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A Design Framework
for Live Audience
Interaction
Management Systems

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L A I X — s c o r e

A     Design     Framework
f           o           r
Live               Audience
I n t e r a c t i o n
Management         Systems

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# Acknowledgements

For Riitta and Niilo

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# Abstract

This study focuses on computer-supported live audience interaction. In conventional lectures audience interacts explicitly with the performer for example by waving hand and asking question directly or clapping hands. For decades, nondigital audience response systems have enabled simple multiple option audience interaction patterns. Modern mobile personal computing devices, digital projectors, wireless networks and real time software platforms enable creation of new kinds of interaction patterns that can significantly increase the amount of audience interaction during events. Audience interaction can make events for example more engaging and productive.

This research presents a design framework for computer-supported live audience interaction called the LAIX-score. LAIX stands for Live Audience Interac(X)tion and the "score" refers to the musical notation language. Musical notation has been an inspiration for the development of the framework and illustrates how LAIX-score is intended as generic and practical framework for coordinating live audience interaction similarly as musical notation is generic and practical framework for coordinating musical performances. However, while musical notation is important inspiration, it is not the core reference for the LAIX-score. LAIX-score core references are the live audio mixing and live light control frameworks, which are technologyenabled frameworks for supporting and producing live performances.

The LAIX-score framework is composed of five core elements: Interaction activities, interface channels, state control matrix, temporal management of interactions and participant's identity management. These five core elements compose a concrete and comprehensive framework that can be directly applied in the design of live audience interaction management system and in the development of live audience interaction production practices.

The research is a constructive and practice-led in the wild research (Chapter 2) that borrows aspects from design research, artistic research and human-computer interaction research. The LAIX-score framework is based on three *core requirements* identified during a five years of practice-led domain exploration (Chapter 3). (Requirement 1) Live audience interaction must support different kinds of interaction patterns. Hence, the framework should acknowledge that live audience interaction is more than questions and answers (Q&A) and poll type interaction patterns. (Requirement 2) Live audience interaction must support different roles. Hence, the role configuration in

live audience interaction can include several different performer, audience and orchestrator roles. (Requirement 3) Live audience interaction framework must also support different kinds and parallel functions live audience interaction function. Hence, in the same event production live audience interaction may be used for example for audience activation, workshop facilitation, participatory decision making and catalyzing social networking, and these functions may take place concurrently.

None of the existing live audience interaction systems satisfy all of the core requirements. This is explained in more detail in Section 4.2. Lack of adequate designs that meets the above mentioned criterias justifies the development of a new design framework. The LAIX-score (Chapter 5) follows a two dimensional matrix type control framework, which is called state control matrix. Also the core references, live audio mixing and live light control (Sections 4.3–4.5), have similar control framework. Rows in the state control matrix are called as *interaction activities*. Columns in the state control matrix are *interface channels*, which is the system equivalent for supporting different roles and user interfaces (requirement 2). The matrix is used for visibility control of the interaction activities. The visibility of interaction activities can be manipulated independently in each interface channel. The matrix form satisfies the three core requirements. The first requirement is satisfied since the matrix format is agnostic to what kind of interactions are controlled in the system. The second requirement is satisfied since the matrix format allows introduction of new roles and there is fundamentally no fixed number for rows. The third requirement is satisfied since multiple interaction activities can be active in any channel and each interaction activity state can be controlled independently.

The core framework is implemented as a functional live audience interaction management system called *Presemo* (version 4) (Chapter 6). The evaluation of the design of Presemo reveals more detailed fivetier structure for the *control of interaction activities*. The interaction activity control levels in LAIX-score design framework are (1.) creation and deletion, (2.) state control matrix, (3.) interaction pattern specific control, (4.) content management and (5.) presentation management. Presemo is limited implementation of the framework since the basic version supports only four interface channels.

Presemo is a commercial level system and it has been utilized in thousands of live audience interaction situations and we have used it to produce more than 100 live audience interaction productions. The research investigates four case studies in more detail (Chapter 7). These four case studies are produced in different environments and this way demonstrate the generic qualities of Presemo and the LAIX-score design framework. One of the case study production focuses on professional event productions, another in application of Presemo in University context, third one focuses on use of live audience interaction in large scale computer-supported workshops and fourth one presents use of live audience interaction techniques in a pervasive adventure designed for K12 students.

The case studies validate the three core requirements and identifies 11 new *additional requirements* for the LAIX-score matrix. The case studies also reveal a more detailed interface channel structure. The revised LAIX-score design framework divides interface channels in three groups: *organizer channels, audience channels and screen channels*. Organizer channels combines performer and orchestrator roles, since these are roles that have some kind of control over interaction activities. Audience interface channels can be divided in groups. Screen channels are public channels whereas organizer and audience channels are personal channels.

The 11 new requirements are further elaborated as two new core elements of the LAIX-score framework (Chapter 8): *temporal management* and *identity management*. Temporal management is divided in three parts; the *functional cue list* realizes the future temporal management, state *control matrix* realizes the real time management, and the *production log* realizes the management of past events. Identity management core element can be visualized as a table that lists all identities on one axis and different identity parameters on another axis. The study has identified six different types of identity attribute categories: identifiers, group membership, access rights, privacy settings, other identity and profile parameters and score attributes used for gamification. Identity attributes and privacy settings are used to manage identity parameters in order to achieve privacy and anonymity, which are important characteristics for most live audience interaction productions. Case studies have shown also that gamification is an important feature for live audience interaction.

The core objective of the research is to create a framework for live audience interaction that could be generic and practical. As such, the study is directly relevant extensive case reference of a live audience interaction system researchers and live audience interaction producers. The framework is adequately described so that any developer can utilize it in their own live audience interaction system designs. Methodologically the research has some areas of improvements mainly due to challenges in organizing data collection in demanding production environments (Sec-

tion 9.3). These problems are common for in the wild research. The strengths of this research are extensive coverage of the live audience interaction domain and concrete validation of the framework as a production level implemented software system.

While we have been developing the LAIX-score framework we have also identified several other research topics for live audience interaction (explained in Section 10.3) that are beyond the scope of the LAIX-score framework. There are for example several issues related to human and organizational factors of live audience interaction that are not covered in the LAIX-score framework, which is designed for the development of the computer system and production practices. These other research topics demonstrate how live audience interaction domain is still emerging domain with many interesting research possibilities.

During the study, we have been involved in commercial development of live audience interaction. The business and marketing development (Section 10.4) will most probably be the driving force for the development of new interaction patterns, live audience interaction production formats, professional practices and generally new applications for live audience interaction. The further business and marketing development will define how organizations can adopt live audience interaction techniques and integrate them in to their communication and participation processes. The study proposes that standards organization would start defining protocols for live audience interaction. Details of wider adoption will ultimately define what kind of further research is relevant and feasible in the live audience interaction domain.

The five core elements of the LAIX-score are integrated to each other and together they compose a comprehensive framework that can be used as design guideline for generic *live audience interaction system* (LAIMS). A LAIMS that is based on LAIX-score can host modularly different kinds of interaction patterns (Section 10.2). Modular approach can be also called as interaction agnostic approach. The modular approach may have several implications: modular approach makes development of new interaction patterns easier, support event productions that host different live audience interaction approaches, support sustainable system evolution and establishment of management practices for live audience interaction productions.

# 1.

# Introduction and background

## 1.1 Emergence of Computer-supported Live Audience Interaction

Digitalization is changing our lives in many aspects, in the areas of entertainment, work, social life or industrial processes. Digitalization has enabled new ways of communication. Email was invented during the era of mainframe computers in the 1970's and these mainframe computers were capable of sending asynchronous messages between individuals. The World Wide Web was born in 1980's but only in the 2000's has it matured to a level that enables practical combinations of rich media and communication. Today, social media has become mainstream and has significant influence on social lives and businesses. Mobile telephones enable wireless calling practically to anybody independent of place. Hence, the ways we communicate today look significantly different from the ways we communicated in the 1980's.

While computers have penetrated into the realm of many of our daily social functions, there are still areas that do not significantly take advantage of computer-supported communication. Computers are rarely used in collocated social situations to facilitate communication between members of the audience or between the audience and the presenters. In practice, computers are already present in most collocated social situations. This is because people rarely go anywhere without their mobile devices. People have their mobile computing devices at events and they often also use them, but they do not use them to support their engagement with the present situation, but rather they use them to engage in something that is not directly related to the performance where they are a member of the audience. Computer-supported live audience interaction focuses on how the audience experience can be extended by utilizing orchestrated computer-based interactions.

Why are computers not used more frequently to support live audience experiences? There are probably two answers to this question. One reason is that computer-supported live audience interaction has not been practically feasible until quite recently. Another answer is that there is no need for computer-supported communication at audience events, as people are focused on spectating and can communicate directly with the presenters and other audience members, without need for computer mediation.

Computer-supported audience interaction should not focus on replacing or competing with direct interaction between people. Direct social interaction is what makes collocated social situations unique and valuable. However, two directional communication in most performance situation is limited, because performers or presenters cannot facilitate or manage interaction with many audience members simultaneously and addressing audience members individually is too time consuming. Providing feedback mechanisms for the audience, mechanisms that go beyond yelling or hand waving, such as collecting feedback with paper notes or group work arrangements, is not practically feasible since organizing such procedures is a complex and timeconsuming task.

Computers can be used to mediate complex interactions and enable parallel commenting and various types of responses. Computers can also quantify responses quickly and accurately. Computers can process audience responses in multiple ways including generating real time analysis and visualization. Computer-based interactions can scale up to hundreds or thousands of parallel participants depending on the interaction type. Hence, computer-based communications could provide significant complementary communications possibilities for audience events.

One important aspect in audience events is that the performer controls the audience's attention. Control of attention must be maintained if computer-supported live audience interaction is to be integrated as a central part of a performance. Loosing audience attention can be significantly destructive for a performance. Supporting the management of attention is an important aspect for a software system that facilitates live audience interaction. Supporting the management of attention in a large scale computer system is a novel design challenge that this thesis research is focused on addressing.

Computers can be used in various ways for audience interaction. Venue can host proprietary computers for the audience, or single computer may be equipped with audio and camera sensors that track the audience. The most common and practical way is to utilize individual's own computing devices since they are widely avaialbe and capable computing systems. Still, smart phone or some other personal computing device is not the only technical enabler needed to make computer-supported audience interaction practical. It is also important that there is enough wireless network capacity to ensure that all audience members can participate in interaction. The space must have a large digital display to visualize audience interaction and provide performer means to initiate and acknowledge interaction. And, there must be functional software system for all audience members that supports real time distribution and management

of interactions. Hence, there are ultimately four critical technical enablers for live audience interaction. These enablers are elaborated in Table 1.1a.

Today, it is common that all four criteria can be met in most large audience events. When this study was started in 2007, the situation was significantly different. Many people did not have smartphones and generally there was not enough wireless network capacity at event spaces. Smartphone browsers were very immature and did not support real time control, and mobile phone application development environments were not widely adopted and they had limited functionality. In 2007, many event spaces had digital screens, but the size and quality of such screens has since significantly improved.

Hence, it has only been in the last few years that live audience interaction has been technically feasible in most audience event situations. Probably for this reason, during the last few years there has been an emergence of different kinds of live audience interaction applications and practices. For example, it is common that organizers of seminars and conferences utilize different kinds of messaging wall systems.

TABLE 1.1A :      CRITICAL TECHNICAL ENABLERS
                           FOR LIVE AUDIENCE INTERACTION

| ENABLER | EXPLANATION |
|---|---|
| Personal computing device | Smartphone, tablet or laptop. Mobile computing device that supports wireless internet connectivity and is programmable such as an iOS and Android device. |
| Wireless network | There are basically two types of wireless networks: cellular networks and WiFi networks. Cellular network providers rarely have the capacity to provide highquality internet access to several hundred participants from the same location[1]. For this reason, a WiFi network is usually the preferred option for wireless connectivity in live audience interaction. |
| Software environment | Modern smartphones, tablets and laptops support applications that can have programs that react on remote control. Such programs can be built as an application, but also modern web browsers support real time interactions. |
| Large display | Large digital surfaces, such as digital projectors, LED, LCD or plasma screens that allow manifesting audience interactions as parts of the performance. |

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1)
Current 3G wireless networks have limited bandwidth. 4G networks have significantly more bandwidth and future 5G networks have most probably enough bandwidth to cover live audience interaction even for hundreds of people.

2)
Backchannel systems are described by Atkinson (2009) or Harry (2012). Commercial systems are for example Tweetwallpro (tweetwallpro.com) and Prospectum (prospectum.fi).

3)
Socrative is one of the most popular student response systems. Other similar systems are Flinga (flinga.com) and Kahoot (kahoot.it)

4)
Electronic brainstorming systems are described for example by Dennis (2007).

5)
See for example Livetweeting by Huotari (2014) or Geerts (2014) or second screen applications.

Some of these systems have a unique web-based interface, some use a native event application and some utilize social media such as Twitter for messaging[2].

Also, some events utilize audience response systems that allow for asking multiple choice questions from the audience. In the classroom context there are similar systems that are called student response systems or classroom interaction systems[3]. Different kinds of workshops utilize, for example, electronic brainstorming systems[4]. Furthermore, related to this phenomenon is the use of social media or some other mobile messaging and presentation system during live television broadcasts and live sports events. This is commonly called live tweeting[5].

## 1.2 Significance of Computer-supported Live Audience Interaction

Why is computer-supported live audience interaction a relevant and interesting research topic? The significance of computer-supported live audience interaction can be elaborated by dividing the question into two parts: First it is important to ask what is the significance of audience events overall. After answering this first question it is possible to elaborate upon how much computer-supported audience interactions can impact such events.

Audience events have had great significance in the development of modern society. A concrete example of this is found in the architecture of ancient cities. Most ancient cities, regardless of their culture, had a central building for hosting large audience events where people could gather together. The function of these sites ranged from politics to entertainment. Large globally recognized audience events are iconic and often broadcasted to millions of people who are offsite audience members. Audience events occupy a vast domain, ranging from education to business conferences, political meetings, research events, hobbyrelated events, sports, various forms of entertainment and interorganizational activities. Audience events vary in size, function and significance. The production of audience events is a significant industry or group of industries, depending on the event function.

Computer-supported live audience interaction can be used in various ways to enhance audience events. It can be used for example to enhance the audience experience or to activate the

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audience. Live audience interaction can be used to collect feed-back, develop new ideas or to make decisions. One extreme scenario of computer-supported live audience interaction is when human and machine computing are combined together, and an audience event is turned into a facilitated social computing activity.

In practice, computer-supported live audience interactions take place in classrooms, meetings, seminars, workshops, marketing events, political events or show events. Each of these contexts has a unique practice and computer-support must be aligned to these practices. Most computer-supported live audience interactions are currently performed by writing messages, pressing buttons or various combinations of these two. In the future, live audience interaction can have other modalities such as phone shaking, sending pictures, drawing, speaking, playing or using the phone as a proxy to sense human physiological activity. The contemporary applications of live audience interaction focus in single context and to single type of interaction. It is expected that in the future same system may be applied in multiple context, and in one event there are multiple different type of interaction approaches.

Considering the variety of different audience events and the variety of different interaction types, it is probable that the live audience interaction domain will be divided in to smaller subgroups. However, there are still certain aspects related to this phenomenon that justify generic treatment of the topic. In most performative situations, there is a need to control the interaction flow and manage audience attention so that it is aligned with the performance. Such management framework is fundamentally similar for all different contexts. The production practices for live audience interaction productions can be considered as a unique profession, similarly as live audio design and engineering or live light design and engineering. This thesis explores how to support management and control of live audience interaction.

## 1.3 Defining and Positioning Computer-supported Live Audience Interaction

The previous chapter revealed how large the domain of live audience interaction is and how there will ultimately be many different kinds of activities that fall under the definition of

computer-supported live audience interaction with personal computing devices. This chapter focuses on elaborating in more detail what computer-supported live audience interaction is, how it is defined within this study and how it is connected to other related concepts.

TABLE 1.3A :   DEFINITION OF COMPUTER-SUPPORTED LIVE AUDIENCE INTERACTION AND ALIGNMENT OF THIS DEFINITION WITH RELATED PRACTICES:

| | |
|---|---|
| Computer-supported live audience interaction with personal devices (live audience interaction or LAIX): | Large audience interaction with digital programmable systems; personal computing devices, wireless networks, digital big screens and software environments. Expects audience with more than 10 people (preferably more than 30) and an established performance. Fundamentally a col-located activity, but can be also organized as a form of hybrid participation, when part of audience is collocated with the performance and part are remotely participating via a streaming connection. |
| Traditional performance: | One presents and performs and many (audience) listen and observe this performance. Traditional performances are established collocated situations and do not expect computing systems for interaction. Audience can interact either directly (for example hand waving) or indirectly (see for example audience effect[6]). Traditional performances should not be confused with general performativity that can take place in various context and were commonly performer and audience roles can mix. |
| Online interaction: | Scalable communication and interaction between group of people (for example social media). Does not have establish performance that is center of attention and facilitates interaction. Participants are not collocated. |
| Electronic live audience interaction or interaction with audience response systems (ARS): | Presenter / performer facilitates audience interaction with specific devices (clickers, voting gadgets) and provides only multiple-option interactions. In live audience interaction, the devices are programmable and can support various types of interactions. |
| Collocated computer-supported collaboration: | Use of online systems for collocated or remote collaboration (for example use of Google Docs during meetings or large digital displays for collaboration). Does not expect established performative situation and large audience similarly as live audience interaction. |

Since this is an emerging and growing domain, other related concepts also exist and for positioning this work it is important to briefly elaborate how these concepts are connected to live audience interaction with personal computing devices.

The above table 1.3a defines computer-supported live audience interaction with personal devices (also shortened in this research as live audience interaction or LAIX) and explains how this activity is related to other established activities. The software system that can be used to realize live audience interaction is called live audience interaction management system (or LAIMS).

7)
See for example Kay and LeSage (2009) review article which includes 52 analyzed related articles for audience response systems in educational context.

8)
Should not be confused with video and audio conference system, which are computer-based mediation tools for allowing dislocated people to form a conference situation.

9)
See for example Huotari (2014)

10)
Interactive cinema was more popular research topic around 2000 and at that time there was for example a research group under that name in MIT Media Lab. Lately, there has not been much studies related to interactive cinema. Enactive Cinema by Pia Tikka (2008) can be considered to be related concept, however it does not consider explicit participation from audience, but is based on implicit feed back.

11)
See for example Alan Wake and Quantum Break by Remedy Entertainment, remedygames.com

TABLE 1.3B :    CONCEPTS RELATED TO LIVE AUDIENCE INTERACTION

| RELATED CONCEPT | USE OF THE CONCEPT |
|---|---|
| Audience response system (ARS) | ARS is a concept used by industry that develops for example clickers or other voting or responding devices. Originates from purpose built devices (Clickers), but currently the name is also used for web-based systems. See for example iClicker (2015). There are many studies that evaluate audience response systems[7]. |
| Student Response System (SRS), Classroom Response Systems (CRS) | SRSs and CRSs are similar to ARS but used in educational contexts. Web versions of the SRS are sometimes coined as classroom engagement systems. See for example Socrative (2015) and Flinga (2015). |
| Clickers | Conference systems are used mostly in meeting rooms for voting and for providing complementary audio channel. Established industry with several vendors such as Taiden (2015) and Gonsin (2015) Proprietary devices that do not utilize individual's personal devices[8]. |
| Backchannel | The concept backchannel comes from politics and especially refers to an alternative communication channel that is in the background. Is used to refer a message wall type complementary communication channel in events. See for example: backchan.nl (2012) |
| Message walls, tweet walls | There are different kinds of message wall systems that are deployed in conferences. These systems can be based on SMS messages, social media messaging or direct web-based message interfaces. See for example: Tweetwall pro (2015) and Prospectum (2015) |
| Live Tweeting | Live tweeting refers to use of Twitter during a live situation. Live tweeting takes place for example during televised broadcasts, seminars and sporting events. Often realized adhoc as a form of communication between audience members, but can also be embraced and acknowledged by the performers or moderators (such as commentators or hosts in live television and live sports). Can be perceived as a form of Computer-supported live audience interaction with personal computing devices, but in this case the software environment (Twitter) does not facilitate different kinds of interaction approaches. Instead of Twitter it is also possible to use other kinds of social media such as Facebook or Yammer.[9] |
| Interactive cinema | Interactive cinema[10] refers to movies, which have a narrative that can change based on different interaction techniques. The early examples of Interactive Cinema date back to sixties. Some of the modern storytelling driven computer games are close to interactive cinema[11]. |
| Audience games | There are many kinds of audience games. Some of the games use proprietary devices, some use mobile devices and others use sensors. See for example: Timeplay interactive and Uplause[12]. |

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| Second screen | Second screen means the use of a mobile, tablet or laptop while watching television or some live event. The mobile device is a complementary interface for media. Commonly deployed by proprietary applications or social media. |
|---|---|
| Electronic brainstorming | Digital systems that are used to enhance brainstorming and collaboration. Can support collaboration and be integrated with performances. Concept mainly used by researchers. See for example: Dennis (1995) |
| Decision support systems | Decision support systems are an established domain with many different kinds of technical approaches. Term is not specific for decisions that are made in live situations. |
| Electronic Meeting System (EMS) | EMS is a type of computer software that facilitates creative problem solving and decision making by groups within or across organizations.[13] The term is synonymous with Group Support Systems (GSS). See for example Meetin.gs, Thinktank and Meeting Sphere[14]. |
| Webinars and webinar systems | Webinars are online seminars. Webinar systems such as Adobe Connect Pro (2015) or Cisco WebEx (2015) can have interactive features such as voting and chat. Webinars do not expect collocation, but since many live audience interactions expect hybrid participation (combined onsite and remote), there is not necessarily that much difference between webinars and webinar systems and live audience interaction management systems. |
| Live Participation | Synonym for live audience interaction with personal devices. Concept used among our colleagues and researchers. Emphasizes how audience interaction can be perceived as a form of participation (to the performance or to the underlying organizational process). Poll everywhere is a widely acknowledged application used for audience interaction and their tagline is "live audience participation". Concept introduced for example by Nelimarkka (2014, 2016) and Kuikkaniemi (2013). |

The above table shows that live audience interaction is related to many concepts. The purpose of this thesis is not to introduce yet another concept. The term live audience interaction is chosen as the central concept instead of other concepts presented in Table 1.3b since it allows generic treatment of the phenomenon independent of the domain or the interaction approach. General treatment of the topic is important because if the same design framework can be applied in different fields, it is easier to establish widely known processes, skills and concepts. Generic treatment enables emergence of independent and acknowledged industry and practice. It is important to remember that this is a practice-led study in an emerging domain that does not have established concepts or recognized independent status.

12)
timeplay.com
and uplause.com

13)
Electronic

14)
Meething Sphere
(meetingsphere.com)
and Meetin.gs
(meetin.gs)

# 1.4 LAIX-score Design Framework for Computer-Supported Live Audience Interaction

This study is focused on developing a design framework for live audience interaction with personal computing devices. The framework is expected to advance the live audience interaction practice by providing a generic framework that could become shared practice among all practitioners in this and related fields. This way the framework could help practitioners to design better live audience interaction productions, manage complexity related to organizing live audience interaction and realize the various possibilities of the computer-supported live audience interaction.

The framework developed in the study is called LAIX-score. LAIX comes from live audience interaction and the score refers to generic musical notation, which is used for example to control an orchestra. Musical notation is abstract inspiration for the framework. The more concrete core references for the framework are live light control and live audio mixing frameworks. The LAIX-score framework introduces core structures for controlling live audience interaction. The framework is developed based on three core requirements: (1.) it must support different interaction activities, (2.) it must support different role configurations and (3.) it must support multiple and parallel functions for the live audience interaction. These requirements are explained in Chapter 3.

The LAIX-score design framework is based on the idea that live interaction environment and individual interaction patterns can be separate to different layers. This is a modular approach that can be called also as interaction pattern agnostic approach. The framework is divided in the five core elements. These core elements are: interface channels, interaction activities, state control matrix, temporal management and identity management and they are presented together with some central details in the figure 1.4a. These core elements are selected based on thorough investigation of the real world live audience interaction productions. These five elements together provide the critical functions for managing and coordinating live audience interaction productions.

The core application of the LAIX-score framework is using it as a reference design overview for the live audience interaction management systems (LAIMS). In addition, the LAIX score can be also used in the development of communication and coor-

FIGURE I.4 :     THE CORE ELEMENTS OF THE LAIXSCORE DESIGN FRAMEWORK

**INTERFACE CHANNELS**
Divided to Organizer, Audience
and Screen channels. Organizer
channels have different control
rights to interaction activities.

**TEMPORAL
MANAGEMENT**
Present state
defined in the
State control
matrix. Future
state in the
cue list. Past
contributions
collected in the
aggregated
session log.

**STATE CONTROL MATRIX**
Defines what is the state of
an interaction activity in the
respective interface channel.

**INTERACTION
ACTIVITIES**
Interaction
activities
have five
control levels.
Audience creates
contributions to
the interaction
activities.

**IDENTITY MANAGEMENT**
Access rights and group management
define interface channel access.
Identity attributes are utilized by
the interaction activities. Profile
management establishes digital identity
and defines privacy setting.

dination practices for the live audience interaction productions. The design framework is not a model that describes the human behavior in live audience interaction or describes the social interaction between people. The LAIX score framework as such does not address any interaction pattern specific qualities. Analyzing and elaborating interaction activities is critically important research topic for live audience interaction, but it is outofscope for this study. There is several interesting research topics in live audience interaction that have been identified during the research, but are outofscope of the thesis. These topics are briefly introduced in the section 10.3.

This chapter has introduced how the live audience interaction phenomenon has emerged gradually through the advancements in digital technology. It has also shown how the phenomenon can significantly change social interaction and communication practices in events. There is potential that live audience interaction can influence what is the function of collocated gatherings. The chapter has briefly also explained the LAIX-score framework, which is the final deliverable of the study. Before focusing in detail on explaining how LAIX-score was developed or what is the detailed content of the LAIX-score, it is important to elaborate the research approach of the study. The Chapter 2 introduces the research objectives and research questions. The chapter will also explain the underlying scientific background for the study, elaborate research methodology and provide an overview of the research.

# 2.

## Research
## Approach

## 2.1 Introduction

This chapter focuses on elaborating upon the research approach of this thesis. The research is focused on developing a practice-focused design framework for live audience interaction that can support development of live audience interaction management system and guide development of production practices.

The chapter begins by discussing practice-led research, which is the core scientific approach for this study and introducing in particular the production-led research in the wild framework, which is the research framework utilized in this study and adapted from Benford's performance-led research in the wild framework. After introducing the practice-led research approach, the core objectives of the study are elaborated together with the detailed research questions and a detailed examination of the scope of the research.

After explaining the research questions, the core related scientific perspectives are discussed. The detailed methodologies applied in the study are based on these related scientific fields. Finally, the structure of the thesis is explained by elaborating in detail what the motivation of each chapter is, what kind of methods are utilized in each chapter and finally how the outcome of each chapter feeds forward into the development and analysis of the LAIX-score design framework.

## 2.2 Practice-led Research Approach

### 2.2.1 Practice-led Research Approach

Live audience interaction is a complex social practice that cannot be researched in the laboratory, mostly because in the laboratory context the social practices become biased. The core objective of this research is to create a design framework that is practical and generic. For this reason, practice-led research is an appropriate research approach, as it combines concrete engineering focused problemsolving actions with an analytical research orientation.

Candy has categorized practice related research in two categories, practice-led research (PLR) and practice-based research (PBR)[15]. If a creative artefact is the basis of the contribution to knowledge, then the research is *practice-based*. If the research leads primarily to new understandings about practice, then

15)
Candy (2006)

16)
Action research history by Masters (1995)

17)
Kemmis & McTaggart (2004)

18)
Lukka (2000)

19)
McNamara (2012)

it is *practice-led*. This is primarily a practice-led research, but since important part of the research is an analysis of a live audience interaction system called Presemo, this study has some characteristics of practice-based research. The research leads to understanding of live audience interaction practice in general, hence the research can be categorized as practice-led research.

The origins of practice-led research (PLR) do not lie in creative practices. PLR originates from action research. Action research is an established research tradition that originated around the 1940's from social and applied psychology[16]. Kemmis & McTaggart[17] have described action research in the following way: *"[Action Research] is characteristically conducted by practitioners working from in their own field, who undertake a process of 'collective, selfreflective enquiry' into their own practices in order to improve those practices"*. Action research is fundamentally different from the classical approaches in psychology or sociology where the researcher takes an observer role and tries to minimize his or her influence on the subject in question.

Constructive research is another tradition that has similar characteristics to action research and practice-led research. Constructive research has been defined as a subset of case study research. Constructive research is often used in computer science whereas practice-led research is more common in the creative practices. Lukka[18] has defined the core features of constructive research. Constructive research should focus on real world problems by producing innovative constructions and also implementations of these constructions. Lukka also points that constructive research also implies close collaboration between the research and the practice or researchers and practitioners. Constructive research should explicitly link to prior theories and reflect empirical findings back to the theory. The definition of constructive as *"having or intended to have a useful or beneficial purpose,"* reflects this research approach also well, as the focus of this research is on advancing the live audience interaction production practice and in general establishing practices that have beneficial purposes.

