a unique and special concert experience
A7: I want to have fun and make party
A8: I like the inspiration of playing a live concert
A9: I like to involve the audience in the show
A10: I like to play new songs at live concerts before they are recorded
A11: I like to focus on playing without being distracted
A12: I like to make a show instead of just playing

Q *(audience and artist)*: Any other reason? Please describe! (Optional)

(Free text)

Q *(audience)*: Imagine they are playing your favorite ballad that touches you deeply. What are you doing?

(Scale: Strongly agree / tend to agree / neutral / tend to disagree / strongly disagree)

A1: Clapping hands
A2: Waving hands in the air
A3: Singing along
A4: Shouting/whistling
A5: Moving
A6: Dancing
A7: Jumping in the air
A8: Moshing around in the mosh pit (where people push and/or slam into each other)
A9: Tap on the floor according to the beat with the foot
A10: Standing still, listening to the music carefully
A11: Closing my eyes and enjoying it
A12: I grab a lighter and wave it in the air
A13: I take my camera for some reason
A14: I take my phone for some reason

Q *(artist)*: Imagine you are playing your favorite ballad that touches you deeply. What are you doing?

(Scale: Strongly agree / tend to agree / neutral / tend to disagree / strongly disagree)

A1: Watching the reaction of the audience while playing
A2: Smiling at certain members of the audience
A3: Ignoring the audience at all
A4: Close my eyes at certain parts of the song
A5: Standing still, enjoy playing this song
A6: Tap on the floor according to the beat with the foot
A7: Moving around
A8: Jumping around
A9: Stop playing/singing and listen to the audience singing along
A10: Jump off the stage towards the audience
A11: Move the microphone towards the audience to amplify their singing
A12: Get a random audience member on stage to let him/her play/sing/dance
A13: Clap in the air to motivate the audience to clap
A14: I make announcements before or/and after the song

Q *(audience)*: Imagine they are playing their fanciest number which really rocks. What are you doing?

Same answers as in the question right above

Q *(artist)*: Imagine you are playing your fanciest number which really rocks. What are you doing?

Same answers as in the question right above

Q *(audience and artist)*: Please mention if you are doing something else during a song which is not listed above:

(Free text)

Mobile phone related questions *(only for audience members)*

Q *(audience)*: Do you have a mobile phone?

(Single choice)

A: smartphone / mobile phone / no phone

Q *(audience)*: Have you ever used your phone during a concert to…?

(Scale: Every time / Often / Sometimes / Never)

A1: (video-)record a clip of a song

A2: make pictures

A3: call a friend who can't be part of the show at that important moment

A4: write a message that is related to a certain song

A5: post a message on a social media platform to share my experience with my friends

A6: shorten the time

Q *(audience)*: How often do you use your phone during a concert?

(Single choice)

A: More than 10 times / 4-9 times / 1-3 times / Never / No answer

Your personal opinion

Q *(audience and artist)*: Let's play fantasy! Imagine you *(for audience)* / the audience *(for artist)* have control of certain parts of a concert, what would you like *(for artist:* them*)* to do with…

(Scale: Strongly agree / tend to agree / neutral / tend to disagree / strongly disagree)

…the visuals? I would like to influence.../ The audience could influence...

A1: the color of the lights/spots

A2: the speed of moving lights/spots

A3: the intensity

A4: projections

A5: the ambience

…the sound?

A6: the general volume

A7: the volume of certain instruments

A8: the mix

A9: add new sounds

A10: rhythm and tempo

…the music?

A11: the order of the songs

A12: the choice of songs the band plays

A13: the duration of a song (e.g. repeat my favorite parts, solos, chorus)

A14: hear a unique version of a song which makes this particular concert special

…something else? Please describe!

(Free text)

Let's talk about your opinion about future innovations

Q *(audience and artist)*: It would make a live concert more exciting if…

(Scale: Strongly agree / tend to agree / neutral / tend to disagree / strongly disagree)

A1: the audience is really involved in a concert

A2: the audience could make a certain creative contribution during a concert

A3: the artist knows what the audience wants

A4: the artist meets the expectations of the audience

A5: the artist is not the only one who performs but involves the whole audience in a suitable way

Q *(audience):* I like the idea and would try out at a live concert if I can interact with the artist through…

Q *(artist):* I like the idea and would try out at a live concert if the audience can interact with me through…

(Scale: Strongly agree / tend to agree / neutral / tend to disagree / strongly)

… a smartphone app for…

A6: voting during the concert

A7: direct feedback after the show

A8: controlling the light/visuals actively

A9: controlling the sound actively

… audience participation…

A10: providing the artist with sensor data of my smartphone

A11: cameras for visual recognition of audience movement

A12: floor sensors for recognition of audience movement

A13: phonometers for noise level

A14: heart rate

A15: breathing rate

…something else (Please describe)

(Free text)

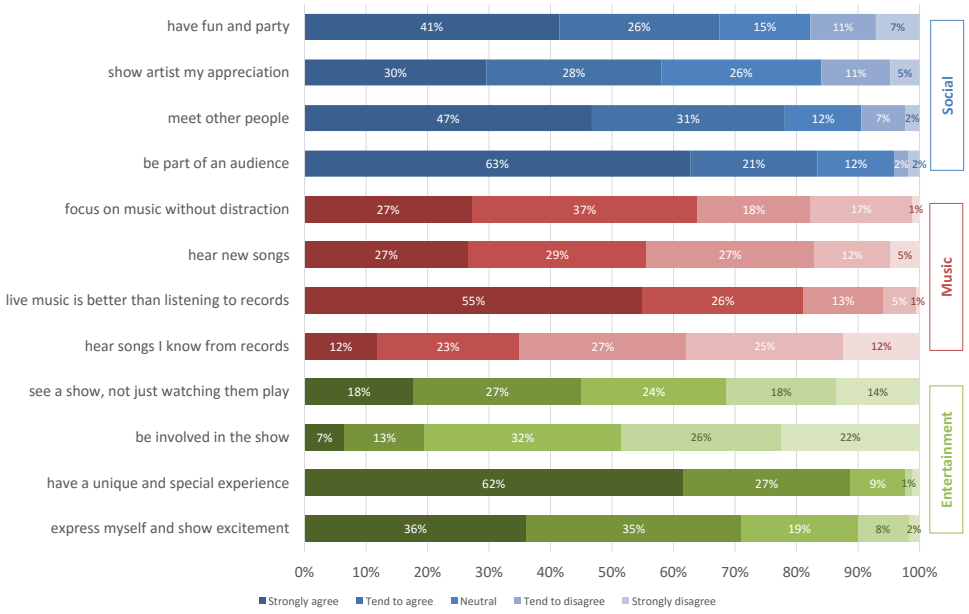


Figure 1: Motivation of spectators to go to live concerts

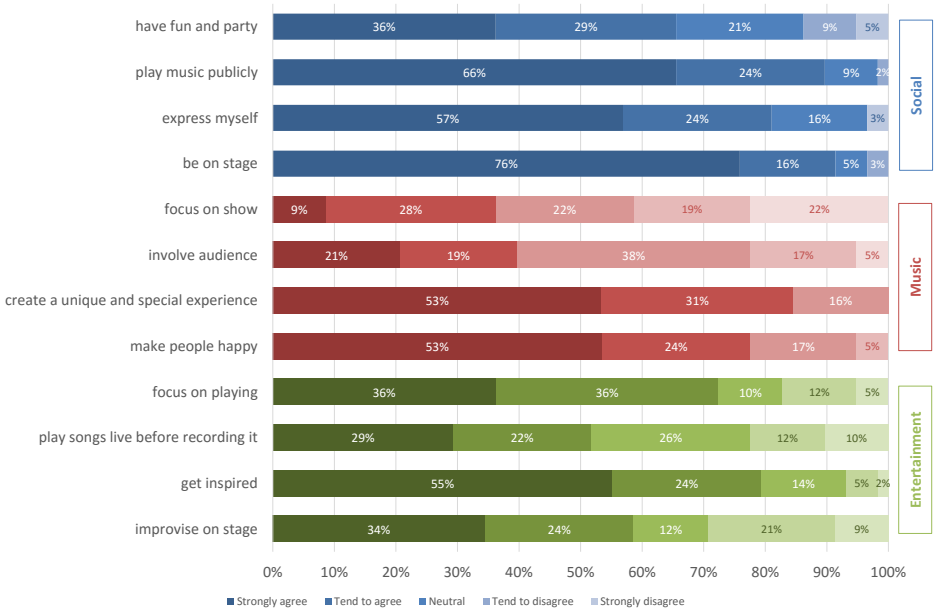


Figure 2: Motivation of musicians to play live concerts

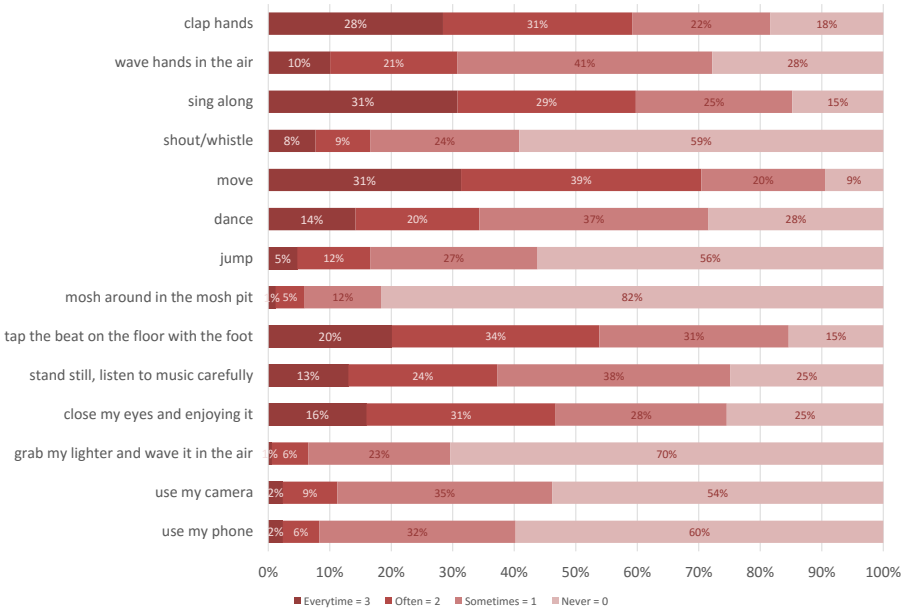


Figure 3: Behaviour of spectators during a ballad

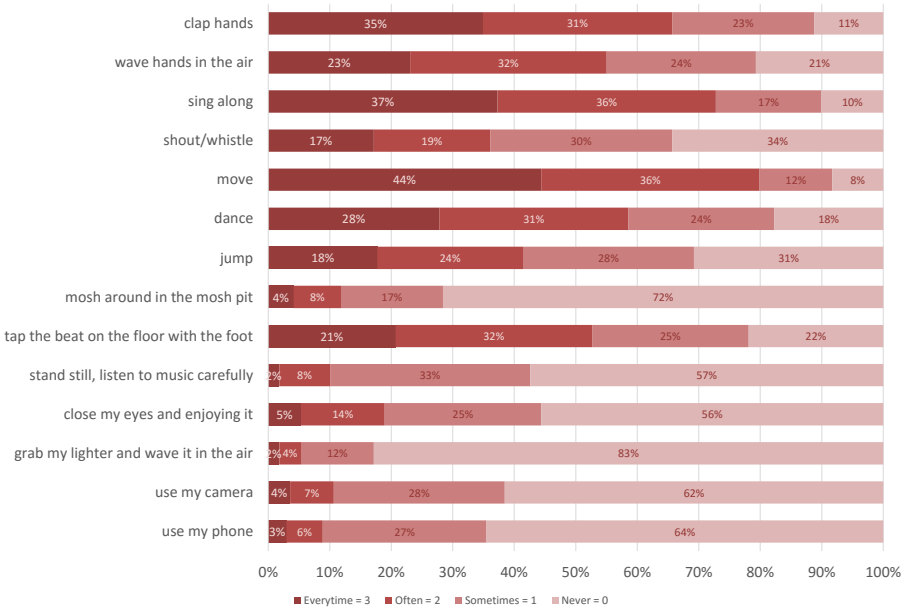


Figure 4: Behaviour of spectators during a rock song

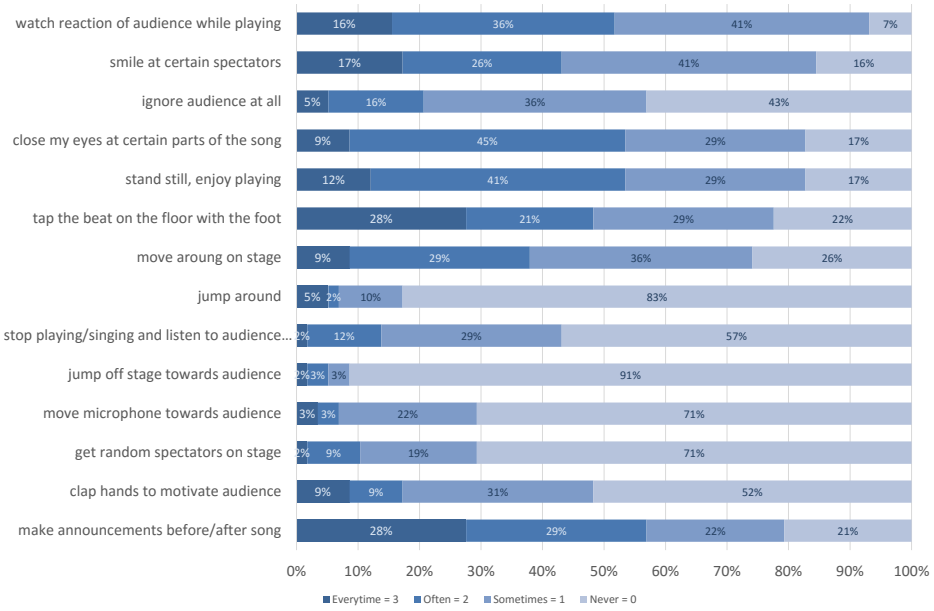


Figure 5: Behaviour of musicians during a ballad

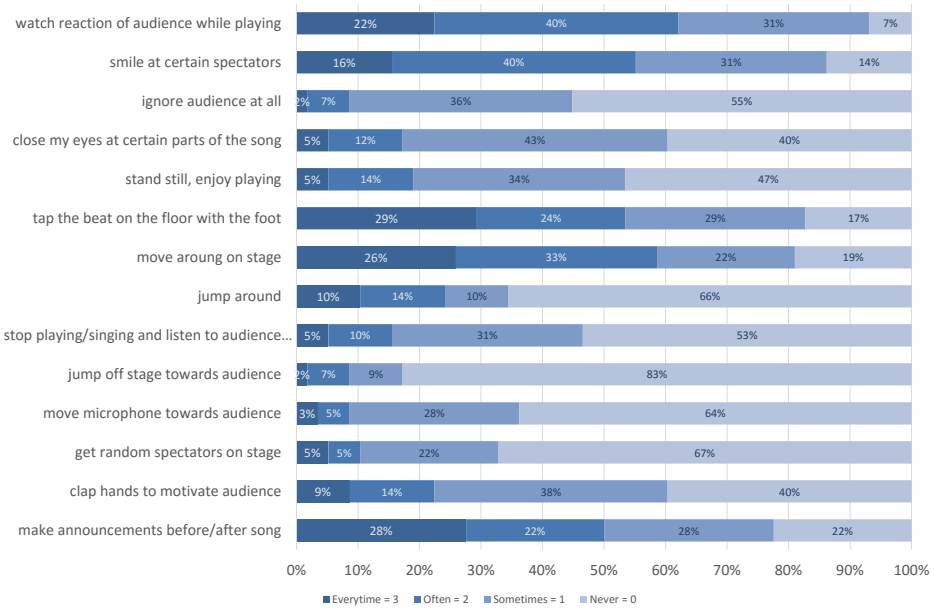


Figure 6: Behaviour of musicians during a rock song

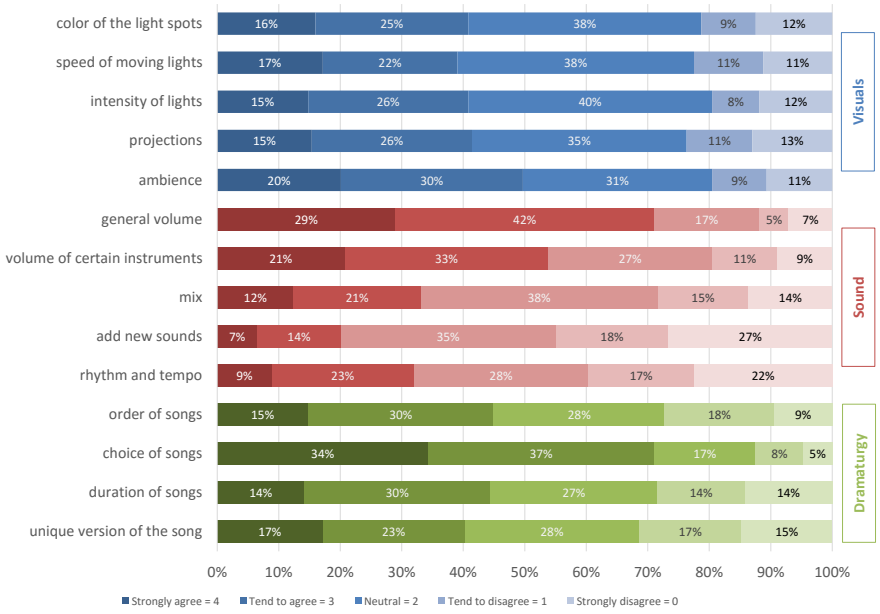


Figure 7: Opinion of spectators about possible impact of TMAP

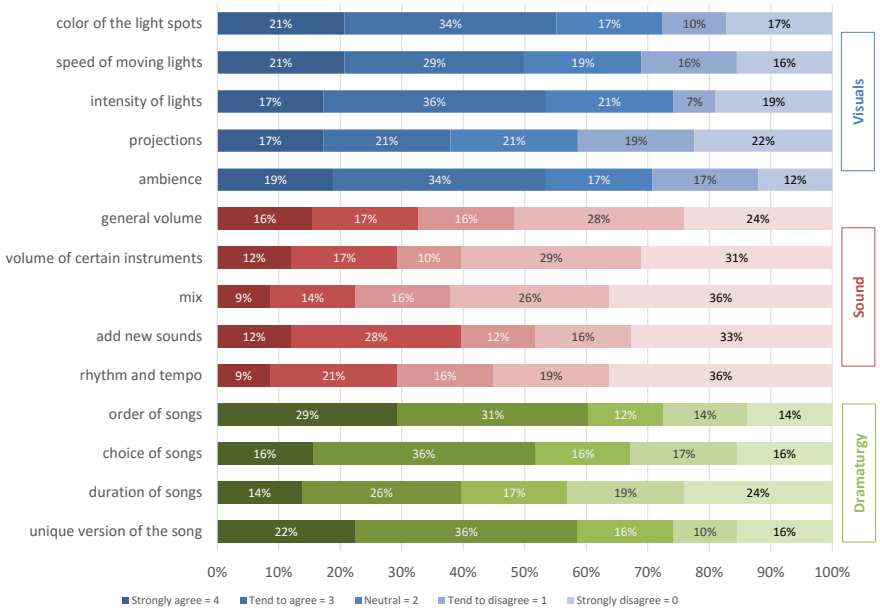


Figure 8: Opinion of musicians about possible impact of TMAP

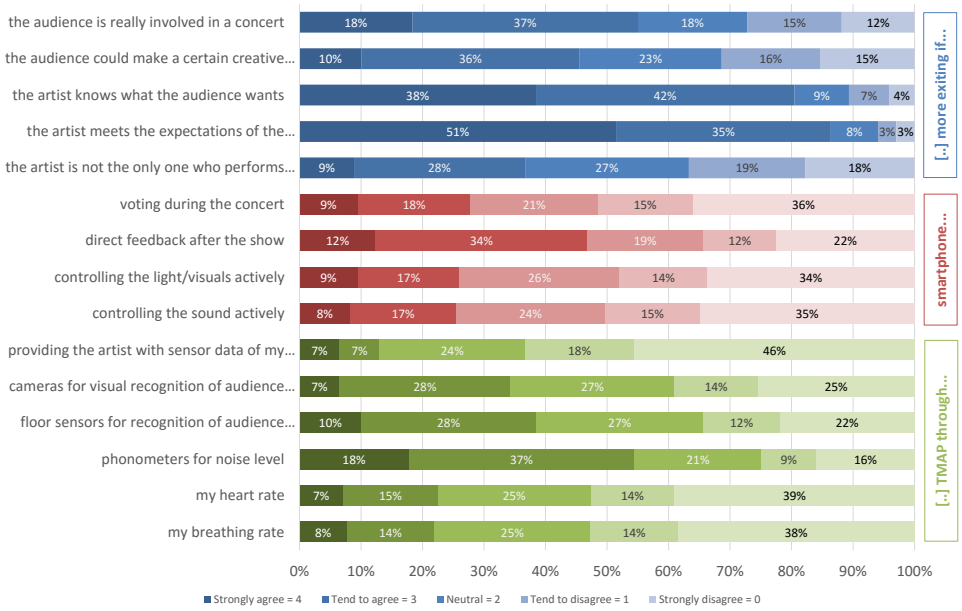


Figure 9: Opinion of spectators about how TMAP could actually work

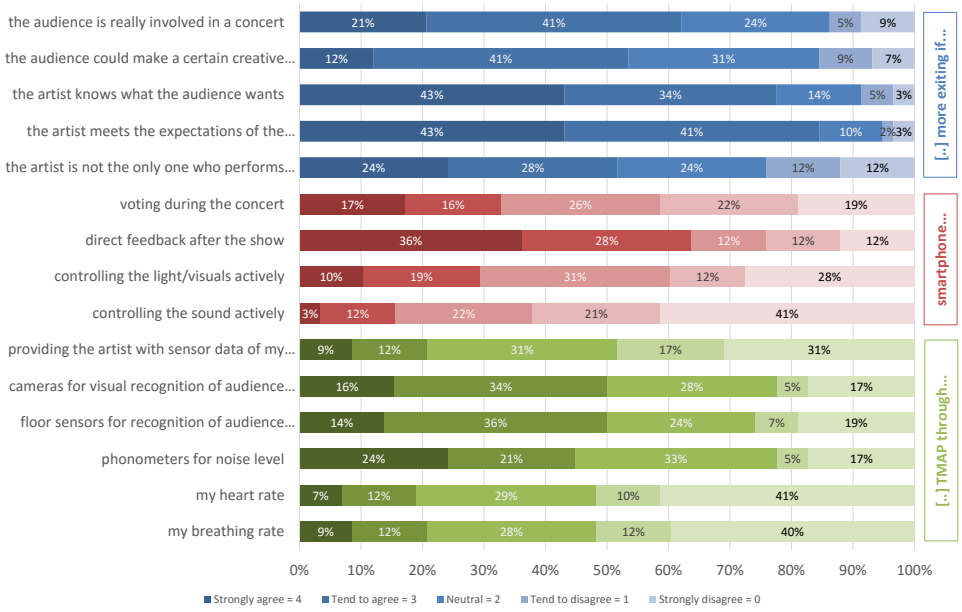


Figure 10: Opinion of 58 musicians about how TMAP could actually work

Appendix C

CoSCoS Case Study

This Appendix contains additional information related to the CoSCoS Case Study described in Chapter 6.

1. Original comments of the after concert interviews as categorised during analysis.
2. Questionnaire used for the after concert interviews.

Categorised comments of participating spectators

- Opinion about CoSCoS:
  - Positive: “Innovative, a bit nerdy but a welcome change.”, “It was fun to be part of an experiment.”, “People were involved and therefore much more active.”, “Traditional audience participation is terrible (e.g. magicians show), in a concert it is cool.”, “I felt honoured to be part of the show”, “Funny!”, “Interesting and innovative approach”, “Awesome, never experienced something comparable at a concert.”
  - Neutral: “The performance with audience participation was a ’special situation’, can’t compare which was better.”
  - Negative: “That band was more relaxed and authentic during the version without interaction.”, “Too much distraction for little musical benefit.”, “I prefer the version without [audience participation]. I could concentrate on the music more.”, “Without interaction it was better but cannot say why.”, “Band loses control, not expedient.”, “Audience is too stupid.”
- Experience with CoSCoS:
  - Positive: “I liked a certain feeling of power when I had exclusive control.”, “Individual control was top / worked well.” (3x)
  - Ambivalent: “With some people it worked, with some not.”, “When all participants interacted together it was like only one person did it not the group.”, “People’s movement was too different”, “It was easy to see my influence when I had exclusive control but I could not really figure it out collaboratively.”

  - Neutral: “I focused on the white dot most of the time.”, “I have tried various different ways to control it.”
  - Negative: “The control was not ideal.”, “I could only move white dot but did not hear music.” (2x), “Did not work.” (3x), “I could hardly move the white dot.”, “The collaboration was chaotic. I missed a coordinator.”, “The movement of all participants together was too average, no extremes.”

- Music-related:

  - Neutral: “I want to influence other effects that change the sound.”, “I would like to distort the guitar signal with my smartphone.”
  - Negative: “Music suffered.”, “too little change in the sound.” (5x)

Categorised comments of non-participating spectators

- Opinion about CoSCoS:

  - Positive: “Good, audience feels involved and appreciated.”, “Innovative.”, “Very funny.” (2x)
  - Negative: “Would be better if there is more group dynamic.”, “More people should participate, at least two thirds of the audience.”, “The flow of the concert was interrupted.”

- Experience with CoSCoS:

  - Positive: “Atmosphere was good.”, “Second version because the band rocked more.”, “Funny to control the sound.”
  - Neutral: “Something new, something different.”, “Both versions of the song were good.” (4x)
  - Ambivalent: “Innovative but improvable.”, “Both, interaction and without is good. Works only live not on CD.”
  - Negative: “Did not work to well.” (2x), “I did not hear much difference.” (6x) , “No one asked me to participate.”, “I liked the version without participation more.”, “Guitar and effect was too silent.”

- Smartphone-related:

  - Ambivalent: “Extremely cool. I am so sorry for not having a smartphone.”
  - Negative: “My iPhone did not work a colleague said during setup.”, “Setup was too complicated.”, “Did not find app in marketplace.”, “Could not install app.”

Interviewer:

Did you participate in the performance with your mobile phone? ↓ Yes	↓ No
Which smart phone do you have?	**Do you have a smart phone? If yes, which one?**
Did it work properly?	***Smartphone yes:*** **Why didn't you take part in the audience participation?** ***Smartphone no:*** **Would you participate if you had one?**
Did you like the moments where just you could control the sound?	**Did you like the moments where just one person could control the sound?**
Did you like the control of the sound by all participants?	
What is your opinion about this audience participation?	
Which version of the song that was played twice for the experiment do you prefer? The one with audience participation or the one without?	

Thank you for this interview!

Appendix D

Experimence Case Study

This Appendix contains additional information related to the Experimence Case Study described in Chapter 7.

1. Original comments of the after concert interviews as categorised during analysis.
2. Questionnaire used for the after concert interviews.
3. Poster to promote the event Wiener Musik-Experimente where the Experimence case study happend.

Categorised comments comments of open questions

- What did you like? (question 5)
  - Concept: "The [interactive] balloon game" (2x), "Balloon" (4x), "The idea [and the overall concept]" (2x), "Interaction is always good."
  - Awareness: "To pay attention to the impact.", "Observe other participants.", "To see people having fun." (2x)
  - Music: "Down-to-earth music, not abstract.", "Music and atmosphere.", "Interaction and music fit together."
  - Audience: "Audience was active, the participation.", "Movement in the audience.", "Audience involvement."
  - Experience: "Funny, interesting experience.", "The togetherness and the interaction.", "When the balloon hit the projector, that was funny."
- What did you dislike? (question 6)
  - Concept: "Ballon" (3x), "Too few touches of the balloon.", "Impact of balloon on sound / Change in music was to weak." (5x), "Too little space for an expressive ball game."
  - Experience: "Could not see musicians.", "People talking"

- Which intentions did you have during the balloon interaction? (question 7)
  - Interaction: “Bounce the balloon in a particular direction.”, “I want to touch the balloon.” (4x), “Bounce the balloon as hard as I can.”, “As many balloon contacts as possible.” (2x), “Follow the balloon.”, “Try not to hit [technical devices / something] with the balloon.” (2x), “Balloon=childish.”
  - Music: “Try to understand how the balloon chances the music.”, “Experience the music.”, “I tried to concentrate on the musicians.”
  - Experience: “Participate and see what happens.” (2x), “No [intention], it was just fun.” (2x), “Good to be part of it.”, “Mesmerised by the balloon.” (2x), “I did not want that the balloon approaches me.”, “I was in the middle and did not want that the balloon approaches me.”
- Do you think TMAP should happen more often at live concerts? If yes, in which way? (question 8)
  - Yes (in general): “The mass [audience] should interact together.”, “Down-to-earth changes in music.”, “Everything.” (2x), “Not disturbing and distracting, music has priority, here it was good.”, “In a way where the own contribution is recognisable.” (2x)
  - Yes (particular suggestions): “Using the senses.”, “Let them hand around objects.”, “Sing and clap along.”, “Similar to the balloon, as it was done here.” (4x), “Play and sing along, have fun.”, “Show ’level’ if interest.”, “At festivals with something similar as the balloon or only body movement.”, “People should have the possibility to show what they like or dislike.”
  - Maybe: “Depends on music, with background music maybe.”, “Depends on music, here it worked well.”, “Depends on music, whether the audience is moving around or rather listens carefully.”
- Would you like to be involved more often at live concerts? (question 9)
  - Yes: “If I understand it.” (2x), “Acoustically and visually.” (4x), “Only if appropriate, not at an opera and only at selected concerts.”
  - Maybe: “Only if the whole audience is involved, focus on one person is not good.”, “Difficult to answer.”
  - No: “Only sing along and jumping.”

Interviewer:

	Fragen	Schwach/Schlecht			Stark/Gut	
		1	2	3	4	5
1	**Haben Sie aktiv beim Ballspiel mitgewirkt?**	JA			Nein	
	Wie oft haben sie ungefähr den Ball berührt?	Ballberührungen:				
	Kommentar (z.b. warum haben Sie nicht mitgewirkt):					
2	**Wie gut war der musikalische Einfluss des interaktiven Ballspiels für Sie akustisch bemerkbar?**					
	Kommentar (z.b. welcher Einfluss war erkennbar):					
3	**Wurden Sie durch das interaktive Ballspiel von der Musik des Künstlers abgelenkt?**					
	Kommentar:					
4	**Könnte das interaktive Ballspiel bei Musikevents eine große Rolle spielen?**					
	Kommentar:					
5	**Was hat Ihnen besonders gut gefallen?** *Antwort:*					
6	**Was hat Ihnen nicht so gut gefallen?** *Antwort:*					
7	**(Die Person hat aktiv am Ballspiel teilgenommen)** **Was waren Ihre Gedanken, Intentionen, Ihre Strategien bzw. Ziele während des interaktiven Ballspiels?** *Antwort:*					
8	**Denken sie, dass Publikumsinteraktionen öfters bei Musikevents stattfinden sollten? Wenn ja, in welcher Art und Weise?** *Antwort:*					
9	**Würden Sie gerne öfters interaktiv als Zuschauer bei Konzerten und Musikevents mitwirken bzw. welchen Einfluss hätten Sie gerne bei interaktiver musikalischer Publikumsbeteiligung?** *Antwort:*					

DANKE FÜR DAS INTERVIEW!

Wiener Musik Experimente

Donnerstag, 6. Februar 2014

TU Wien, Institutsgebäude Argentinierstr. 8, 1040 Wien (Erdgeschoß, Ecke Argentinierstraße /Paniglgasse). Beginn: 19.30 Uhr. Eintritt frei.

LIVEBANDS

Sain Mus
Cello, Akustikgitarre

BOB
Gesang, Gitarre, Keyboard, Electronics

Sapiavo
Daniela Schwarz & Peter Natterer
Gesang, Saxofon, Electronics

Oliver Linus
Gesang, Klavier, Trombosonic, Electronics

INTERAKTIVE VISUALISIERUNG

Raffael Kéménczy & Jakob Bleier
Fractal Visualizer

INTERAKTIVE KLANGINSTALLATION

Stefan Voglsinger
Circuit Cooking Orchestra
Klangskulpturen

www.musikexperimente.at

WIEN KULTUR

TU WIEN FAKULTÄT FÜR INFORMATIK Faculty of Informatics

Human Computer Interaction Group

Music Computing Lab

Appendix E

This Appendix contains additional information related to the Framework Development described in Chapter 8.