McNamara has created a list of rules for those implementing practice-led research[19] that can be used as a checklist for evaluating this study:

1. Eliminate — or at the very least, limit — the use of the first person pronoun.

2. Avoid recourse to one's own experience as the basis or justification of the research ambition.

3.    Avoid PLR instrumental relations between theory
      and practice; and avoid conflating practice with
      research.

4.    Always write an abstract that equally encompasses
      one's creative practice and the exegesis and/or
      thesis component.

5.    Good PLR can acknowledge other research paradigms.

6.    Avoid defining PLR as more selfreflexive than
      other research methods.

McNamara's guidelines are used to evaluate this research. Still, some items in McNamara's list can be discussed further and criticized. McNamara proposes to avoid recourse to one's own experience or emphasizing selfreflexivity. The research through design (RTD) framework emphasizes the reflexive nature of research. Overall, reflexive research is an important research paradigm and its qualities can be important for knowledge generation and advancing the practice. In comparison to most scientific methods of inquiry, PLR is comparatively more focused on reflexive inquiry. Reflexive parts of the study should be equally analytical and systematic as other scientific approaches.

The mechanisms of how theory informs practice and vice versa can be considered as the fundamental motif for conducting a PLR. Critical practice should generate theory and theory should inform practice'[20]. Understanding how the reciprocity between theory and practice is realized is the core challenge for a PLR study. Gray has described PLR in the following way. PLR is "initiated in practice and carried out through practice', and follows 'research which is initiated in practice, where questions, problems, challenges are identified and formed by the needs of practice and practitioners"[21].

McNamara has an alternative position regarding how good research and practice reflect each other: "On the contrary, it is more likely that the research insight will be found where the needs of practice and the needs of the practitioner researcher do not correlate." He also continues: "The greatest challenges — and potentially greatest innovations — that PLR can offer, spring from the discrepancy between the needs of the practice and the research question, rather than a pre-supposition of their harmonious correspondence."

It is easy to criticize practice-led research from traditional scientific viewpoints. Practice-led research has an inherent tendency to allow the practitioner researcher to influence the research with intrinsic practice-centric motifs or then to argu-

20)
Gray (1996)

21)
Gray (1996)

22)
Jaaniste (2009)

23)
Nimkulrat (2007).
PLR is related to
grounded theory in
how it is focused
on documentation.

ment the validity of the research with a superficial relevance to the practice. But there is a reason why a practice-led approach is relevant and important. Practice-led research builds bridges between research and practice and has a focused goal of advancing the practice. In PLR, theoretical models are valid only if they advance the practice. A big part of research is measured through its relevance to a particular research community. Conventionally, research communities are detached from practice and start to reflect upon each other with self-fulfilling argumentation. Such research has often only superficial relevance to practice.

In this research my objective is to primarily contribute to practice with a research-based analysis and development of a design framework for live audience interaction. Jaaniste proposes that the popularity of practice-led research is related to innovation-driven funding of research, which is focused on delivering concrete innovation outcomes[22]. Design research and a practice-led research approach can be partially considered as the research community's response to bridging the gap between innovation research and scientific research. This research is primarily funded by innovation funds, which expect concrete innovation outcomes. The outcomes of this research have been used in several commercial productions, the outcomes have been in persistent use in several organizations and the research has generated a spinoff company.

In the actual implementation of this research, the research-side and practiceside have been kept mostly separate. The early productions were primarily research-oriented and organized by the research team. After that, there has been a separate production organization that has focused on the development of live audience interaction management systems and the production of live audience interaction in commercial events. After the early productions, most productions have been developed with commercial motifs. In some cases, the research material has been gathered with interviews and questionnaires. Still the most empirical material is collected retrospectively through computer system logs, production plans and digital communication records during the production. In addition to documenting the cases, in practice-led research it is important to also document one's own work processes[23]. In this study, since the event production is a social practice, the work processes are mostly documented in digital communication records, hence production plans and emails. In most productions there are also some handwritten memos that I have been reviewing while analyzing the case studies. In this chapter the background of the PLR approach has been presented broadly. In the next chapter, a more detailed

PLR research framework is introduced that explains in more detail how theory, studies, practice and constructive tool development are supporting each other in this study.

## 2.2.2 Production-led Research in the wild Framework

The framework for this research is adapted from the *performance-led research in the wild* framework[24] introduced by Steve Benford and his colleagues from the University of Nottingham's Mixed Reality Laboratory. The framework describes how a practice-led artistic research can be structured and how practice, theory and studies feed into one another. The performance-led research in the wild framework is redrawn in Figure 2.2a.

24)
Benford (2013) defines performance-led research in the wild as an approach and framework. It is the core methodological framework for this thesis.

FIGURE 2.2A :   OVERVIEW OF THE PERFORMANCE-LED RESEARCH IN
                THE WILD RESEARCH FRAMEWORK BY BENFORD ET AL (2013)
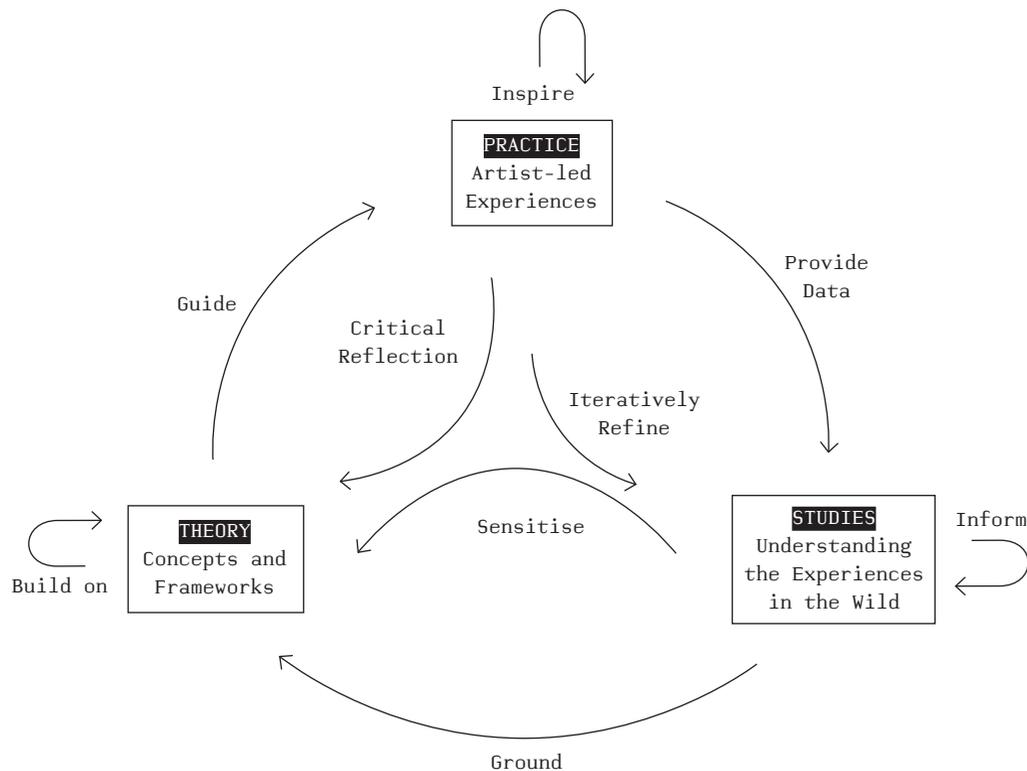
25)
Desert Rain, Uncle Roy All Around You and Day of the Figurines are examples of widely known productions produced by artist team Blast theory (blasttheory.co.uk) in collaboration 0with the University of Nottingham Mixed Reality Laboratory (nottingham.ac.uk/research/groups/mixedrealitylab/index.aspx)

26)
Well cited studies such as Framing in Uncle Roy (Benford 2006) and Orchestrating Desert Rain (Koleva 2001)

27)
Such as Temporal trajectories (Benford 2011), Spectator experience (Reeves 2005) and Collocated interaction (Lundgren 2015)

Benford et al have developed this framework to describe their own research practice. The framework is contextualized mainly in the field of human-computer interaction and more specifically to cases where groups of artists are developing performances that combine physical and digital elements. Benford's research team has partnered with artists in the development of productions and the research team has implemented the studies. The framework describes how there are three activities — *practice, studies and theory formulation* — feeding and enriching each other. In practice the framework is used in a continuum of several productions, studies and theories, and group of people. Even though the framework originally describes a method that is appropriate for a team of researchers and practitioners working together, Benford also proposes that a single artistic researcher can also apply this model in his or her thesis work and perform all these three activities as part of one research. This research has been performed primarily independently, but many researchers and practitioners have also supported it in practice. The performance-led research in the wild framework is appropriate since Benford, his research colleagues and artist partners have created well-acknowledged productions[25], studies[26] and theories[27] that are relevant references for live audience interaction research in general. Hence, the performance-led research in the wild framework has been developed in a context similar to that of this research.

This research is focused on developing tools that can be applied in various live audience interaction contexts and especially for advancing live audience interaction production practices. For this reason, it is appropriate to change the performance-led focus to a *production-led* orientation. Live audience interaction is a performance-centric activity, but the performance orientation implies an artistic application of the developed framework whereas most live audience interaction productions are in non-artistic contexts.

Another variation on the *performance-led research in the wild* framework is the introduction of a fourth activity, which is called *tools* or *tool development*. Tool development complements *productions, studies* and *theory*. The tool development refers to how the focus in this study is to develop a framework as a tool that can be applied in the concrete software environment (live audience interaction management systems) that is used during the productions as well as how the framework can be used for communication during the productions. The tool dimension also emphasizes the constructive nature of the study. Delivering a software design as a form of research dissemination or as a

research hypothesis is similar to how artistic work is considered to be dissemination in the area of artistic research. Software that is developed iteratively and in parallel with research activities embodies the lessons learned during the study. The revised methodological framework that can be labeled as production-led research in the wild is introduced in Figure 2.2b.

FIGURE 2.2B :   OVERVIEW OF THE PRODUCTION-LED RESEARCH IN
                THE WILD FRAMEWORK. THE FRAMEWORK ILLUSTRATION
                EXPLAINS HOW THE TOOLS DEVELOPMENT IS
                COMPLEMENTING THE PRACTICE, THE STUDIES AND
                THE THEORY. THE FRAMEWORK IS STRUCTURED IN
                A 2X2 MATRIX THAT DIVIDES ACTIVITIES INTO
                SPECIFIC VERSUS GENERIC AND PRACTICE ORIENTED
                VERSUS RESEARCH ORIENTED.
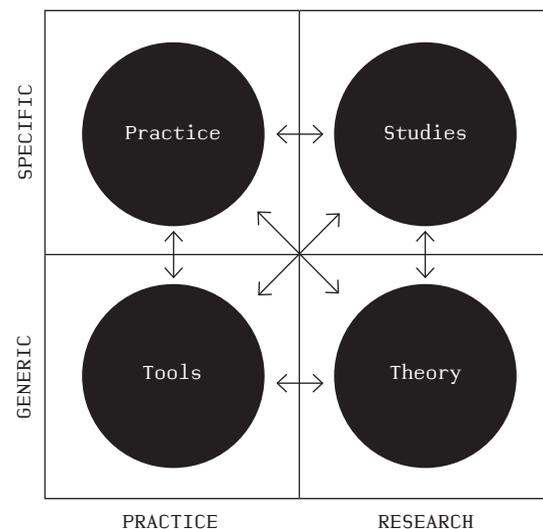


In the *performance-led research in the wild* model Benford et al emphasizes and specifies how knowledge is generated between and within the three activities. The *production-led research in the wild* framework also expects connections between all activities. Tools enable productions. This is the main function of the tools. Tools interact with the theory formulation and the developed design framework is a form of theory that can be translated directly into a functional tool, which is directly relevant for the practice. Tools can also be used in several ways to assist data collection during research, as data logged by the tools is used often as an empirical material in studies.

Practice-led research in general and production-led research in the wild more specifically provide the general orientation for this research. A more detailed formulation of the research however requires a more specific methodological approach. In the following chapters, I will first present the detailed research questions and scope of the research, then some overviews of the specific methodological frameworks that have been applied in specific parts of this research, and finally a detailed structural overview for the research.

## 2.3 Research Questions, Research Objectives and Research Scope

In order to develop a design framework for live audience interaction, it is important to ask two fundamental questions:

1.    What are the core requirements for a live
      audience interaction design framework?

2.    What are the core characteristics of
      related designs and design frameworks?

The first question addresses topics related to how the design framework is appropriate for the live audience interaction context and the second question provides references that can be used to make effective and functional design frameworks for live audience interaction or live productions in general. These questions are adequate for producing the first version of the design framework. By borrowing characteristics of existing designs and design frameworks it is possible to build on top of prior design capabilities.

After the first version of the design framework is produced there is a set of follow-up research questions that help to evaluate and elaborate the research framework.

3.    How can the design framework
      be applied in practice?

4.    Is there potential extensions and modifications
      needed in the original design framework based
      on practical production experiences?

The third question is dealt by introducing how the framework is implemented as a functional live audience interaction management system (LAIMS). The fourth question is basically a practical evaluation of the initial framework. This question is addressed with a set of case studies that provide empirical validation for the proposed framework.

In this study, the objective is to develop a design framework that is practical and generic. These objectives can also be translated into core criteria for the design framework. In order to evaluate the design framework according to these criteria it is important to analyze the core criteria in more detail. A design framework can be considered practical if it can be used in practice. This is a statement that is basically tautology, but still true. However, for a practice-led and constructive study, tautological framing for the core evaluation criteria is not appropriate. In this study, the practical applicability is tested by analyzing how the design framework can be applied to the design of a live audience interaction management system, and ultimately how the functional system can be applied in practical and real world productions. The design framework can be considered generic if it can be applied to live audience interaction in variety contexts. Generality is an important criterion since this way same skills and resources can be applied independent of context and the practice gains more critical mass.

The study expects that in future there will may be probably other kinds of designs and design frameworks in this domain. From this perspective, the objective is to make a comprehensive, but not a complete framework. Also, the objective of this thesis is not to develop an overarching model that describes the human activity during the practice or a model that could be used to describe the live audience interaction activities for research purposes. The focus is in the development of a design framework that can be utilized in the development of practical tools and production processes.

# 2.4 Scientific perspectives

## 2.4.1 Scientific Perspectives Overview

There are four central scientific disciplinary perspectives that the research is building on top of and which support the primary research perspective that is the practice-led research. The four

28)
Origins of design research can be reflected for example from the website of design research society (designresearchsociety.org/joomla/about/history.html).

29)
Fallman (2005)

30)
Ludgvinsen (2006)

31)
Faste and Faste (2005)

32)
Zimmerman (2007)

33)
Zimmerman (2010)

disciplines are design research, artistic research, in the wild research and human-computer interaction research. These four disciplines are often complementary research perspectives, but they all have distinct backgrounds and scientific emphasis. In this section 2.4, the research perspectives are elaborated broadly and core methods and references relevant to this study are contextualized within these disciplines. The chapters conclude by explaining what is the relevance of this perspective for the study specifically.

## 2.4.2 Design Research

Design research has origins in 1960's industrial design research and research on design methods[28]. The need for design research emerged from the need to understand better the design processes especially when designing complex systems such as large military systems. Later on, design research was formalized as a combination of design-oriented research and research-oriented design[29] or research on design, research in design and research through design[30]. There is a lot of conceptual discussion about the connection between the research practice and the design practice. For example, Faste & Faste[31] propose in their white paper, titled as *Design is Not Research, Research is Design*, that design research is not situated at all within the research practice, but is purely a subset of the design practice. The fact that there are many people in the research community involved in design research can be seen as a practical counter argument against their statement. Still, in the area of design research, practice and research are entangled with each other.

During the last twenty years, design has developed new disciplinary branches. Design professionals can specialize in service design, interaction design and experience design, to name a few. Design is related to more than product development. With the concept call *design thinking* the design approaches and methods are spreading further towards organizational processes.

Research through design (RtD) is a methodological concept used in the design research community and in the human computer interaction research (HCI). In the RtD approach (interaction) designers create a design artifact, which is then used as a target for research. Research through design is basically analogous to design-oriented research[32]. RtD has been the subject of some criticism, as it does not present a systematic method of inquiry, but is more of an attitude to (towards) doing work[33]. RtD is considered as a designerly approach and perspective em-

ployed by the researcher. RtD expects that design should serve as a model for how to explore the subject matter[34]. Basically in the RtD the iterative, explorative and constructive modes of inquiry that characterize designerly reflection and practice are presented as a valid research strategy. Faste[35] describes RtD in following way: wherein designers design things as usual but consider their results research because, in addition to shaping tangible outcomes, they have learned something new about their practice.

Hence, while RtD is an emerging approach for conducting constructive research, it may lack some of the methodological rigor expected from the scientific research. Whereas RtD borrows design thinking to research, Leinonen et al have introduced a design approach that borrows from research. They call this approach research-based design (RbD) methodology[36]. This methodology focuses on software development and considers software as a research hypothesis. The RbD methodology defines iterative design process with four phases: contextual inquiry, participatory design, product design and software. While RtD is design thinking contextualized within the research context, RbD can be described as research thinking contextualized within design practice.

This research takes elements from both RbD and RtD. This study defines the core requirements by utilizing domain exploration, which resembles the contextual inquiry practice in the RbD. The study also builds a software system as a tool that is used in practice. In this sense, the research is RbD. Then again, the research is expected to advance the practice and the tools can be considered as one of the core deliverables of the research, and the tool development is expected to continue after this research. In this sense, the research is RtD. Overall, examining the connections between design and research is important for this research. The most important elements of design research are the way research-based design builds on top of the contextual inquiry, the way that design research appreciates and expects iterative development in general, and the way research through design expects a constructive approach in research.

This research produces a design framework for live audience interaction. Design framework is the underlying structure that defines the core elements of the system. The design framework should not be confused with the framework that guides the design process. The framework developed in this study is used as a baseline and structure for building concrete tools for live audience interaction productions. Design research provides examples and reference and guidance for developing a design framework.

34)
Dahlsgaard (2010)

35)
Faste (2012)

36)
Leinonen (2010)

37)
Research agenda review of artistic research and design research in Finland (AKA 2009). Research agenda proposal for artistic research and design research in Europe (Elia 2011).

38)
Elaboration of the original artistic research methodology can be found for example from Hannula (2005)

39)
Definition of Art from Britannica

### 2.4.3 Artistic Research

Artistic research and design research can be considered to be siblings. For example, they are often presented together[37] in research policy surveys. They both are relatively novel research approaches even though they have origins in an established practice. They both borrow research methodologies from other more established academic disciplines, but at the same time, they seek to establish original research approaches, evaluation criteria and methods[38]. The big difference between these fields originates from the differences between the practices. The artistic practice differs significantly from the design practice. Art is sometimes conceptualized as a mean to acquire truth. Art has even been called the avenue to the highest knowledge available to humans and to a kind of knowledge impossible to attain by any other means[39]. Artistic research can be considered to be either artistic practice, that is, pursuing the creation of knowledge in its own right, research on artistic practice or research on artistic works. The definition of artistic research has been constantly evolving.

Artistic research has influenced this research in several ways. First of all, artistic research forums and especially performative arts forums have been important venues for demonstrating the progress of research and for acquiring more understanding about the challenges and constraints on performative practices. Second, this research is conducted at a film school, which is also primarily an art school. In this context, it has been possible to develop artistic productions for exploring the aesthetical qualities for live audience interaction.

In artistic research, it is common to approach analysis through case studies. Many artistic research works are reflective evaluations of the artist's own productions. In this research, the evaluation is based on reflective case studies. Case study research is a common research methodology that has been practiced within many disciplines ranging from management studies to medical sciences. Most of the time, the researcher takes an observer role in the case studies, whereas in artistic research the case studies are usually reflective and based on the researcher's own artistic productions. It is still important to note that while the case study would be primarily reflective they should still follow analytical structures for case studies that require systematic data collection and systematic analysis of different cases.

## 2.4.4 In the Wild Research

Origins of the in the wild concept in research can be linked to Edwin Hutchins and his book cognition in the wild[40]. The book describes theories on how cognition is context dependent and how cognition is a cultural process. He also introduced the concept of cognitive ecology, which describes how cognition is contextually sensitive. Before Hutchins there has been a lot of research for example in ethnography that is based on similar methodological basis, but utilizes different conceptual framework. Later on, the in the wild concept has been used in different kinds of studies[41] to describe how the study is conducted in a real life context instead of a laboratory environment. The following definition originates from Johnson[42] who summarizes Rogers' seminal paper[43] on in the wild studies in the interaction design and human computer interaction context as *"studies, which involve deploying new technologies in real use, real world situations and studying how they are used in this context often with the intention of improving a design. Implicit within this type of methodology is the idea that physical and social context will have a critical effect on usage."*

Rogers describes how her perspective on in the wild studies builds on top of theories that describe how context influences human behavior. Examples of such theories are embodiment, felt experience, ecological rationality, proxemics and mindfulness. Rogers explains that in the wild approach is inspired by her own experience in investigating the use of a large public display in lab conditions and then finding out how their practical use in in the wild does not correlate with the laboratory findings[44] . Their initial research questions were focused on analyzing collaboration within multiuser groups around the display, but in reality such group arrangements did not emerge during the in the wild studies. Because of this they had to change their research question perspective from: *"How do I design a multitouch surface or a natural user interface that will enhance cooperation or collaboration?"* to *"What is the interplay between the various behavioral mechanisms for the proposed activity and setting?"*

Roger and Marshall's multitouch study is a good example of how realizing a research intervention with novel technology is sensitive to context. Developing valid research findings in the wild requires an analysis of the phenomenon in different contexts and repetition. A single context cannot validate the findings. For this reason, this study is composed of several live audience interaction case studies in different contexts.

Controlling or even describing context is not an easy task.

40)
Hutchins (1995)

41)
Examples of in the wild studies that relate to Live Participation are Hinrichs (2011) and Peltonen (2008)

42)
Johnson (2012)

43)
Rogers (2011)

44)
Marshall (2011)

45)
Johnson (2012)

46)
Johnson (2012)

47)
Pine & Gilmore (1998) have written a book titled as the experience economy, which proposes that our common daily activities are framed as experiences and can be in this sense approached dealt like performances. This is aligned with classical thoughts of Goffman (1949) and also my earlier paper titled as Space to Stage, which proposes that digital technology can transform everyday spaces as stages and common people as performers (Kuikkaniemi 2012)

For example, just the presence of a researcher may significantly influence a participant's experience as explained by Johnson[45] in her study about challenges and insights of researcher participation in in the wild studies. In cases when the researcher is not present, the data collection may be limited, and when the researcher is present in the situation, the participants may change their behavior. In the practice-led research approach the problem of data collection is somewhat different. In the practice-led approach the researcher, also acting in a dual role as a practitioner can and should take an insider role in the actual production and perform the research tasks outside the production context. Other roles that the researcher can take during the in the wild study are for example the role of facilitator, explainer, stranger and friendly outsider [46].

The production-led in the wild research framework is aligned with that of Rogers' formulation of research in the wild. Rogers argues that in the wild studies should focus on situations with some form of everdayness and interventions that are not scaffolded. This is a complicated claim for situations that include performances and special temporal framing. Can there be in the wild studies related to special events?

Live audience interaction is taking place most of the time at special events. Benford concludes that this is not a problem for approaching performance-led studies as in the wild research because: *"... even though the experiences we discuss are often unusual and even extreme, they still constitute research in the wild in that they operate as recognized cultural experiences."* It is also notable that similar staging that is involved in cultural production is emerging also in our everyday experiences[47].

Rogers presents a convincing argument that *"instead of trying to change behavior through influencing what and how people consciously think about an issue, we have to begun thinking about how to change the context in which they make their decisions"*. Since performance design and production design are domains that also explore the manipulation of context, combining these perspective with the emerging field of in the wild research can produce very interesting results by allowing us to explore and rearrange connections between context, staging, experience, research, design and intervention. Live audience interactions have multiple established roles and each role has a somewhat different contextual setting. Different roles create the context for others. For example, presenters actively frame the context for participants' contributions and activity.

What does this mean for the producer who focuses on live audience interaction and the development of the design frame-

work? Iterating the system design alone might not solve the challenges related to the overall experience, but exploring possibilities to affect the context and participants' attitudes might be a key for meeting expectations. The following analogy can exemplify what I mean by this. The design space for an interaction designer is the digital system. The design space for a performance designer is the performance on stage including the actors and related systems. The design space for an event producer (and also for the live audience interaction producer) consists of the organization surrounding the event including the computing system, the performance, the event space but also the marketing and coordination practices within the team. This is a line of thought that should be kept in mind while developing the design framework. The core idea is to develop a design framework that is suitable for developing a specific software system but at the same time it is important to develop a framework that helps the producer to design the production and experience, and while doing this the software system should also help to control and coordinate more than the primary interactions taking place through the computer system. Design framework should not be focused on the event context as is, but expect and anticipate changes in event context according to the requirements of computer-supported live audience interaction.

## 2.4.5 Human Computer Interaction and Computer-supported Collaborative Work

Human computer interaction (HCI) is an interdisciplinary academic discipline that draws from several other academic fields such as psychology, ergonomics, cognitive science, design and phenomenology[48]. HCI emerged during early eighties but has grown rapidly and is currently taught at many universities[49]. The origins of the field are according to Card more in psychology than in computer science[50]. Generally, HCI is multidisciplinary field that combines human and social factors with technology. One could argue that one of the core reasons for the popularity of HCI is related to the increased demand for understanding the user experiences related to digital products and services. A pleasant user experience is often considered as the core success factor for a new digital service. Human computer interaction does not have a single core study methodology. In the HCI community, it is common to borrow and adapt methodological approaches from established fields such as psychology, social psychology, ethnography, ergonomics and usability research[51].

48)
See for example Hartson (1998)

49)
HCI education activities report 2012 managed to contact 336 respondents in 36 countries that show there is significant amount of teachers in different countries. (SigCHI 2012)

50)
The concept Human Computer Interaction term was initially popularized by Stuart K. Card (1983) with colleagues in their seminal 1983 book, The Psychology of Human-computer Interaction, which is, as title suggest, originating from psyhochology.

51)
There is a review in the book Research Methods in Human-computer Interaction (Lazaar 2010) on different research approaches in HCI that demonstrates the methodological variety of HCI discipline

52)
Examples of public screen interaction research: (Koppel 2012, Jacucci 2010, Müller 2012 and Peltonen 2008), backchannels research: (Harry 2009, 2012 and McCarthy 2005), spectatorship experience research: (Reeves 2005, 2010), large display interaction with mobile device research (Vepsäläinen 2015, Pears 2009 and Seifert 2015), computer systems as tools for performance (Correia 2014)

53)
Lundgren (2015)

54)
See list of related publications in the Appendix B Nelimarkka (2016)

56)
Kuikkaniemi (2011), Kuikkaniemi (2014b)

57)
Nelimarkka (2014)

58)
Nelimarkka (2016)

Computer-supported collaborative work (CSCW) is considered to be a unique discipline or, alternatively, a subset of HCI. CSCW research in particular is focused on understanding how computers can be used to support social interaction between people. There is also a lot of research that is not focused on work, but other forms of social activity such as education and play and for this reason the CSCW field should be potentially described as computer-supported collaborative activities or practices. There are several HCI and CSCW studies that are relevant to live audience interaction. For example, studies on large public screens, multiple interface ecologies, spectatorship experience, audience interaction systems, big screen interaction with mobile device and backchannels are examples of topics addressed by HCI researchers that relate to live audience interaction[52].

Lundgren et al. have developed a design framework for collocated interaction[53], which is relevant for live audience interaction. The framework contains four core elements: social, spatial, technical and temporal. The framework does not specifically address live audience interaction situation which expects central performance and tens or hunders of simultaneous audience members. Lundgrens framework considers all kinds of collocated interactions and in this sense live audience interaction is a more focused domain. Lundgren's framework is developed as a design tool for ideating and (re)designing the collocated experiences and as an analytic tool for describing collocated mobile experiences. In this study, the design framework for live audience interaction focuses on modeling the management system for live audience interaction. Hence, the scope and objective of these two frameworks are different. The LAIX-score design framework presented in this study focuses primarily on detailing the technological dimension of the Lundgren's framework even though the live audience interaction must connect to also other elements of the framework. The Lundgren's framework is used as an inspiration and considered especially when the LAIX-score is extended with the temporal dimension.

The design research, in the wild research and HCI research are related disciplines. Majority of the studies and research papers we have been producing while developing the design framework has been disseminated in the HCI and CSCW forums[54]. These studies have significantly extended our understanding of the live audience interaction phenomenon[55], helped us to understand the connection between performativity and computer systems[56], and these studies have also helped us to elaborate in more detail some of the core features of the design framework such as the requirement for support for anonymity[57] and modular system design for live audience interaction system[58].

# 2.5 Research Methodology Overview

This chapter summarizes the research approach and presents a structural overview of the research process. Basically the research is divided in eight parts that are visualized in Figure 2.5. Each part has a unique chapter. First two chapter lay the foundations for the design framework by defining the core requirements and core references. The next four chapters iteratively define and elaborate the LAIX-score design framework. Final two chapter evaluate the study and indicate possibilities for future research and development.