E.1 Instructions Data Collection

The next two pages show the instructions of the exercise “Interaction between Performer and Audience in Live Music” conducted with a class of interaction design students described in chapter 8.

Exercise Instructions
"Interaction between Performer and Audience in Live Music"

Formal Instructions

- Write your submission in English.
- Use the dedicated shared online spreadsheet for submissions: <URL>
- Hint: Prepare everything offline and copy & paste to the form for not losing data in case of any submission error.

Content-Related Instructions

- Overall the quality counts, not the quantity! We rate what you have written and not how much.
- There is no right or wrong answer, the content and your effort counts!
- The exercise can be done alone or in a group of three people maximum. If you decide to do it within a group, use the advantages of inspiring discussion and shared knowledge. However, if you choose to do the exercise in a group, everyone has to do a separate submission which must be clearly independent from the others. Of course exceptions are e.g. commonly created sketches or common references.

Additional Note

This exercise is done as part of a scientific project. Hence, it is not only about getting points to pass the course. Please be aware that this is - your - contribution to research and take it serious. If you are interested in getting further information about the underlying project and results later please mention that in your submission and leave your e-mail address.

continue on next page

TASKS

1. SEARCH FOR EXAMPLES DEALING WITH INTERACTION BETWEEN PERFORMER AND AUDIENCE IN LIVE MUSIC

- Use different resources such as Google Scholar (http://scholar.google.com), YouTube, scientific literature databases (e.g. http://portal.acm.org, http://ieeexplore.ieee.org), books...
- Hint: You have a lot more access to scientific literature using a TU IP-address or TU-VPN.
- Use different keywords and combinations.
- Keep in mind that interaction between performer and audience can happen in various different ways (e.g. using technology, non-technical, music-related, non-music...)
- Examples may be scientific or non-scientific. The quality of the example and the references count that are available to support it.

2. CHOOSE AN EXAMPLE WHICH YOU WANT TO ANALYSE IN DETAIL

- Take the one you like most or which is very outstanding.
- Do not necessarily take the first result.
- Same examples may not be chosen by more than three people (whether as group or not).
- Enter your choice as soon as possible in the shared online spreadsheet to "save" it for yourself: <URL>
- Hint: The earlier you choose the more choices you will have.

3. ANALYSE YOUR CHOSEN EXAMPLE

- Describe and summarize the chosen example with a few words using the following ten questions. If there is not enough evidence or material to answer particular questions, mention it and make your own assessment.

    1. Who is participating from the audience's perspective?
    2. Which technology is used?
    3. How does the interaction happen?
    4. Which feedback is provided for the audience?
    5. What is the motivation for the audience to participate?
    6. Who is participating on the side of the performer?
    7. How does the performer perceive the participation?
    8. What is the motivation of the performer to let the audience participate?
    9. What is the result of the participation?
    10. What are possible problems, issues and constraints?

- Provide links to scientific resources and sources which reflect on the actual audience participation (e.g. interviews, press articles...). At least one scientific if available.
- Use the shared online spreadsheet to submit your written analysis.

E.2 Collected Examples during Data Collection

- TMAP (33)

  Ad Infinitum • An Interactive Music Environment for Large Groups with Giveaway Wireless Motion Sensors • Applause Meter Jacket • Augmented Opera Performance • Biophilia • BioSync • Cheering-Meter • Control • Cryptone • Dan Deacon App • Dialtones • Engaging the Crowd • EOS Pods • Flock • Glimmer • Heart • Hybrid Reality • LiveScore • MassMobile • Moori • MubuFunkScatShare • Musical Skin • Nike Fuelband Party • No Clergy • Opphos • Sketching • Sound Surfing Network • SWARMED • SYNK • The Interactive Dance Club • Tweet Dreams • Weiv • Wham • City Lights

- Collaborative Music Making (7)

  GenJam • iPoi • Jam with Chrome • MadderLibs / MadPad • Make a Baby • Mass collaboration and content creation inspired by Hatsune Miku • WanderOnStage

- Audience Participation without Technology (4)

  Bobby McFerrin Demonstrates the Power of the Pentatonic Scale • GLANK • Rhythm Extreme • The Rocky Horror Picture Show

- Art Installations (4)

  Do Not Touch • Human Aquarium • Light Around the Edges • The Last Man to Die

E.3 Preliminary List of Design Aspects

- Music (3 sub-categories, 15 elements)

  - Time related: Beat and Meter (e.g. accents) • Rhythm (e.g. note lengths) • Tempo (e.g. slower, faster) • Pitch (e.g. definite (piano), variable (violin), indefinite (cymbals))
  - Sound related: Key/Tonality (e.g. major/minor scales) • Harmony (e.g. triads, chords) • Dynamics (e.g. loudness, softness) • Melody • Timbre/Tone colour (e.g. dark, bright) • Instruments & Voice • Effects (e.g. delay, distortion) • Texture (e.g. monophonic, polyphonic, homophonic)
  - Structural: Figures (e.g. riff, phrase) • Form (e.g. layout of composition) • Notation

- Visuals (4, sub-categories, 9 elements)

  - Ambient on stage: Light (e.g. colours, moving spots, strobe speed) • Video-walls/Projections (e.g. sound-generated visualisations, videos, animations)

  - Ambient off stage: Venue lights (e.g. darker/brighter) • Wristbands (e.g. changing colours) • Smartphones (e.g. display colours, flash)
  - Informational on stage: Graphical visualization (e.g. shapes, drawings) • Data visualization (e.g. charts, bubbles) • Light (e.g. pointing laser beams)
  - Informational off stage: Smartphones (e.g. text, messages, numbers)

- Haptic (2 sub-categories, 5 elements)
  - Feeling: Vibration (e.g. Haptic bracelets, Smartphone vibration) • Speakers (e.g. low "perceptible" frequencies, subwoofers)
  - Moving: Instruments (e.g. rotating drumkit) • Artefacts (e.g. decoration) • Parts (e.g. rise/lower platforms)

- Interaction technique (4 sub-categories, 13 elements)
  - Static/Environmental: Visual (e.g. Kinect, marker-based technologies) • Acoustic (e.g. microphones) • Floor sensors • Special locations (e.g. planetarium, big labs)
  - Spectator-owned: Voice (e.g. singing, screaming) • Visible emotion (e.g. laughing) • Smartphone Sensors (e.g. Accelerometer/Gyro, Microphone, Proximity) • Smartphone Actuators (e.g. Flashlight, Speaker (e.g. collaborative sound), Headphones (e.g. additional individual acoustics), Vibration (e.g. rhythm)) • Smartqphone Application (Social media (e.g. Twitter, Facebook), Media (e.g. photos, videos, music), Communication (e.g. phone call, texting))
  - Invisible/Untraceable: emotion (e.g. heart rate, EEG)
  - Provided mobile technology: Bluetooth, RFID, WiFi, NFC • Wristbands (e.g. Haptic Bracelets) • Emotions (e.g. pulse, EEG)

- Kinds of interaction (6 sub-categories, 21 elements)
  - Spatial: Movement (e.g. dancing, waving, standing/moving on place) • Location in the space/room (e.g. GPS (open air), low range wireless technology)
  - Synchronous/real-time: collaborative (playing all together/in groups/with partner) • competitive (competing individuals/groups/with partner) • participating remotely (e.g. internet and livestream) • Playful approaches (e.g. Singstar, Guitar Hero) • Methodical, intentional (e.g. use and apply certain musical knowledge and approaches)
  - Asynchronous: Voting prior to performance (e.g. setlist) • Rating after the performance (e.g. songs) • Provide information to be used in the performance (e.g. personal dates, chosen numbers)

  - Role related: influencing actively/intentionally (e.g. doing something, using/operating something) • being "observed/analyzed" • being/acting as "another" performer • influencing a performer's playing/instrument (partly) • influencing (e.g. changing parameters) • creating (e.g. collaborative performance)
  - Sound generation: centralized (e.g. PA) • decentralized (e.g. participants devices, distributed speakers)
  - Intensity/depth of audience participation: parts of a song (e.g. solo singing) • certain songs (e.g. band members from audience) • whole concert (e.g. singing, clapping)

- Decision to enable participation (2 sub-categories, 3 elements)
  - Performer: Music (e.g. effects) • Visuals (e.g. lights)
  - Composer: Music (e.g. structures)

E.4 TMAP Framework Development Versions (V1 and V2)

The next two pages show the two versions V1 and V2 of the TMAP Framework after development step 3 and 4. Figure 11 revisits the description of the framework structure and terminology at the example of TMAP Framework V2 as presented in chapter 8 after development.

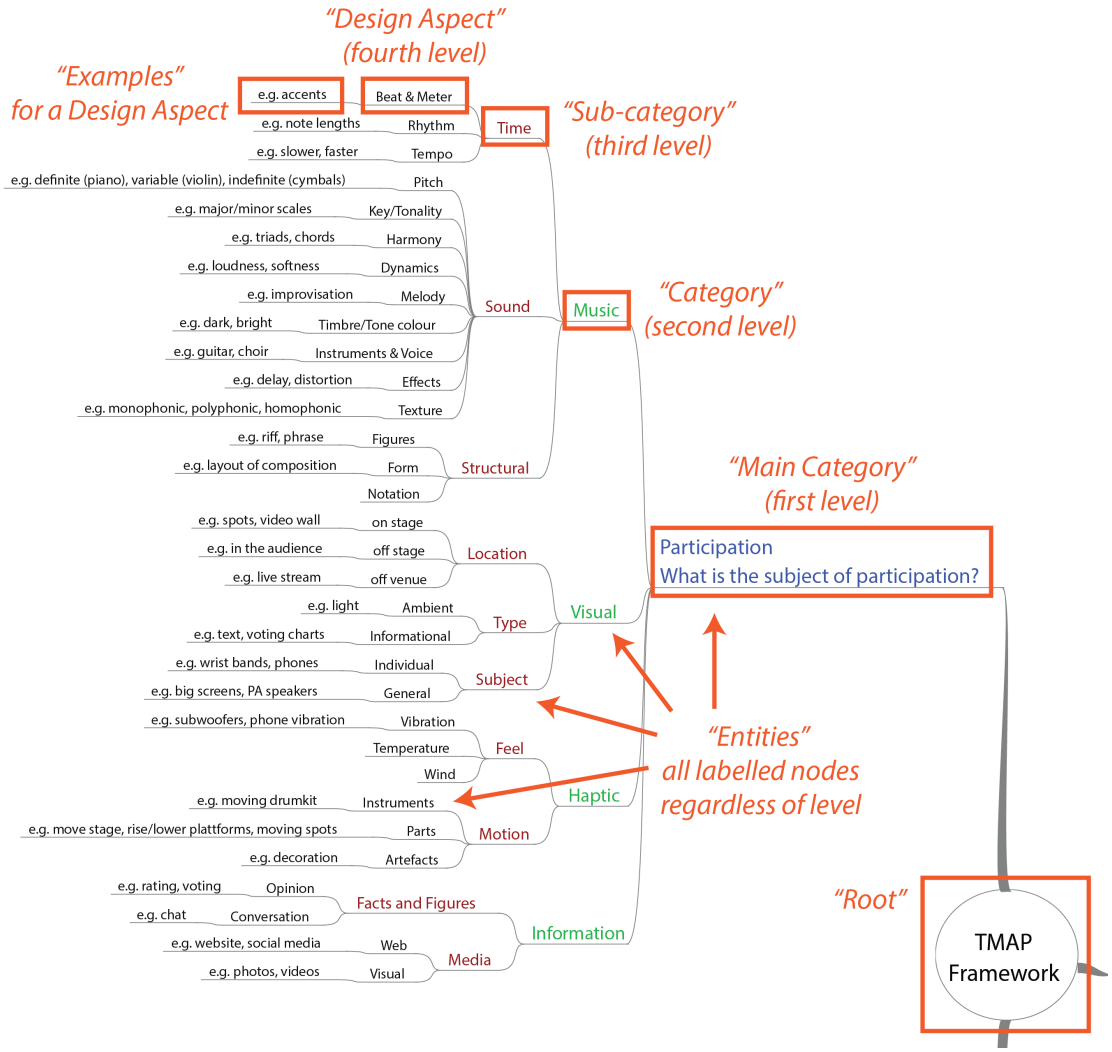
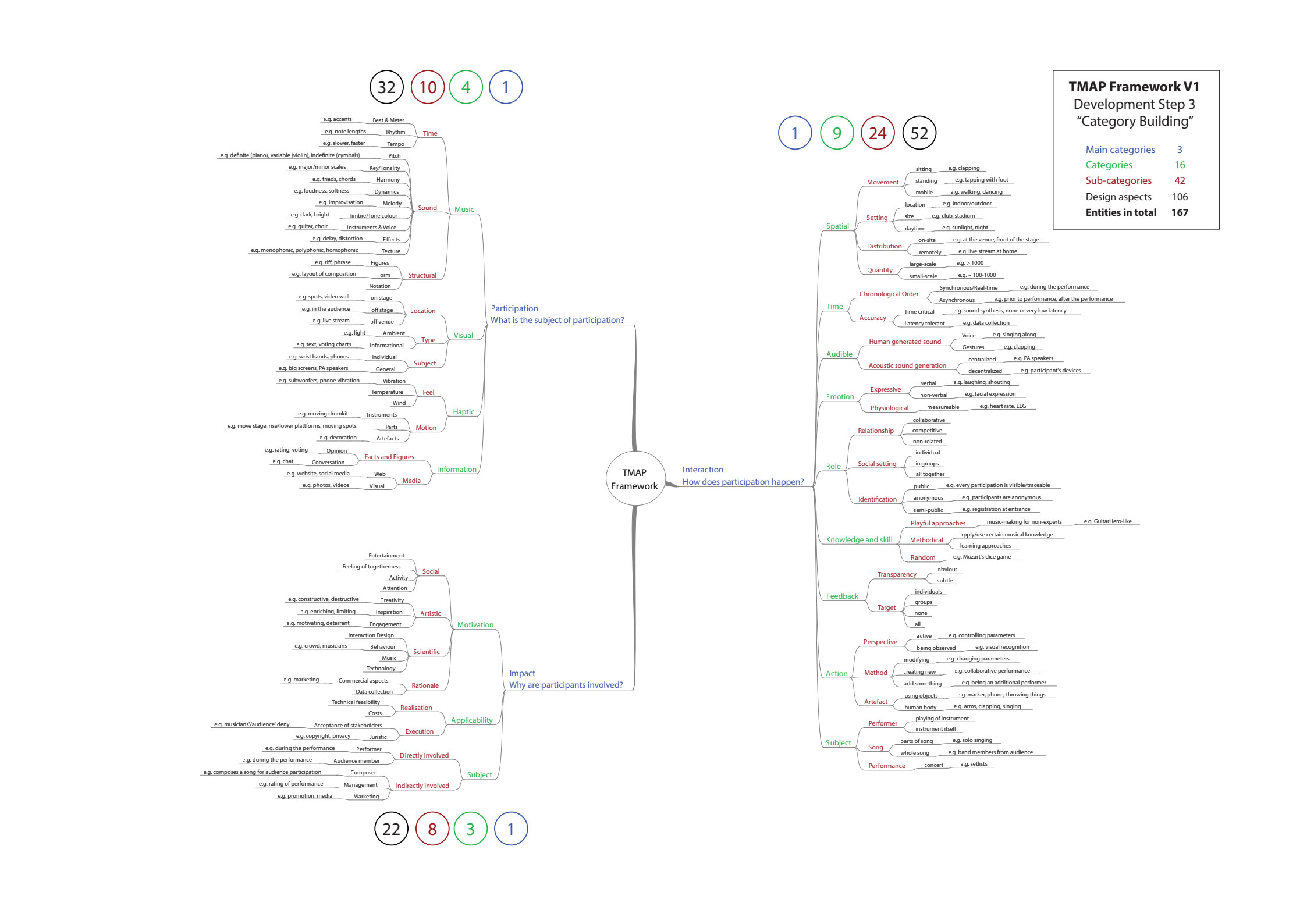
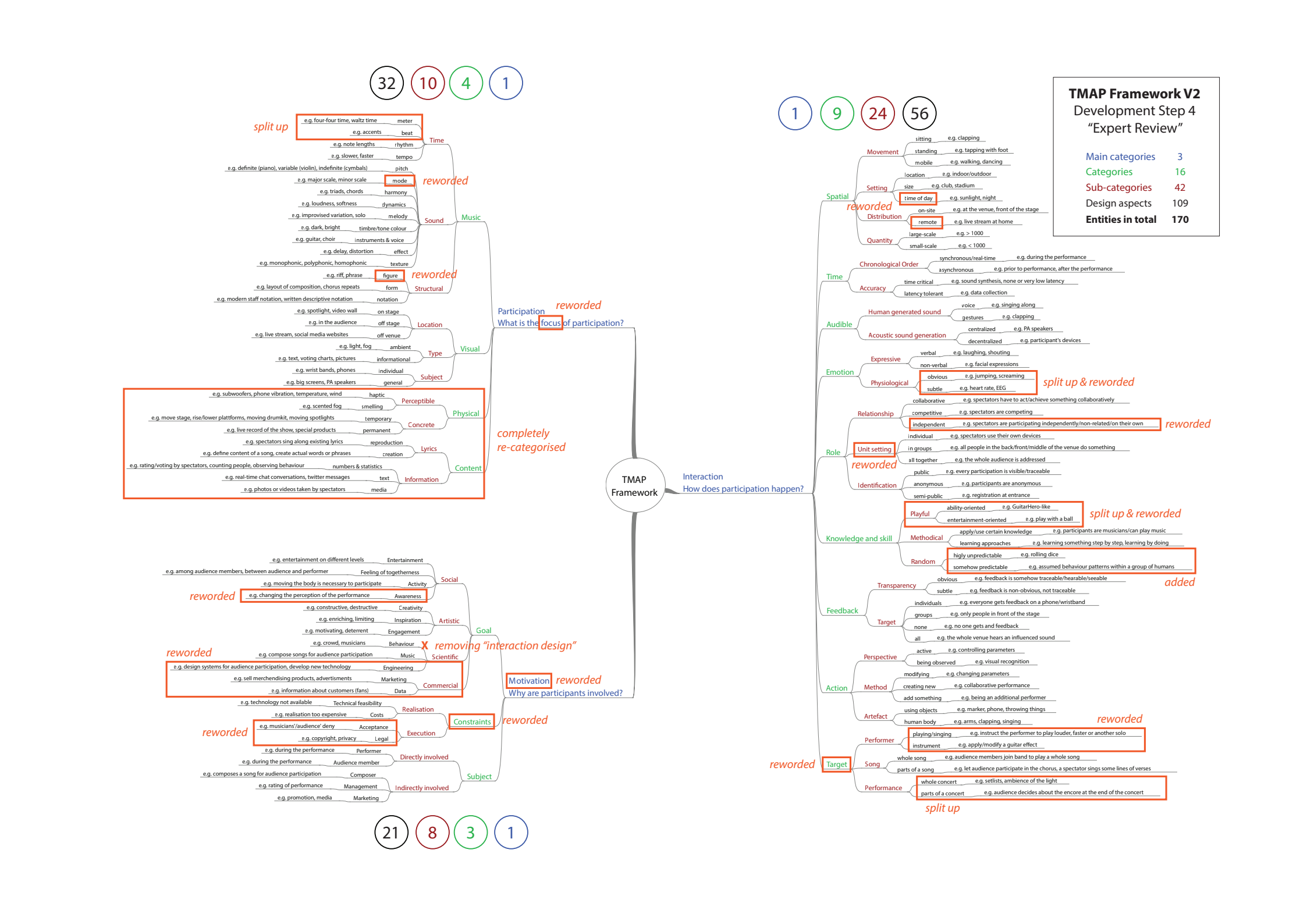