FIGURE 2.5 :    RESEARCH STRUCTURE, RESEARCH METHODS
                OVERVIEW AND EVOLUTION OF THE LAIX-SCORE
                DESIGN FRAMEWORK THROUGH THE THESIS



| CHAPTER 3 | is focused on identifying the core requirements. The chapter is based on 5 years of domain exploration, which involved development of multiple software systems for live audience interaction as well as implementing several experimental and commercial productions that utilize live audience interaction. This chapter addresses the research questions: "What are the core requirements for a live audience interaction design framework?" |
|---|---|
| CHAPTER 4 | explores related designs and design frameworks. This chapter answers to question: What are the core characteristics of related designs and design frameworks? The chapter analyzes first existing live audience interaction systems and how they meet the core requirements. Then the chapter identifies and elaborates the core references for the LAIX-score framework. The core reference frameworks are live audio mixing and live light control. |
| CHAPTER 5 | introduces the LAIX-score design framework, which is the synthesis of core requirements and core references. The LAIX-score is composed of three core elements: interaction activities, interface channels and state control matrix. Each core elements corresponds to a core requirement presented in Chapter 3. |
| CHAPTER 6 | demonstrates how LAIX-score design framework can be implemented in action, by presenting a live audience interaction management system Presemo (version 4). The chapter analysis Presemo design in detail and this way establishes a more detailed structure for the control of interaction activities. |
| CHAPTER 7 | presents four in the wild case studies that demonstrate the LAIX-score in action. The case studies focus on analyzing in more detail the interface channel structure, elaborate how LAIX-score satisfies the core requirements and identify additional requirements. |
| CHAPTER 8 | revises the LAIX-score design based on the additional requirements identified in the case study chapter. The revised LAIX-score includes two additional core elements: temporal management and identity management. |
| CHAPTER 9 | evaluates the study by analyzing what is the novelty and relevance of the study and how methodologically reliable is the study. Chapter 10 presents future research topics based on the research experience and discusses how the LAIX-score can be elaborated further and applied concretely in practice. |

Hence, the LAIX-score development is divided in four phases as described in Figure 2.5. The first version with three core elements is introduced in Chapter 5 (version 1.0), and it is then extended in Chapter 6 (version 1.1) with interaction activity details and in Chapter 7 (version 1.2) with interface channel details. In Chapter 8 a new revised version is introduced that includes overall five core elements (version 2.0). The LAIX-score version (2.0) introduced in the chapter 8 is the core deliverable of this thesis.

# 3.

# Identifying Core Requirements for the Design Framework for Live Audience Interaction

## 3.1 Introduction to Core Requirements

The objective of this study is to develop a design framework for live audience interaction that is practical and generic. This chapter focuses on identifying the core requirements for this design framework. The requirements are identified through a constructive domain exploration that lasted for over five years. During this time, we developed different kinds of software systems for supporting live audience interaction and engaged in numerous experimental and commercial productions in different contexts. Through these productions, we gained knowledge about the practical challenges related to live audience interaction with personal computing devices.

The three core requirements are basically three core findings of the domain exploration. The core requirements are: (1.) support for different kinds of interaction patterns (Section 3.3), (2.) support for different roles (Section 3.4) and support for different functions (Section 3.4). Section 3.2 provides background and overview for how domain exploration was initiated and how it progressed. Chapter 3 and Chapter 4 are parallel chapters. While Chapter 3 focuses on elaborating the core requirements based on the constructive domain exploration, Chapter 4 focuses on a theoretical analysis of existing design frameworks and designs. Together, Chapter 3 and the Chapter 4 build the foundations for the LAIX-score design framework, which is presented in Chapter 5.

## 3.2 Origins of Domain Exploration

Before introducing the core requirements as a synthesis of the domain exploration, it is important to provide some background for how the domain exploration was initiated and how it got started. Constructive domain exploration is a practice-oriented and reflective approach. The origins and available resources can have significant influence on how such research progresses and what kind of findings it produces. This research has evolved significantly over time. Each finding has been a significant turning point in the research. The evolution of domain exploration had critical influence for scoping the research on development of a

design framework. In the beginning the research was focused on developing successful experimental live audience interaction productions without focus on any type of specific theoretical objective. The outcome of this exploration has not been deterministic and with different resources and collaborations the outcome of the domain exploration and consequently outcome of the research might have become significantly different.

The starting point of the research dates back to almost ten years ago. The origins of the research were not actually focused on live audience interaction, but more on interacting with digital big screens and more specifically on interacting with digital big screens in a cinema context. The research started basically with the hypothesis that digital cinema technology could change the social dimensions of the cinema experience and enable the development of a new kind of cinematic content. A core assumption behind this hypothesis was that digital technology could enable the creation of new kinds of interactions between the audience and the content presented on the cinema screens, and that these interactions would enable new content formats and the emergence of new experiences.

In order to understand this line of thought, we need to go back to the origins of cinema. Current cinema institutions are built around technical enablers that no longer apply. Producing movies has changed completely from film-based systems to digital systems[59]. Digital technologies provide fundamentally different capabilities than the original film medium. Still, most filmmaking practices as well as the way in which movies are exhibited in cinema theaters are aligned with conventions dating back to the early days of cinema. The roles in the production process are primarily the same (directors, screenwriters, cinematographers, editors, actors), the production format is fundamentally the same (1.5–2.5 hours feature film) and the marketing mechanisms are the same (ticket pricing and distribution is premier-focused). At the same time, we have seen how digitalization is significantly changing the media landscape overall. For example, the print, television and music industries have been going through major changes that have fundamentally changed their production practices, pricing and marketing logic. We have also witnessed the emergence of new content formats such as digital gaming and social media. These content types would not exist without digital technologies. Since the media landscape overall has gone through such radical changes due to digitalization, it made sense to begin the research process for my thesis by considering that also cinema might go through some radical changes due to digitalization.

59)
Cinema institution can be considered to be composed of four primary components: camera, film, editing system and projector. All these components are now digitalized and hence the basic technology that enables cinema has changed. More information regarding the digital cinema can be found for example from the Swartz (2004)

For this reason, the first experiments in this study were situated in cinema spaces[60]. These experiments were basically games for cinemas. Overall, there were three different projects focusing on developing game content for cinema, which ultimately produced three games that were tested in the cinema context. Figure 3.2a illustrates snapshots of these games. These game experiments were technically successful, but the audience experience did not meet the objectives of the research. The core observation from all these experiments was that collocated multiuser gaming was fun when the activity was situated to a context were participants knew each other, but in a conventional cinema setting the audience members do not have practically any relationship between each other, and in such an environment the social experience did not differ significantly from the experience of playing casual multiplayer games anonymously over the internet[61]. This observation led to the conclusion that the traditional cinema context is not the most suitable place for exploring the interactive possibilities of the digitalized big screen interface or possibilities of computer-based large audience interaction in general.

60)
We conducted the cinema experiments in the cinema space of the film school and student cinema.

61)
We conducted an extensive experiment with 12 groups of players in two different locations focusing on the social aspects of cinema games before we came to this conclusion.

FIGURE 3.2A :   SCREENSHOTS OF THE THREE CINEMA GAMES:
                QUIZ GAME GALACTIC TRIVIA (TOP LEFT),
                STRATEGY GAME PALM BEACH (BOTTOM LEFT),
                AND BIG SCREEN AND MOBILE SCREEN OF
                STRATEGY GAME MOONRUSH (RIGHT)
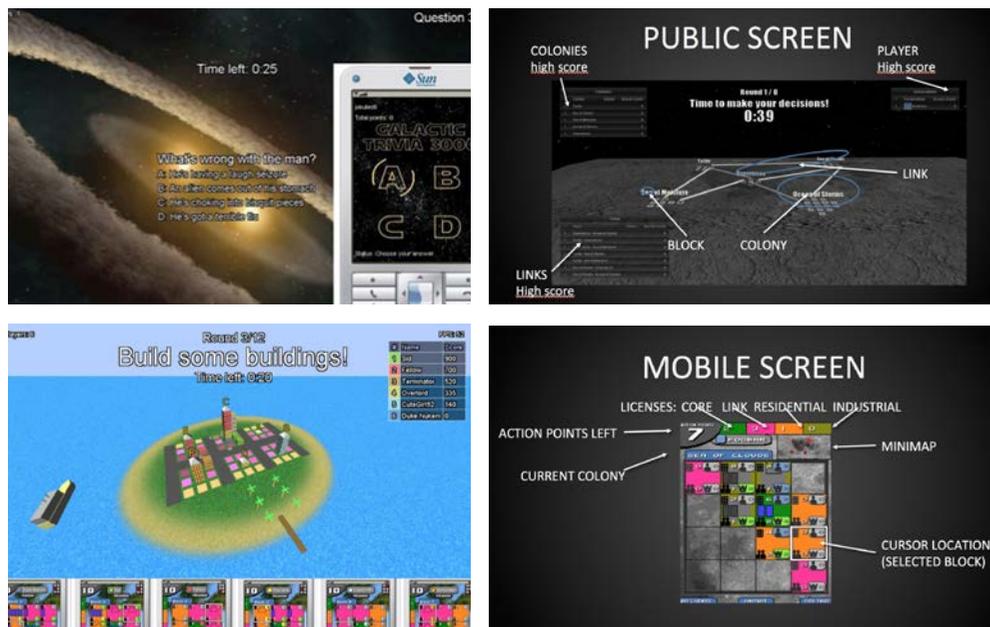
At the same time while we understood the problems related to cinema games, we also understood that audience interaction should not only be approached as a form of new kind of entertainment medium, but interaction with the big screen had also other functions. We had previously built some audience interaction experiments that utilized SMS messages, but now we realized that the same technical enablers that we had built for cinema gaming could be also utilized for functional communication in presentation situations. Audiences could interact with the presenter in order to provide feedback, answer questions or make decisions. The study objectives evolved because exploring functional interactions could provide more possible application contexts and societal relevance for the research than focusing only on entertainment applications.

Cinemas were not originally designed for functional interactions or live performances. And for this reason, the research focus then shifted from the traditional social cinema setting to other kinds of events that host audiences in front of large digital displays such as seminars, conferences, classrooms, workshops and artistic live performances. One significant outcome of this decision was that the study focus changed from exploring the design of digital and interactive content for the digital big screen to creating computer-based support for audience interactions with a live performance. There is a big difference between designing a computer program that people interact with and creating practices and computer-based tools that enable and support social practices.

The focused domain exploration phase started in earnest after this fundamental realignment of the research and lasted for five years (2009–2014). During this time, we produced over 30 experimental productions and three different software systems for live audience interaction with personal devices[62]. The next three sections present the outcome of this domain exploration, which is fundamentally identification of three core requirements for live audience interaction design framework. The sections are structured in three parts. The first part introduces the topic and initial assumptions, the second part explains the core observation and how the initial assumption was challenged, and the third part elaborates how the observation was translated into a core requirement for the design framework.

62)
List of different software systems developed during this thesis related to live audience interaction can be found from Appendix A.

## 3.3 Support for Different Kinds of Interaction Patterns

The previous chapter explained how the origins of the study were connected to big screen gaming. In these experimental projects, we developed game designs that included specific audience to big screen interaction design patterns. These game designs were based on translating turnbased board gaming patterns to roundbased audience interaction gaming. Overall, our conclusion was that many board gaming designs could be translated or adapted to big screen gaming. After the thesis was refocused on live audience interaction in performative situations, the design space changed significantly. The interactions in our cinema games were very detailed and complex, and composed often from multiple game design patterns, whereas in the case of computer-support for live performances and presentations the interaction patterns[63] have been generally simpler.

After we started to explore the support for live audience interaction we realized that, broadly speaking, this was not a particularly new field of research and there was also prior commercial development in the domain. As explained in Chapter 1, for more than three decades various digital and electronic systems have been used for live audience interaction. These audience response systems are basically voting systems that allow audiences to respond to multiple choice questions, which we often simply call polls. This is a simple interaction pattern, but it has various uses. For example, in her 2007 review article, Jean Cladwell identified nine different uses for audience response systems in education ranging from finding out more about students and formative assessment, to quizzes and guiding thinking[64]. Hence, polling is a common and well-established live audience interaction pattern.

Another already well-established live audience interaction pattern is the *message wall*. Actually, prior to our work on cinema games studies we did organize some message wall experiments in 2004. At that point, the interaction was realized with SMS-messages, and for this reason we did not foresee possible future applications when these interactions would be realized with personal computing devices. Overall, there is a significant amount of related work on message walls and more broadly messaging systems for live performances, classroom situations and presentations[65]. Originally, message walls were based on either sending text messages or emails to a computer system that is connected to a projector. With modern smartphones and personal computing devices it is possible to create interfaces for sending and viewing messages, which enables more complex messaging patterns and discussions among audiences.

Hence, in late 2009 we started our domain exploration knowing that message walls and polls are common and well-established interaction patterns. The core focus of the exploration was to elaborate how personal computing devices and web-based audience interfaces could be used to realize these live audience interaction patterns, and how these interactions could be enhanced when the interaction interface was a personal smartphone computer or portable laptop computer instead of proprietary devices and simple messaging systems such as SMS and email. The first conclusion was that a single system could easily support both message wall and poll interaction patterns, and that supporting both interaction patterns within the same system was beneficial for the productions since it reduced the complexity for engaging audience to multiple systems. Quite soon after this first conclusion we also noticed that the system could also support other kinds of interaction patterns, in addition to polls and messaging walls. After this realization, a big part of our domain exploration was focused on exploring different interaction patterns, and understanding how different interaction patterns can be applied in live audience interaction productions.

One of the first experiments was the BitBang course system that demonstrated how messaging and discussions could be extended with multiple choice interactions. The experiment demonstrated that there are actually multiple ways to combine messaging and poll interaction patterns (Figure 3.3a). Another related experiment was the Sometime 2011 production that demonstrated how two or more interactions are combined together for providing crossreference visualizations and how one of these interactions can be peerreviewing activity and another can be a profiling poll (also visualized in Figure 3.3a). The difference between the BitBang and Sometime 2011 experiments was that in the first case the interactions were blended in a parallel fashion, whereas in the second experiment the interactions were integrated but took place sequentially. Both of these interaction patterns are functionally unique and cannot be reduced as variations of the same interaction pattern. Figure 3.3a illustrates the interaction patterns in these two productions in more detail. The core conclusion from these experiments is that poll and text input interactions can be combined to form various different kinds of live audience interaction patterns.

63)
Interaction pattern (or interaction design pattern) concept is commonly used in interaction design for a generic approach in a usability problem. In this thesis the interaction pattern concept is coined from the game design patterns described by Staffan et al (2004). Game design pattern are generalized and practical design choices that are used to illustrate varying types of gameplay found in all types of games. Live audience interaction patterns are similarly generalized and practical design choices that are found in in all types of live audience interaction situation including game like interaction, but not limiting to it. Interaction pattern requires specfic capabilities from the underlying computing system, but also involves social coordination between individuals. For example chat is an live audience interaction pattern, but it may have also subpatterns such as chatbased Q&A that contain more details.

64)
Cladwell (2007) reviews of classical choicebased audience response system uses.

65)
See more for example Beatty (2006), Harry (2009), Harry (2012), Yardi (2006)

FIGURE 3.2A :   SCREENSHOTS OF THE THREE CINEMA GAMES:
                QUIZ GAME GALACTIC TRIVIA (TOP LEFT),
                STRATEGY GAME PALM BEACH (BOTTOM LEFT),
                AND BIG SCREEN AND MOBILE SCREEN OF
                STRATEGY GAME MOONRUSH (RIGHT)

In both of these experiments there was some form of playfulness involved, but we also experimented with setups that were specifically based on gamification. One example of such interaction patterns is a lottery pattern. In this pattern audience members subscribe to the lottery by entering to the live audience interaction system. The winner is chosen randomly, but the presenter can choose the duration of the lottery procedure and how the winner is presented[66]. We also organized productions that supported group functions and explored interactions with collaborative drawing and presentations[67]. Another experiment focused on threaded chat discussion[68]. We also experimented with how the system could be used for collecting physiological signals from the audience or how to use motion sensors for live audience interactions[69]. At the same time, we also noticed that others have been developing live audience patterns that utilize pointing, camera, or voice. Table 3.3b lists the different experimental live audience interaction patterns we experimented during the domain exploration phase.

| INTERACTION PATTERN | EXPLANATION | EXPERIMENT |
|---|---|---|
| Collective storytelling | Audience members can continue the story and fork the story. Story composed of simple paragraphs. | Storytree at the ISEA 2006 conference. Part of MUPE project. |
| Cinema games | Strategy games and trivia games for direct big screen interaction. | Galactic Trivia 3000, Palm Beach and Moonrush |
| Participation games | Audience gets points by participating in chat and poll. | Part of commercial productions that are not public. |
| Crossreference polls | Initial poll is used as profiling and following poll is organized considering the profiling poll. | Sometime 2011 conference audience interaction experiment. |
| User annotating chat | User includes tags in addition to text messages. | Bitbang course experiment classroom participation system. |
| Threaded chat | Message thread is not only chronological, but also threaded, hence either participant or orchestrator can respond to individual messages. | Classroom experiments by Nelimarkka (2014). |
| Lottery | One of the participant is randomly chose as winner among all participants. | Function in Slides & Polls system used in several productions. |
| Affective feedback | Participants mobile phones are connected to mobile physiological sensors that sends continuous feedback to interaction system. | Emokeitai experiments disseminated in BiosPlay (2010). |
| Collective presentations | Live audience interaction system was utilized to manage and distribute Google Presentation views according to group arrangements. | Presemo Brainstormer by Liikkanen et al (2011) and many other productions. |
| Collective mindmap development | Audience proposed new concepts and voted the relevance of the concept and ranked how different concepts are related to each other. | Servdes 2012 conference audience interaction system. |

70)
Original Presemo was used for example in Presemo Brainstormer (Liikkanen 2011), Sometime 2011 production and in the Emokeitai project for affective feedback. The development of the Presemo was originated in Emokeitai project and the name is derived from Presentation Emotional.

Each of these productions could have been developed further and studied and analyzed in more detail. At this point the core focus of the domain exploration was not to develop models or finalized versions of the interaction patterns but to acquire an overall understanding about the different possibilities of live audience interaction and the dimensions of the phenomenon overall. Based on these demonstrations we concluded that there are various interaction approaches for live audience interaction with personal devices that go beyond the well-established message wall and poll interaction patterns. We also observed that the same system can be used to support various different interaction patterns, rather than developing independent systems for each interaction pattern. In order to summarize these observations, we organized together with the research team a collaborative design session to generate a map of different live audience interaction patterns. A refined version of the outcome of this workshop is visualized in Figure 3.3c.

Figure 3.3c is fundamentally a design reflection and should not be considered as a comprehensive map of the design space. The map has not been validated or significantly elaborated after it was developed collaboratively. The significance of this illustration is to concretize the core conclusion of this chapter that live audience interaction design framework should consider different interaction patterns. Actually, our expectation is that with the advancement of new sensors and interaction techniques such as camera technology and physiological sensors, new kinds of interaction patterns will continuously emerge. Furthermore, it is important to note that new patterns can be realized by combining two or more existing patterns, such as was the case in the Bit Bang and Sometime productions visualized in Figure 3.3a. There should be further studies that generate some general principles for live audience interaction patterns. Ultimately each of these interaction patterns should be developed further and evaluated independently. Based on the domain exploration, all of these interaction approaches can belong to the same live audience interaction framework. This conclusion was concretized since most of the patterns explained in Table 3.3b were realized within the same software system. Hence, a core requirement follows from this conclusion:

1.      A generic live audience interaction design framework should be able to accommodate different kinds of live audience interaction patterns.

Collective Mindmap

Ranking ideas

Organizing

Chat

Threaded chat

Anonymous chat

Chat with rating

Chat with tagging

Likert scale review

Choose best

Ranking

Order

Distribute resources

Open questions with peer review

Open format questions

Polls

Multiple choice

Single-choice

Combination of closed and open

Send pictures/ take pictures

Collective drawing

Collective editing of slides

Pictures

Closed format questions

Rating scales

Number

Sliders

Multiple connected polls

Live Audience Interaction Patterns

Heart rate

Skin response

Active

Game patterns

Lottery

Trivia

Participation games

Strategy games

Light source

Audio source

Pointing

Accelerometer

Phone as sensor or actuator

Social media

Participation through social media account (Twitter/Facebook)

Push messages to social media

Link web page or track browsing

## 3.4 Support for Different Roles

In the first phase of domain exploration we used a live interaction system called *Presemo*[70]. The original Presemo system was a versatile software framework and allowed us to realize many experimental productions such as those introduced in Figure 3.3b. The problem with the original Presemo system was that it was a fairly complex system to setup and operate. Operation usually required multiple technical persons, and each production had to have a unique software configuration. To set up even the basic software configuration took several hours using an experienced developer. Spending hours and sometimes days setting up the computer system was feasible in the first phase of the domain exploration, as each production introduced some new technical features, the focus of the research was in exploring new interaction patterns and the productions took place in somewhat special conditions where spending significant amounts of time for preparation was expected. In order to advance the live audience interaction practice it was important to develop a software tool that allowed more focused and robust implementations in high-profile productions[71] and with significantly fewer organizational resources. For this need we developed a new system called *Slides & Polls*, which was a productized and streamlined live audience interaction management system mostly built by utilizing the basic technical components of the Presemo[72].

The main focus during the development of Slides & Polls was on creating a session management environment and an easy-to-use control interface. The core design hypothesis was that Slides & Polls would ultimately be a presenter tool. Hence, we expected that a presenter would be the individual who organizes and controls the live audience interaction and that there is no need for additional technical support to manage the system. For this reason, the core design of the Slides & Polls control interface was inspired by presentation tools such as Microsoft Powerpoint and Apple Keynote. Each interaction episode would basically be just a unique type of slide. Since this was not appropriate for the messaging wall functions we allowed the system to have specific controls for the messaging features[73]. Basically, as the name implies, Slides & Polls was a presenter tool with interactive features.

71)
First version of Slides & Polls was applied in over 1000persons conference featuring first panel discussion between the presidential candidates for the Finnish 2010 presidential election.

72)
Core technical components of the Slides & Polls are same as in Presemo, hence Conduit composition framework (lacquer.fi/ pixelconduit.html) and XMPP (xmpp.org) messaging platform

73)
In the evolution of Slides & Polls we allowed also some other interaction features that could not be squeezed inside a single slide to have other types of controls.

EXPECTED ROLE CONFIGURATION
FOR SLIDES & POLLS

REALIZED ROLE CONFIGURATION FOR
SLIDES & POLLS IN LARGER PRODUCTIONS

Slides & Polls was distributed in the Mac Appstore and used by teachers and presenters in many different countries[74]. Quite soon after releasing Slides & Polls we made two observations. First of all, most productions required some new features, but it was challenging to accommodate those modifications in the streamlined and productized system. Secondly, and more importantly, in most productions, a single performer was not able to manage the live audience interaction situation alone even though the presenter interface had all the necessary functions for controlling all aspects of the supported interaction patterns. Actually, in most commercial productions the presenter was not directly using the Slides & Polls system at all. Figure 3.4b illustrates a common production setup in commercial and larger productions for Slides & Polls and how that compares with the expected role setup, which was realized only in some smaller productions and in educational settings.

74)
Overall Slides & Polls had users from more than 10 different countries.

75)
Q&A (questions and answers) pattern is an application of messaging wall pattern. Audience sends questions to presenter, but host receives the questions primarily and asks the questions from the presenter.

Figures 3.4b demonstrates how the presenter was not the primary user of the Slides & Polls in all situations even though the system was designed in such a way. The reason why the presenter was not the primary user of the system is two-fold. First of all, presenters have limited cognitive resources to focus on moderating and facilitating audience interaction and secondly, some interaction patterns such as Q&A pattern[75] after the presentation are often led and organized by the session facilitator instead of the presenter.

The design of Slides & Polls was based on the hypothesis that live audience interaction is primarily a presenter orchestrated practice and that a live audience interaction system would be an evolution based upon currently available presentation tools. The field experimentation proved this hypothesis wrong. In order to compensate this false hypothesis, we developed some additional interfaces to Slides & Polls in order to support different roles.

Basically, we made modifications to the presenter system so that it was more suitable for control by an off-stage orchestrator and developed a new host interface that could be operated from a tablet device (shown also in Figure 3.4b). Hence, the next hypothesis was that the roles in live audience interaction could be categorized as presenter, orchestrator and audience[76]. Further domain exploration revealed that the modifications we made were not adequate for making Slides & Polls capable to manage all kinds of live audience interaction productions. Many productions had more detailed role definitions than orchestrator, presenter and audience. Also interesting is that presenter and orchestrators are often blended roles. The host is often acting both as presenter and orchestrator[77]. Figure 3.4c exemplifies a production with more complex role configuration.

76)
For further elaboration of presenter, orchestrator and audience roles in Computer-supported performances see for example Reeves (2011)

77)
Reeves (2011) also explains possible transitions between orchestrator and presenter roles.

78)
This production was MVV2011 (Markkinoinnin viestinnän viikko), and it was one of many commercial networking event productions that had a more complex role configuration during the domain exploration.

Ultimately, during the domain exploration phase we identified several different kinds of roles in live audience interaction. Presenters can have either active facilitator and orchestrator roles or then presenters can be more passive and expect that for example session hosts take the active facilitator role. Panel members are a unique presenter role since they can for example convert between the audience member and presenter roles.

A facilitator (also often titled as the moderator or the host) is also a performer role, but distinct from the presenter. A performing facilitator is often active in moderating and controlling live audience interactions also while off-stage. In some productions, we also had an off-stage moderator that never enters the stage. The off-stage moderator can be an assistant for the on-stage moderator. The off-stage moderator can also have a technical facilitator role or then there can also be a separate technical facilitator depending on how challenging it is to operate the particular live audience interaction pattern. Sometimes there is a distinct event organizer role that is also actively responsible for orchestrating the overall performance and production and hence also takes an active role in controlling and directing live audience interaction without taking any active role in moderating interactions. Hence, while there are different presenter roles in live audience interaction, there can be also different kinds of orchestrator roles.

Audience members (also called participants) can also take on different roles. Sometimes, a subset of the audience can have a special role focused on providing certain predefined contributions and activating other audience members. Also, part of the audience can participate remotely while others are collocated with the performers. Remote participants might have different needs and capabilities for participation and for this reason they may require a different kind of interface. Table 3.4a overviews some of the different roles identified in the domain exploration productions. This list is not comprehensive, but demonstrates the scale of different possible roles.

FIGURE 3.4C : EXAMPLE OF A NETWORKING EVENT PRODUCTION[78] WITH MORE COMPLEX ROLE CONFIGURATION.

| ROLE | EXPLANATION |
|------|-------------|
| **Examples of presenter roles (on-stage)** | |
| Facilitating presenter | While presenting also facilitates live audience interaction. |
| (Passive) Presenter | Focuses on presenting and interacts with the audience indirectly through the host. |
| Remote presenter | Presents via video conferencing or streaming video. |
| On-stage facilitator | Focused facilitator role. Not chairing the session, but focused on facilitating audience interaction and interacts with the host or chair. |
| Host, chair | For example panel host or session chair. |
| Panel member | Panel member can take either presenter or audience position in live audience interaction. |
| **Examples of orchestrator roles (off-stage)** | |
| Off-stage facilitator or orchestrator | Facilitator who controls the live audience interaction situation. |
| Moderator | A role focused on moderating messages and assisting on-stage facilitator or host. |
| Technical assistant | Person who assists facilitators and moderators and monitors the system. |
| Supervisor or event organizer | Person who can decide upon timing or changes in the live audience interaction plans. Do not take active moderator or facilitator role but observes progress and operates through moderators and assistants. |
| **Examples of audience roles** | |
| Audience member | Common audience role. |
| Specially assigned audience member | Specially briefed and prepared audience member who focuses on contributing and influencing the flow of events implicitly and not with direct controls such as presenters and orchestrators. |
| Group member | In addition to being member of audience, can belong to a subgroup within the audience. |
| Remote participant | Audience member that participates remotely via video and audio streaming. |

66 In different live audience interaction production have different role configuration. Sometimes only presenter and audience roles exist, and sometimes the live production organization can be more complex with several different roles. The Table 3.4c divides roles in the performer, orchestrator and audience categories and provides examples of more detailed roles. The core reason for making a detailed identification of these roles is that each of these roles can have a specific task for realizing an interaction pattern, and for providing optimal support for realizing this task,

the role should have a task-specific interface. For example, the presenting-performer and facilitating-performer roles are fundamentally different in the case of Q&A interaction pattern. The facilitator should be able to choose an audience question, while the presenter should be able to recognize the choice that the facilitator made and respond to this without being overwhelmed by other messages. Similarly, an off-stage moderator must have a focused view of all contributions and be able to edit messages, while technical facilitators are often focused on managing the overall visibility of different interaction activities in the interface and potentially should not have any rights to edit content. Besides recognizing that there are multiple subcategories of roles, it is still practical to primarily categorize roles as on-stage presenter roles, off-stage orchestrator roles and audience roles. Also, it is important to understand that each role can have multiple representatives. Based on the definition of live audience interaction there are always multiple audience members in the production (see definition in Section 1.2), but there can be also multiple presenters, multiple hosts, multiple moderators and multiple technical facilitators in a production. The list of different roles presented in Table 3.4a is not a comprehensive list. There are potentially more roles depending on the interaction pattern. For example, in a simple poll pattern there is no similar requirement for various moderator roles as there is in a Q&A interaction pattern. Hence, different interaction patterns require different kinds of roles and role arrangements. When new interaction patterns emerge, new roles may also emerge.