Figure 11: Structure and terminology of the TMAP Framework V2


32
10
4
1
1
9
24
52
TMAP Framework V1
Development Step 3
"Category Building"
Main categories 3
Categories 16
Sub-categories 42
Design aspects 106
Entities in total 167
TMAP Framework
Participation
What is the subject of participation?
Music
Time
Beat & Meter
e.g. accents
Rhythm
e.g. note lengths
Tempo
e.g. slower, faster
Sound
Pitch
e.g. definite (piano), variable (violin), indefinite (cymbals)
Key/Tonality
e.g. major/minor scales
Harmony
e.g. triads, chords
Dynamics
e.g. loudness, softness
Melody
e.g. improvisation
Timbre/Tone colour
e.g. dark, bright
Instruments & Voice
e.g. guitar, choir
Effects
e.g. delay, distortion
Texture
e.g. monophonic, polyphonic, homophonic
Structural
Figures
e.g. riff, phrase
Form
e.g. layout of composition
Notation
Visual
Location
on stage
e.g. spots, video wall
off stage
e.g. in the audience
off venue
e.g. live stream
Type
Ambient
e.g. light
Informational
e.g. text, voting charts
Subject
Individual
e.g. wrist bands, phones
General
e.g. big screens, PA speakers
Haptic
Feel
Vibration
e.g. subwoofers, phone vibration
Temperature
Wind
Motion
Instruments
e.g. moving drumkit
Parts
e.g. move stage, rise/lower plattforms, moving spots
Artefacts
e.g. decoration
Information
Facts and Figures
Opinion
e.g. rating, voting
Conversation
e.g. chat
Media
Web
e.g. website, social media
Visual
e.g. photos, videos
Impact
Why are participants involved?
Motivation
Social
Entertainment
Feeling of togetherness
Activity
Attention
Artistic
Creativity
e.g. constructive, destructive
Inspiration
e.g. enriching, limiting
Engagement
e.g. motivating, deterrent
Scientific
Interaction Design
Behaviour
e.g. crowd, musicians
Music
Technology
Rationale
Commercial aspects
e.g. marketing
Data collection
Applicability
Realisation
Technical feasibility
Costs
Execution
Acceptance of stakeholders
e.g. musicians'/audience' deny
Juristic
e.g. copyright, privacy
Subject
Directly involved
Performer
e.g. during the performance
Audience member
e.g. during the performance
Indirectly involved
Composer
e.g. composes a song for audience participation
Management
e.g. rating of performance
Marketing
e.g. promotion, media
Interaction
How does participation happen?
Spatial
Movement
sitting
e.g. clapping
standing
e.g. tapping with foot
mobile
e.g. walking, dancing
Setting
location
e.g. indoor/outdoor
size
e.g. club, stadium
daytime
e.g. sunlight, night
Distribution
on-site
e.g. at the venue, front of the stage
remotely
e.g. live stream at home
Quantity
large-scale
e.g. > 1000
small-scale
e.g. ~ 100-1000
Time
Chronological Order
Synchronous/Real-time
e.g. during the performance
Asynchronous
e.g. prior to performance, after the performance
Accuracy
Time critical
e.g. sound synthesis, none or very low latency
Latency tolerant
e.g. data collection
Audible
Human generated sound
Voice
e.g. singing along
Gestures
e.g. clapping
Acoustic sound generation
centralized
e.g. PA speakers
decentralized
e.g. participant's devices
Emotion
Expressive
verbal
e.g. laughing, shouting
non-verbal
e.g. facial expression
Physiological
measureable
e.g. heart rate, EEG
Role
Relationship
collaborative
competitive
non-related
Social setting
individual
in groups
all together
Identification
public
e.g. every participation is visible/traceable
anonymous
e.g. participants are anonymous
semi-public
e.g. registration at entrance
Knowledge and skill
Playful approaches
music-making for non-experts
e.g. GuitarHero-like
Methodical
apply/use certain musical knowledge
learning approaches
Random
e.g. Mozart's dice game
Feedback
Transparency
obvious
subtle
Target
individuals
groups
none
all
Action
Perspective
active
e.g. controlling parameters
being observed
e.g. visual recognition
Method
modifying
e.g. changing parameters
creating new
e.g. collaborative performance
add something
e.g. being an additional performer
Artefact
using objects
e.g. marker, phone, throwing things
human body
e.g. arms, clapping, singing
Subject
Performer
playing of instrument
instrument itself
Song
parts of song
e.g. solo singing
whole song
e.g. band members from audience
Performance
concert
e.g. setlists
22
8
3
1


TMAP Framework
Participation
What is the focus of participation?
Interaction
How does participation happen?
Motivation
Why are participants involved?
32
10
4
1
split up
reworded
completely re-categorised
Time
Music
Sound
Structural
Visual
Location
Type
Subject
Physical
Perceptible
Concrete
Content
Lyrics
Information
meter
beat
rhythm
tempo
pitch
mode
harmony
dynamics
melody
timbre/tone colour
instruments & voice
effect
texture
figure
form
notation
on stage
off stage
off venue
ambient
informational
individual
general
haptic
smelling
temporary
permanent
reproduction
creation
numbers & statistics
text
media
1
9
24
56
TMAP Framework V2
Development Step 4
"Expert Review"
Main categories 3
Categories 16
Sub-categories 42
Design aspects 109
Entities in total 170
Spatial
Time
Audible
Emotion
Role
Knowledge and skill
Feedback
Action
Target
Movement
Setting
Distribution
Quantity
Chronological Order
Accuracy
Human generated sound
Acoustic sound generation
Expressive
Physiological
Relationship
Unit setting
Identification
Playful
Methodical
Random
Transparency
Target
Perspective
Method
Artefact
Performer
Song
Performance
sitting
standing
mobile
location
size
time of day
on-site
remote
large-scale
small-scale
synchronous/real-time
asynchronous
time critical
latency tolerant
voice
gestures
centralized
decentralized
verbal
non-verbal
obvious
subtle
collaborative
competitive
independent
individual
in groups
all together
public
anonymous
semi-public
ability-oriented
entertainment-oriented
apply/use certain knowledge
learning approaches
higly unpredictable
somehow predictable
obvious
subtle
individuals
groups
none
all
active
being observed
modifying
creating new
add something
using objects
human body
playing/singing
instrument
whole song
parts of a song
whole concert
parts of a concert
split up & reworded
added
21
8
3
1
Entertainment
Feeling of togetherness
Activity
Awareness
Creativity
Inspiration
Engagement
Behaviour
Music
Engineering
Marketing
Data
Technical feasibility
Costs
Acceptance
Legal
Performer
Audience member
Composer
Management
Marketing
Social
Artistic
Scientific
Commercial
Realisation
Execution
Constraints
Directly involved
Indirectly involved
Goal
Subject
removing "interaction design"

Appendix F

F.1 Additional Information for the Statistical Analysis of Exercises

This is intended as additional information for the exercises analysis described in chapter 9.3.4 were we also introduced the concept of the majority checks. The annotated screenshot in Figure 12 supports the following description. It shows an exemplary screenshot of the TMAP Online analysis view of a single example.

This particular screenshot contains all exercises of the example *MassMobile*. The columns in the middle show eight exercises done by students. The seven green ones are completed submissions while the red one was an empty submission. The rows below show rating points and comments to grade the exercise. Additional links, short description and dimensions[3] are the actual submission of the students. The lower half of the screenshot shows the entities of the framework as a list and if a particular design aspect was chosen it was indicated by a hook.

We have such a majority check with *pitch* where four of seven students chose pitch as a design aspect. The blue box in the upper right corner summarises each example evaluation showing how many exercises were completed and the total number of majority checks. For this particular example it means 34 design aspects were chosen by the majority of students considering all exercises for this example.

The green and red boxes summarise each exercise separately. For analysis we calculated the difference between the number of individually chosen design aspects and the majority checks for each exercise. These differences as shown in the green/red boxes are colour-coded: we consider 5 or less (green) as little difference, 6 to 15 (orange) as moderate, and more than 15 (red) as high deviation from the majority checks. For example, the student of exercise 1 chose 41 design aspects which means a difference of 7 to the majority checks indicated as in an orange box next to 41, the number of chosen design aspects. The student of exercise 6, on the other hand, chose 64 design aspects which resulted in a difference of 30 (in a red box) to the majority checks for this example.

[3]Dimensions refer to the entities of the TMAP Framework as we called them for this particular exercise.

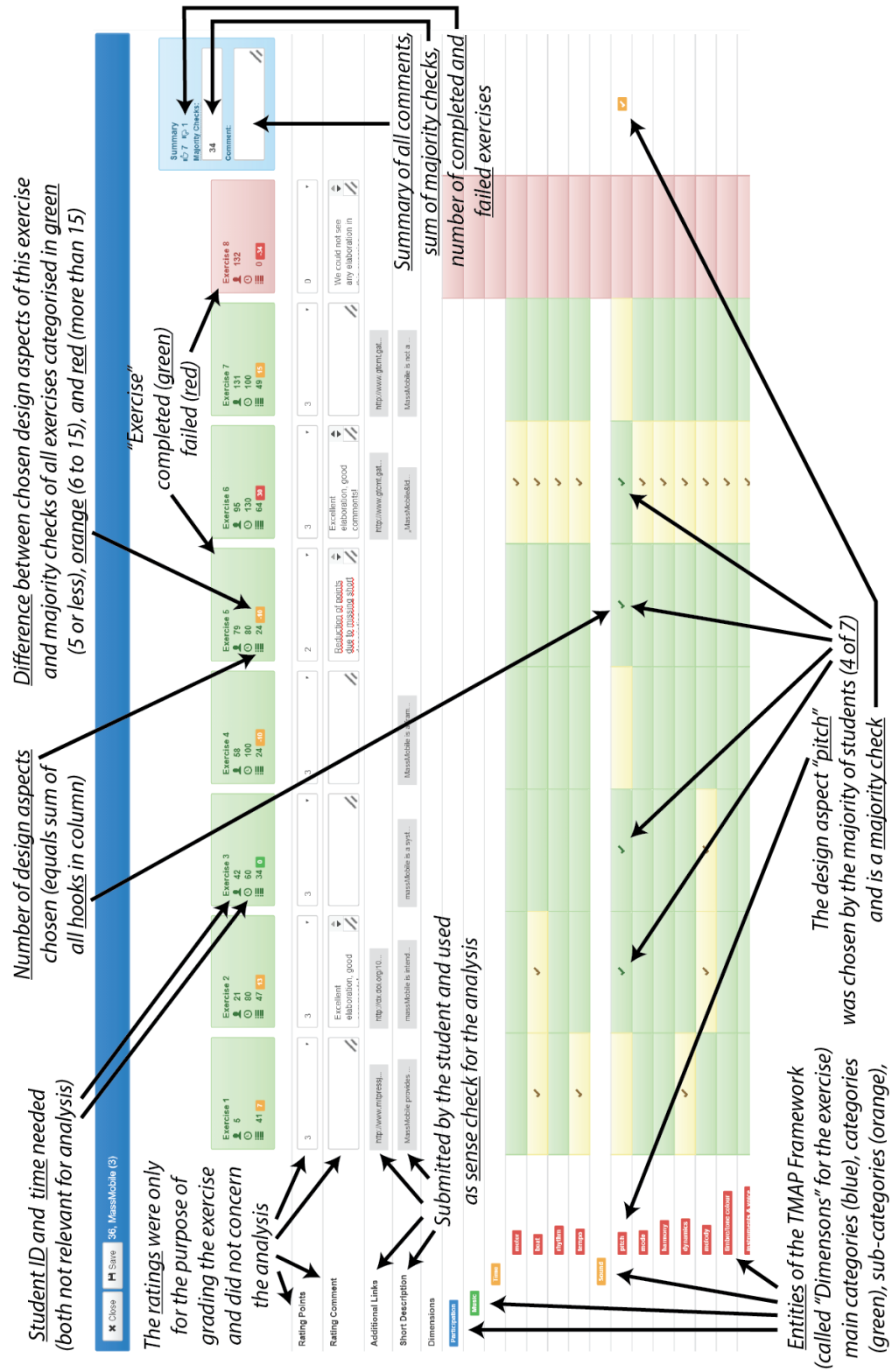


Figure 12: Screenshot of the analysis view of one particular example

F.2 List of Classification Examples with Calculated Statistical Values

The table below (which continues on the next page) contains all examples used for the classification exercises and the calculated statistical values. All average values in this table describe average values of all exercises of an example. Statistically, these average values are the arithmetic mean of all exercises for a particular example. Two columns are most interesting for the analysis and mainly references during the presentation of the results: "Average difference (mean) to majority checks" (third column) and "Standard deviation of differences to majority checks" (fourth column).

List of examples (title coloured according to the effort category)	**Checked design aspects in average** (for all exercises of an example)	**Average difference (mean) to majority checks** (for all exercises of an example)	**Standard deviation of differences to majority checks** (for all exercises of an example)	**Average difference to majority checks is between -5 and 5**	**Average difference of majority checks is bigger than 5 or smaller than -5**
A sophisticated soirée	39	10	9		x
Ad Infinitum	34	5	7	x	
An Audience-Interactive	33	1	11	x	
An Interactive Music	38	-5	6	x	
Applause Meter Jacket	30	1	6	x	
Augmented Opera	31	5	9		x
Augmented Stage for	43	8	9		x
BioMuse	31	6	11		x
Biophilia	36	-4	8	x	
BioSync	30	-3	12	x	
Bobby McFerrin Demonstrates	33	8	9		x
Boomerang Mobile Media	33	7	18		x
Cheering-Meter	29	1	7	x	
CodeBLUE	38	-1	13	x	
Control	36	8	5		x
Converge 2.0	27	-1	6	x	
Cryptone - Interaction between	31	-7	11		x
Dialtones	36	-1	10	x	
Dissonance	34	8	16		x
Do Not Touch	29	7	11		x
echobo	40	-2	10	x	
Eos Pods	32	-3	9	x	
Experimence	37	8	8		x
Experio	36	-3	19	x	
EZ3kiel Ballon	38	6	8		x
Flock	31	-1	13	x	
geMuse	14	12	8		x
GenJam	32	-2	15	x	

List of examples (title coloured according to the effort category)	**Checked design aspects in average** (for all exercises of an example)	**Average difference (mean) to majority checks** (for all exercises of an example)	**Standard deviation of differences to majority checks** (for all exercises of an example)	**Average difference to majority checks is between -5 and 5**	**Average difference of majority checks is bigger than 5 or smaller than -5**
GLANK	34	4	10	x	
Glimmer	38	1	12	x	
Hatsune Miku	39	2	15	x	
Heart	24	-4	5	x	
hpDJ	31	2	10	x	
Human Aquarium	33	-3	8	x	
iClub	28	7	5		x
Interactive Audience	32	4	8	x	
iPoi	37	1	5	x	
Jam with Chrome	41	3	13	x	
Laugh with facial recognition	19	4	9	x	
Light Around the Edges	38	2	10	x	
LiveScore	33	-1	14	x	
Lovegetty	31	13	22		x
Madder Libs	34	6	7		x
MadPad	51	9	32		x
Make a Baby (Luke Fishbeck)	30	-4	9	x	
MassMobile	40	6	13		x
Maybe...1910	24	5	10	x	
Moori	41	9	13		x
MubuFunkScatShare	39	1	6	x	
Musical Skin	28	4	12	x	
Musikalisches Würfelspiel	20	6	6		x
Nike Fuelband party	42	9	14		x
No Clergy	26	4	8	x	
Opphos	37	-2	11	x	
Orkestra	34	-2	16	x	
Performative Control of Light	33	7	8		x
Rhythm Extreme	39	-2	10	x	
SimpleTEXT: A Cell Phone	34	8	10		x
Sketching	38	-1	4	x	
Sound Surfing Network (SSN)	28	2	15	x	
SWARMED	31	5	11	x	
The Interactive Dance Club	42	5	9	x	
The Last Man to Die	39	4	11	x	
The Rocky Horror Show	20	2	4	x	
The Tin Men & the Telephone	33	5	10	x	
Tweet Dreams	34	9	6		x
WanderOnStage	35	7	9		x
Weiv	34	9	15		x
Wham City Lights Dan Deacon	22	6	9		x
Mean	**33**	**3**	**10**		
Sum of examples (69)				**42**	**27**

F.3 Students' Comments for Improvement of TMAP Framework V2

- Participation: the focus is also the crowd around you: what are they doing, what's the way i can add to the collective experience? Interaction: There was no field that suited the physical interaction with the sensors, while they are supposed to be hidden and not hinder the dancers, people needed to keep the sensors in their hands for the system to work properly. (Student ID 41, An Interactive Music Environment for Large Groups with Giveaway Wireless Motion Sensors)
- Participation: Music - as it is a mobile phone performance it has its focus on the different locations and the overall performance (waves, louder when more phones etc.), not just on the music parts on its own. (Student ID 46, Dialtones)
- Interaction: The audience does not need any prior knowledge in playing a music instrument, think about an aspect "intuitive"? (Student ID 31, Eos Pods)
- Motivation: About Subject/Indirectly involved: I chose Composer, but what I really meant is the creator of the whole thing who chooses what kinds of sounds, etc. the audience can generate. (Student ID 139, Make a Baby Luke Fishbeck)
- Interaction: if the feedback is obvious or subtle depends on what is meant by traceable. The viewers of the building get an obvious feedback about the activity of the participants, but they cannot trace back how much influence each individual has, although this information is exists as data somewhere. Therefore I checked both. (Student ID 66, Nike Fuelband Party)
- Participation: Nothing fits the noise-making the battle mode offers. The battle mode amplifies any noise input and uses the phone speakers to play it back. I'd put it under Music - Sound - Noise. (Student ID 99, Opphos)
- Motivation: In this case also the programmer is involved indirectly. Other constraints might be the incompetence of the audience e.g. to connect to a WiFi. (Student ID 65, SWARMED)
- Participation: these aren't directly influenced by the audience its more like to set a motto for the next performance part. I feel that an option describing this would fit in the Content subtree and be called "motto/mood of performance" (e.g. playing holiday musik, x-mas music). (Student ID 137, The Last Man to Die)
- Participation: Missing looping in category music sound. (Student ID 143, WanderOnStage)

F.4 TMAP Framework Evaluation Versions (V3 - V6)

The next four pages show the four versions V3 to V6 of the TMAP Framework after each evaluation step from 1 to 4. Figure 13 revisits the description of the framework structure and terminology at the example of TMAP Framework V6 as presented in chapter 9 after evaluation.

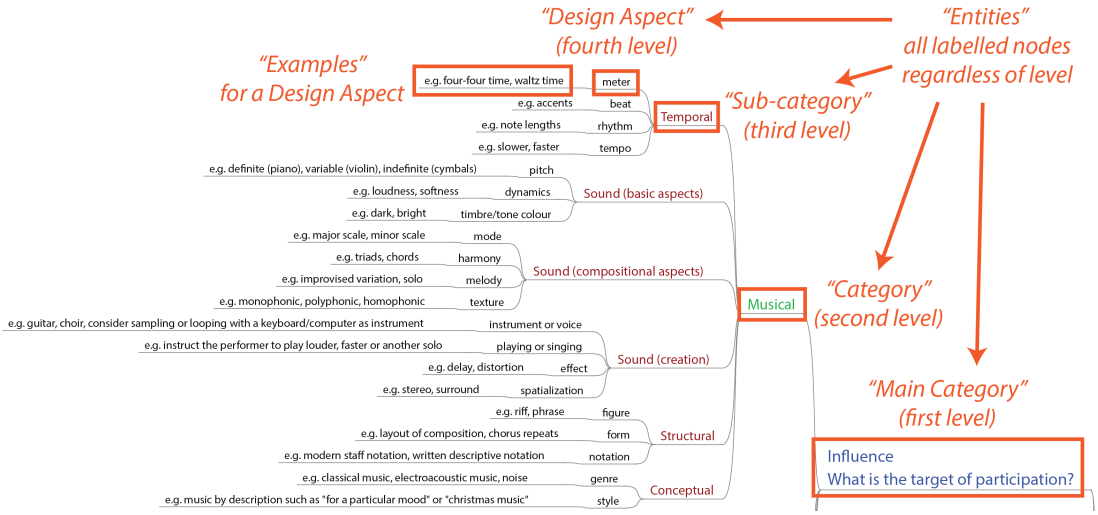
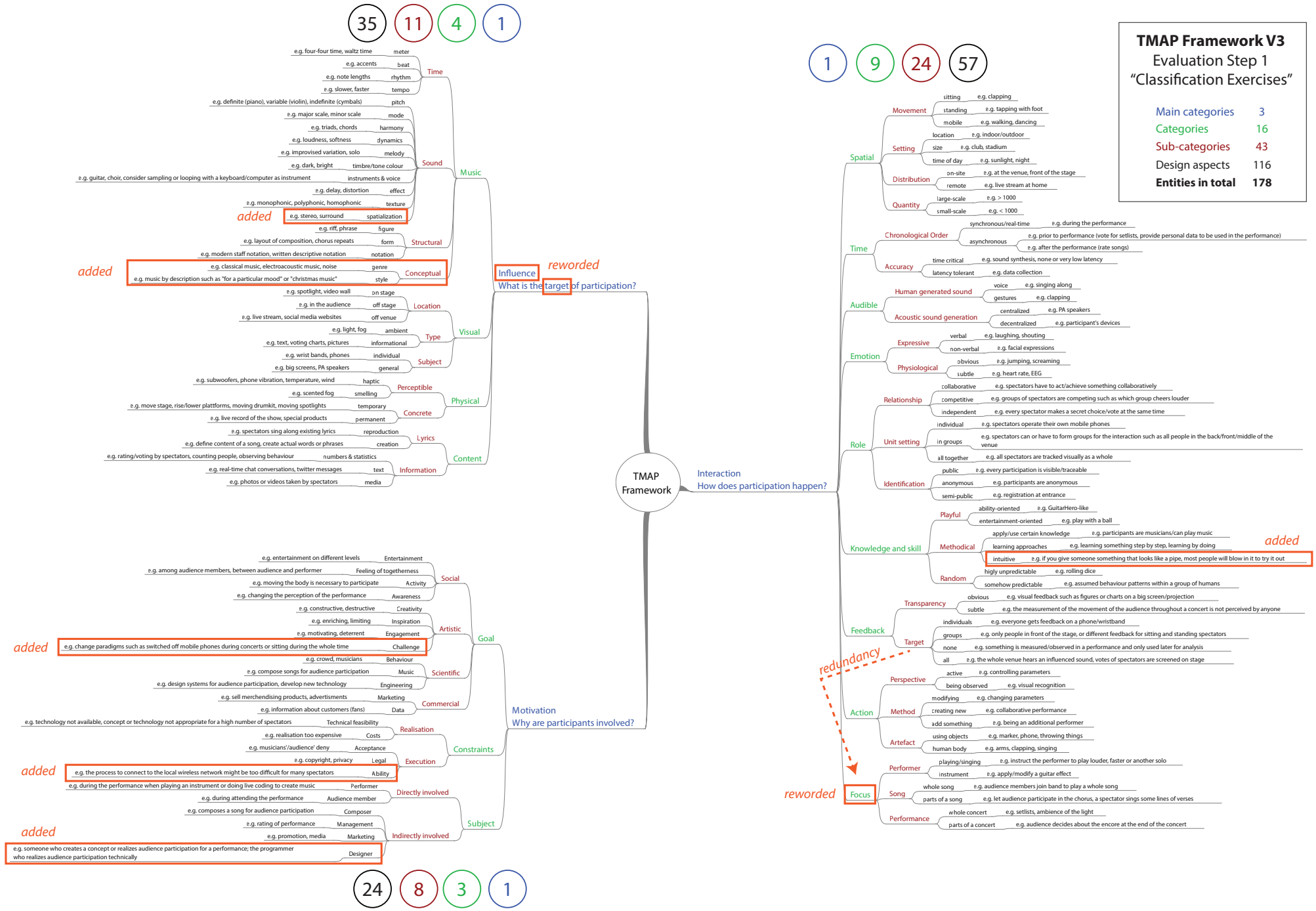
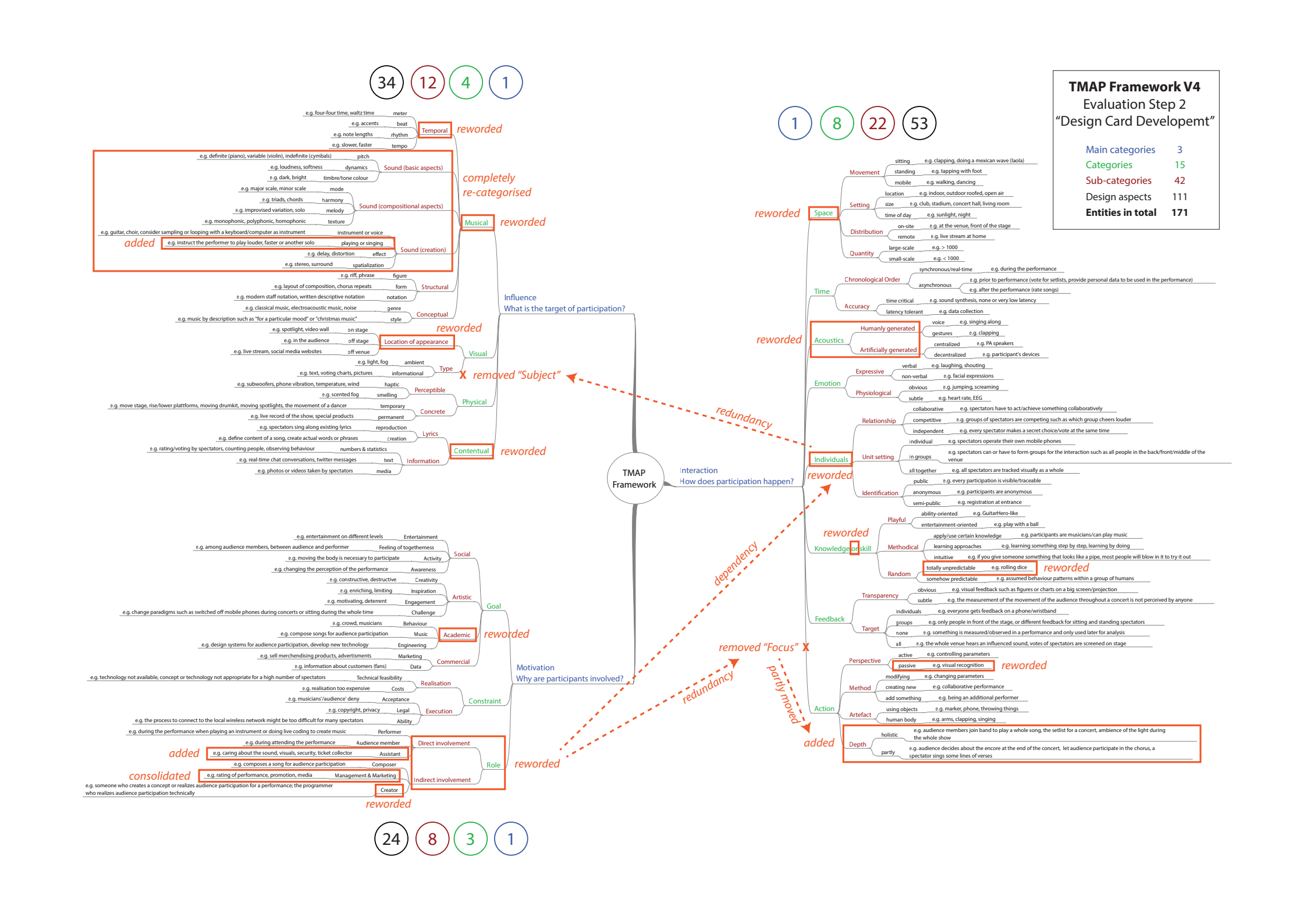
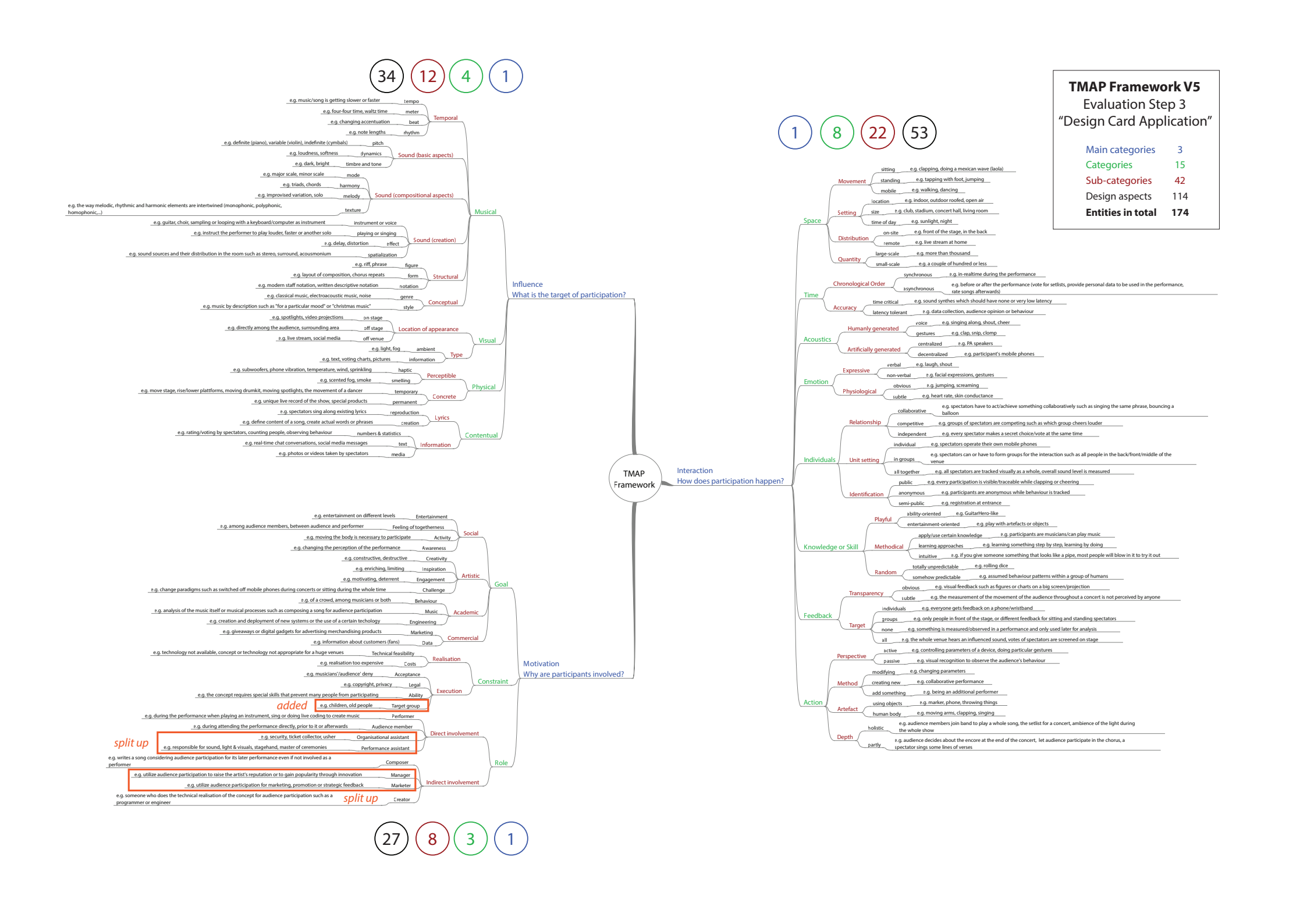
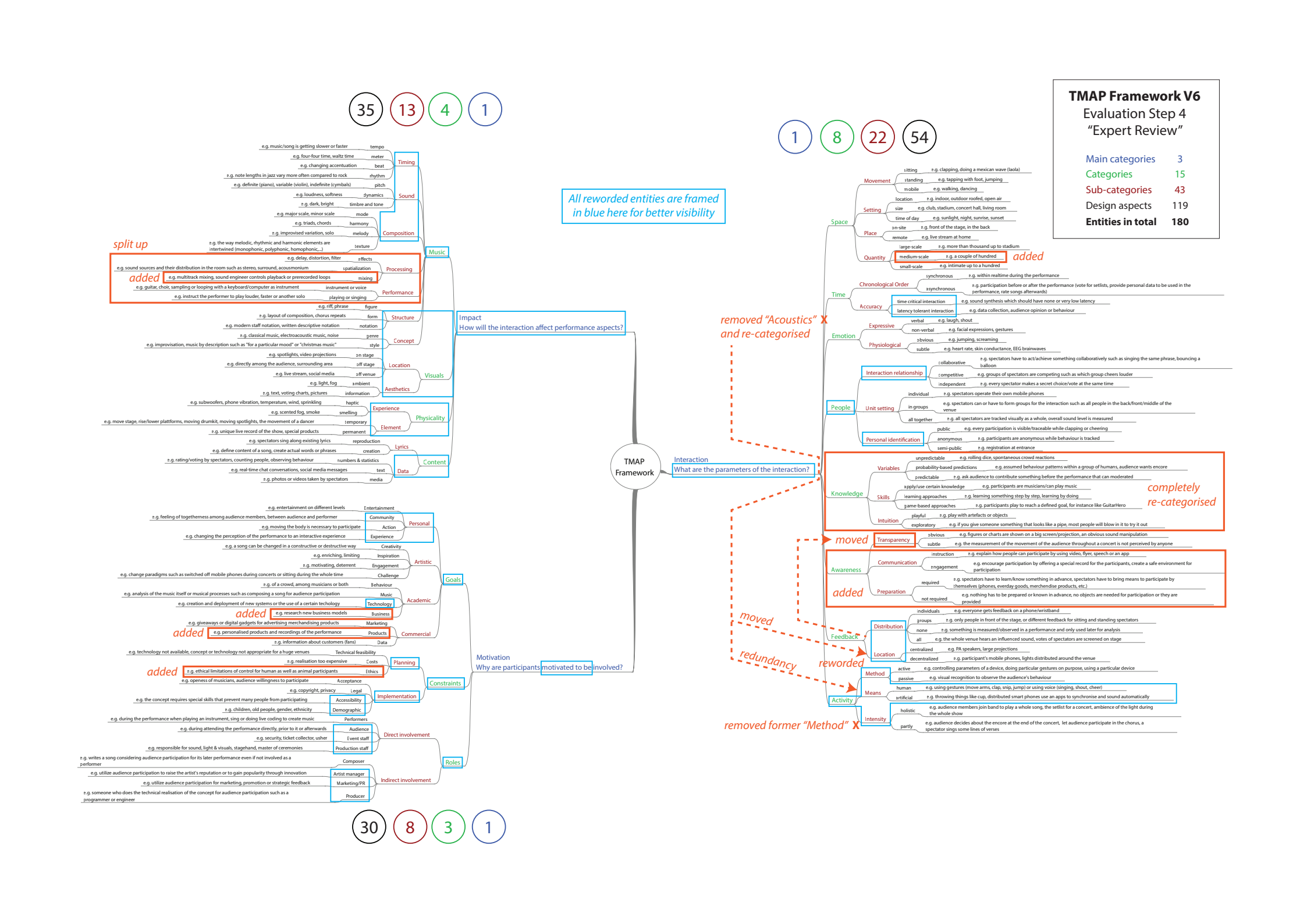