This chapter explained how a presenter-centric approach to live audience interaction has been shown to be an inadequate in many live audience interaction productions setup. In practice, live audience interaction requires many different kinds onstage, off-stage and audience roles. There can also be multiple individuals taking the same production role. Based on these observations, it is possible to define another core requirement for the live audience interaction design framework as:

67

2.    Live audience interaction design
      framework should provide support
      for multiple different roles.

## 3.5 Support for Parallel Functions

Section 3.2 explained how the focus of this research changed after the cinema games experiments from exploring the designs of digital content for the big screen to creating computer-based support for audience interaction with a live performance. With this change, the functional orientation of the research also expanded. Originally, the cinema games were designed for entertainment whereas live audience interaction was expected to also be for functional interactions such as communication during events and knowledge generation.

The first experiments in the domain exploration phase focused on knowledge generation, as it was a new functional perspective for this research. This is well demonstrated for example in the different interaction pattern experiments introduced in Table 3.3a. The early phases of the domain exploration could be described as a phase where entertainment was left behind and the focus of the research was geared towards exploring how live audience interaction can have functional relevance and be used for explicit knowledge production.

Surprisingly, the primary objective for applying live audience interaction in the first commercial productions was not knowledge production or communication but rather enhancing the event experience very broadly. In the commercial productions, the event organizer is often the client who interacts and invites the live audience interaction production team. At networking events, such as the example presented in Figure 3.4c, the event organizer has little influence or impact upon the presenter's content. What the event organizer is focused on is the event experience and how the audience is engaged during the presentation. In such a case the event organizer considers live audience interaction as a tool that can increase audience engagement. We often interacted with event producers who considered live audience interaction as "something new" that can make the event trendy and at the frontline of technological advancements. The event organizer expects that the facilitator and presenter take advantage of live audience interaction for improving communication between the presenters and the audience, or for producing new knowledge, but his or her primary focus is on enhancing the event experience. This is well demonstrated by the so-called warm-up questions. The primary motivation for these warm-up questions is to introduce live audience interaction techniques to the audience, but at the same time these questions are used for audience activation. The content of such a question is often

79)
Uysal and Li
(2008)

80)
Severt (2007)

81)
Networking game and participation game (Figure 3.3c) are fundamentally similar; games, which count audience contributions to any kind of live interaction activity.

humorous and the outcome does not provide any significant new knowledge.

Actually, events are rarely a forum for new knowledge generation. Uysal and Li have reviewed motivations to attend events and identified core reasons as socialization (24%), togetherness (with the family) (19%), novelty (19%), escape (16%), entertainment (6%), exploration (5%) and attractions (4%)[79]. These results emphasize social aspects and experience. Another study, by Severt et al, focuses specifically on evaluating why people participate in conventions[80], and identifies education, networking opportunities, educational information at exhibits, reasonable travel time and business activities as the primary motivators for attendance. The same study also points out that those who were most satisfied with the educational aspects of the event were also the ones most satisfied in the event overall. Hence, the educational component is significant at most events and not only in the educational context. Explicit knowledge generation or decision making within the community does not appear to be a significant motivation in conventions or a motivation component considered in event studies. Hence, according to the prior studies, social aspects and education aspects are the most important motivations for participation at public professional events and can be considered as the functions of the events from the audience perspective. In order to be useful for the audience, live audience interaction should support these functions.

In order to align our research with these research findings, we organized events that were focused especially on facilitating the social aspects of the event experience. These productions were called networking games[81]. Basically, in these productions audience members had the possibility to collect points during the event by creating links between themselves and other audience members. Most of the time this activity took place during the breaks. In this sense, the networking game stretches the concept of live audience interaction, as a part of the interaction takes place outside the performance context. However, the game setup is initialized during the performance, part of the interactions take place during the performance, the interactions are activated by showing highscore lists during the performance and the game is concluded by rewarding the winner during the performance. Based on our experience, a networking game would not be a successful concept without the performative and audience interaction elements. The networking game is a borderline concept for live audience interaction. But there are also other interaction patterns that support social interaction. For example, the message wall function is often introduced for

asking questions from the presenter, but according to our studies a significant part of the messages are actually discussions between audience members[82].

Based on the observations during the domain exploration, it is fair to conclude that live audience interaction can be used for different functions at an event. Different functions can be realized with the same interaction patterns such as the case with the message wall, which is used to allow the audience to ask questions from the presenter but also to increase the social activity level among audience members[83]. Alternatively, different functions usually utilize different interaction patterns, but these different interaction patterns can be realized with the same live audience interaction system. Some of the functions are emerging from the presenters' need to communicate and interact with the audience, whereas some functions originate from the event organizer who is not directly involved in the design of the individual presentation. Table 3.4 lists different functions of live audience interaction based on the domain exploration part of the research. The table provides examples of what kind of interaction patterns can be used for realizing this function, and refers to example productions that realize this function.

These different functions can utilize same interaction pattern, but performer and orchestrators behavior might be different. It is also common that these functions coexist in the same production. A common example is that there are parallel discussion streams in a single message wall and each of these discussion streams serves different functions[84]. It is also common that there are various closed and openended questions while message wall function is active. Such parallel functions can be confusing for audience members. In such a case audience members need to focus on multiple simultaneous activities, hence multitask, for example focus on the presentation, read audience comments and respond to the organizers feedback questionnaire at the same time. Such multitasking arrangements are often considered as a bad and ineffective design. In order to avoid multitasking, different functions should be realized one at the time. Alternatively, different functions can be distinguished and different systems used to realize each function, but this would not necessarily solve the multitasking issue in any meaningful way.

Realizing one function at a time is the recommended approach in most cases, but there should be the possibility to diverge from this rule in certain conditions. For example, it is not good design to disconnect a message wall while asking participants to answer a single poll question. Disabling the message wall's chat thread can significantly affect any ongoing discussion stream in

82)
Nelimarkka
(2014)

83)
Nelimarkka
(2014) and
Nelimarkka
(2016)

84)
Nelimarkka
(2012)

TABLE 3.4 :          DIFFERENT FUNCTIONS FOR LIVE AUDIENCE INTERACTION

| FUNCTION | EXPLANATION | PRODUCTION EXAMPLE |
|---|---|---|
| Pedagogical function | See various uses of Clicker in education. Also other patterns commonly used such as message wall for asking questions and quizzes as a teaching pattern. | Teachers used Slides & Polls as a clicker replacement. |
| Audience engagement | Event organizer prepares various interaction activities (gamification, lottery to poll and message wall) as the primary goal for activating the audience and increasing the event experience. No direct connection to presentation. | For example the case MVV example production in the figure 3.4c. |
| Communication | Q&A pattern. Also presenter can utilize polls and other interaction activities for strengthening the delivery of the message. | Q&A pattern. Common use for Slides & Polls by many presenters. |
| Facilitation of social activity | Live audience interaction facilitates interaction between audience members and lowers the threshold for networking. | Networking game. Chat as a discussion between audience members. Integration with social media for enhancing visibility of social media. |
| Production of ideas and knowledge | Various patterns that combine group assignments open-ended idea collection with sorting and possibly also collaborative visualization of drawing (mind-maps, collective presentations). | Production case Sometime 2012, Presemo Brainstormer and Servdes 2012 |

the chat. There are also cases when focusing on the performance is not the core motivation among audience members or for the event organizer, and in such a case the presentation and associated interaction can be considered as secondary activity. It is a common situation at many conferences that audience members have other priorities, such as reading email while watching a presentation, and there are valid reasons that in some cases such alternative priority can be a live audience interaction pattern that takes place in the background. Overall, large audience events are complex social organizations and audience members may have several ongoing tasks during a performance, some of which are directly related to the ongoing performance, some may be related to the event context in general, and some may be disconnected from the event. The audience should not be considered as homogeneous. For many live audience interaction patterns, it is not a requirement that all audience members par-

ticipate. For example, most often, only a fraction of audience members write messages, while most of them still read them. Overall, for a live audience interaction producer, an important question is whether the functions are specific for the particular presenter or whether the functions originate from the performance surroundings. The design framework should be applicable in both cases and be able to accommodate different and parallel functions. Hence, the third requirement can be formulated as:

```
3.      The live audience interaction design
        framework should support different and
        parallel functions for live audience
        interaction.
```

# 3.6 Summary of the Core Requirements for the Design Framework

The three sections 3.3–3.5 introduced and explained the three core requirements for the live audience interaction design framework based on the domain exploration. These requirements are used as a basis for the LAIX-score design framework presented in Chapter 5.

While elaborating and explaining these core requirements, many important observations and findings have been left out. There are for example important observations regarding how the audience interaction system should be aesthetically integrated to the event and performance design, how the technical integration between live audience interaction and various video systems should be developed, how the big screen should be used to manage audiences' attention, and how live interaction production requires tools for training and simulation. These observations are important, but considered secondary in comparison to the three core findings presented here. The other relevant research topics and requirements that emerged during the domain exploration are listed and introduced in Section 10.2.

There is one significant observation from the domain exploration that should be acknowledged separately and this is how reactivity and improvisation take place in live audience interaction productions. Many live performance practices are based on well-designed plans and rehearsed procedures. This is the case with musical performances, keynote presentations and classical theater. Live audience interaction has some inherent

improvisational qualities that should be acknowledged. This is also how a live audience interaction production differs from the live performances, which do not consider audience input. First of all, it is understandable that there are changes during a live audience interaction production because planning a live audience interaction production is hard without design tools, simulation tools or significant experience. Often presenters and organizers are doing live audience interaction for the first time, and developing a detailed plan that is appropriate to the live situation is not practically easy. However, there is also another and more fundamental factor for why live audience interaction should be considered as a practice that requires an improvisational approach. Audience contribution in live audience interaction should have the possibility to have a structural impact on the production. This is especially relevant in cases where live audience interaction has an explicit functional role.

Hence, reactivity and improvisation are important characteristics of live audience interaction. In the development of the design framework, they are not considered as requirements, but they are considered as an evaluation topic. How does the proposed framework accommodate reactivity and improvisation? Reactivity and improvisation can take several forms, and it is not appropriate to impose any of these specific forms upon live audience interaction more generally.

This chapter has presented the core requirements for the live audience interaction design framework based on domain exploration. The three core requirements for live audience design framework are:

```
Reg1 :  Support different kinds of live
        audience interaction patterns.

Reg2 :  Support for multiple different roles.

Reg3 :  The live audience interaction design
        framework should support different and
        parallel functions of live audience
        interaction.
```

The next chapter will build on top of these empirical findings and look in more detail at established related designs and design frameworks. Then the findings from this chapter and Chapter 4 are combined together in Chapter 5, which presents the details of the LAIX-score design framework.

# 4.

# Exploring Related Designs and Frameworks

# 4.1 Introduction to Related Frameworks

This chapter focuses on identifying and elaboring related frameworks and structures, which could function as inspiration for a design framework for live audience interaction. The chapter builds on top of the domain exploration presented in Chapter 3, but focuses on analyzing established software products for live audience interaction and other related frameworks. The objective of this chapter is to analyze how existing live audience interaction systems realizes the core requirements and to identify core framework references for the design framework for live audience interaction.

Section 4.2 analyzes the designs of the various established software products that are used for live audience interaction. While the domain is novel, there are already some commercial systems available on the market and there are also studies that evaluate and present these live audience interaction tools. None of the studies related to these systems specifically elaborate what kind of design framework these systems are based on. For this reason, Section 4.2 evaluates existing systems and develops three early stage design frameworks that present the core design approaches of the existing software. These draft frameworks are evaluated based on the core requirements presented in Chapter 3.

Section 4.3 presents related frameworks that are already well established in the field of live performances. These are not live audience interaction frameworks, but frameworks that are applied elsewhere in live productions. Section 4.4 focuses in detail on live audio mixing systems and Section 4.5 on live light control systems designs, which all are well established and widely applied control frameworks for live productions. The frameworks behind audio mixing and light control are utilized in different contexts and are the basis for various technical implementations. These frameworks are also used as basis in planning and coordination between live production professionals. These functional frameworks are also taught in schools and mastering these systems can be considered as a core competence of professional practitioners in each of these domains.

85)
kahoot.it,
socrative.com,
polleverywhere.com,
tweetwallpro.com,
and sli.do

86)
These systems have been in the market for a long time, and practitioner in the field usually knows some of these system or all the system.

87)
See for example Dellos (2015)

88)
See for example Sellar (2011)

# 4.2 Designs of Live Audience Interaction Systems

There are several computer systems that are related to live audience interaction. Table 1.3 presented a wide range of concepts and phenomenon that are related to live audience interaction. This chapter analyzes five existing live audience interaction systems: Kahoot, Socrative, Poll Everywhere, Tweetwall Pro and Sli.do[85] and develops an abstract design frameworks based on these designs. All of these systems are widely recognized and relatively popular[86]. These five systems are only the tip of the iceberg and there are several other similar systems in the market. The evaluation is based on benchmarking the system and evaluating the feature lists provided by the manufacturer. These five examples have also been chosen so that the reader can easily trial them and get direct experience with these designs. Overall, I expect that the selected reference products present broad overview of different conventional design options in the domain.

Kahoot and Socrative are tools specifically designed for the educational context. Poll Everywhere, Sli.do and Tweetwall Pro are systems that are basically applicable in all kinds of environments, but for example Tweetwall Pro is not specifically functional for education, since the use of Twitter or social media messaging is not commonly preferable in the classroom setting. Kahoot is a popular live audience interaction system focused on providing quizzes in classroom[87]. Basically, the system design is focused on providing trivia in live audience interaction setup. With Kahoot a teacher or presenter asks questions from the audience onebyone and there is one question at the time that the audience answers. The students are scored based on how the answer the questions. The system is optimized for this single function and does not provide additional interaction patterns or capabilities. As such, the system does not fulfill any of the three core requirements presented in Chapter 3.

Poll Everywhere is a system that is based originally on multiple choice (poll) questions[88]. The core objective of the system is focused on orchestrating polls. The system has been extended with additional features and currently it supports many different kinds of interaction patterns such as openended questions and a message wall. Hence, there is support for new interaction paradigms, but no support for multiple different roles. Polls (interaction activities) are basically all independent and the presenter chooses to present polls either in groups or one at a time. Poll Everywhere also supports user management, grading

and message moderation.

Tweetwall pro is also a popular live audience interaction system. It is built on top of the message wall function that is realized by utilizing Twitter messaging. Tweetwall pro supports moderator interface, and polls if they are Twitter polls. Hence, the Tweetwall pro has limited support for other interaction activities, and limited support for more roles than that of presenter.

Socrative is a popular live audience interaction system used especially in classrooms[89]. Socrative supports different kinds of activities, but is mainly focused on interaction patterns where teachers asks questions from the students. In Socrative each interaction pattern is shown one at the time similarly as in Kahoot, except that Socrative accommodates more interaction patterns. Socrative, like Kahoot, also support user management.

Sli.do is another live audience interaction system designed for events. Sli.do is based on tab design. It supports two tabs: one for polls and one for messages. There is no support for other types of interaction patterns. The system has an admin and audience view and this way has limited support for different roles.

Table 4.2a lists the qualities of the existing live audience interaction designs according to the core requirements identified in the previous chapter. Our Slides & Polls system is also included in the table to demonstrate how our earlier design does not either satisfy the core requirements presented in Chapter 3.

89)
See for example
Wash (2014)

TABLE 4.2A :    TABLE DEFINING TO WHAT EXTENT THE CURRENT LIVE AUDIENCE
                INTERACTION DESIGNS MEET THE CORE REQUIREMENTS FOR
                THE LIVE AUDIENCE INTERACTION DESIGN FRAMEWORK

| | SUPPORT FOR DIFFERENT INTERACTION PATTERNS | SUPPORT FOR DIFFERENT ROLES (MORE THAN PRESENTER AND AUDIENCE) | SUPPORT FOR PARALLEL AND DIFFERENT FUNCTIONS |
|---|---|---|---|
| STEREOTYPICAL CLICKER | No | No | No |
| KAHOOT | No | No | No |
| SOCRATIVE | Yes | No | No |
| POLL EVERYWHERE | Yes | No | Limited (group) |
| TWEETWALL PRO | Limited (only Twitter polls and Tweets) | Limited (moderator) | Limited |
| SLI.DO | Limited (only poll and messages) | Limited | Yes |
| SLIDES & POLLS | Limited | Limited | Yes |

The table can be simply summarized with the statement that most systems available in the market have been originally designed for one core functional paradigm. Only Socrative makes a clear distinction here, as Socrative's design is basically independent of interaction pattern (this is called later as interaction pattern agnostic approach). This is important, as this design also exemplifies the importance of a generic approach. Then again, Socrative does not provide comprehensive support for different roles or parallel functions.

Socrative, Poll Everywhere and Kahoot are examples of systems that are based on the sequential interactions design framework. There is a predefined functional flow for each of the interaction activities, and only this one functional flow can be realized at a time. Figure 4.2b illustrates the design framework for the *sequential interaction* approach. A use case example of sequential design would be that teacher presents first one question and after this first question is answered by all students, then the teacher moves forward to the next question, until all predefined questions are completed.

FIGURE 4.2B :    SEQUENTIAL INTERACTIONS DESIGN FRAMEWORK
                 FOR LIVE AUDIENCE INTERACTION SYSTEM



Time
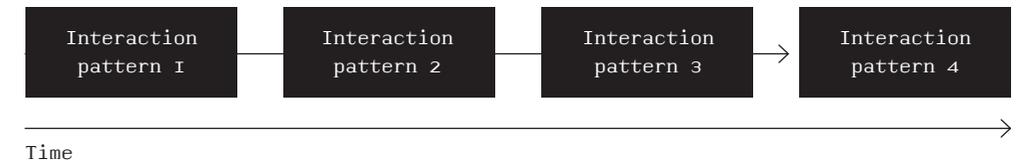
Tweetwall Pro is a design that is based on a single core function, but has been later extended with new features. This design approach could be called a design core function design. It is important to note that the core function is not always the same, but depending on the origins of the system, the core function may have changed. In some sense our Slides & Polls follows this design as it had a persistent chat feature as a core function. Figure 4.2c illustrates the design framework for the core function approach.

FIGURE 4.2D :          TAB DESIGN FRAMEWORK FOR LIVE AUDIENCE INTERACTION SYSTEM

| Additional interaction pattern 1 | | Additional interaction pattern 2 | |
|---|---|---|---|
| Primary interaction pattern | | | |

Time

| Tab2 | Interaction pattern 2.1 | Interaction pattern 2.2 | Interaction pattern 2.3 |
|---|---|---|---|
| Tab1 | Interaction pattern 1.1 | | Interaction pattern 1.2 |

Time
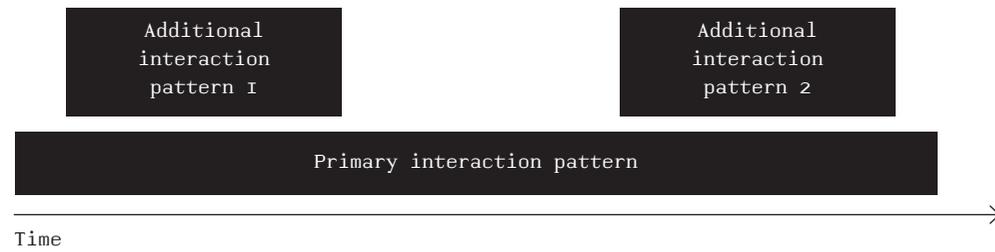
Sli.do is a system that is limited support for all the requirements. It supports different interaction patterns (each in own tab), it also supports the use of a moderator (administrator), and two different interaction patterns can be realized in parallel. There are also other systems on the market that utilize similar tabcentric designs[90]. Basically, tab designs can be extended for various kinds of interaction patterns. However, in Sli.do, the tab structure is basically static (two tabs) and cannot be extended during the live session and the function of both tabs is also static. Hence, the system does not expect new interaction patterns. The tab design demonstrates how multiple interaction patterns can be supported in parallel. As such it does not provide any structure for how new roles could be introduced in the system. Presumably in the tab design there are functionally unique views for additional roles needed to realize this particular interaction activity. Figure 4.2d illustrates the design framework for the tab approach.

90)
See for example
Prospectum
prospectum.com

This chapter presented five different live audience interaction systems and synthesized three abstract design frameworks based on these designs. Each of the design approaches has merits, but they do not provide structural qualities to meet the core requirements presented in Chapter 3. The *sequential interactions* approach is limited in how it supports parallel functions and does not provide any guidance on how to support multiple roles. The *core function* approach is limited in how it supports different kinds of interaction patterns and the support for multiple roles is fundamentally restricted based on this core function. The tab design approach is more flexible in terms of support for different and parallel interaction frameworks, but does not provide guidance on how to support multiple roles and has some systemic limitations on how many different kinds of interaction activities it can support. Also, there are no references for tab designs with more than two tabs. A twotab live audience interaction management system has very limited support for parallel functions and different interaction activities.

The analysis of the existing systems also revealed certain features that are repeated in most systems. Such core features are support for visual modification of the system, integration to other systems such as social media, interaction to presentation and event management platforms, and various login and user management options. Some of these observations are considered in Chapter 7, while extending and revising LAIX-score design framework.

The design frameworks presented in this chapter are not exclusive, but can also overlap in some cases. Hence, it is possible that core qualities of each of these frameworks could be combined. For example, a single tab can be managed with the sequential approach or a tab may be fixed and apply the core function design. All of these design frameworks provide valua-

ble insight for what kind of qualities live audience interaction framework should have. Since, the analysis shows that none of these conventional design approaches is adequate to comprehensively satisfy the core requirements, they cannot be the basis for the generic design framework for live audience interaction, and there is justified reason to develop a new design framework that is based on the three core requirements.

## 4.3 Established Frameworks for Live Performance

There are various frameworks applied in the design, production and coordination of live performances. For example, the theatrical practices, dance and performance studies have frameworks that could be considered as relevant references and inspiration for the live audience interaction design framework. Based on the objectives of the research (Section 2.3) there are two criteria for selecting the reference framework for the design framework for live audience interaction. The framework should be *generic* and *practical*. Three well-established frameworks used in live performances that meet these three criteria are musical notation, live light control and live audio mixing. Live video mixing would be another similar reference but on an abstract level it does not significantly different from live audio mixing. These frameworks should not be considered as design frameworks or theorethical frameworks as coined in research, but as *functional* frameworks that outline the system used in practice. Since this is a practice oriented research it is relevant to consider functional frameworks as references for a theorethical design framework.

Classical music notation is extensively applied, developed and accepted "coordination framework". Using framework label is not appropriate since musical notation as such has unique and widely acknowledge conceptual position. Musical notation has become widely accepted language for music and used to design musical performances, coordinate playing during the musical performances, and it can be also used in the documentation of a musical performance. There are also software systems that utilize musical notation for generating music[91]. Musical notation can support multiple different instruments, which is the equivalent of supporting multiple different roles. Hence, musical notation can be considered as a good example of a practical and generic framework. Musical notation that presents all the

players together is called a *score*. The use of score in the LAIX-score name is adopted from musical notation. Figure 4.3a shows an example of a score.

It took hundreds of years for musical notation to evolve to the current de facto standard form[93]. Even though core classical notation can be considered fixed and standardized, the use of musical notation has kept evolving and there are new types of musical notation variations used for example in rap and electronic music. It is common that computers are used to generate musical notation and play directly from musical notations. But there are also specific music programs such as trackers, samplers and sequencers that have a unique form of notation and control.

91)
See for example musescore.org and avid.com/sibelius

92)
Image is public domain and downloaded from mutopiaproject.com

93)
See for example history and evolution of musical symbols (thisisgabes.com/images/docs/musicsymbol.pdf)

Musical notation is an important example of how generic and practical framework can become an institution and have a significant impact on advancing the practice. From a very abstract level, it is possible to see an analogy between playing music and conducting live audience interaction, how different roles in live audience interaction can correspond to different roles in an orchestra. Musical notation is not, however, an appropriate reference for live audience interaction as there is only "one kind of" music. Musical notation considers temporal management accurately and provides support for multiple roles, but as such there is only one kind of activity involved in the musical score – the one piece. Hence, score does not qualify for the third requirements – support for parallel functions. Musical notation and music scores provide an important inspiration for this work, but the core reference frameworks for this study is live audio mixing and live light controls. These two frameworks are introduced in the next two chapters in detail.

## 4.4 Live Audio Mixing Framework

Live audience mixing systems are used to control the amplification of music and audio during a live performance. Basically, all live audience mixing systems (also called mixing consoles or audio mixers) follow the same principal structure. Similar mixing systems are used also in studios for recording, but in this chapter the focus is in the application of audio mixing systems during live performance. Live audio mixing is not limited to musical presentations, but it is also used in all kinds of presentations that require electrical manipulation of sound. The core concept in the audio mixing system is the channel. The live audio mixing framework is basically composed of three components:

```
– Input channels
– Output channels
– Mixing console (mixing system)
```

An input audio signal is usually an audio source such as a microphone, computer, audio player or electrical instrument. These input signals are connected to the input channels of the mixing system. In the mixing system, an audio engineer manipulates the input signals and combines multiple signals together that feeds them to output channels. The master output signal is commonly connected to the loudspeakers. This is usually referred to as a

public audio (PA) system. In a simple mixing system, there are usually only a few output channels, the master channel and additional auxiliary output channel. Auxiliary channels (also called auxiliary sends or buss) are used for recording. In large mixing console. there can be more than 10 output channels. Different output channels are used for providing unique audio mixes for each artist as sound monitors, for recording, for streaming, for effects processing and for synchronizing live performance with other live systems such as videos and lights. Figure 4.4a presents three examples of a live audio mixing setup and how they all follow the same fundamental matrix based control framework.

FIGURE 4.4A :    THREE DIFFERENT EXAMPLES OF THE DESIGN
FRAMEWORK FOR LIVE AUDIENCE MIXING[94]



94)
Images of mixing
consoles are used
under Creative
commons licence.

The third example in the Figure 4.4a illustrates an example of professional highquality live mixing system. Such a system can have 48 or more input channels, various inbuilt signalprocessing features and more than 10 output channels. Such systems costs hundreds of thousands of euros and basically require a trained and well-prepared professional as an operator. Still, the basic underlying framework in these systems is fundamentally the same as in the few hundredeuro 4-channel live audio mixing console used in a classroom presentation to adjust the presenter's microphone volume (example on left in the figure 4.4b). The live audio mixing framework has emerged as a de facto standard and different parts of the overall live mixing system can be connected together, as the interfaces are standardized. Computer-based audio mixing systems also apply the same control framework and can integrate to the same overall audio setup. Audio engineers used fluently both digital and analog audio mixing systems.

Live audience interaction management and live audio mixing have certain similarities. Both are technically supported live practices. A live audio control system is operated by an off-stage sound engineer (an orchestrator role). A live audio control system focuses on aggregating and controlling several different inputs that are then fed forward, primarily to a public audio system, but also to different monitor systems, recording and streaming systems. The output channels in a live audio mixing system can be perceived as analogous to the different roles and interfaces in a live audience interaction. The public audio system is analogous to the big screen in live audience interactions. Similarly, as live audio mixing supports multiple different audio sources, live audience interaction must support multiple different interaction patterns. The different output signals are independent. There can be for example different tracks playing on the monitor or the streaming channel than on the master public audio channel. Commonly output channels are divided as master channels, effect channels, monitor channels and auxiliary channels,

The live mixing framework is a relatively simple framework. It is used widely among live music performers, and in all kinds of situations that involve audio amplification. The live audio mixing framework is used for communication during practice in relatively simple ways. It is common that performers, bands and producers send a channel list to audio engineers so that they know what kind of input signals and output signals they should be expecting from the production. A big part of the adjustment of different output signals takes place during the sound check and during the live situation.

95)
DMX is a USITT (United States Institute for Theater Technology) standard.

96)
This is called a XLRcable, however usually DMX is utilizing a 5-pin cable instead of a common 3-pin microphone cable, but with adapters a microphone cable can function adequately.

97)
Called DMX Universe.

98)
The maximum basic frequency of the DMX control system is 44hz, but this can be enhanced by limiting the size of the signal sent.