Figure 13: Structure and terminology of the TMAP Framework V6


TMAP Framework
Influence
What is the target of participation?
reworded
Interaction
How does participation happen?
Motivation
Why are participants involved?
35
11
4
1
Music
Time
meter
e.g. four-four time, waltz time
beat
e.g. accents
rhythm
e.g. note lengths
tempo
e.g. slower, faster
Sound
pitch
e.g. definite (piano), variable (violin), indefinite (cymbals)
mode
e.g. major scale, minor scale
harmony
e.g. triads, chords
dynamics
e.g. loudness, softness
melody
e.g. improvised variation, solo
timbre/tone colour
e.g. dark, bright
instruments & voice
e.g. guitar, choir, consider sampling or looping with a keyboard/computer as instrument
effect
e.g. delay, distortion
texture
e.g. monophonic, polyphonic, homophonic
added
spatialization
e.g. stereo, surround
Structural
figure
e.g. riff, phrase
form
e.g. layout of composition, chorus repeats
notation
e.g. modern staff notation, written descriptive notation
added
Conceptual
genre
e.g. classical music, electroacoustic music, noise
style
e.g. music by description such as "for a particular mood" or "christmas music"
Visual
Location
on stage
e.g. spotlight, video wall
off stage
e.g. in the audience
off venue
e.g. live stream, social media websites
Type
ambient
e.g. light, fog
informational
e.g. text, voting charts, pictures
Subject
individual
e.g. wrist bands, phones
general
e.g. big screens, PA speakers
Physical
Perceptible
haptic
e.g. subwoofers, phone vibration, temperature, wind
smelling
e.g. scented fog
Concrete
temporary
e.g. move stage, rise/lower plattforms, moving drumkit, moving spotlights
permanent
e.g. live record of the show, special products
Content
Lyrics
reproduction
e.g. spectators sing along existing lyrics
creation
e.g. define content of a song, create actual words or phrases
Information
numbers & statistics
e.g. rating/voting by spectators, counting people, observing behaviour
text
e.g. real-time chat conversations, twitter messages
media
e.g. photos or videos taken by spectators
24
8
3
1
Goal
Social
Entertainment
e.g. entertainment on different levels
Feeling of togetherness
e.g. among audience members, between audience and performer
Activity
e.g. moving the body is necessary to participate
Awareness
e.g. changing the perception of the performance
Artistic
Creativity
e.g. constructive, destructive
Inspiration
e.g. enriching, limiting
Engagement
e.g. motivating, deterrent
added
Challenge
e.g. change paradigms such as switched off mobile phones during concerts or sitting during the whole time
Scientific
Behaviour
e.g. crowd, musicians
Music
e.g. compose songs for audience participation
Engineering
e.g. design systems for audience participation, develop new technology
Commercial
Marketing
e.g. sell merchendising products, advertisments
Data
e.g. information about customers (fans)
Constraints
Realisation
Technical feasibility
e.g. technology not available, concept or technology not appropriate for a high number of spectators
Costs
e.g. realisation too expensive
Execution
Acceptance
e.g. musicians'/audience' deny
Legal
e.g. copyright, privacy
added
Ability
e.g. the process to connect to the local wireless network might be too difficult for many spectators
Subject
Directly involved
Performer
e.g. during the performance when playing an instrument or doing live coding to create music
Audience member
e.g. during attending the performance
Indirectly involved
Composer
e.g. composes a song for audience participation
Management
e.g. rating of performance
Marketing
e.g. promotion, media
added
Designer
e.g. someone who creates a concept or realizes audience participation for a performance; the programmer who realizes audience participation technically
1
9
24
57
Spatial
Movement
sitting
e.g. clapping
standing
e.g. tapping with foot
mobile
e.g. walking, dancing
Setting
location
e.g. indoor/outdoor
size
e.g. club, stadium
time of day
e.g. sunlight, night
Distribution
on-site
e.g. at the venue, front of the stage
remote
e.g. live stream at home
Quantity
large-scale
e.g. > 1000
small-scale
e.g. < 1000
Time
Chronological Order
synchronous/real-time
e.g. during the performance
asynchronous
e.g. prior to performance (vote for setlists, provide personal data to be used in the performance)
e.g. after the performance (rate songs)
Accuracy
time critical
e.g. sound synthesis, none or very low latency
latency tolerant
e.g. data collection
Audible
Human generated sound
voice
e.g. singing along
gestures
e.g. clapping
Acoustic sound generation
centralized
e.g. PA speakers
decentralized
e.g. participant's devices
Emotion
Expressive
verbal
e.g. laughing, shouting
non-verbal
e.g. facial expressions
Physiological
obvious
e.g. jumping, screaming
subtle
e.g. heart rate, EEG
Role
Relationship
collaborative
e.g. spectators have to act/achieve something collaboratively
competitive
e.g. groups of spectators are competing such as which group cheers louder
independent
e.g. every spectator makes a secret choice/vote at the same time
Unit setting
individual
e.g. spectators operate their own mobile phones
in groups
e.g. spectators can or have to form groups for the interaction such as all people in the back/front/middle of the venue
all together
e.g. all spectators are tracked visually as a whole
Identification
public
e.g. every participation is visible/traceable
anonymous
e.g. participants are anonymous
semi-public
e.g. registration at entrance
Knowledge and skill
Playful
ability-oriented
e.g. GuitarHero-like
entertainment-oriented
e.g. play with a ball
Methodical
apply/use certain knowledge
e.g. participants are musicians/can play music
learning approaches
e.g. learning something step by step, learning by doing
added
intuitive
e.g. if you give someone something that looks like a pipe, most people will blow in it to try it out
Random
higly unpredictable
e.g. rolling dice
somehow predictable
e.g. assumed behaviour patterns within a group of humans
Feedback
Transparency
obvious
e.g. visual feedback such as figures or charts on a big screen/projection
subtle
e.g. the measurement of the movement of the audience throughout a concert is not perceived by anyone
Target
individuals
e.g. everyone gets feedback on a phone/wristband
groups
e.g. only people in front of the stage, or different feedback for sitting and standing spectators
none
e.g. something is measured/observed in a performance and only used later for analysis
all
e.g. the whole venue hears an influenced sound, votes of spectators are screened on stage
redundancy
Action
Perspective
active
e.g. controlling parameters
being observed
e.g. visual recognition
Method
modifying
e.g. changing parameters
creating new
e.g. collaborative performance
add something
e.g. being an additional performer
Artefact
using objects
e.g. marker, phone, throwing things
human body
e.g. arms, clapping, singing
reworded
Focus
Performer
playing/singing
e.g. instruct the performer to play louder, faster or another solo
instrument
e.g. apply/modify a guitar effect
Song
whole song
e.g. audience members join band to play a whole song
parts of a song
e.g. let audience participate in the chorus, a spectator sings some lines of verses
Performance
whole concert
e.g. setlists, ambience of the light
parts of a concert
e.g. audience decides about the encore at the end of the concert
TMAP Framework V3
Evaluation Step 1
"Classification Exercises"
Main categories 3
Categories 16
Sub-categories 43
Design aspects 116
Entities in total 178


34
12
4
1
TMAP Framework V4
Evaluation Step 2
"Design Card Developemt"
Main categories 3
Categories 15
Sub-categories 42
Design aspects 111
Entities in total 171
1
8
22
53
TMAP Framework
Influence
What is the target of participation?
Interaction
How does participation happen?
Motivation
Why are participants involved?
Temporal
meter
beat
rhythm
tempo
reworded
Musical
Sound (basic aspects)
pitch
dynamics
timbre/tone colour
Sound (compositional aspects)
mode
harmony
melody
texture
Sound (creation)
instrument or voice
playing or singing
effect
spatialization
added
completely re-categorised
reworded
Structural
figure
form
notation
Conceptual
genre
style
Visual
Location of appearance
on stage
off stage
off venue
reworded
Physical
Type
ambient
informational
removed "Subject"
Perceptible
haptic
smelling
Concrete
temporary
permanent
Contentual
Lyrics
reproduction
creation
Information
numbers & statistics
text
media
reworded
redundancy
Space
Movement
sitting
standing
mobile
Setting
location
size
time of day
Distribution
on-site
remote
Quantity
large-scale
small-scale
reworded
Time
Chronological Order
synchronous/real-time
asynchronous
Accuracy
time critical
latency tolerant
Acoustics
Humanly generated
voice
gestures
Artificially generated
centralized
decentralized
reworded
Emotion
Expressive
verbal
non-verbal
Physiological
obvious
subtle
Individuals
Relationship
collaborative
competitive
independent
Unit setting
individual
in groups
all together
Identification
public
anonymous
semi-public
reworded
Knowledge or skill
Playful
ability-oriented
entertainment-oriented
Methodical
apply/use certain knowledge
learning approaches
intuitive
Random
totally unpredictable
somehow predictable
reworded
Feedback
Transparency
obvious
subtle
Target
individuals
groups
none
all
Action
Perspective
active
passive
Method
modifying
creating new
add something
Artefact
using objects
human body
Depth
holistic
partly
reworded
removed "Focus"
partly moved
added
dependency
redundancy
Social
Entertainment
Feeling of togetherness
Activity
Awareness
Artistic
Creativity
Inspiration
Engagement
Challenge
Academic
Behaviour
Music
Engineering
Commercial
Marketing
Data
Goal
reworded
Constraint
Realisation
Technical feasibility
Costs
Execution
Acceptance
Legal
Ability
Role
Direct involvement
Performer
Audience member
Assistant
Indirect involvement
Composer
Management & Marketing
Creator
added
consolidated
reworded
24
8
3
1


34 12 4 1
TMAP Framework
Influence
What is the target of participation?
Musical
Temporal
tempo
e.g. music/song is getting slower or faster
meter
e.g. four-four time, waltz time
beat
e.g. changing accentuation
rhythm
e.g. note lengths
Sound (basic aspects)
pitch
e.g. definite (piano), variable (violin), indefinite (cymbals)
dynamics
e.g. loudness, softness
timbre and tone
e.g. dark, bright
Sound (compositional aspects)
mode
e.g. major scale, minor scale
harmony
e.g. triads, chords
melody
e.g. improvised variation, solo
texture
e.g. the way melodic, rhythmic and harmonic elements are intertwined (monophonic, polyphonic, homophonic,..)
Sound (creation)
instrument or voice
e.g. guitar, choir, sampling or looping with a keyboard/computer as instrument
playing or singing
e.g. instruct the performer to play louder, faster or another solo
effect
e.g. delay, distortion
spatialization
e.g. sound sources and their distribution in the room such as stereo, surround, acousmonium
Structural
figure
e.g. riff, phrase
form
e.g. layout of composition, chorus repeats
notation
e.g. modern staff notation, written descriptive notation
Conceptual
genre
e.g. classical music, electroacoustic music, noise
style
e.g. music by description such as "for a particular mood" or "christmas music"
Visual
Location of appearance
on stage
e.g. spotlights, video projections
off stage
e.g. directly among the audience, surrounding area
off venue
e.g. live stream, social media
Type
ambient
e.g. light, fog
information
e.g. text, voting charts, pictures
Physical
Perceptible
haptic
e.g. subwoofers, phone vibration, temperature, wind, sprinkling
smelling
e.g. scented fog, smoke
Concrete
temporary
e.g. move stage, rise/lower plattforms, moving drumkit, moving spotlights, the movement of a dancer
permanent
e.g. unique live record of the show, special products
Contentual
Lyrics
reproduction
e.g. spectators sing along existing lyrics
creation
e.g. define content of a song, create actual words or phrases
Information
numbers & statistics
e.g. rating/voting by spectators, counting people, observing behaviour
text
e.g. real-time chat conversations, social media messages
media
e.g. photos or videos taken by spectators
Motivation
Why are participants involved?
Goal
Social
Entertainment
e.g. entertainment on different levels
Feeling of togetherness
e.g. among audience members, between audience and performer
Activity
e.g. moving the body is necessary to participate
Awareness
e.g. changing the perception of the performance
Artistic
Creativity
e.g. constructive, destructive
Inspiration
e.g. enriching, limiting
Engagement
e.g. motivating, deterrent
Challenge
e.g. change paradigms such as switched off mobile phones during concerts or sitting during the whole time
Academic
Behaviour
e.g. of a crowd, among musicians or both
Music
e.g. analysis of the music itself or musical processes such as composing a song for audience participation
Engineering
e.g. creation and deployment of new systems or the use of a certain techology
Commercial
Marketing
e.g. giveaways or digital gadgets for advertising merchandising products
Data
e.g. information about customers (fans)
Constraint
Realisation
Technical feasibility
e.g. technology not available, concept or technology not appropriate for a huge venues
Costs
e.g. realisation too expensive
Execution
Acceptance
e.g. musicians'/audience' deny
Legal
e.g. copyright, privacy
Ability
e.g. the concept requires special skills that prevent many people from participating
added
Target group
e.g. children, old people
Role
Direct involvement
Performer
e.g. during the performance when playing an instrument, sing or doing live coding to create music
Audience member
e.g. during attending the performance directly, prior to it or afterwards
split up
Organisational assistant
e.g. security, ticket collector, usher
Performance assistant
e.g. responsible for sound, light & visuals, stagehand, master of ceremonies
Indirect involvement
Composer
e.g. writes a song considering audience participation for its later performance even if not involved as a performer
Manager
e.g. utilize audience participation to raise the artist's reputation or to gain popularity through innovation
Marketer
e.g. utilize audience participation for marketing, promotion or strategic feedback
split up
Creator
e.g. someone who does the technical realisation of the concept for audience participation such as a programmer or engineer
27 8 3 1
Interaction
How does participation happen?
1 8 22 53
Space
Movement
sitting
e.g. clapping, doing a mexican wave (laola)
standing
e.g. tapping with foot, jumping
mobile
e.g. walking, dancing
Setting
location
e.g. indoor, outdoor roofed, open air
size
e.g. club, stadium, concert hall, living room
time of day
e.g. sunlight, night
Distribution
on-site
e.g. front of the stage, in the back
remote
e.g. live stream at home
Quantity
large-scale
e.g. more than thousand
small-scale
e.g. a couple of hundred or less
Time
Chronological Order
synchronous
e.g. in-realtime during the performance
asynchronous
e.g. before or after the performance (vote for setlists, provide personal data to be used in the performance, rate songs afterwards)
Accuracy
time critical
e.g. sound synthes which should have none or very low latency
latency tolerant
e.g. data collection, audience opinion or behaviour
Acoustics
Humanly generated
voice
e.g. singing along, shout, cheer
gestures
e.g. clap, snip, clomp
Artificially generated
centralized
e.g. PA speakers
decentralized
e.g. participant's mobile phones
Emotion
Expressive
verbal
e.g. laugh, shout
non-verbal
e.g. facial expressions, gestures
Physiological
obvious
e.g. jumping, screaming
subtle
e.g. heart rate, skin conductance
Individuals
Relationship
collaborative
e.g. spectators have to act/achieve something collaboratively such as singing the same phrase, bouncing a balloon
competitive
e.g. groups of spectators are competing such as which group cheers louder
independent
e.g. every spectator makes a secret choice/vote at the same time
Unit setting
individual
e.g. spectators operate their own mobile phones
in groups
e.g. spectators can or have to form groups for the interaction such as all people in the back/front/middle of the venue
all together
e.g. all spectators are tracked visually as a whole, overall sound level is measured
Identification
public
e.g. every participation is visible/traceable while clapping or cheering
anonymous
e.g. participants are anonymous while behaviour is tracked
semi-public
e.g. registration at entrance
Knowledge or Skill
Playful
ability-oriented
e.g. GuitarHero-like
entertainment-oriented
e.g. play with artefacts or objects
Methodical
apply/use certain knowledge
e.g. participants are musicians/can play music
learning approaches
e.g. learning something step by step, learning by doing
intuitive
e.g. if you give someone something that looks like a pipe, most people will blow in it to try it out
Random
totally unpredictable
e.g. rolling dice
somehow predictable
e.g. assumed behaviour patterns within a group of humans
Feedback
Transparency
obvious
e.g. visual feedback such as figures or charts on a big screen/projection
subtle
e.g. the measurement of the movement of the audience throughout a concert is not perceived by anyone
Target
individuals
e.g. everyone gets feedback on a phone/wristband
groups
e.g. only people in front of the stage, or different feedback for sitting and standing spectators
none
e.g. something is measured/observed in a performance and only used later for analysis
all
e.g. the whole venue hears an influenced sound, votes of spectators are screened on stage
Action
Perspective
active
e.g. controlling parameters of a device, doing particular gestures
passive
e.g. visual recognition to observe the audience's behaviour
Method
modifying
e.g. changing parameters
creating new
e.g. collaborative performance
add something
e.g. being an additional performer
Artefact
using objects
e.g. marker, phone, throwing things
human body
e.g. moving arms, clapping, singing
Depth
holistic
e.g. audience members join band to play a whole song, the setlist for a concert, ambience of the light during the whole show
partly
e.g. audience decides about the encore at the end of the concert, let audience participate in the chorus, a spectator sings some lines of verses
TMAP Framework V5
Evaluation Step 3
"Design Card Application"
Main categories 3
Categories 15
Sub-categories 42
Design aspects 114
Entities in total 174


35 13 4 1
1 8 22 54
TMAP Framework V6
Evaluation Step 4
"Expert Review"
Main categories 3
Categories 15
Sub-categories 43
Design aspects 119
Entities in total 180
All reworded entities are framed in blue here for better visibility
TMAP Framework
Impact
How will the interaction affect performance aspects?
Interaction
What are the parameters of the interaction?
Motivation
Why are participants motivated to be involved?
Music
Timing
Sound
Composition
Processing
Performance
Visuals
Structure
Concept
Location
Aesthetics
Physicality
Experience
Element
Content
Lyrics
Data
split up
added
Goals
Personal
Artistic
Academic
Commercial
Constraints
Planning
Implementation
Roles
Direct involvement
Indirect involvement
Space
Movement
Setting
Place
Quantity
Time
Chronological Order
Accuracy
Emotion
Expressive
Physiological
People
Interaction relationship
Unit setting
Personal identification
Knowledge
Variables
Skills
Intuition
Feedback
Distribution
Location
Activity
Method
Means
Intensity
removed "Acoustics" and re-categorised
completely re-categorised
moved
added
reworded
redundancy
removed former "Method"
30 8 3 1

F.5 TMAP Design Cards

The following pages show the front and back of all 46 TMAP Design Cards including the three recommendation cards and a cover card. Note: The size of the cards in this illustration does not correspond with the real size of the cards.

by Oliver Hödl

TMAP
Design Cards

Design of technology-mediated audience participation (TMAP) in **Live Music**

Content

The TMAP Design Cards

The full deck contains 49 cards divided in 3 purple *Recommendation* cards, 6 red *Role* cards, 6 yellow *Motivation* cards, 12 blue *Influence* cards, and 22 green *Interaction* cards.

TMAP Design Cards
Recommendations for Usage

Purpose

Generate ideas and concepts to create technology-mediated audience participation (TMAP) in live music or add participatory elements to a live performance.

Use the TMAP Design Cards either in a group or on your own.

Preparation

Separate the deck and make four piles, one of each colour. The coloured side of a card is its main side and always appears face up. **Shuffle** each pile and have pens and paper prepared.

Basic Rules

The card's main side

The fully coloured side of a card is its main side. Always use the main side first when you draw a card and do not turn around a card immediately.

Use a card

Read the *Challenge* and the optional *Explanation* on the main side carefully to trigger your imagination. Do not turn around a card immediately after you draw it! Always try to think on the basis of the *Challenge* and the *Explanation* first.

Turn around a card

You may turn around a card if you need further *Suggestions*.

Multi Person Mode
Recommendations for Usage

Preparation

Every person draws a role card (red) which defines the person's role.

Everybody keeps thinking for a moment about the role and refines it quietly.

Hint

If the **Group Size** extends to six people or more, we recommend to make smaller groups of three or four people each.

Course of the Session

First round

Everybody **draws one card** in addition to the *Role* card (red). The person who starts takes an *Influence* card (blue), the second one an *Interaction* card (green), the third one a *Motivation* card (yellow), the fourth an *Influence* card, and so on.
Now everyone tries to **create an idea** based on the *Challenge* written on the card and the further *Explanation* below.
Do not **turn around a card** immediately but do so if you need further *Suggestions* while you create your idea.
This is followed by a **group discussion** where everyone contributes ideas based on their own cards. Use pen and paper to make notes and sketches.

Further rounds

After the first round, further rounds may follow. At this point **cards may be discarded** if wanted to draw a new card and even from another colour. Discarded cards may be either fully discarded from the game (of course only for this session) or discarded for later use by dropping it on the related sketches or notes of the finished previous round.

Single Person Mode
Recommendations for Usage

Preparation

For using the TMAP Design Cards alone, read the Multi Person Mode instructions first and in addition the alterations on the back side of this card.

Hint

In Single Person Mode we recommend to use **Pen and Paper** to sketch your ideas instead of just thinking.

Course of the Session

Alterations

You may draw a *Role* card (red) but you may also **define a role** on your own.

Act as if you were doing a session in a group but **draw all cards by yourself**. First, draw an *Influence* card (blue), then an *Interaction* card (green), then a *Motivation* card (yellow), then another *Influence* card and so on.

However, **do not draw more than one card at once**. Every time when you draw a card, think thoroughly about the *Challenge*, read the *Explanation* and finally turn the card to make use of the *Suggestions*.

Always **make notes and sketches** to write down your ideas before you draw another card.

Role. Who are you?

Challenge

Consider your direct involvement in the performance as a performer

Explanation

The Role you have is defined by a certain **Involvement.** Various kinds and degrees of involvement motivate stakeholders to be part of a participatory performance at some point.

1 | Involvement | Direct

Suggestions

Performer

Imagine your are an artist who plays an instrument or does live coding to create music is involved in the interaction for instance.

Role. Who are you?

Challenge

Consider your direct involvement in the performance as a spectator

Explanation

The Role you have is defined by a certain **Involvement.** Various kinds and degrees of involvement motivate stakeholders to be part of a participatory performance at some point.

2 | Involvement | Direct

Suggestions

Audience member

Imagine yourself among the spectators that are involved while they attend the performance, prior to it or afterwards, for instance.

Role. Who are you?

Challenge

Consider your direct involvement in the performance as an assistant or helper

Explanation

The Role you have is defined by a certain **Involvement.** Various kinds and degrees of involvement motivate stakeholders to be part of a participatory performance at some point.

3 | Involvement | Direct

Suggestions

Assistant or Helper

Imagine you are involved as an assistant or helper, e.g. someone responsible for sound, light, safety or ticket collection.

Role. Who are you?

Challenge

Consider your indirect involvement in the performance as a composer

Explanation

The Role you have is defined by a certain **Involvement.** Various kinds and degrees of involvement motivate stakeholders to be part of a participatory performance at some point.

4 | Involvement | Indirect

Suggestions

Composer

Imagine you are a composer who writes a song considering audience participation for its later performance even if not involved as a performer.

Role. Who are you?

Challenge

Consider your indirect involvement in the performance as a manager

Explanation

The Role you have is defined by a certain **Involvement.** Various kinds and degrees of involvement motivate stakeholders to be part of a participatory performance at some point.

5 | Involvement | Indirect

Suggestions

Management

Imagine yourself in the management that utilises audience participation for strategic feedback or promotional aspects for instance.

Role. Who are you?

Challenge

Consider your indirect involvement in the performance as a creator

Explanation

The Role you have is defined by a certain **Involvement.** Various kinds and degrees of involvement motivate stakeholders to be part of a participatory performance at some point.

6 | Involvement | Indirect

Suggestions

Creator

Imagine you do the actual creation or realisation as a designers or programmers to initiate the audience participation.

Motivation. Why are participants involved?

Challenge

Include someone for social reasons

Explanation

The Motivation could be led by a certain **Goal.** Different goals can drive the motivation to establish audience participation in a live performance.

7 | Goal | Social

Suggestions

Entertainment

What if playing an entertaining game is necessary to participate?

Feeling of togetherness

What if participants get in touch with each other by finding random peers or within groups of friends?

Activity

What if moving the body such as jumping or stretching is necessary to participate?

Awareness

What if the participation changes the perception of the whole performance and affects issues other than music?

Motivation. Why are participants involved?

Challenge

Include someone for artistic reasons

Explanation

The Motivation could be led by a certain **Goal.** Different goals can drive the motivation to establish audience participation in a live performance.

8 | Goal | Artistic

Suggestions

Creativity

What if creative aspects drive the motivation of the artist to let people participate whether they are planned or spontaneous?

Inspiration

What if the participation of people is seen as source of inspiration to either enrich or limit artistry for instance?

Engagement

What if the participation affects the people's behaviour and how they are engaged in a motivating or deterrent way for instance?

Challenge

What if the participation challenges a particular paradigm, such as switched off mobile phones during concerts or sitting quietly on a chair the whole time?

Motivation. Why are participants involved?

Challenge

Include someone for academic reasons

Explanation

The Motivation could be led by a certain **Goal.** Different goals can drive the motivation to establish audience participation in a live performance.

Suggestions

Behaviour

What if the analysis of a certain crowd behaviour (e.g. among the audience, the artists or both) is the reason for letting people participate?

Music

What if the analysis of the music itself or musical processes such as composing a song is the reasons for enabling participation?

Engineering

What if the creation and deployment of new systems or the use of a certain technology drives the motivation of a participatory performance?

Motivation. Why are participants involved?

Challenge

Include someone for commercial reasons

Explanation

The Motivation could be led by a certain **Goal.** Different goals can drive the motivation to establish audience participation in a live performance.

Suggestions

Marketing

What if the concept for interaction includes giveaways or digital gadgets for advertising merchandising products?

Data

What if audience participation helps to get particular information about customers (i.e. fans) for further use?

Motivation. Why are participants involved?

Challenge

Consider issues that constrain the actual realisation

Explanation

The Motivation could be led by a certain **Constraint.** Possible constraints might limit the motivation to establish audience participation in a live performance.

Suggestions

Technical feasibility

What if the require technology is not available or not appropriate for particular settings (e.g. performances in huge venues)?

Costs

What if the costs to realise a concept for audience participation are inappropriately high for instance?

Motivation. Why are participants involved?

Challenge

Consider issues that constrain the actual execution

Explanation

The Motivation could be led by a certain **Constraint.** Possible constraints might limit the motivation to establish audience participation in a live performance.

Suggestions

Acceptance

What if the audience or the musicians deny the participatory elements for certain reasons?

Legal

What if copyright or privacy issues get in the way of the realisation?