## 4.5 Live Light Control Framework

Live light control is another example of a well-established framework applied in live performances. Live audio mixing and live light control systems are often built next to each other in most performances, but in practice they are fundamentally different systems. On an abstract level, these frameworks have certain similarities. The majority of live light control systems are built on top of DMX control[95]. DMX control signals have a special history that connects light control to audio control. DMX control signals can basically be carried out through an analog microphone cable[96]. This signal carrying cable produces unique constraints for the live light control framework. Each DMX signal[97] can carry 512 channels and each channel can have a value within the range 0-255 (8 bit). This signal (512 times 8 bit value) is broadcasted through the control network to every connected device and lamp several times a second[98]. Each light can "listen" to one or more channels. Conventional lights such as par fixtures or traditional profile lights require only one DMX control channel, which corresponds to their light intensity. Modern moving lights can "listen" to over 20 channels where one channel can control one parameter such as tilt orientation, pan orientation, red color, green color, filter effect, focus etc. The lights can be connected to a network loop where the same signal is broadcasted to all lights. For this reason, the same channel can be used to control multiple lights. Light control becomes more complex when light effects are dynamic (flickering or moving) and there are different kinds of lights in the setup. For managing such complex effects, the light control system has a programming part that groups together multiple lights with similar properties. Most of the time light control involves manipulation of multiple lights simultaneously. The light control framework is basically divided into three parts:

–    Controller interface element (fader or button)

–    Programming system (connects control action to output channels)

–    Output channel(s) (based on DMX standard).

Figure 4.5a illustrates three different kinds of light control systems. The simple system has 4 control interface elements (faders) and it can command only 4 DMX channels that are trivially mapped to the control faders. Hence, this system has basically

no programming capabilities. The system in the middle has eight faders that can be used to control 64 DMX channels. Hence the system can control multiple lights or control lights with multiple properties. This system has simple programming capabilities.

FIGURE 4.5A :     THREE EXAMPLES OF LIGHT CONTROL ENVIRONMENTS FROM A SIMPLE 4-CHANNEL SYSTEM TO A COMPLEX SYSTEM WITH MORE THAN 32 000 CONTROL CHANNELS



Trivially mapped.
No output channel programming.
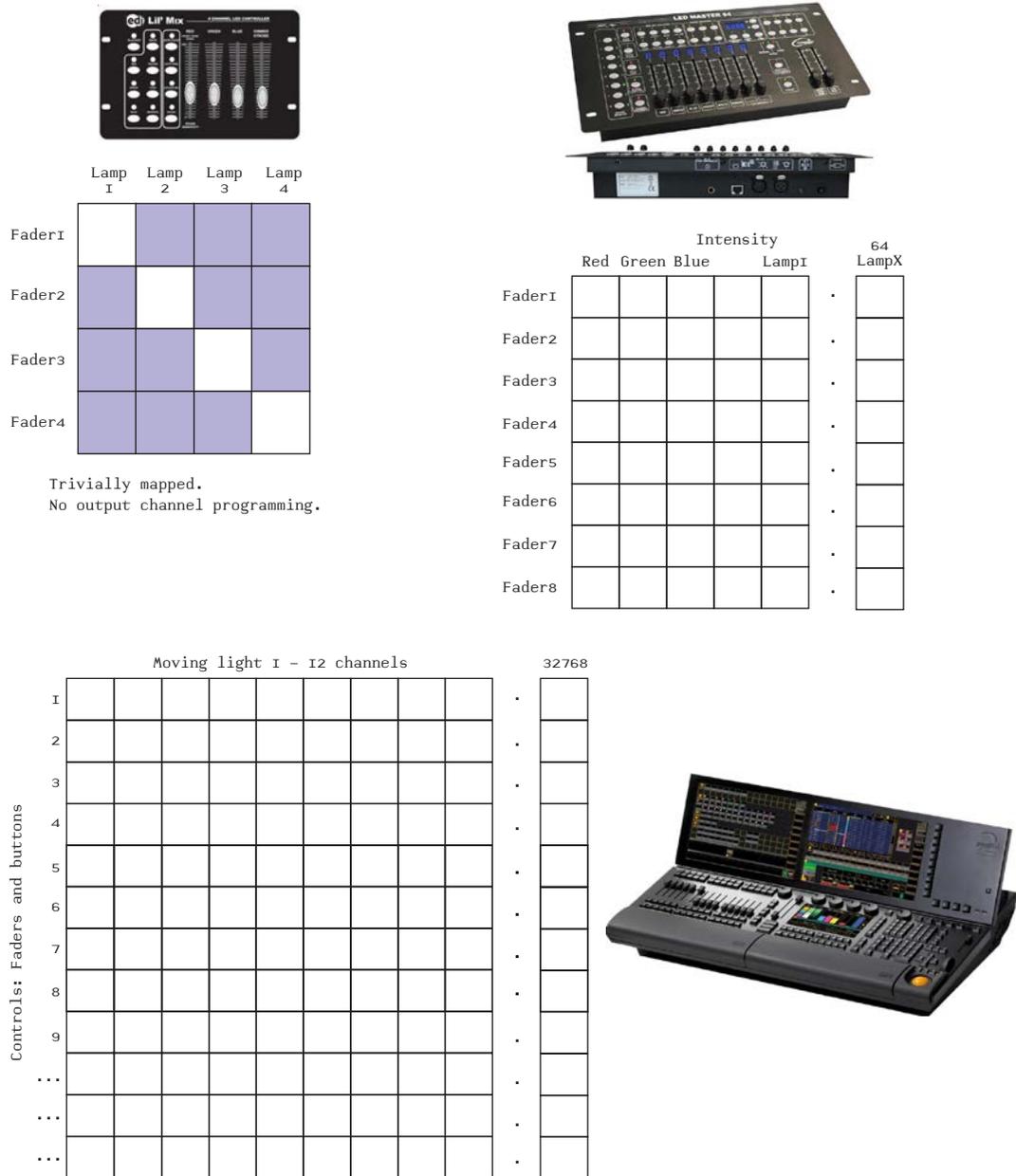
The third system is a complex and expensive modern light control interface that has several buttons and fader elements. Each fader can be programmed for complex commands that combine not only the activation of an individual DMX channel, but also temporal control such as flickering and various movement paths. The system supports 64 DMX universes, which means over 32000 control output channels.

Since the DMX signal is inherently limited (only 512 channels) and there are many different kinds of lights, the control systems have created different ways to realize the *practical control* of the light system. An advanced computer-based light control system knows the profile of each light and understands what kind of control qualities each channel requires. This way the light operator does not have to specify that certain values correspond to a specific color for example. Also, the dynamic effects can be created inside the light control system with specific functions that define the movement speed and how different lights are synchronized. Controlling, for example, a common movement effect with multiple lights would be impossible without a computer-based control system. Still, the fundamental control system is built on the same core framework originating from the DMX standard, and the same lamps can be operated with a fullfeatured modern light control system as well as a simple light control system costing only few hundred euros.

The light signal can also be synchronized with other external signals such as audio or movement sensors. Control faders are used in theatrical settings in particular in chronological order as a way to operate predefined light situations. This is an example of how a real time control system such as a live light control can be utilized to realize similar features as the sequential interaction design framework visualized in Figure 4.2b. Most light control systems have a separate programmer mode and the live mode. The programmer mode is used to predefine the controls and create presets. In the live situation usually only these predefined controls are used. However, it is possible to live operate the systems also in programmer mode, which provides the light operator much more room for improvisation than predefined controls.

Live light control is another important reference for live audience interaction for two reasons. First of all, live light control is a standard framework that can be extended for new kinds of lights and is basically agnostic about what kind of features the lights can have. Actually, light control framework is often used to control other kinds of live effects such as smoke and fire effects, projector shutters and simple actuators. Hence, a light

control framework is an important example of how generic live performance control frameworks function. Second, a light control framework is also scalable for different kinds of system configurations. Multiple light control systems can be connected together and one light control system can be used to control multiple light settings such as hall, ambient light, and stage light. The matrix control system also enables that light control framework can be used to control different independent light setups or different light groups. Hence, the light control framework can be utilized for controlling different parallel functions.

Live light control frameworks resemble live audio mixing frameworks on an abstract level, but live light control has more specific and detailed standards than audio mixing. The control system implementations are similar (tables with faders and buttons), even though the actual control signal is completely different. Considering the differences, it is remarkable that the live light control and live audio mixing can be both presented on an abstract level in a similar control matrix form.

## 4.6 Summary of the Related Designs

The primary function of this chapter is to identify, introduce and elaborate the core references for the live audience interaction design framework. This chapter first explored multiple existing live audience interaction designs and concluded that the abstract design frameworks underlying these live audience interaction systems are not systemic level adequate to support the core requirements defined in Chapter 3. Then the Section 4.3 explained how there are three widely adopted, generic and practical framework applied in live performances that should be considered as core reference for live audience interaction design framework.

Musical notation is probably most widely recognized framework for live performances. Most people recognize this notation and it is taught widely in schools for children. Musical notation is an inspiring reference for live audience interaction management, but it is not directly applicable reference, as it does not provide means to manage both multiple different roles and different interaction activities. Live music mixing and live light control frameworks are better core references for a live audience interaction framework because they are focused

on control and provide support for parallel functions. Both of these frameworks are widely adopted and there is a significant amount of technology that builds on top of these frameworks. These frameworks are not as well known as musical notation, but they have become de facto standards and the basis for practices among professionals.

Live audience mixing and live light control are generic control frameworks since they are used in all kinds of live performance context ranging from seminars and religious events to musical shows and sporting events. They are practical design frameworks since they provide direct basis for how audio or light engineer can control audio or light during the live production and define how audio and light control systems are built. Control system in both of these core reference frameworks are based on a two dimensional matrix format. For this, reason the matrix control format is thus proposed as the basis for the live audience interaction design framework. The matrix format produces control capabilities that may the three core requirements for the live audience interaction design framework.

# 5.

Introducing
t          h          e
LAIX —score
D e s i g n
Framework

## 5.1 Core Elements of the LAIX-score Design Framework

This chapter introduces the LAIX-score design framework, which is the core deliverable of this thesis. The chapter focuses on introducing and elaborating the core elements of the LAIX-score design framework and explains how the framework is built based on the core requirements (chapter 3) and by applying the lessons learned from the core references (chapter 4).

The core structure of the design framework is a control matrix, which is related to control framework used in live light control and live audio mixing. The two dimensions of this matrix are called *interface channels (columns)* and *interaction activities (rows)*. A single cell in the matrix defines the state of the interaction activity in the corresponding interface channel. The control matrix is called a *state control matrix* for live audience interaction. The three core elements of the LAIX-score design framework are defined as follows:

INTERFACE CHANNEL is an interactive computer interface. Practically, the interface channel is a visual computer interface, which is unique for a role or several roles in a live audience interaction production. Interface channel can be for example, the user interface for presenters, user interface for audience members, shared big screen interface used primarily by the audience and presenter, moderator interface, shared monitor interface for panel members or remote participant interfaces. The channel name is adopted from the reference frameworks. The interface channel concept is specific for live situation and live control. It is possible that live audience interaction management system has also other interfaces, such as system administration and system integration that are not interface channels and controlled with the state control matrix.

INTERACTION ACTIVITY is an instance of an interaction pattern that realizes the real time communication and interaction between different agents in the live audience interaction setup. For example, one poll instance or instance of a more complex question and peer rating interaction pattern. An interaction activity is a compact rephrasing of interaction pattern instance and more suitable for use in practice.

STATE CONTROL MATRIX is a control matrix that has interface channels and interaction activities as dimensions. One cell in the matrix represents the visibility state of

the interaction activity in the corresponding interface channel. E.g. whether a poll instance is visible in the audience interface, or whether a message wall activity is visible on the big screen.

Figure 5.1a visualizes the core elements of the LAIX-score design framework and shows how the different elements map to the core requirements described in Chapter 3.

FIGURE 5.IA :  CORE STRUCTURE OF LAIX-SCORE DESIGN FRAMEWORK AND HOW THE FRAMEWORK CONNECTS TO THE CORE REQUIREMENTS DESCRIBED IN CHAPTER 3.
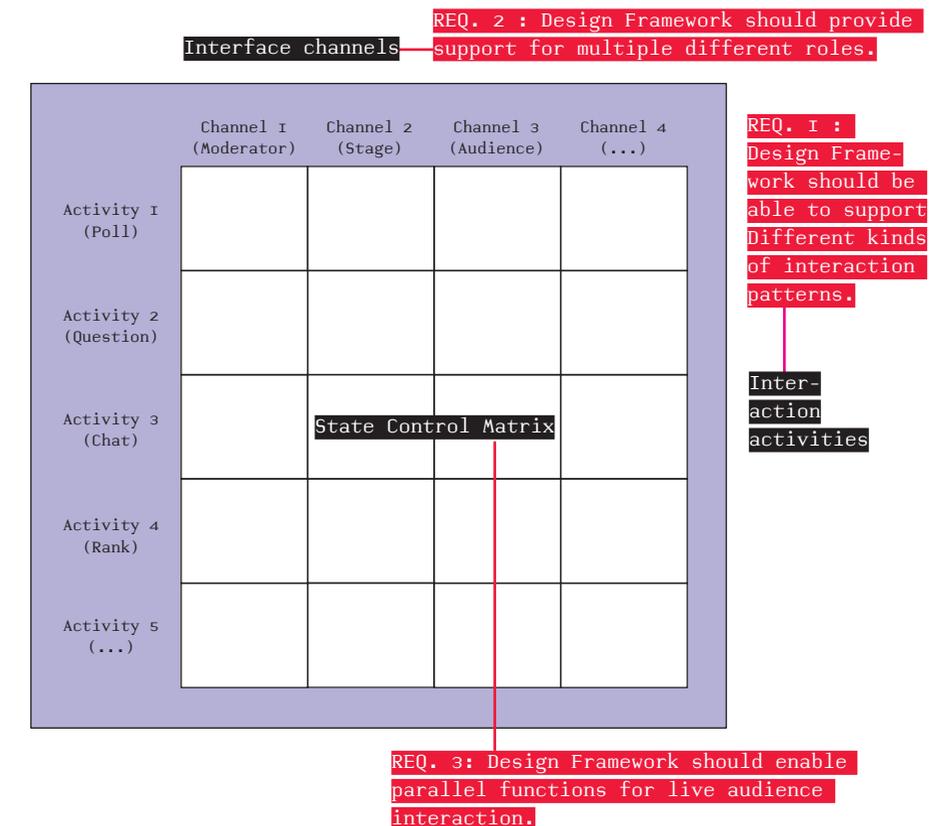


The core objective of this thesis is to develop a design framework for live audience interaction that is generic and practical (explained in Section 2.3). The hypothesis is that the LAIX-score design framework with the state control matrix satisfies these objectives. The LAIX-score design framework is expected to be a generic framework because the matrix format scales from small and simple to large and complex productions at least in light

control and audio mixing frameworks (explained in Chapter 4). The LAIX-score design framework is expected to provide a direct and concrete model for developing live audience interaction management systems and the framework is intended to be used also in coordination of the practice. The next chapter provides an example of how the LAIX-score framework can be applied in different kinds of live audience interaction contexts.

# 5.2 Examples of the LAIX-score Design Framework

As explained in the previous chapter, the core of the LAIX-score design framework is a state control matrix that defines the state of an interaction activity in the interface channels. The core state parameter in the state control matrix is visibility. Hence, the state control matrix defines the interaction activity visible in the respective interface. The state can also have more focused layout control properties such as transparency and position.

Let's provide three examples of live audience interaction scenarios that demonstrate how the framework behaves in productions of different scales. Figure 5.2a visualizes the state control matrixes for these three examples.

It is important to note that these state control matrices are snapshots of a situation in the production. During the production, the configuration of the state control matrix would change according to the program and for example those interaction activities that are not active during the example situation would become later on active. This also implies the state control matrices do not help coordinate temporal dimensions directly, hence the core design of LAIX-score does not have a temporal dimension. In practice, the state control matrix should be also a user interface that is used to control the production. The state control UI can be either a separate unique UI or it can be included for example in the moderator UI. In these three case examples, we consider that the state control is collocated with the moderator UI.

FIGURE 5.2A :   EXAMPLES OF 2-, 4- AND 6-CHANNEL STATE CONTROL
MATRIXES OF THE LAIX-SCORE DESIGN FRAMEWORK
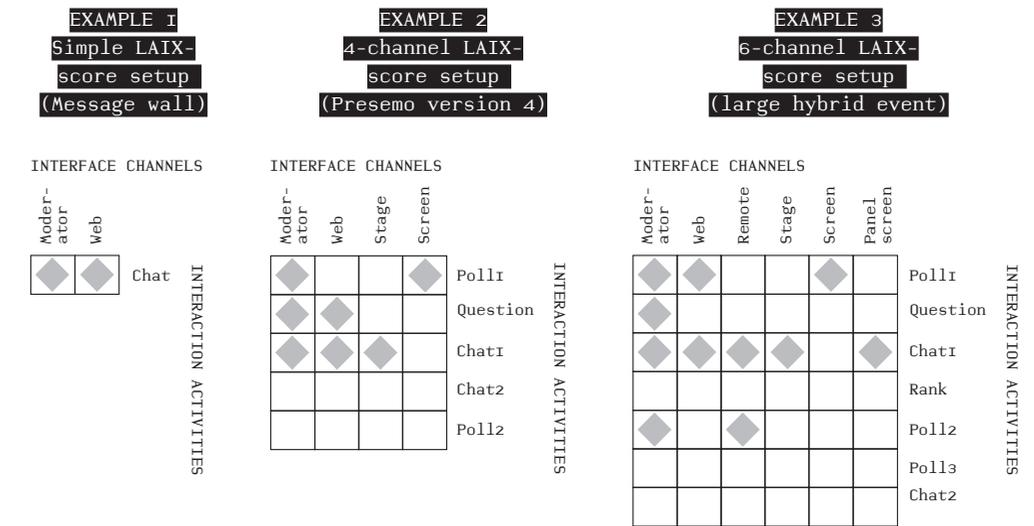


EXAMPLE 1 (Figure 5.2b) demonstrates a very simple LAIX-score setup in an environment with two interface channels (moderator and web) and one interaction activity (chat). Such role configuration is a common example in the classroom setting. In this setup there is no screen interface at all.

FIGURE 5.2B :   ILLUSTRATING THE SIMPLE LAIX-SCORE SETUP IN ACTION,
WITH ONLY TWO INTERFACE CHANNELS (AUDIENCE WEB AND
MODERATOR) AND ONE INTERACTION ACTIVITY (CHAT)
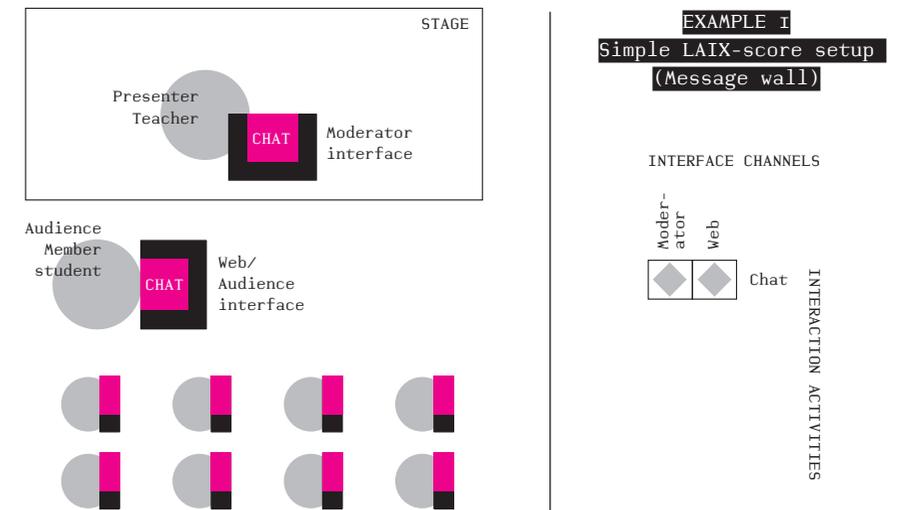
EXAMPLE 2 (Figure 5.2c) demonstrates a 4-channel LAIX-score setup.
This is a common seminar production. This setup has one interface channel
for the audience, one for the main moderator, one for the chair and the
big screen, which is visible to all. Note that the presenter does not have
a unique interface. It is common for many seminars and presentations that
there are multiple discussion threads, polls and other interaction activities
and that the polls and discussions for example are active simultaneously.

For these reason the example has multiple interaction activities.
The screen still visualizes an old poll, which is no longer active on
the audience interface. The stage is focused only on chat activity.

FIGURE 5.2C :    ILLUSTRATING THE 4-CHANNEL LAIX-SCORE SETUP IN ACTION,
                 WITH FOUR INTERFACE CHANNELS (BIG SCREEN, STAGE,
                 MODERATOR AND AUDIENCE WEB) AND FIVE DIFFERENT
                 INTERACTION ACTIVITIES, WHICH THREE ARE ACTIVE
                 SIMULTANEOUSLY.
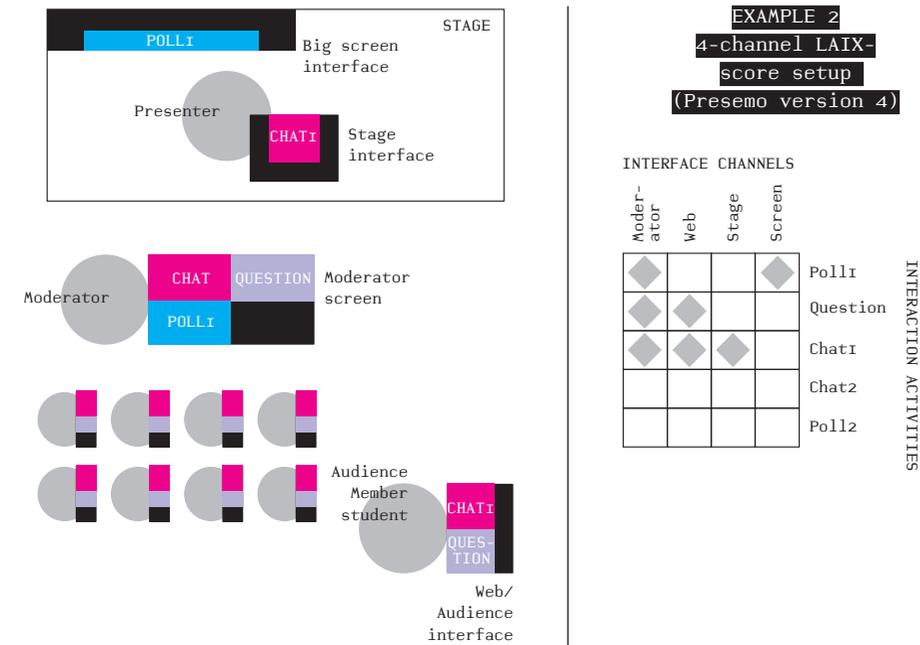


EXAMPLE 3 (figure 5.2d) demonstrates a 6-channel LAIX-score setup.
Here the difference with the previous setup is that there are remote
participants and panelists in addition to the roles introduced in the
example 2. Panel members would have their own monitor screen channel that
is similar to the public big screen, but can also show some additional
material for the panelists. In this example, the panelist monitor screen
shows chat while the audience big screen shows poll. In this example,
the onsite audience and remote audience have different poll questions.

FIGURE 5.2D :    ILLUSTRATING THE 6-CHANNEL LAIX-SCORE SETUP IN ACTION.
                 SIX INTERFACE CHANNELS ARE MODERATOR, ONSITE AUDIENCE WEB,
                 REMOTE AUDIENCE WEB, STAGE, SCREEN AND PANELIST MONITOR.
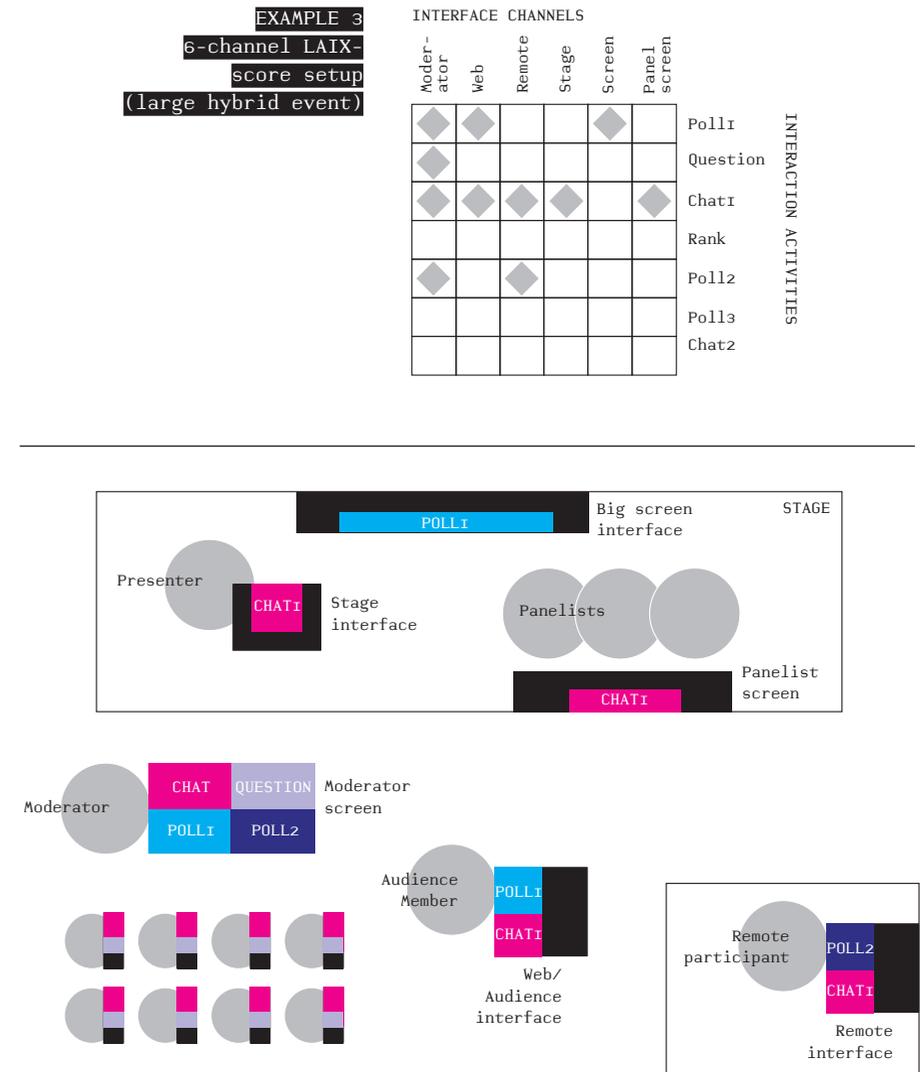
## 5.3 How LAIX-score Design Framework Satisfies the Core Requirements

The research has defined and presented three core requirements for a design framework for live audience interaction in Chapter 3. This chapter will elaborate in detail how the LAIX-score design framework satisfies these core requirements.

The first core requirement states that *the design framework should be able to accommodate different kinds of live audience interaction patterns* (Section 3.2). This requirement originates from the core observation that the design space for different live interaction patterns is large and most productions utilize multiple interaction patterns. Chat (message walls) and poll are common interaction patterns in live audience interaction, but the domain exploration presented in Section 3.2 revealed that there are also other relevant interaction patterns. The core aspect of the LAIX-score design is that the control system has no interaction pattern specific features. Such framework design can be described as interaction *pattern agnostic*. In Section 4.2, different kinds of existing live audience interaction designs were introduced and the sequential interactions design and tabcentric designs also satisfy this first core requirement. Actually, achieving the first requirement is relatively trivial. This requirement can basically be achieved by defining that the control framework does not have pattern specific functions, but can accommodate many different kinds of interaction patterns. The downside of the pattern agnostic approach is that pattern specific controls must be defined and managed outside the state control matrix. This implies a separate interaction pattern specific control level. This issue is elaborated in more detail in Section 6.3. The LAIX-score framework as such does not guide or create significant boundaries for the implementation of specific interaction patterns. The state control matrix can have an unlimited number of interaction activities. As the examples in Section 5.2 show, there can be several instances of the same pattern type in one production.

The second core requirement is that *the design framework should provide support for multiple different roles* (Section 3.3). This requirement originates from the observation that in a live audience interaction production there are often more roles than just presenter and audience member. During the domain exploration we identified roles such as stage host or facilitator, presenter, panelists, off-stage moderator, audience member,

99)
See for example
Sli.do and
Polleverywhere.com
and Section 4.2

groups within the audience and technical support. The existing live audience interaction systems presented earlier (Section 4.1) do not provide any generic capabilities for supporting different roles. They either expect only the roles of presenter and audience member, or then provide only an admin interface that can be used either by presenter or orchestrator[99]. The LAIX-score framework is based on the idea that each role has a unique interface channel. This design allows role dependent views, each role can have different control capabilities in the specific interaction activity, and each role can have access to a unique set of interaction activities at the time. Attention management is a central aspect in all kinds of performance design. For this reason, attention control should be also a central aspect in live audience interaction. Role specific interface channels help to manage the attention of each role specifically. The channel concept is coined from the core references – live audio mixing and live light control, which also utilize the channel concept. The LAIX-score framework does not limit how many interface channels there can be. There can also be other interfaces in addition to those explained above and there can be multiple instances of the same kind of interface (e.g. screen A and screen B).

The third requirement states that *the live audience interaction design framework should support different and parallel functions for live audience interaction*. This requirement is realized in the LAIX-score design framework with the state control matrix that allows independent manipulation of each interaction activity. For example, as explained in Section 4.2 in the sequential design approach there is only one interaction activity at a time and in the primary interaction approach there is always one core interaction that is visible. Allowing independent manipulation of each interaction activity also implies that one interface channel should be able to display multiple interaction activities simultaneously. This topic is discussed in more detail in Section 5.4.

This chapter explained how the core requirements are realized by the LAIX-score design framework. The next chapter will elaborate how the other existing frameworks have inspired the LAIX-score design framework.

## 5.4 How LAIX-score Design Framework is Related to Other Frameworks for Live Productions

The interface channel concept and the overall state control matrix design is inspired and based on the analysis of existing live production frameworks — live light control and live audio mixing. As explained in Section 4.2 both of these systems have a scalable control matrix as core control structure. Figure 5.4a presents the LAIX-score control matrix in parallel with the live audio mixing matrix and live light control matrix and illustrates how these frameworks have analogous core structures. It is important to note that on a technical level the control actions and the controlled elements are fundamentally different between these frameworks and the LAIX-score framework, but similarly the control actions and elements are fundamentally different when comparing live light control and live audio mixing.

FIGURE 5.4A :  ABSTRACT COMPARISON OF STATE CONTROL MATRICES FOR LIVE AUDIENCE INTERACTION, LIVE AUDIO MIXING AND LIVE LIGHT CONTROL. THE VISUALIZATION DEMONSTRATES HOW THE FRAMEWORKS ARE ANALOGOUS AND ALL HAVE CONTROL MATRIX AT THEIR CORE.

A framework should also provide affordances for improvisation and reactivity (elaborated in Section 3.6). Live light control and live audio mixing practices demonstrate how the matrix control structure is used in live performances and how the matrix structure provides affordances for reactivity and improvisation.

For simple use cases such as when a presenter wants to create a single poll of the audience, such a generic framework may appear unnecessarily complex. Then again, such use case would be equivalent to contemplating what kind of control framework is appropriate for shutting down the lights in the classroom auditorium and considering fullfeatured live light control environment for this use case. In the actual auditorium situation, the light control might be based on the DMX-standard, which is the core control framework for most live light control systems, but the control interface is simplified as a single channel control[100]. Similarly, the LAIX-score live audience interaction framework also scales from simple twochannel scenarios to more complex multichannel and multiactivity scenarios. The expectation is that when the same framework is applied independent of the production, the production competencies, practices, conventions and tools improve and overall the live audience interaction as a phenomenon and practice would become more established.

How is the LAIX-score different from other design approaches for live audience interaction? Other designs (presented in Section 4.2) have a fixed and very limited role configuration and most often also significant limitations for what kind of interaction activities they support. The state control matrix provides a new control layer for live audience interactions that enables scalability and flexibility for realizing different interactions independently and different role configurations. LAIX-score promotes a clear logical separation between interface channel visibility control and management of individual interactions. Interface channel visibility control is in practice attention management in live audience interaction productions.

Chapter 6 introduces the Presemo live audience interaction management system and concretizes how the LAIX-score design framework can be implemented in practice. Chapter 7 continues an elaboration of the framework by introducing 4 different kinds of case study productions that apply the LAIX-score design framework and the Presemo live audience interaction management system.
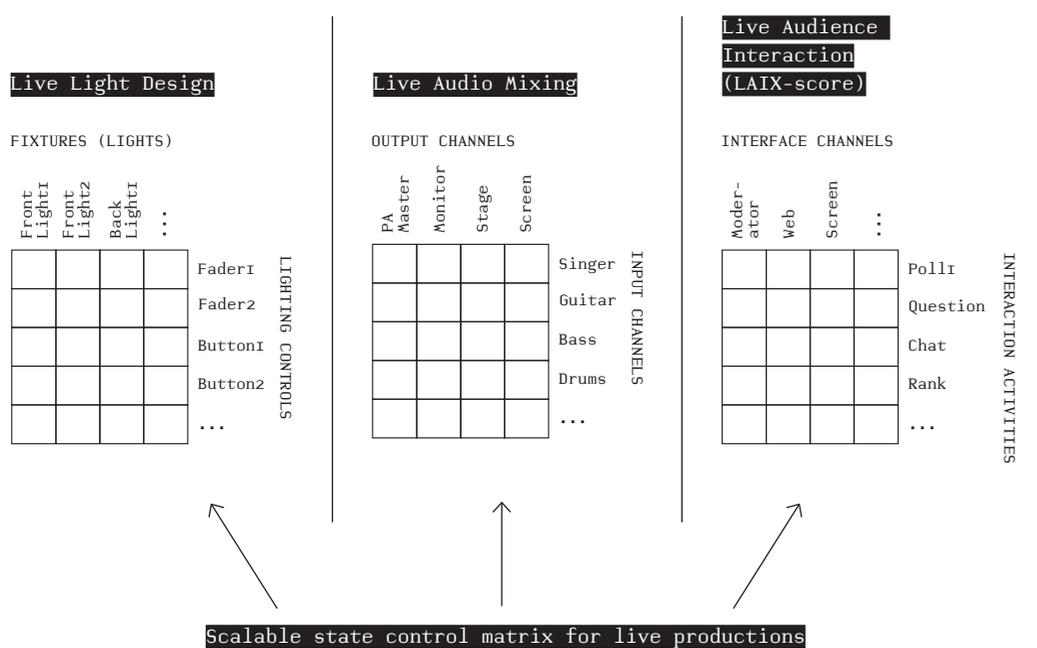
# 6.

# Implementing the LAIX—score Design Framework

## 6.1 Introducing Presemo

We have developed a live audience interaction management system (LAIMS) based on the LAIX-score design framework and the state control matrix, which is at the core of the LAIX-score. The LAIMS is named Presemo version 4 (which we will refer to in this text as Presemo) after our first live audience interaction system[101]. It is an entirely web-based system and available as open source software[102]. The system has been in commercial use since 2013 in different kinds of productions and it is also used as a basis for all the case study productions presented in Chapter 6. The system functions as practical proof for the LAIX-score design framework. In terms of research methodology, the Presemo implementations and iterative development follows the software-as-a-hypothesis approach, which is part of research based design approach and discussed in Section 2.4.2[103].

Presemo is a web-based system, which means that all interfaces are accessed through a web browser. The fact that Presemo is a web-based system does not mean that all LAIX-score implementations or interface channels should be web-based. The LAIX-score framework is technologically agnostic and it can be deployed basically in any software framework[104]. Section 6.2 introduces how Presemo generally realizes the LAIX-score design framework. Section 6.3 focuses in more detail how Presemo realizes the interaction activity control. Section 6.4 briefly elaborates what Presemo reveals about interface channel control and synthesizes an elaborate version of the LAIX-score framework based on the findings of the developing Presemo.

## 6.2 Implementing the State Control Matrix into Presemo

The development of Presemo started in 2012 with a simple sketch of the LAIX-score state control matrix, similar to the picture presented in Figure 5.1a. The working title for the system was a webmixer, which illustrates how the live audio and live light control frameworks have functioned as the core inspiration for the framework and the system. Figure 6.2a shows how the abstract 4-channel LAIX score matrix is implemented as the real functional control interface in the Presemo. Figure 6.2b shows the individual interface channels of Presemo that correspond to the state control matrix of the Figure 6.2a.

101)
See Section 3.3 for introduction of the first Presemo system and follow-up system called Slides & Polls. Slides & Polls can be considered as Presemo v.2. Presemo v.3 was a prototype version of a completely web-based LAIMS, which was used in few productions such as the first Metagroups production presented in Section 7.4. Version 3 had similar design but was ultimately replaced with the current version, which is a more refined implementation. In Chapter 3 Presemo refers to Presemo version 1, but in other chapters Presemo refers to Presemo v.4. See more details of the softare systems developed during this thesis in the Appendix A.

102)
Presemo v.4 is programmed by Petri Lievonen and available in Github under an AGPL3 licence github.com/presemo. My role in all of Presemo's versions has been that of codesigner and project manager (I am former CEO of Screen.io the company behind version 4). In Github, Presemo is referred as a Live participation engine,

which is synonymous to a live audience interaction management system.

103)
See more Leinonen (2010).

104)
More technical details about the system can be found from the Presemo webpage on Presemo web page: github.com/presemo

FIGURE 6.2A :

ON TOP IS AN ABSTRACT ILLUSTRATION OF A 4-CHANNEL LAIX
SCORE STATE CONTROL MATRIX. IN THE MIDDLE, THERE IS
A CONTROL UI SKETCH FOR THE SAME SITUATION. ON BOTTOM IS
THE FUNCTIONAL PRESEMO STATE CONTROL INTEGRATED IN
THE MODERATOR UI. 4-CHANNEL PRESEMO HAS ONLY TWO CHANNELS
IN CONTROL BECAUSE MODERATOR CHANNEL IS ALWAYS ON AND
STAGE INTERFACE CHANNEL IS SYNCHRONIZED WITH WEB INTERFACE.

FIGURE 6.2B :

VISUALIZATION OF THE FOUR INTERFACE CHANNELS BASED ON
THE STATE CONTROL MATRIX SHOWN IN FIGURE 6.2A. THE MODERATOR
INTERFACE SHOWS ALL ACTIVITIES, THE AUDIENCE AND STAGE
INTERFACES SHOW THREE ACTIVITIES AND THE SCREEN INTERFACE
SHOW ONLY ONE POLL ACTIVITY. COLOR BARS ON THE RIGHT ARE
ADDED TO INDICATE WHICH INTERACTION ACTIVITIES ARE SHOWN
IN EACH CHANNEL.



LAIX-score state control matrix

LAIX-score state control matrix defines what is the visibility state of the inter-action activity in the respective interface channel.

| | Channel1 (Moderator) | Channel2 (Audience/web) | Channel3 (Stage) | Channel4 (Screen) | |
|---|---|---|---|---|---|
| | ON | ON | ON | | Activity1 (scatter) |
| | ON | ON | ON | ON | Activity2 (pollplus) |
| | ON | | | | Activity3 (chat) |
| | ON | | | | Activity4 (voting) |
| | ON | ON | ON | | Activity5 (chat) |

Moderator channel is always on

Audience and stage channels are synchronized

State control UI (sketch)

UI Sketch showing how state matrix can be translated as an state control UI. White background buttons are state off and full color buttons are state on.

Activity 1 (scatter): Moder. Audience Presenter Screen
Activity 2 (poll plus): Moder. Audience Presenter Screen
Activity 3 (chat): Moder. Audience Presenter Screen
Activity 4 (voting): Moder. Audience Presenter Screen
Activity 5 (chat): Moder. Audience Presenter Screen

Presemo state control UI (+ collapsed moderator UI)

Presemo state control UI collocated with the moderator interface and displaying also activity specific controls. Moderator always on and web and presenter controls synchro-nized for simplifying state control.

Interface channel 1 : Moderator + control UI

Interface channel 2 : Web/Audience

3 interaction activities visible in web channel

Web and stage are synchronized

Interface channel 3 : Stage (synchronized with web)

Interface channel 4 : Screen

Only one interaction activity visible on screen interface

The state control setting described in Figure 6.2a and Figure 6.2b is a common seminar situation very much analogous to Example 2 in Section 5.3. The state control matrix shown in Figure 6.2a could represent a situation for example at the beginning of a presentation. The poll and scatter questions would function as a warmup question and they would be removed after the introduction. The chat activity would stay throughout the presentation, which would be actively used during the final Q&A phase. The next presentation could have another chat activity and potentially some other interactions.

*Interface channel 1* is the combined state control UI and moderator UI. The interface channel 1 in Figure 6.2b is the expanded version of the state control UI interface visualized on the bottom in Figure 6.2a. On the black background are the state control UI functions. On the grey background are interaction pattern specific controls and on the white background are interaction activity content and content controls.

*Interface Channel 2* is the audience interface often shortened as the *web interface*. The audience interface channel shows the three interaction activities chosen to be visible from the state control UI. Interface channel 3 is the stage interface commonly used either by presenters, moderators or the chair. The stage interface differs from the web UI since it also has content management functions. This interface is synchronized with the interface channel 2 in order to simplify the control. In Presemo, the order of interaction activities in the web and stage interface is the same in the state control UI. The order of interaction activities can be manipulated from the state control UI that is on interface channel 1. There can also be other kinds of layout management functions. The layout management is a detailed parameter of the state control matrix. Interface channel 4 is the shared big screen interface. In Presemo the screen channel can show only one interaction activity at the time.

The Presemo system is not only a research prototype, but it is a practical and functional tool used actively in various commercial productions. As we have had only limited software development resources[105] we have had to focus a significant amount of resources on finetuning and making the system robust. The production version of Presemo has only a fixed number of interface channels (4 channels) whereas LAIX-score proposes a dynamic number of interface channels. This limitation results in other design choices that compromise the realization of the LAIX-score framework. As Section 4.3 revealed, also many live audio mixing and live light control systems are limited imple-

I06)
It is common that audio mixing environments have 24 output channels or 416 input channels, and similarly live light control frameworks have a limited number of control channels.

I07)
Presemo version 4 version operational June 2016

I08)
Scatter plot is a interaction pattern with two sliding percentage scales in the audience interface and two dimensional visualization of the audience results in the big screen. Delta poll is a combination of two identical polls that measure the difference between the first and second response (delta).

I09)
In individual productions Presemo has been extended for example with different chat variations, new kinds of polls, gamification and networking activities.

I05)
The production version Presemo v.4 has been developed by Petri Lievonen. Individual case production modifications have also been made by other programmers.

mentations of an abstract scalable control framework[106]. We have made certain modifications in individual productions to bypass these limitations that are explained in more detail in Chapter 7. Another significant simplification of the Presemo is that the state control UI does not have controls for all four channels, but only two because the moderator channel has all interactions visible all the time and the state control of the stage channel is synchronized with the web. This limitation causes some problems in attention management, which is discussed more in the case study in Section 7.2. This design decision was made in order to simplify the Presemo use in situations when there is only a single orchestrator presenter managing the system (such as a teacher). This issue will be fixed when Presemo supports dynamic creation and configuration of interface channels.

Hence, due to resource constraints, Presemo is a not a complete implementation of the LAIX-score design framework and the *state control matrix*. The implementation is complete for the *interface channel* part and for this reason the Presemo design can be analyzed in more detail in order to elaborate *interaction activity* control structures of the LAIX-score framework (presented in the next chapter). The interface channel structures of the LAIX-score framework are elaborated based on the case studies presented in Chapter 7.

## 6.3 Interaction Activity Control Structure

As described in Section 3.2 the core requirement of the LAIX-score design framework is support for different kinds of interaction patterns. The interaction activities are instances of the interaction patterns. Currently[107] the basic version of Presemo supports five interaction patterns: chat (message wall), voting (question), poll, scatter plot and delta poll[108]. As such, Presemo is designed as a modular system and in the research context we have also experimented with other kinds of interaction patterns than those supported by the basic Presemo version[109].

The state control matrix defines the state of each interaction activity in the interface channels. This is one aspect of interaction activity control. This chapter describes a generic model for the interaction activity control for the LAIX-score based on the Presemo design. This model is divided into five layers.

The five control levels are:

1.      Activity creation and deletion

2.      Activity state control

3.      Interaction pattern
        specific activity control

4.      Interaction activity content
        and contribution management

5.      Interaction activity
        presentation management

The first level is the creation and deletion level, which basically defines whether the interaction activity exists at all. The second level is the LAIX-score state control matrix. The third level realizes interaction pattern specific controls. The fourth level is focused on content management and the fifth level on presentation management. This 5-level model is interaction pattern agnostic even though the details in levels 3–5 are interaction pattern specific.

LEVEL 1 : INTERACTION ACTIVITY CREATION AND DELETION
In Presemo all interaction activity instances must have a name, they must be based on a specific interaction pattern, and they must follow the state control framework. In Presemo, an interaction activity is created from a pulldown menu that specifies the pattern type. Then the user writes the name and defines, in some cases, pattern specific details such as poll options. In Presemo, an interaction activity is deleted from an activity specific pulldown menu. From this same menu, the activity can be also reset, which means that all activity specific content is deleted, but the name and other creation details remain. Figure 6.3a visualizes how an interaction activity is created and deleted.

FIGURE 6.3A :   CREATION AND DELETION OF AN INTERACTION ACTIVITY IN PRESEMO



Activity creation has two phases:
1. Choose pattern from a pull down menu and then
2. Type the name
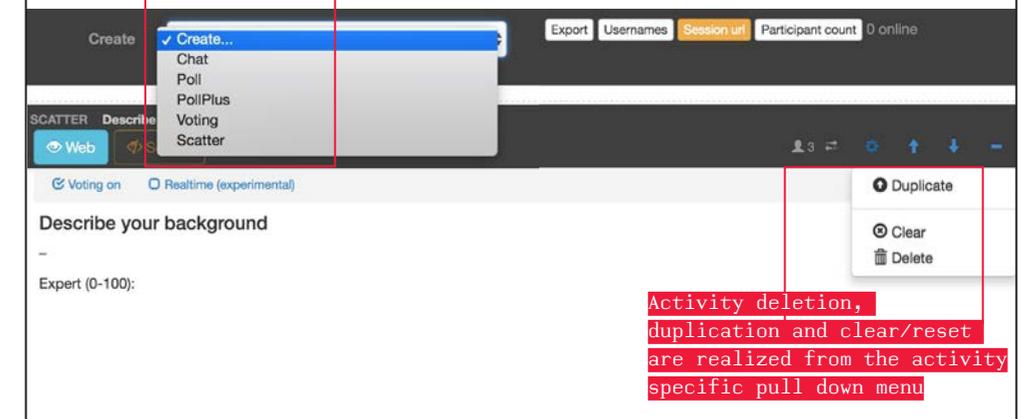
Activity deletion, duplication and clear/reset are realized from the activity specific pull down menu

LEVEL 2 : INTERACTION ACTIVITY STATE CONTROL corresponds to the LAIX-score state control matrix. The primary activity is to manipulate the activity visibility in the corresponding interface channel. As explained in the previous chapter, the Presemo basic version has controls for only two interface channels, because the moderator is set as always on and the stage channel is synchronized with the web channel. In cases where there would be more interface channels, there would also be more state controls in the interface activity. Presemo has also ordering buttons that realize the simple layout order management. Order parameter can be considered as part of the state control matrix visibility management. In case of Presemo state control matrix has been realized as part of the activity control, but it could also be a unique interface, or it could be realized as part of interface channel management. Figure 6.3b details the activity specific state control UI in Presemo.

FIGURE 6.3B :    INTERACTION STATE CONTROL IN PRESEMO INCLUDING THE LAYOUT
                 MANAGEMENT REALIZED WITH SIMPLE ORDERING BUTTONS.



Activity state controls for the corresponding interface channel

Layout management. Activity order in the interface channels

LEVEL 3 : INTERACTION PATTERN SPECIFIC CONTROL is unique for each interaction pattern. Figure 6.3c visualizes different interaction specific controls in Presemo. The LAIX-score design framework does not impose any limitations on the interaction pattern specific controls. Some of the controls are channel specific. The number of pattern specific controls can vary. For example, in Presemo a chat pattern has 10 controls whereas a poll pattern has only three. The examples in Figure 6.3c demonstrate that each pattern has unique controls.

FIGURE 6.3C :    USER INTERFACES OF THE PATTERN SPECIFIC CONTROLS IN
                 PRESEMO FOR CHAT, POLL AND VOTING (QUESTION)



Chat pattern has many controls for example for activating moderator, anonymity, hiding messages and managing big screen layout.



Current poll pattern has less controls, but there are variations with more controls for example different visualizations options.



Voting has controls for activating peer-view and changing the peer-view patterns from "choose the best" to likert-scale.

LEVEL 4 : CONTENT AND CONTRIBUTION MANAGEMENT means control rights for moderating and modifying activity content and contributions. Activity content is for example an activity name and subtitle. Each activity can have also label picture (feature in earlier Presemo versions). There could possibly be other types of content in the activity such as introductory text or help text. Audience contributions are audience messages are also content. Contribution moderation is important part of the content management. Figure 6.3d visualizes how content and contribution moderation is realized in Presemo.

FIGURE 6.3D :   CHAT ACTIVITY CONTENT AND CONTRIBUTION MANAGEMENT FEATURES.
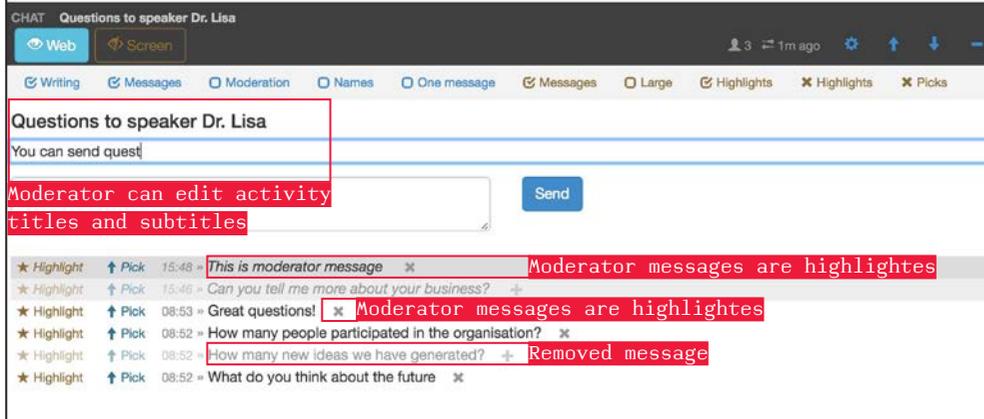


LEVEL 5 : PRESENTATION MANAGEMENT is related to content management but it is a separate control level. Presentation management controls does not manipulate content, but manages how individual content elements are presented and highlighted in interfaces. The most common example of presentation management is the highlight feature of chat messages, which is visualized in Figure 6.3e. Also, contributions other than chat messages, such as poll results, or question results can be highlighted. The stage interface of the basic Presemo has presentation management rights, but does not have access to any other control levels.

FIGURE 6.3E :   CHAT ACTIVITY PRESENTATION MANAGEMENT
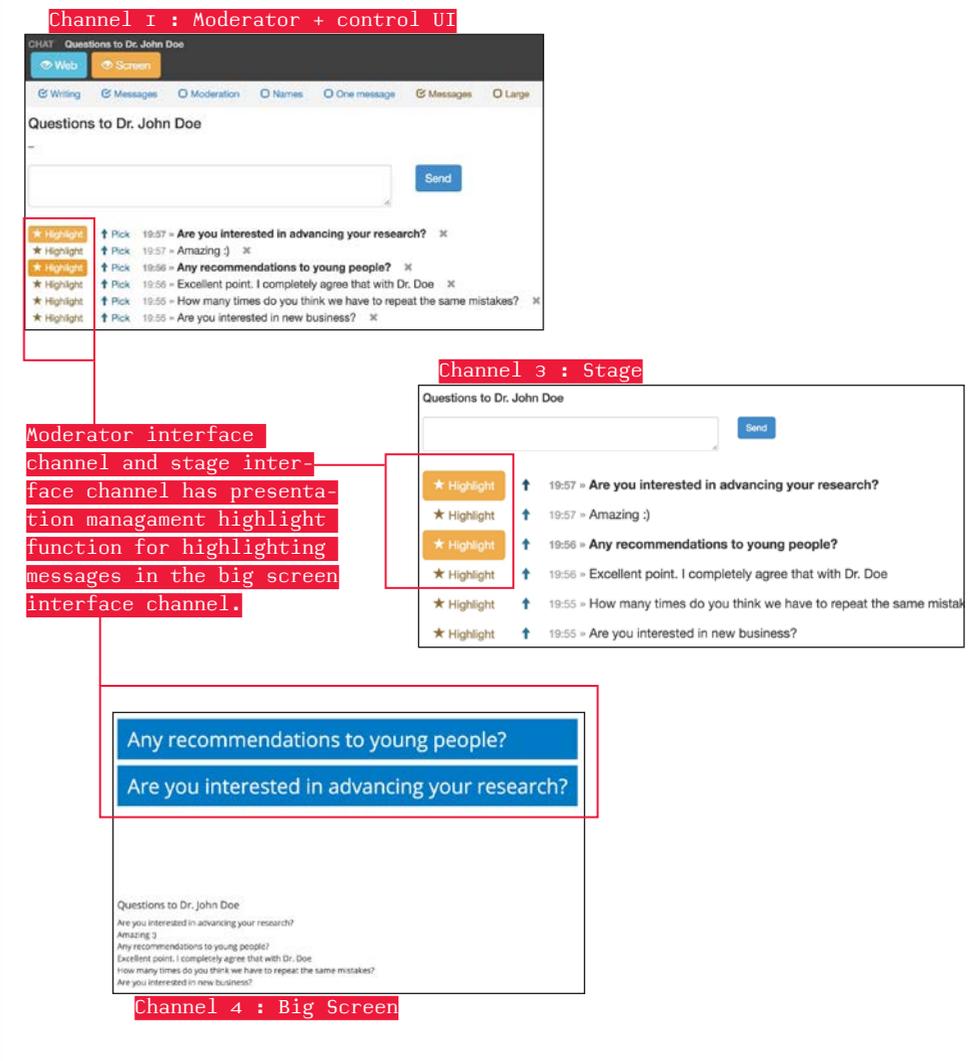
## 6.4 Overview of the LAIX-score Design Framework Based on the Presemo Design

The Presemo is a functional LAIMS that implements the LAIX-score design framework. We have used the Presemo design to show what kind of detailed structure LAIX-score interaction activity management should have. Hence, we use Presemo design to provide more detailed structure for the LAIX-score design framework. The elaborated LAIX-score design framework is visualized in Figure 6.4a.

The basic Presemo is not complete implementation of the abstract LAIX-score design framework since it has only fixed amount of interface channels, and the LAIX-score design framework expects dynamic number of interface channels. For this reason, analysis of Presemo design does not reveal details for the interface channel structure.

FIGURE 6.4A :  ELABORATED LAIX-SCORE DESIGN FRAMEWORK WITH
THE STATE CONTROL MATRIX, INTERFACE CHANNELS,
INTERACTION ACTIVITIES AND THE DETAILED STRUCTURE
FOR INTERACTION ACTIVITIES



Because Presemo is fixed 4-channel system it provide only limited insight for defining more elaborated framework for the interface channel structure

Interface channels

?

|  | Channel 1 (Moderator) | Channel 2 (Stage) | Channel 3 (Audience) | Channel 4 (...) |
|---|---|---|---|---|
| Activity 1 (Poll) | | | | |
| Activity 2 (Question) | | | | |
| Activity 3 (Chat) | State Control Matrix | | | |
| Activity 4 (Rank) | | | | |
| Activity 5 (...) | | | | |

Interaction activities

1. Creation and deletion
2. State control
3. Pattern specific activity management
4. Content management
5. Presentation management

CONTROL LEVELS

+ Contributions

Presemo design provides structure for the interaction activities in the design framework.

# 7.

Applying the LAIX—score Design Framework in In The Wild Productions

# 7.1 Introduction to the Case Study Analysis

The LAIX-score design framework was developed based on the requirements that were defined during the domain exploration phase of this research. Domain exploration included over 30 different live audience interaction productions, and during this phase, the focus of the research was on experimenting and identifying the core requirements for the framework. For this reason, individual cases were not analyzed in detail.

This chapter presents four case studies in depth. All of the case studies are in the wild productions. In comparison to the productions developed during the domain exploration, these case productions are larger in scale. They present real uses without the researcher artificially manipulating the setup, and these case productions are able to be analyzed in more detail. As the objective of the study is to create a generic framework, it is important to cover multiple case studies which reveal different perspectives regarding the live audience interaction phenomenon. These case studies are used to both *evaluate* and *elaborate* the LAIX-score design framework.

The LAIX-score evaluation questions applied in the case studies are as follows:

I.    How do the case studies correspond to
      the core requirements for the live audience
      interaction design framework (presented
      in Chapter 3)?

2.    How can the LAIX-score design framework
      be applied to the case studies (presented
      in Chapter 6)?

In addition to evaluation, the case studies are also conducted to extend the LAIX-score design framework. The following are elaboration questions in the case studies:

3.    What kind of detailed structure do the cases
      propose for the interface channel dimension of
      the LAIX-score design framework?

4.    What kind of additional and complementary
      requirements, which are not covered with
      original three core requirements, do the cases
      present for the LAIX-score design framework?

The first objective of these case studies is (1) to evaluate how these core requirements are realized in the case study productions. The LAIX-score design framework is based on core requirements, thus the purpose of the chapter is to understand how these core requirements are fulfilled in the individual case production and how the LAIX-score satisfies such core requirements. For this reason, the second objective of this chapter is (2) to analyze how the case studies execute the LAIX-score design framework. The LAIX-score framework is realized in the case study productions by applying the basic or modified version of the Presemo LAIMS. The case evaluation summary describes whether the Presemo design was feasible and preferable for this production, if there was some feedback or conclusion on how to change the Presemo design and how well these changes would have been compatible with the LAIX-score framework.