Ability

What if the concept requires special skills that, for instance, prevent too many people from participating?

Influence. What is the target of participation?

Challenge

Influence temporal characteristics of the music

Explanation

The Influence could be on something **Musical.** Certain musical characteristics and their creation can be the target of influence of a participating audience.

Suggestions

Tempo

What if the tempo is changed and the music is getting slower or faster according to the participation?

Meter

What if the meter of a song is influenced, such as fourth-fourth time or waltz time?

Beat

What if the beat is influenced by changing accentuation for instance?

Rhythm

What if the rhythm (e.g. note lengths) is subject to the participation?

Influence. What is the target of participation?

Challenge

Influence the sound considering basic aspects

Explanation

The Influence could be on something **Musical.** Certain musical characteristics and their creation can be the target of influence of a participating audience.

Suggestions

Pitch

What if the participation affects the pitch which might be definite (e.g. piano), variable (e.g. violin) or indefinite (e.g. cymbal) for instance?

Dynamics

What if the dynamics of a performed piece of music are influenced, e.g. the loudness or softness?

Timbre & Tone colour

What if the timbre or tone colour (e.g. bright, dark) of the sound itself is changed by the participation?

Influence. What is the target of participation?

Challenge

Influence the sound considering compositional aspects

Explanation

The Influence could be on something **Musical.** Certain musical characteristics and their creation can be the target of influence of a participating audience.

15 | Musical | Sound (compositional aspects)

Suggestions

Mode

What if the participation affects the mode, for instance, changing the scale from major to minor?

Harmony

What if harmonic structures, such as triads or chords are influenced?

Melody

What if the melody is changed in terms of an improvised variation or a solo by the participants?

Texture

What if the texture varies due to the participation which affects the way melodic, rhythmic and harmonic elements are intertwined?

Influence. What is the target of participation?

Challenge

Influence the creation of sound

Explanation

The Influence could be on something **Musical.** Certain musical characteristics and their creation can be the target of influence of a participating audience.

16 | Musical | Sound (creation)

Suggestions

Instrument or Voice

What if an instrument or the voice becomes the target of participation, for instance, a guitar, a choir, or the sampling or looping with a computer?

Playing or Singing

What if the playing or singing becomes the target of participation, for instance, the instruction to a performer to play louder, faster or another solo?

Effect

What if sound effects (e.g. delay, distortion) or any combination are affected by the participation?

Spatialisation

What if spatialisation plays a role, such as the number of different sound sources that exist (e.g. stereo, surround) and their distribution in the room (e.g. acousmonium)?

Influence. What is the target of participation?

Challenge

Influence structural characteristics of music

Explanation

The Influence could be on something **Musical.** Certain musical characteristics and their creation can be the target of influence of a participating audience.

17 | Musical | Structural

Suggestions

Figure

What if a figure (e.g. riff, phrase) is influenced?

Form

What if the form of a song, such as the overall layout of the composition or the number of chorus repeats are influenced?

Notation

What if the notation is affected by the participants whether it is as modern staff notation or as written descriptive notation, for instance?

Influence. What is the target of participation?

Challenge

Influence conceptual characteristics of music

Explanation

The Influence could be on something **Musical.** Certain musical characteristics and their creation can be the target of influence of a participating audience.

18 | Musical | Conceptual

Suggestions

Genre

What if the musical genre becomes the target of participation such as classical music, electroacoustic music or noise?

Style

What if the style of music is influenced, for instance, by describing it (e.g. "music for a particular mood", "christmas music")?

Influence. What is the target of participation?

Challenge

Consider the location of appearance where the influence happens

Explanation

The Influence could be on something **Visual.** Visual aspects might be the target of influence in a participatory performance.

19 | Visual | Location of appearance

Suggestions

On stage

What if elements on stage such as spotlights or video projections are affected?

Off stage

What if elements off stage are affected, for instance, directly among the audience members or their surrounding area?

Off venue

What if the influence happens off venue, e.g. in a live stream or on social media?

Influence. What is the target of participation?

Challenge

Consider different types of visual elements that might be influenced

Explanation

The Influence could be on something **Visual.** Visual aspects might be the target of influence in a participatory performance.

20 | Visual | Type

Suggestions

Ambience

What if ambient elements such as light or fog are affected?

Information

What if the participation is visualized as text, voting charts or pictures, for instance?

Influence. What is the target of participation?

Challenge

Consider the influence on perceptible physical elements

Explanation

The Influence could be on something **Physical.** Several physical elements can be considered to be the target of an influencing audience.

21 | Physical | Perceptible

Suggestions

HAPTIC

What if the influence becomes haptic, for instance through a vibrating phone, temperature, wind or powerful subwoofers?

SMELL

What if the influence affects the smell such as scented fog or smoke?

Influence. What is the target of participation?

Challenge

Consider the influence on concrete physical elements

Explanation

The Influence could be on something **Physical.** Several physical elements can be considered to be the target of an influencing audience.

22 | Physical | Concrete

Suggestions

TEMPORARY

What if the influence affects concrete physical elements temporarily such as moving the stage, rise platforms, moving a drumkit, moving spotlights or the movement of a dancer?

PERMANENT

What if the influence affects permanent physical elements such as a unique live record of the show or other special products which are given away right after a performance?

Influence. What is the target of participation?

Challenge

Influence the content considering the lyrics

Explanation

The Influence could be on something **Contentual.** Textual content might be the target of participation when an audience is included in a performance.

23 | Contentual | Lyrics

Suggestions

REPRODUCTION

What if the influence addresses the reproduction of lyrics such as letting spectators sing along existing lyrics?

CREATION

What if the influence affects the creation of lyrics, for instance, by defining the content of a song or by creating actual words or phrases?

Influence. What is the target of participation?

Challenge

Influence the content considering information

Explanation

The Influence could be on something **Contentual.** Textual content might be the target of participation when an audience is included in a performance.

24 | Contentual | Information

Suggestions

NUMBERS & STATISTICS

What if numbers and statistics are subject to the influence, such as letting spectators vote or rate something or count the number of people according to a certain behaviour?

TEXT

What if textual information is part of the influence, for instance, real-time chat conversations or social media messages?

MEDIA

What if the influence contains any kind of media, such as photos or videos taken by the audience?

Interaction. How does participation happen?

Challenge

Consider spatial movement for interaction

Explanation

The Interaction could be dependent on **Space.** Spatial aspects might shape the nature and ways of interaction.

25 | Space | Movement

Suggestions

SITTING

What if sitting spectators interact by clapping or doing a mexican wave, for instance?

STANDING

What if standing spectators interact by tapping with the foot or by jumping, for instance?

MOBILE

What if spectators are mobile which allows them to walk around or dance, for instance?

Interaction. How does participation happen?

Challenge

Consider the spatial setting for interaction

Explanation

The Interaction could be dependent on **Space.** Spatial aspects might shape the nature and ways of interaction.

26 | Space | Setting

Suggestions

LOCATION

What if the actual location plays a role (e.g. indoor, outdoor)?

SIZE

What if the size of the location makes a difference (e.g. club, concert hall, stadium, living room)?

TIME OF DAY

What if interaction is dependent on the time of day (e.g. sunlight, night)?

Interaction. How does participation happen?

Challenge

Consider the spatial distribution of interacting participants

Explanation

The Interaction could be dependent on **Space.** Spatial aspects might shape the nature and ways of interaction.

Suggestions

ON-SITE

What if interaction depends on the on-site distribution of the spectators at the venue (e.g. front of stage, in the back)?

REMOTE

What if interacting participants are distributed remotely (e.g. through a live stream over the internet)?

Interaction. How does participation happen?

Challenge

Consider the quantity of interacting participants

Explanation

The Interaction could be dependent on **Space.** Spatial aspects might shape the nature and ways of interaction.

Suggestions

LARGE-SCALE

What if a huge audience is present, for instance more than 1000?

SMALL-SCALE

What if a small audience is present (e.g. a couple of 100 or less)?

Interaction. How does participation happen?

Challenge

Consider the chronological order as an aspect of interaction

Explanation

The Interaction could be dependent on **Time.** Temporal considerations can characterise the actual interaction.

Suggestions

SYNCHRONOUS

What if the interaction happens in real-time, for instance, during the performance?

ASYNCHRONOUS

What if the interaction happens before or after to the performance (e.g. vote for setlists, provide personal data to be used in the performance, rate songs afterwards)

Interaction. How does participation happen?

Challenge

Consider accuracy for the interaction

Explanation

The Interaction could be dependent on **Time.** Temporal considerations can characterise the actual interaction.

Suggestions

TIME CRITICAL

What if the interaction is time critical (e.g. sound synthesis which should have none or very low latency)?

LATENCY TOLERANT

What if the interaction is latency tolerant, for instance, data collection of audience opinion or behaviour?

Interaction. How does participation happen?

Challenge

Consider interaction in terms of acoustics that is humanly generated

Explanation

The Interaction could be dependent on **Acoustics.** Acoustical elements and considerations might be relevant for interaction.

Suggestions

VOICE

What if interaction is based on audible sound produced by the human voice (e.g. singing along, shout, cheer)?

GESTURES

What if interaction is based on audible sound produced by human gestures (e.g. clap, snip, clomp)

Interaction. How does participation happen?

Challenge

Consider interaction in terms of acoustics that is artificially generated

Explanation

The Interaction could be dependent on **Acoustics.** Acoustical elements and considerations might be relevant for interaction.

Suggestions

CENTRALIZED

What if audible interaction happens centralized (e.g. through PA speakers)

DECENTRALIZED

What if audible interaction happens decentralized (e.g. through the spectators' mobile phones)

Interaction. How does participation happen?

Challenge

Consider interaction based on expressive emotion

Explanation

The Interaction could be dependent on **Emotion.** An interaction can be driven by emotional aspects.

Suggestions

VERBAL

What if emotional interaction happens verbal (e.g. laughing, shouting)?

NON-VERBAL

What if interaction is based on non-verbal emotion, such as facial expressions or gestures?

Interaction. How does participation happen?

Challenge

Consider interaction based on physiological emotion

Explanation

The Interaction could be dependent on **Emotion.** An interaction can be driven by emotional aspects.

Suggestions

OBVIOUS

What if emotional interaction happens obvious, for instance, jumping or screaming spectators?

SUBTLE

What if interaction is based on subtle emotion (e.g. the heart rate, the skin conductance)?

Interaction. How does participation happen?

Challenge

Consider the relationship of the interacting participants

Explanation

The Interaction could be dependent on **Individuals.** An interaction might be dependent on the role the participants have for participation.

Suggestions

COLLABORATIVE

What if all spectators have to act or achieve something collaboratively (e.g. singing the same phrase, bouncing a balloon)?

COMPETITIVE

What if spectators are competing, such as who cheers louder?

INDEPENDENT

What if spectator act independently, for instance, everybody makes a secret choice/vote at the same time?

Interaction. How does participation happen?

Challenge

Consider the unit setting of the interacting participants

Explanation

The Interaction could be dependent on **Individuals.** An interaction might be dependent on the role the participants have for participation.

Suggestions

INDIVIDUAL

What if all spectators interact individually, for instance, by operating their own mobile phones?

IN GROUPS

What if spectators can or have to form groups to interact, for instance, all people in the front, middle and back of the venue?

ALL TOGETHER

What if all spectators interact together as a whole (e.g. tracked visually, sound level measurement)

Interaction. How does participation happen?

Challenge

Consider the identification of the interacting participants

Explanation

The Interaction could be dependent on **Individuals.** An interaction might be dependent on the role the participants have for participation.

Suggestions

PUBLIC

What if the interaction is public and every spectator's participation is somehow visible or traceable (e.g. cheering, waving hands)?

ANONYMOUS

What if the interaction happens anonymous, for instance, by measuring a certain behaviour or using smartphones?

SEMI-PUBLIC

What if the interation is semi-public, for instance, everybody has to register at the entrance while the actual interaction is not traceable by the audience?

Interaction. How does participation happen?

Challenge

Consider a playful approach for interaction

Explanation

The Interaction could be dependent on **Knowledge or Skill.** A certain knowledge or skill can be taken into account for participation.

Suggestions

ABILITY-ORIENTED

What if a playful interaction is ability-oriented, similar to GuitarHero or SingStar?

ENTERTAINMENT-ORIENTED

What if a playful interaction is entertainment-oriented where the audience plays a game with artefacts, for instance?

Interaction. How does participation happen?

Challenge

Consider a methodical approach for interaction

Explanation

The Interaction could be dependent on **Knowledge or Skill.** A certain knowledge or skill can be taken into account for participation.

Suggestions

APPLY/USE CERTAIN KNOWLEDGE

What if a special knowledge is required for interaction, e.g. that the participants are musicians/can play music?

LEARNING APPROACHES

What if the interaction includes a learning approach, for instance, learning by doing where the participants learn something step by step during the performance?

INTUITIVE

What if the interaction expects an intuitive behaviour? (e.g. if you give someone something that looks like a pipe in a musical context, people will most probably blow in it to try it out)

Interaction. How does participation happen?

Challenge

Consider a random approach for interaction

Explanation

The Interaction could be dependent on **Knowledge or Skill.** A certain knowledge or skill can be taken into account for participation.

Suggestions

TOTALLY UNPREDICTABLE

What if the interaction includes random elements that are totally unpredictable, such as rolling a dice?

SOMEHOW PREDICTABLE

What if the interaction includes somehow predictable elements, for instance, assumed human behaviour patterns?

Interaction. How does participation happen?

Challenge

Consider the transparency of the feedback given to the interacting participants

Explanation

The Interaction could be dependent on **Feedback.** Feedback as a central element of interaction can be considered differently.

Suggestions

OBVIOUS

What if the feedback of the interaction is obvious? (e.g. visual feedback as figures or charts of every individual on a big screen)

SUBTLE

What if the feedback of the interaction is subtle? (e.g. the measurement of a particular behaviour, such as the movement of the spectators throughout a performance, is not perceived by anyone in the same way or even any way)

Interaction. How does participation happen?

Challenge

Consider the target of the feedback

Explanation

The Interaction could be dependent on **Feedback.** Feedback as a central element of interaction can be considered differently.

Suggestions

INDIVIDUALS

What if everyone gets individual feedback, for instance, on a smartphone or a wristband?

GROUPS

What if groups of spectators get different feedback? (e.g. only people in the front of the stage get feedback of their interaction or different feedback for sitting and standing spectators)

NONE

What if no one gets any feedback? (e.g. if something is measured/observed during a performance and only used later for analysis)

ALL

What if everybody gets the same feedback? (e.g. the whole audience hears an influenced sound or votes of the spectators are screened publicly on stage)

Interaction. How does participation happen?

Challenge

Consider the perspective of the interacting participants

Explanation

The Interaction could be dependent on **Action.** The way interacting participants might act or react may be varied for participation.

Suggestions

ACTIVE

What if the interaction requires an active behaviour, such as controlling certain parameters of a device or doing particular gestures?

PASSIVE

What if the interaction happens passively? (e.g. visual recognition is used to observe the audience's behaviour)

Interaction. How does participation happen?

Challenge

Consider the method that characterizes an interaction

Explanation

The Interaction could be dependent on **Action.** The way interacting participants might act or react may be varied for participation.

Suggestions

MODIFYING

What if the interaction modifies something existing, such as changing sound effect parameters of an instrument?

CREATING NEW

What if the interaction creates something new from scratch? (e.g. all spectators perform together to create music collaboratively)

ADD SOMETHING

What if the interaction adds something new to something existing? (e.g. the audience is considered as an additional "musician")

Interaction. How does participation happen?

Challenge

Consider the artefact that characterize an interaction

Explanation

The Interaction could be dependent on **Action.** The way interacting participants might act or react may be varied for participation.

Suggestions

USING OBJECTS

What if the interaction requires special objects, such as a traceable marker, a phone or throwing things around?

HUMAN BODY

What if the interaction requires the human body? (e.g. moving arms, clapping, singing)

Interaction. How does participation happen?

Challenge

Consider the depth of interaction

Explanation

The Interaction could be dependent on **Action.** The way interacting participants might act or react may be varied for participation.

Suggestions

HOLISTIC

What if the interaction affects certain aspects holistically, for instance, audience members join the band on stage to play a whole song, the setlist for a concert is created collaboratively, or the ambience of the light during the whole show is influence

PARTLY

What if the interaction affects a performance party, for instance, the audience decides about the encore at the end of the concert, the audience participates only during the chorus, or a single spectator sings some lines of verses?