The case studies are also intended to elaborate and extend the initial LAIX-score design framework. Analysis of the Presemo design produced a detailed structure for the *interaction activities* contained in the LAIX-score design framework (Section 6.3). Presemo does not have dynamic interface channel management capabilities. For this reason, it was not possible to produce a more detailed model for the interface channel management based on the Presemo design, hence the third objective of the case study analysis is (3) to elaborate the LAIX-score with a detailed interface channel structure. The fourth objective in the case study analysis is (4) to identify additional requirements for the LAIX-score design framework that could extend the framework beyond the current core elements (interaction activity, interface channels and state control matrix). The objective of this part is to analyze whether there could be other important additions to the LAIX-score framework that cannot be described using the current core elements.

EACH CASE STUDY IS DIVIDED INTO SIX SECTIONS:

I.      Context overview
        (why is this case context significant?)

2.      Case overview (who, where, when,
        author's role, statistics and feedback)

3.      Core audience interactions in the case
        (describes the core live audience interaction
        patterns applied in the case)

4.      Applying the LAIX-score design framework to
        the case (what kind of LAIX-score state
        control matrixes model the case production)

5.      Other findings (identifies significant findings
        that are beyond the scope of initial core elements
        and additional requirements not included in
        the initial LAIX-score design framework)

6.      Case evaluation and elaboration summary
        (summarises the case evaluation results according
        to evaluation and elaboration questions)

The case studies begin with an introduction of the case context. This section focuses on describing the main characteristics of the case context and explaining why this particular case context is important for live audience interaction. After the case context is presented, there is a general case overview, which defines the case actors, case history, my role in the production, the general statistics of the case and the feedback collected from the case. The third section focuses on detailing the core live audience interactions in the case.

The fourth section explains how the LAIX-score design framework was adapted to the case by describing the role configuration and corresponding interface channel structure, as well as combining the interface channels with the interaction activities in order to generate the state control matrix. The LAIX-score implementation in the cases is somewhat narrow because of the limitations of Presemo. For this reason, the fourth chapter also compares how the LAIX-score result (or the realisation of the LAIX-score) could have been extended or modified based on the case observation and feedback.

The fifth section of the case study extends the analysis beyond the role configuration and explores what other elements should be considered in the LAIX-score design framework. The findings are translated as additional requirements for the LAIX-score. These requirements have been identified based on the feedback

110)
This is a prac-
tice-led study,
and in this case
the practitioner
perspective is
live audience in-
teraction producer.
However, producer
takes significantly
different position
in different kinds
of production
context.

111)
There has been
some form of
research data
collection in most
of our case produc-
tions. The studies
related to casesare
not focused to pro-
vide only data for
this case study,
but they are also
part of independent
studies.

112)
In the domain
exploration
research phase,
we conducted over
30 experimental
productions.
As a company,
we have been
hands-on producing
more than 100 pro-
ductions. Presemo
has been used in
over 1000 live
audience interac-
tion sessions.

and analysis in each particular case, but the sixth section also links to the findings in other cases. The final case study chapter summarises the evaluation by answering the evaluation and elaboration questions which were introduced earlier in this chapter.

The four case studies presented in this chapter differ from each other significantly. To start, the production context was different for each case. My role as a producer practitioner[110] was different in each of the cases as well. The production organization or how the production was related to the surrounding organization also varies in each case study. The case studies also each had a distinctive data collection approach and methodological perspective[111]. Finally, the purpose and function of live audience interaction also differed in each of these cases.

During the last four years, we have conducted over 100 live audience interaction productions by utilizing Presemo and the LAIX-score design framework[112]. Consequently, after domain exploration with over 30 productions, we have gained a significant amount of new expertise in producing live audience interaction. Around these selected case studies, there are many interesting observations and findings that could demonstrate and further extend the LAIX-score design framework. These four case studies were chosen because they are well documented and present a variety of live audience interaction productions. These are also successful productions that have caused persistent use within target organizations and new follow-up productions. In this sense, these cases present practical success, hence the selection of these case studies was based on the core objective of the study to make a *generic and practical* design framework for live audience interaction. In short, these cases satisfy the generalizability objective for the LAIX-score as the cases are different in multiple ways and the cases satisfy the practicality objective since they have been successful in the wild productions.

Table 7.1a summarises how each of these case studies diverges from the others. Even though the cases have many differences, they are all part of the same phenomenon, applied the Presemo LAIMS and followed the same LAIX-score design framework.

| CASE STUDY | CONTEXT | PRODUCTION VS. ORGANIZA-TION | PRODUCER PERSPECTIVE | RESEARCH APPROACH | FUNCTION OF LIVE AUDIENCE INTERACTION |
|---|---|---|---|---|---|
| SCREEN.IO | Commercial outsourced event production. | Part of longlasting collabora-tion in-volving several productions. | Outsourced technical and produc-tion compe-tence. | Research by analysing and reflect-ing upon documenta-tion. | One of the central program components; mainly facilitation of Q&A. |
| PRESEMO | Educational context, lectures. | System used within organiza-tion in hundreds of lectures. | System provider, support and training. | Research through data collection, reflection and ques-tionnaires. | Various pedagogical functions. |
| METAGROUPS | Professional networking event and workshop. | Series of workshops with simi-lar program structure. | Interaction design lead and facili-tator. | Constructive production. Workshop approach was proposed to the tar-get organi-zation. | Facilitate co-creation. Core compo-nent in the produc-tion. |
| LOST LAB | Experimen-tal enter-tainment production. | One-off experience production. | Host and producer of the experi-ence. | On site researcher-observers, statistics and feedback collection. | On-board audience to the experi-ence. |

THE FIRST CASE STUDY introduces how our live audience
interaction production start-up Screen.io has been col-
laborating with the event production company Sisters[113].
Screen.io collaborates with many event producers, but we
had our most extensive collaboration with this particular
event producer, covering over 20 commercial productions.
The case study presents a high-profile seminar production,
which had only a few live audience interaction activi-
ties but still a relatively complex role configuration.
The study also explains how professional event producers
approach live audience interaction.

THE SECOND CASE STUDY elaborates on how the University
of Helsinki has appropriated the use of the Presemo sys-
tem. The system has been in action in the university for
two years on a commercial basis,[114] and during that time,
hundreds of lecturers have utilised the system for live
audience interaction. The study does not focus on any

113)
sisters.fi

114)
For the in the wild
approach it is
relevant difference
whether the service
is provided on com-
mercial basis, or
whether the service
is used on experi-
mental basis.
Users have often
more critical de-
mands and expecta-
tions for a commer-
cial service, than
a system provided
as a research pro-
totype.

115)
Getz's (2012) has
typology of planned
events (page 41)
that consists also
27 sub-categories
for events.

lecture or teacher specifically, but evaluates the use
of Presemo generally and applies a few productions as an
example. This case study has different kinds of production
contexts, and it provides a significantly different case
environment for live audience interaction in comparison
to the first case study, which focuses on a high-profile
seminar production. The case study presents how the
LAIX-score framework can also be applied in smaller pro-
ductions and how individual teachers expect features for
controlling and reusing the audience interaction sessions.

THE THIRD CASE STUDY is a series of three workshops named
as Metagroups. These productions are focused on creating
large-scale computer-supported workshop productions for
knowledge creation by utilizing Presemo. The Metagroups
show how live audience interaction production can host
remote participants and complex group configurations.
The case demonstrates how a larger audience can be divided
into smaller groups and how such group organization poses
new demands for live audience interaction. The Metagroups
case also demonstrates a more complex live audience-inter-
action pattern – idea collection with peer review. This
interaction pattern combines chat and choice interaction
and produces a significant amount of audience contribu-
tion, which also enables a more advanced analysis of vari-
ous approaches for live audience interaction.

THE FOURTH CASE STUDY presents a pervasive game production
called Lost Lab that applied Presemo as an interaction
engine, even though a large part of the production did
not take place in a stage performance setting. The case
study presents how the LAIX-score design framework can be
extended from seminar halls and classrooms to the outdoors
and to artistic contexts. The Lost Lab production was
a gamified production and included different types of
interactions patterns and functions for live audience
interaction.

# 7.2 Screen.io Event Productions

## 7.2.1 Event Production Professionals

Event production is an established professional discipline. An
event producer is a specialist that a company hires for organizing
events. Organizations organize events for different functions.
Gentz divides planned events into the following categories: cul-
tural celebrations, business and trade, arts and entertainment,
sport and recreation, political and state events, and private
functions[115]. Our own experience is that business events can be
practically divided into employee events, management events,
customer events or networking events.

Event production can be a significant undertaking for an organization. The direct costs for organizing one 500-person employee event is commonly over one hundred thousand euros and the indirect costs can be significantly higher[116]. Companies are expecting a return for this investment and for this reason they often hire a professional event manager to make sure that the time and money invested in the event production are used effectively. In a traditional seminar event, there is little interaction between the audience and presenter. Computer-supported live audience interaction systems can significantly increase the amount of interaction in the event. Live audience interaction can be used to produce results and measure the impact of the event.

The event producer is the manager of the event production. She creates a timetable for the production, recruits and coordinates the event production team and coordinates the development of the event program together with the customer. In our case, the live audience interaction producer is a sub-contractor for the event producer just like other technical producers (light, video and sound) or outsourced performers like hosts and guest speakers.

In our experience, event managers often consider live audience interaction systems as a part of the technical production setup. For this reason, the organizational procedures for live audience interaction are expected to be aligned with the general technical procedures. Event producers commonly have substantial experience in producing events, and for this reason they are familiar with the value of live audience interaction and they are more sensitive to the details of live audience interaction than the people from the company organizing the event. For this reason, an experienced event producer is an important promoter and developer for live audience interaction practices.

## 7.2.2 Introduction to the Screen.io Event Production with Sisters

We have founded a company called Screen.io to commercialize our live audience interaction services and the Presemo LAIMS software[117]. With *Screen.io*, we have organized tens of commercial live audience interaction productions. Many of these productions have been organized in collaboration with a professional event producer. *Sisters*[118] is an award-winning Finnish event production company that Screen.io has collaborated with for years. Our collaboration with Sisters started during the domain exploration phase and has lasted for more than 20 commercial

116)
Cost per partici-
pant in a profes-
sional event is
often over 200
euros. Indirect
costs can be
calculated by con-
sidering what is
the cost of the
work lost during
the event. If
workers daily work
costs 500 euro per
day, then the indi-
rect costs for 500
participant event
is 250 000 euros.
This is a hypothet-
ical calculation
that just demon-
strates the econom-
ical significance
of an individual
event.

117)
See more screen.io.
I am CEO of
Screen.io.
Screen.io was
founded 2011 during
the commercializa-
tion of the Slides
& Polls software.

118)
See more sisters.fi

119)
First collaboration
with Sisters took
place 2012

120)
The official name
of the event was
Trafi Liikenteen
Tila 2013 and 2014

121)
See more trafi.fi

productions[119]. This collaboration has been focused on corporate event productions that have 50 to 400 participants.

The production case in focus in this case study is called the *Trafi seminar*[120]. This event was a 400-person seminar and networking event organized by the transport safety organization in Finland[121]. The production was repeated together with Sisters both in 2013 and in 2014. The fact that the event was repeated with similar arrangements and the fact that the organization (*Trafi*) decided to acquire the Presemo system for permanent use confirm the live audience interaction part of this production was successful and valuable.

During the 2013 Trafi Seminar event, the session lasted for three hours and 170 out of approximately 350 audience members participated through the live audience interaction system. Hence, approximately 50% of the audience members participated in live audience interaction activities. Together, these 170 participants contributed by sending over 500 messages and providing over 300 contributions to the poll questions. The event was organized in an old movie theater with a large cinema screen. Figure 7.2a shows how the stage looked during a question and answer (Q&A) activity. Figure 7.2a shows how the screen interface was layered on top of interactive video graphics and a live video stream. My role in the production was acting as an orchestrating moderator and I sat in the front row in the audience together with the session host and supporting moderators. Table 7.2b introduces the event program in detail.

FIGURE 7.2A :   THE HOST IN TRAFI SEMINAR IS ASKING THE PRESENTER
A QUESTION AND USING THE STAGE INTERFACE FOR
HIGHLIGHTING THE QUESTION.

TABLE 7.2B :     OVERVIEW OF THE EVENT PROGRAM

| TIME | PROGRAM | LIVE AUDIENCE INTERACTION (TYPE AND NUMBER OF CONTRIBUTIONS) |
|------|---------|-------------------------------------------------------------|
| 9:00 (10 min) | Introduction | Warm-up poll (172) + Chat (greetings messages) (34) |
| 9:10 (30 min) | Presentation 1 : Minister | Chat (commenting + Q&A) (85) |
| 9:40 (40 min) | Panel : Department directors | Chat (Continuous Q&A and commenting) (154) |
| 10:20 (25 min) | Break | – |
| 10:45 (30 min) | Presentation 2 : CEO of large union | Chat (continuous Q&A and commenting) (38) |
| 11:15 (25 min) | Presentation 3 : Director | Q&A (continuous Q&A and commenting ) (90) + Poll (154) |
| 11:40 (15 min) | Presentation | Q&A (continuous Q&A and commenting) (101) |
| 11:55– 12:05 | Conclusion | Chat (Commenting and feedback) (4) |

Table 7.2b explains how the production utilized only the common poll and chat (message wall) interaction patterns. Polls were used during the warm-up and in one presentation. Each presentation had a unique chat activity, which was used to ask the presenter and panelists questions, general commenting, and for discussion between audience members. Hence, the continuous Q&A and commenting interaction pattern can be considered as the primary interaction pattern in this case. In the 2014 production, the setup was basically the same except instead of one presentation with the poll, there were four presentations that utilized a poll activity for interacting with the audience.

In terms of interaction activities, the production was simple. The amount of audience contributions was moderate, but there have been several production cases with significantly more audience activity. This production is chosen for this study because it presents a complex role configuration. Complex role configuration was needed to manage the moderation challenge. Moderation was challenging in this case because the production combined significant amount of audience contribution with high-profile presenters. Organizers wanted to make sure that audience contributions were kept in control and host would selected right kinds of contributions for asking questions from the presenters.

### 7.2.3 Core Audience Interactions in the Case

This section focuses on describing the chat-based Q&A interaction pattern during the *Trafi seminar* production. The production also utilized a poll interaction pattern, but the chat-based Q&A pattern was the element that made this production so challenging. The chat interaction patterns were used in seven intertwined ways in the Trafi seminar production:

- Greetings during warm-up
- Audience questions directed to the presenter
- Audience comments directed to the presenter
- Audience commenting to each other in messages or to the event organization in general
- Audience questions directed to the panelists
- Audience final comments and feedback
- Chat communication between the orchestrators

There are different ways to categorize audience messages during a chat interaction pattern. Different kinds of messages serve different communication functions during live audience interaction. A detailed analysis and elaboration of different audience messages and their significance in a production can be found for example in our studies regarding the chat episodes and chat threading[122]. For this case study, we are not focusing on analyzing how different uses coexist in the same chat pattern based interaction activity. It is most important to recognize that chat has different uses and, for example, introductory chat, conclusion chat and feedback chat are different from discussion chat and Q&A chat used during the presentations and panels. It is also important to note that the uses in presentations and panels differ, as during panels the orchestrator and chair are continuously acknowledging and interacting with messages, while with presentations the host acknowledges audience contributions commonly only after the presentation. In addition, there is a seventh application for chat interaction, which is messaging between orchestrators. Even though this part is not directly related to audience interaction, it is an important coordination resource for live audience interaction productions and for this reason should be considered in the LAIX-score design framework.

The chat based Q&A pattern during presentations and panels utilized a workflow that required continuous support from six different roles. Overall, 468 messages were sent during these interaction activities (154 in panel and 314 during the four presentations). Figure 7.2c illustrates how different roles

122) Nelimarkka (2016) presents an analysis of interaction episodes in multiple productions including different uses of chat interaction activity. Nelimarkka (2014) analysis the threading of chat and how people respond to other messages considering that messages have different functions in the production.

were organized in the production and how the chat interaction activity was realized during the Q&A phase in the production.

FIGURE 7.2C :  ABSTRACT SPATIAL BREAKDOWN OF THE ROLE ARRANGEMENTS IN THE TRAFI SEMINAR PRODUCTION (LEFT) AND THE CORRESPONDING INTERACTION FLOW FOR A Q&A INTERACTION ACTIVITY (RIGHT).



Bird eye spatial view

Role specific interaction flow diagram
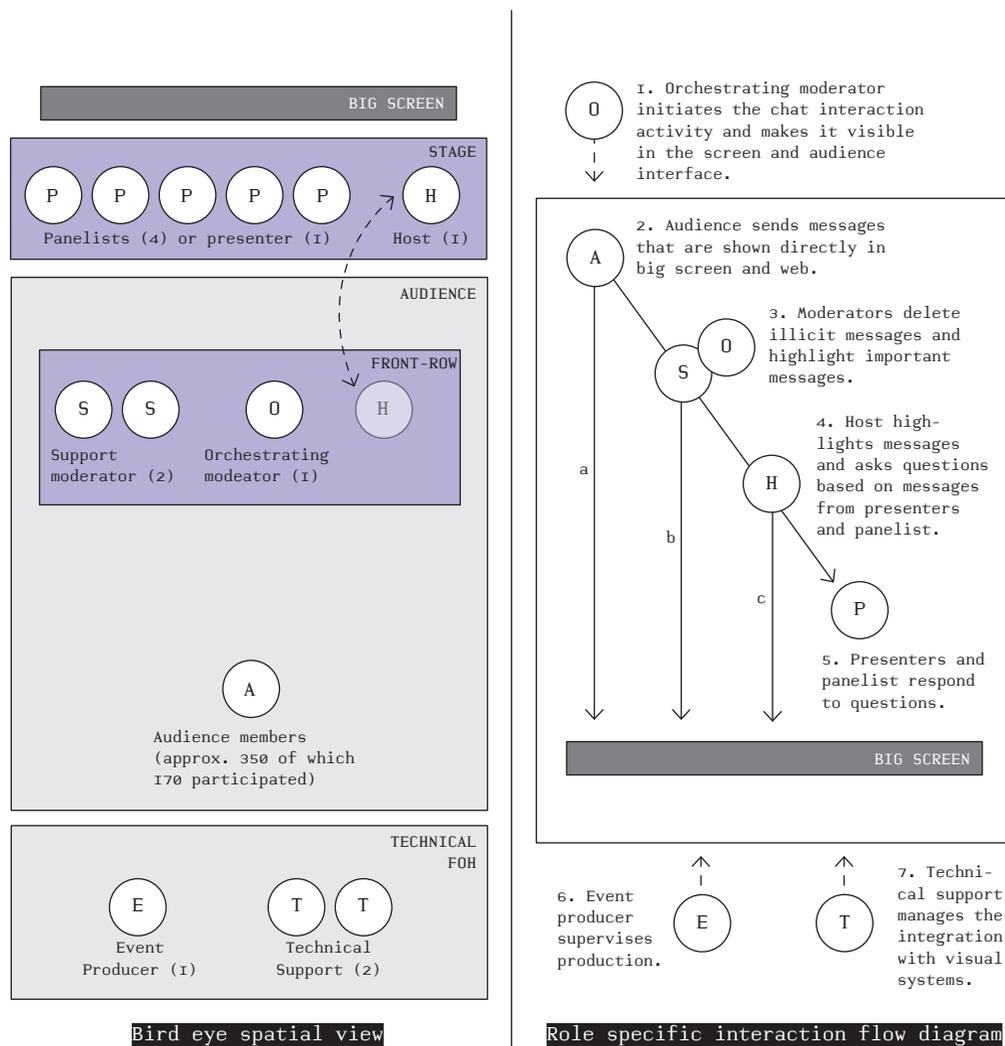
I23)
There are different kinds of illicit messages in chat. Some use four-letter words, some are off-topic, some messages comment presenters in an inappropriate way and some plainly try to cause nuisance to the event. In the Trafi seminar there was only few illicit messages.

I24)
Acknowledging basically means that host either asks the question or addresses some other way the audience comment. Commonly host can acknowledge several questions simultaneously.

I25)
The transition between presenter and orchestrator roles is discussed in more detail in Reeves (2011)

A chat interaction activity was initially (1.) activated by the orchestrating moderator (O) from the Presemo state control interface. Activation by orchestrating moderator (1.), supervision (6.) by event producer (E) and (7.) technical management by technical support (T) can be considered indirect support for this interaction activity. The chat interaction activity started when audience members (A) sent (2.) comments and question messages through the Presemo audience interface. These messages were immediately shown on the big screen (a). Messages were also shown on each audience member's own mobile interface, so that audience members could see each other'messages. Only the last three messages were shown directly on the big screen. In some other productions, more messages were shown on the screen than in this production. Additionally, in other productions, audience messages were moderated first before being shown, or they were not directly shown at all.

Moderators (S + O) read all messages,(3.) deleted illicit messages[123] and highlighted important and relevant messages for the host. The highlighted messages were highlighted immediately on the big screen (b) if the highlight function was set to 'visible' by the orchestrating moderator (O) or by the technical support person (T). Both support moderators (S) as well as the host (H) used a stage interface of the basic Presemo system. The technical support person (T) and orchestrating moderator (O) used the moderator interface channel (with combined state control UI). The event producer did not have a unique interface and she did not use any interface in this production, but monitored the audience interaction through the big screen interface.

The host (H) could also highlight individual messages (c) and then acknowledge[124] either the messages highlighted by support the moderators or by himself. The host (H) transitioned between the on-stage role and the off-stage moderator roles, which demonstrates how the host was not limited to a presenter role[125]. The host acknowledged audience contributions by asking these questions from the presenters and panelists (P). The panelists (P) could see the messages from the monitor screen, which was a copy of the big screen shown to the audience but facing towards the panelists (P). The layout details were different in the audience big screen and monitor screen, but the content was synchronized. Because of the monitor screen, the presenters and panelists (P) did not have to turn their backs to see the messages.

Why were there so many different roles in this production? Couldn't the host manage all the interactions alone? The orchestrating moderator (O) was needed, as he was able to com-

municate both with the technical team, with the host and the support moderators as well as use the Presemo LAIMS control UI. Support moderators (S) were needed since the host could not choose the right messages independently for two reasons: there were too many messages for the host to read through, and the host was an invited professional performer and not a specialist in the domain. Technical support (or, a technical support person/team) (T) was needed to monitor and manage the more complex screen integration (overlay with the video rendering system) and network setup. The event producer (E) was the only person on top of the schedule and managing the overall event flow.

This interaction activity and corresponding role setup in the first Trafi seminar production had one major problem. As figure 7.2c demonstrates, there were several roles that could manage the screen visibility directly. Multiple roles managing the screen visibility created confusion on stage and within the audience. The use of a big screen should have been more coordinated. There was a communication chat in use between the orchestrating moderator and technical support person/team, but this did not help with communication between the host and support moderators. The support moderators communicated (S) with the host (H) by highlighting messages directly in to the big screen (b). This caused confusion within the audience, especially in cases where the host removed the highlight or did not acknowledge highlight created by a support moderators. Ultimately, the highlight function became a general reward for good messages and not a support function for the presenter to acknowledge messages while interacting with presenters, for which the feature was originally designed.

In order to address this problem a new pick feature was added to the Presemo system that supported communication between off-stage moderators and on-stage moderators and hosts. Figure 7.2d visualizes the new pick function and how it ultimately changed the interaction flow of Q&A interaction activity. Pick tagging is not directly visible to the audience.

The new pick function was not used in the first *Trafi seminar*, but it has been used in subsequent productions by Sisters and has since become a core feature in the Presemo system. The pick function is presented as part of this case study as the feature was developed and introduced based on the lessons learned and the feedback obtained during this case study. The pick function also demonstrates well the difference between the host and support moderator roles.

FIGURE 7.2D :      PICK FUNCTION AND CHANGE IN THE Q&A CHAT INTERACTION FLOW. SUPPORT MODERATORS DO NOT HIGHLIGHT MESSAGES ANYMORE, BUT PICK THE MESSAGES FOR THE HOST. ONLY HOST PERFORMS HIGH LIGHTS, AND MAINTAINS SYNRONIZITY BETWEEN ASKING QUESTIONS AND HIGHLIGHTING.



Stage interface channel in Presemo with Pick and highlight functions
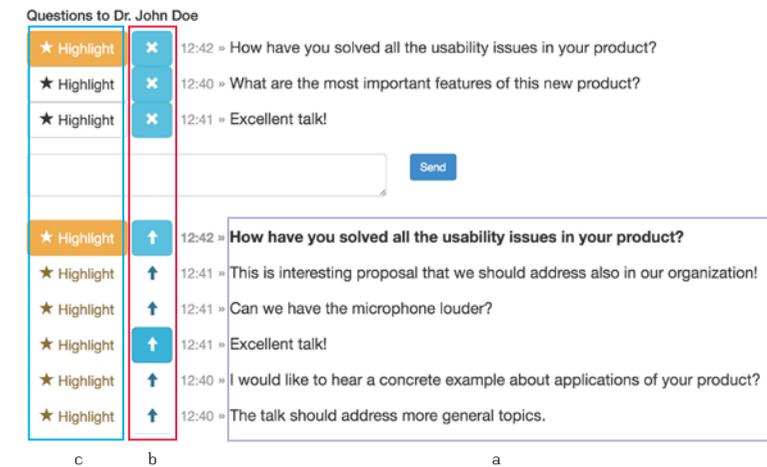


Role specific interaction flow diagram
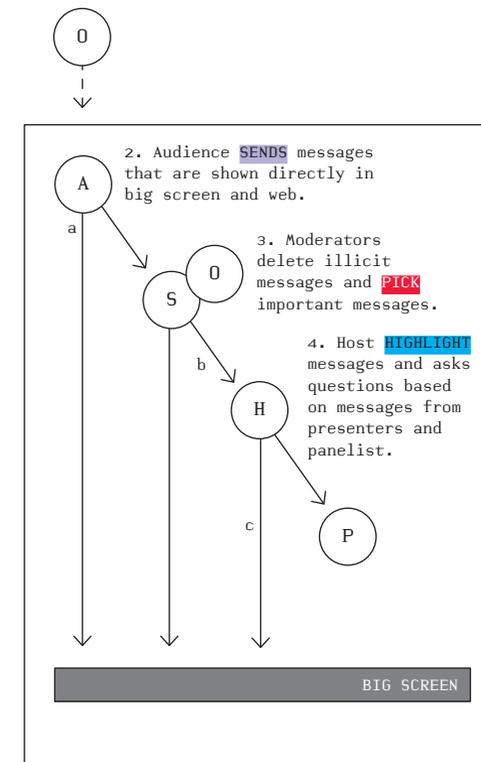
## 7.2.4 Applying LAIX-score to the Case Production

The previous section described the core interaction activity in the Trafi production and explained the role configuration in this production. This section models the production with the LAIX-score state control matrix. The section focuses on elaborating on what would have been an ideal interface channel structure and corresponding state control matrix and compares that with the realized state control matrix. The basic Presemo version (described in Section 6.1) was used in the production and for this reason the production was limited to four interface channels.

Figure 7.2e presents both the realized and idealized versions of the state control matrix. The idealized version is a 7-channel system. The 3 new channels proposed for the idealized LAIX-score state control matrix are highlighted in the picture with red color. In the realized version, technical support (T) and orchestrating moderator (O) utilized the moderator and control



FIGURE 7.2E :    REALIZED AND IDEAL LAIX-SCORE STATE CONTROL MATRIX FOR
                 THE TRAFI SEMINAR PRODUCTION
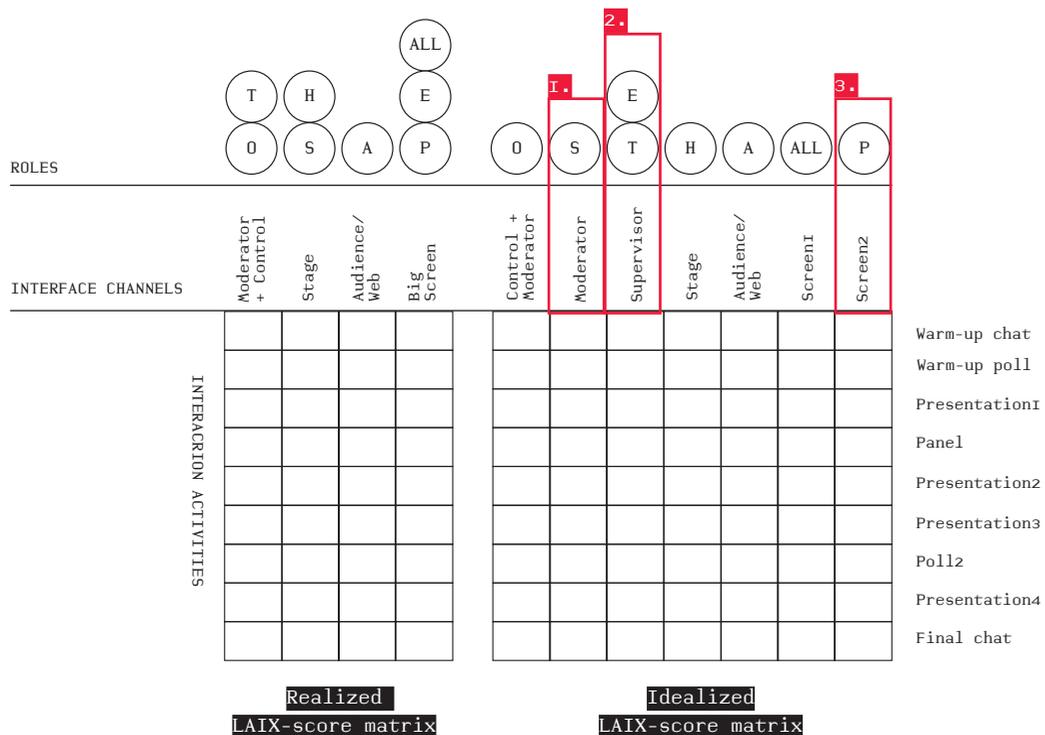
channels, host (H) and support moderators (S) utilized the state interface, the audience members (A) utilized their own screen, and the performers (the panelists and presenters) (P) and event production personnel (E) did not have any personal interface, but could perceive the session only through the shared big screen interface.

In an ideal version, the first proposed modification would be that (1.) the support moderators (S) would have a different interface channel than the host (H). The stage interface is designed for hosts who are on stage and have limited cognitive capabilities to focus and manage audience contributions. Preferably, the host should not focus on any other interaction activity control function than presentation management. The support moderators would also need content management functions and potentially also interaction pattern specific controls, because they are actively moderating messages and responding to specific audience questions. The support moderators should also be able to prepare and see other interaction activities than those visible to the audience, and for this reason their interface should not be synchronized with the host interface.

The second proposed modification (2.) is that there should be a separate monitor and supervision interface especially for the event producers, but also for the technical support people. The technical support personnel are often focused on managing the audiovisual integration and monitoring the system state. They do not need content management rights or presentation management rights. The event producer is commonly a supervisor (E) who needs to monitor the situation and for this reason wants to see, which interaction activities are active on screen and in the audience interfaces, which interaction activities are forthcoming as well as a statistical view of the current state of the interaction system. The current Presemo implementation provides only limited supervisory functions. Presemo provides some statistical feedback in the control UI. In an ideal system, there should be a separate overview interface that can be used for monitoring the overall interaction state.

The third proposed change (3.) is that there would be another big screen interface that would function as a monitor for the presenters. There are two main reasons why the presenters should have a different view than the audience. First of all, the monitor screen layout should be different than the big screen layout. The presenters should be able to read the highlighted or sent messages more easily. A small text box on top of the live video may be appropriate for the big screen, but not for the monitor screen. Also, the orchestrators should be able to com-

municate with the presenters and provide them with feedback (such as coordination notices) that are not visible for the audience. Table 7.2f summarizes the role configuration, role responsibilities, realized interfaces and proposed ideal interfaces for this production.

SUMMARY OF ROLES AND INTERFACES IN THE TRAFI SEMINAR PRODUCTION THAT SHOW THE DIFFERENCE BETWEEN THE REALIZED AND IDEAL INTERFACE STRUCTURE.

| ROLE | ACTOR AND NUMBER | RESPONSIBILITIES | REALIZED INTERFACE | IDEAL INTERFACE |
|---|---|---|---|---|
| Host | Professional host (1) | Introduction of presentation, facilitation of panel and audience questions. | Stage | Stage |
| Presenter | Speakers (4) | Presentation, introduce and acknowledge poll and respond to audience questions. | Screen | Monitor screen |
| Panelists | Host organization (4) | Participate in panel and respond to audience questions. | Screen | Monitor screen |
| Support moderators | Host organization (2) | Moderate messages and support host. | Stage | Moderator |
| Orchestrating moderator | Team member (1) | Control live audience interaction (control UI). Assist host and moderators. | Moderator + control | Moderator |
| Technical support | Team member (2) | Manage and monitor system and support technical integration. Assist orchestrator. | Combined Moderator + control | Supervisor (or control) |
| Event producer | Professional producer (1) | Coordinate and supervise above roles. | None | Supervisor |
| Audience members | Event guests (350) | Ask questions and answer poll questions. Participate in discussion. | Audience + Screen | Audience and Screen |

The requirements for these three new interfaces have been repeated in other larger seminar productions. These requirements can be summarized as (1) the need for a moderator interface that does not have full control rights, (2) the need for a supervisory interface and (3) the need for a dedicated monitor interface. In other event productions with professional event producers, we have also identified the need for a dedicated personal interface for the panelists and the need for two different types of big

screen interfaces for the audience. This analysis validates the core requirement 2 – live audience design framework should support for different roles.

### 7.2.5 Additional Requirements Identified During the Case Production

There are two other important findings that were identified from this case study. First of all, the event producers utilized technical cue lists for temporal coordination during the production. The design framework for live audience interaction should be compatible with the event producers cue list format. The second observation is that the documentation of the live audience interaction is important for the event organizers.

CUE LIST (ADDITIONAL REQUIREMENT 4)

The event program is not an adequately detailed temporal management tool for professional event producers. Professional event producers use a technical cue list as the main planning and coordination tool for productions. Figure 7.2g shows part of the cue list used in the latter Liikenteen Tila production (2014) anonymized and translated into English. The 2014 production was similar to the 2013 production presented in section 7.2.2 in detail, except that it had more poll interactions and did not have a panel discussion.

CUE LIST FOR THE LIIKENTEEN TILA 2014 PRODUCTION

The cue list is realized in a table design format and it is used for coordination of live productions. The column structure has some similarities to the interface channel structure of the LAIX-score design framework. In this production, there was one column (1.) that was specific to live audience interaction, and another column (big screen), which was actively used to coordinate all big screen visuals including live audience interaction. However, these two columns were not used coherently to specify each individual live audience interaction activity. The resolution of rows was not detailed at the individual interaction activity level, but was defined in more general level. For example, there was one item in the cue list that involved several poll questions (3.). Each audio input channel (2.) had a unique column in the cue list. Similarly, each live audience interface channel could have its own column in the cue list. The two columns (1.) applied for live audience interaction would be adequate to define the LAIX-score in the standard Presemo system if there were unique cues (rows) when there was fundamental change in interaction activity state control matrix.

A cue list structure can realize a temporal dimension of the LAIX-score design framework. The problem with the cue list design is that it is only a two-dimensional table presentation whereas the LAIX-score state matrix alone already has a two-dimensional structure. For this reason, the interaction activity dimension of the LAIX-score state control matrix must either be collapsed within each cell or another kind of cue list design must be developed that complements the proposed two-dimensional cue list design for modeling the temporal dimension in the LAIX-score design framework. Hence, the temporal dimensions would entitle a third dimension for the LAIX-score design framework.

CASE DOCUMENTATION (ADDITIONAL REQUIREMENT 5)

After the Trafi seminar production, the event organizers immediately requested documentation of the audience contributions. Based on the debriefing after this particular production and our experience with many other productions with event organizers, we have identified that there are at least four different reasons why case documentation is needed:

I)    RESPONDING TO UN-ANSWERED QUESTIONS:
      As there are so many questions and comments
      coming from the audience, it is not possible to
      address all of these questions during the live
      session, and for this reason organizers want
      to have sufficient case documentation so that
      they can respond to all questions afterwards
      by utilizing, for example, intranet sites.

2)    PROMOTING AND DISSEMINATING THE EVENT:
      Event organizers want to share the event's
      findings with an audience for those who were
      not onsite by using the video recording of
      the event complemented with the event live
      audience interaction documentation.

3)    DISSEMINATING THE EVENT INTERNALLY:
      Event organizers need to report on the event
      to their superiors and the live audience
      interaction documentation serves effectively
      for this purpose.

4)    ANALYZING THE EVENT:
      The audience interaction log can
      be used to analyze the event.

Currently, exporting the event report is a standard feature in the basic Presemo system, but there was not a similar support in the version used in the first Trafi production. The export function in the Presemo lists all audience contributions either as a text file or in the csv file format. Ultimately, event producers expect either stylized text document or a raw data file that can be used in analysis. 7.2.6 Case Evaluation and Elaboration Summary

The live audience interaction in the Trafi seminar case was focused on a chat-based questions and answers (Q&A) interaction pattern. Based on our experience the Q&A is the most common interaction activity in seminars that utilize a computer-based live audience interaction systems. The case presents how organizing Q&A in a high-profile seminar with a significant number of audience contributions may require more roles than just those of orchestrator, audience, host and presenter. The role configuration in this production validates the second core requirement of the live audience interaction design framework (support for different role configurations).

The case production provides only limited validation for the other two core requirements. The case utilizes only the basic interaction activities (chat and poll) and the function of the live audience interaction was mainly focused on the audience asking questions from the presenter. The system was also used for collecting feedback and activating the audience in the beginning, but these should be considered as complementary and detailed interaction patterns to the primary chat interaction pattern.

The production utilized the basic Presemo system and for this

reason the LAIX-score state control matrix for this production is aligned with the state control matrices presented in Chapter 6. The case analysis elaborated how the case could have been produced also with a 7-channel LAIMS system. 7-channel system would have corresponded better to the specific role configuration of this production and provided better coordination and management possibilities.

The case also produced two additional requirements for the live audience interaction design framework. The design framework should support the technical cue list format, which is the common temporal coordination instrument for event producers. Another additional requirement for the design framework is the need to produce session documentation. In this kind of seminar production there are several reasons for documenting audience contributions.

There was a problem in coordinating the highlight procedures and managing the communication between the moderators and the host in this production. This problem is related to the management of the complex role setup. The problem was mitigated in follow-up productions with the new presentation management feature called pick. Despite the coordination problems, the feedback received from the event organizers for this production was positive or very positive. The host was interested in applying the system in his other productions and the support moderators decided to propose this system for persistent use in other events in their organization. Overall, this case study presents an example of a common live audience interaction production. The same setup has been repeated several times with the same event producer and with other event producers. The other seminar productions co-produced with event producers support the observations presented in this case study.

## 7.3 Presemo at the University

### 7.3.1 Digital Learning Environments

Education has an important function in our society. Most western people spend more that 10 years in schools. Overall, the education sector has over 6000 billion dollars in global turnover[126]. Training and education takes place often in workplaces and organizations as well as in schools. People are expected to learn continuously, and appropriate new kinds of learning skills. Organizations need to change, which also poses demands on

126)
Education industry (2012), Unesco Education Global Education Digest (2012)

127)
For example, the Bitbang course presented in the chapter 3.

128)
Review article by Kay and LeSage (2009) went through 52 different studies about how to use clickers in education. Vanderbilt University of Teaching has a Bibliography of clicker and audience response system studies with 295 entries. According to Lane (1996) the clickers have been used in education at least since 1991 with the name networked classroom, even though the audience response system date back to 1960's and 1970's according to the early patents

129)
Cladwell (2007) reviews of classical choice-based audience response system uses.

130)
Wang (2014)

131)
Cruz e Costa (2008)

employees to acquire retraining. For these reasons, the need for education is going to grow furthermore in the future.

The educational domain was the first application contexts for our live audience interaction experiments. In the beginning, we used our own courses and educational events as test environments for live audience interaction systems[127], but gradually teachers from varying institutions have persistently used first Slides & Polls and later different versions of Presemo in their classes. We could expect that the educational domain is interested in LAIMS tools, as clickers and audience response systems have a long history in the educational domain[128]. Clickers are fundamentally first generation live audience interaction tools.

What is important in LAIMS in comparison to clickers is that they can provide multiple different interaction approaches, which then again enables different pedagogical processes. Clickers basically support only multiple choice patterns (polls). Even though multiple choice is a simple pattern it still has various uses. For example, in her 2007 review article Jean Cladwell identified at least nine different use patterns for audience response systems (that support fundamentally only polls) in education ranging from *finding out more about students and formative assessment*, to *quizzes and guiding thinking*[129]. Other researchers have also observed the limitations of the conventional audience response systems and coined also new terms that describe better the possibilities related to audience interaction in the physical classroom with personal computing devices. Concepts such as social classroom applications[130] or mobile lecture interactions[131] have been introduced for this purpose.

Digitalization has arrived in classrooms in many ways. Commonly, digital computer systems used in education are called *digital learning environments*. Digital learning environment is a broad title. Different digital learning environments are for example learning management systems (LMS) such as Moodle, Frontier and Canvas, collaboration systems such as Google Docs and Microsoft Office products, massive online course systems and MOOCs such as Coursera and Edx, games and simulation environments such as Scratch, social media such as Facebook, Google+, Twitter and D-Cent, web publishing and blogs such as Wordpress. Live audience interaction management systems (LAIMS) can be considered as a type of learning environment. LAIMS are designed for live presentation situations where the presenter (teacher) orchestrates the audience interaction. Systems such as Kahoot and Socrative presented in Section 4.2 are examples of LAIMSs mainly designed for educational use.

Figure 7.3a demonstrates how live audience interaction can be compared with other types of learning environments. Live audience interaction takes place during a performative situation and the current systems are designed for groups (approximately 10+ participants to a larger audience of up to 500 participants), but they are not suitable for crowds of more than 500 participants, because crowd interaction requires significantly different management features (more messages) and technical capabilities (server system that support large number of synchronized clients). It is possible that different learning environments such as LMS systems and MOOC environments appropriate live audience interaction features in the future. Smartboard is a learning environment that is directly supporting teacher performances in ways that are similar to live audience interaction systems. Some Smartboard environments also have features for student engagement with personal devices[132].

FIGURE 7.3A :    LIVE AUDIENCE INTERACTION (LIVE PARTICIPATION) VISUALIZED ALONGSIDE OTHER DIGITAL LEARNING ENVIRONMENTS. THE Y-AXIS REPRESENTS ACTIVITY DURATION (HOW LONG ACTIVITY LASTS) AND X-AXIS REPRESENTS ACTIVATY SCALE (HOW MANY PARTICIPANTS)

132)
For example, Interactive board manufacturer Promethean (2015) has own response systems and Smart Technologies (2015) has a Smart Response system, which is basically a simple live audience interaction system.

133)
Blended learning is a formal education program in which a student learns at least in part through delivery of content and instruction via digital and online media with some element of student control over time, place, path, or pace.

134)
Bonwell (1991), Prince (2004)

135)
We have had a separate research project called Lead that was partially focused on developing live audience interaction for education.

136)
Sessions are also called rooms

137)
Day visit is a statistical concept we have used to describe how many users an interaction session has. If one day session has 500 visitors, then the visit count is 500. If a session has 50 visitors in ten different days, then it has also 500 day visits. Sessions that have 30 000 day visits have been used repetedly for two years.

The combination of physical and online education is often referred to as *blended learning*[133]. The use of digital tools during classroom teaching and learning is also related to an active *learning approach*[134]. Active learning is a pedagogical approach that expects learning to improve when students are doing and not only listening. The effects associated with active learning have helped to motivate the introduction of LAIMS in education.

Because of the wide adoption of clickers, live audience interaction already has a history in the education domain. Overall, the educational domain is in transition and digitalization is changing teaching practices. There is a demand for new kinds of tools and approaches in teaching. Live audience interaction can provide several different approaches for teaching if it is designed as a tool that helps teachers to realize different kinds of pedagogical patterns.

### 7.3.2 Introduction to Presemo at a University Case Study

Overall, our LAIMS systems have been used in many different educational institutions ranging from elementary schools to the professional education setting[135]. Universities were the first organizations to adopt the Presemo system for their own use. From the production perspective, the big difference between organizing live audience interaction in the educational domain in comparison with the professional event productions described in the previous section (7.2) is that in the educational context teachers (performers) organize and facilitate the use independently without direct support from live audience interaction experts or often teachers do not have any assistance during the classroom presentation.

This case study presented in more detail is focused on how the University of Helsinki has been adopting the use of live audience interaction and Presemo. Presemo has been in use at the University for two years. During those two years, teachers have created over 500 rooms for live audience interaction[136] and the most popular rooms have had over 30 000 unique day visits[137]. Figure 7.2b visualizes the aggregated use of all Presemo rooms at the University of Helsinki during the two-year period. The figure illustrates how there is a significant weekly cycle in the system use and how the peak use periods are always in the beginning of the term and during the period when the introductory lectures are usually held. Hence, the LAIMS systems seem to be especially popular in the introductory lectures. In general, the figure demonstrates that the use of Presemo is persistent and regular.

FIGURE 7.3B :    USE STATISTICS OF PRESEMO AT THE UNIVERSITY OF HELSINKI.
                 THE FIGURE SHOWS HOW MANY PARTICIPANTS THERE ARE IN ALL
                 OF THE UNIVERSITY OF HELSINKI PRESEMO SESSIONS DAILY.
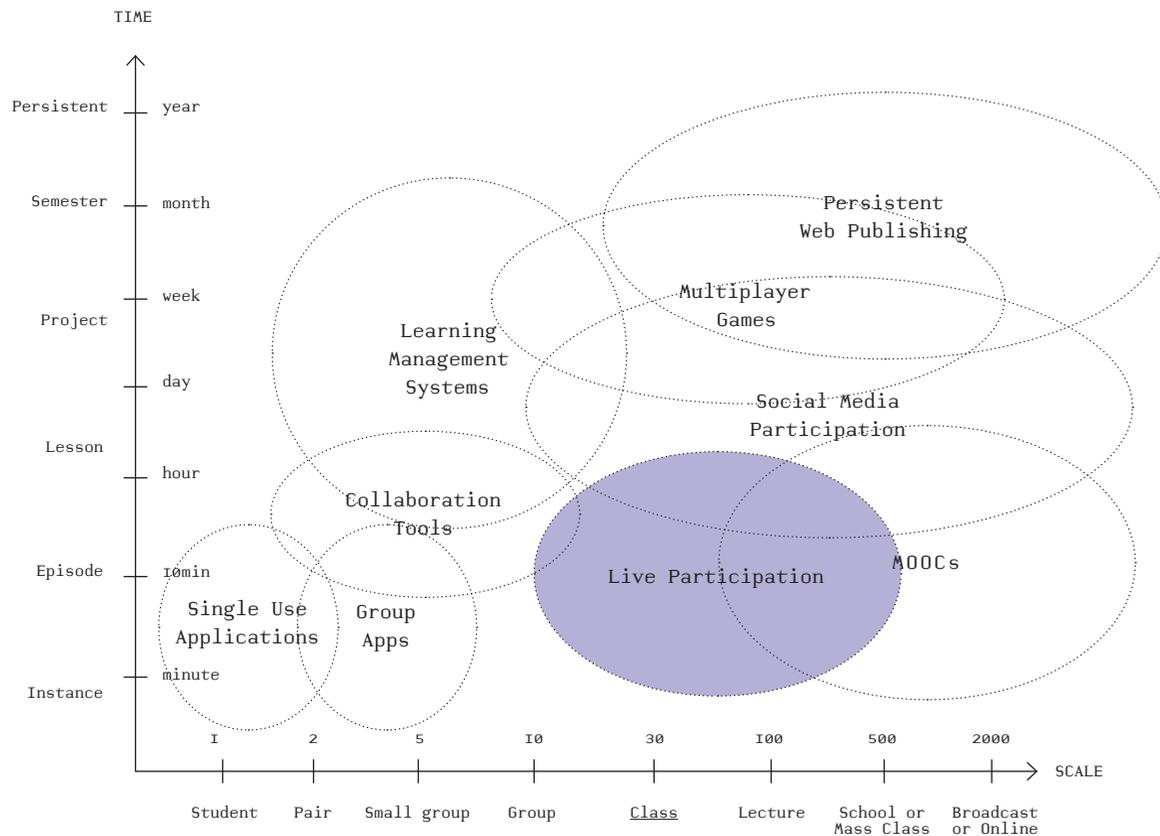


Presemo use at the University of Helsinki (unique daily visits)
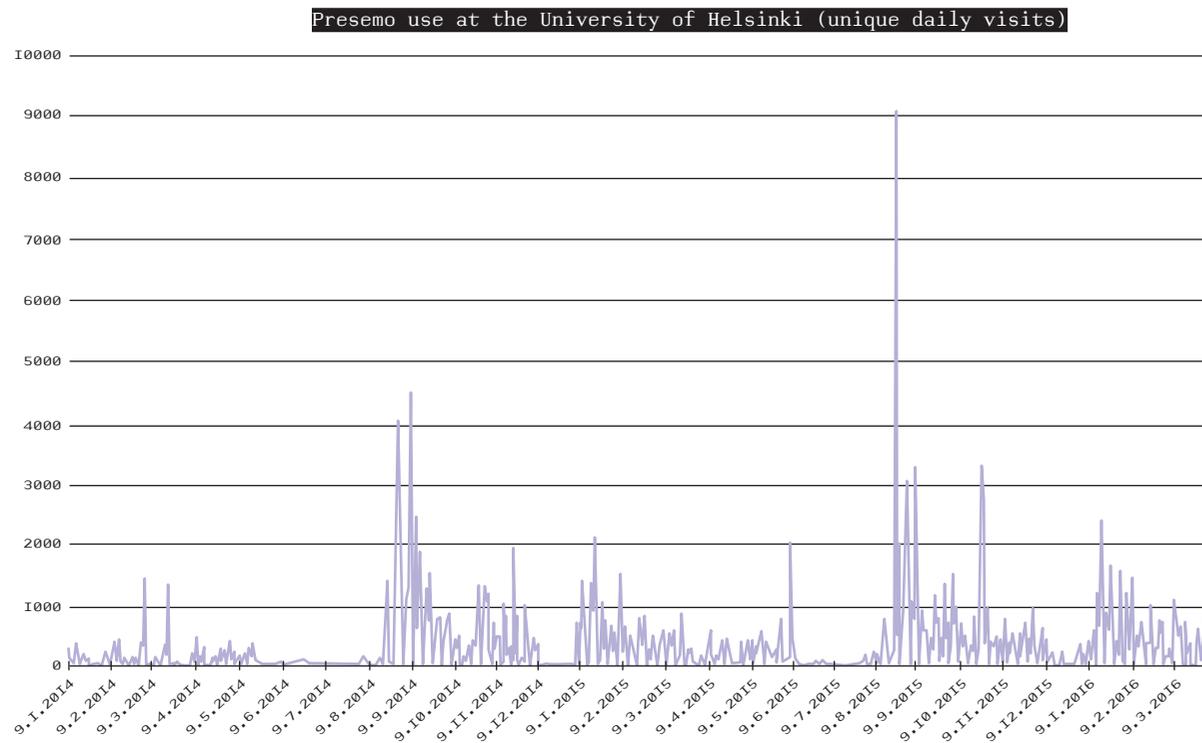
The University of Helsinki is not the first University that started to provide the Presemo system for teachers. This research and the development of Presemo has been taking place at Aalto University, which also was the first university to adopt the Presemo. The University of Helsinki is not affiliated directly with the research and the service provided for the University of Helsinki is on a commercial basis. For this reason, we chose the University of Helsinki as a case study as it demonstrates a neutral adoption of the Presemo LAIMS. The adoption process of Presemo lasted for almost a year. The organizational unit at the University of Helsinki that is responsible for new digital learning systems tested Presemo internally, and after their initial tests there was a half a year pilot period before the service contract was finalized and the service was opened for all teachers. My role in the University of Helsinki case has been that of salesman, support person and trainer. Hence, I have been organizing part of the regular training sessions for the teachers at the University of Helsinki along with my colleagues and have interacted with the university teaching support team for helping the adoption and for improving Presemo so that it supports the use cases of the University.

138)
Currently there are over 15 organizations in Finland that have adopted Presemo for internal and idependent use ranging from consulting companies and industry to public offices and marketing.

139)
Use in Swedish medical studies (blogs.helsinki.fi/medopetus/2013/10/29/interaktion/) and University teacher listing four lessons-learned how to use Presemo (blogs.helsinki.fi/msilenti/2014/03/05/nelja-saantoa-presemo-kayttajalle/)

140)
Presemo feedback (Helsinki 2014)

The LAIMS system used in the University of Helsinki is the standard Presemo version 4 LAIMS system. The system is extended with a session creator environment, where teachers can independently create their own Presemo rooms. After a teacher creates a room, she receives an email that has the room pin-code and links to all interface channels. The room creator is also used in all other organizations that have adopted Presemo in wide internal use[138].

We have been collecting feedback from University of Helsinki teachers regarding how they like the use of live audience interaction system in their classes. The common observation is that there is no single dominant use case for how the live audience interaction and Presemo is used in university classrooms. The next section (7.3.3) introduces in detail three interesting use case examples of how Presemo has been used at the University of Helsinki. Presemo is not used only for teaching at the University but also as a tool in internal communication and among researchers in conferences.

Teachers at the University of Helsinki have generally found the use of Presemo to be pleasant. Some have written blog posts about how it is a convenient application in the classroom[139]. From the teacher perspective, the most important quality of the Presemo system appears to be its *ease of use*. Teachers understand that similar interactions could be performed with some other tools, but Presemo's ease of control, ease of access and ease of taking the system into use seem to be the important reasons for why it is preferred instead of other freely available systems.

Also, students appear to like the use of Presemo and live audience interaction. A teacher has posted the results of a student feedback questionnaire (conducted with Presemo) regarding the use of Presemo. Positive feedback quotes from the students included the following[140]:

More fun to write, you can say more things, all must answer, complementing each other's answers and thoughts.

Everyone's opinions come front, lower threshold to respond poorly:

Good new ideas. not always the same people talking. you get several express satisfaction or dissatisfaction forward and dare to suggest things outside the box.

great! multiple views...

Visibility for all! Also good to occasionally take group discussion. Comes more info / opinions in a shorter time = effective

Basically, students prefer that all students can contribute at the same time and that discussion is more open and democratic with the live audience interaction tool than with a direct face-to-face classroom discussion. Also, it is important that the threshold for asking is lower with Presemo than in the direct face-to-face situation.

The main critique was related to the management of visibility. Students thought that it is not optimal that the results sent by others are already seen when they are still responding.

```
see other people's responses when you
yourself are still sitting and brooding.

could be helpful if responses could
be kept hidden until all answers

other people's ideas comes up before you
had time to think you always see all the answers.
```

This main critique from students is somewhat misleading. Presemo has different features for managing visibility of responses. In this case, the teacher has not been able to control the message visibility of the interaction patterns appropriately. Still this student critique is an important example of how visibility controls are very important for a LAIMS system and how live audience interaction management is fundamentally about attention management. This small feedback questionnaire already demonstrates two fundamentally different use cases: classroom discussion and facilitating small assignments through LAIMS.

Overall, the use of Presemo in University classes can be considered a success. The use is currently persistent and the University has created documentation, guidance and support plans for Presemo. The experience with the University of Helsinki shows that the same LAIMS tool can be a generic tool and used for different live audience interaction patterns and with different pedagogical approaches.

## 7.3.3 Core Live Audience Interaction in the Case: Different Educational Use Scenarios

In the case of the Screen.io event production case study (discussed in Section 7.2) it was easy to identify the core live audience interaction pattern. In the case of Presemo at a University, it is not possible or appropriate to similarly identify a single

```
141)
Such use is often
called as BYOD
(Bring Your Own
Device) use.

142)
Cladwell (2007)
```

primary interaction pattern.

This section will present three different kinds of use case scenarios for Presemo. These scenarios have been identified during the support process with the University and while interacting with the teachers. These use case scenarios can be considered generic since the same pattern has been repeated multiple times by different teachers. These cases are not the most stereotypical uses for live audience interaction, but present use cases that go beyond the obvious and simple uses such as asking a few poll questions or allowing student Q&A with the chat interaction pattern. The three cases demonstrate the variety of different uses of live audience interaction in education. However, the cases do not provide a comprehensive view of all different possibilities, but there are also several other kinds of use cases in addition to the ones discussed below. The three use cases are:

```
A:      Use of Presemo as a clicker replacement
B:      Use of Presemo in group-work assignments
C:      Use of Presemo as a chat environment and
        for chat onboarding
```

```
SCENARIO A : Some teachers prefer to use the Presemo as
a convenient way to replace clickers with a tool that does
not require proprietary devices and is more convenient to
setup141. These teachers only use Presemo's poll features
and do not use any messaging patterns and generally don't
use any other interaction patterns. As noted already,
there are several different ways polling can be applied in
the education environment142. For example, a teacher in the
medical department of the University of Helsinki reported
in a training session that she had over 30 choice-based
poll questions in one session. She also reported that man-
aging so many different questions with the current control
and moderator interface was fairly challenging and could
be improved with some controls. This is evidence that the
current control interface can be used with more than 30
interaction activities, but should be improved for better
managing such situations
```

```
SCENARIO B : Teachers have found out that Presemo is
not only good for student to teacher interaction, but
can be used for facilitating group interactions in larger
classrooms. For example, one teacher at the University
of Helsinki had a special emphasis on exploring the use
of Presemo for activating and structuring pair work and
group work in the classroom. A common interaction pattern
is that teacher asks a question from students who then
responded to the question by typing. This same pattern
can be extended by inviting students to discuss and delib-
erate the question in small face-to-face groups, and only
```

after deliberating the students send the answers into the system for other groups and students to see. This pattern can be further extended with the peer-evaluation feature, which basically means that students rank and rate other groups' answers and comments. The peer-review pattern will be explained more in Section 7.4.3. The teacher, who focused on exploring various group work facilitation patterns, commented that in his class he receives more comments on average from a group work session than when students contribute individually even though there are a smaller number of groups than individuals. This leads to a hypothesis that in live audience interaction, the quality and quantity of interaction can be improved with group interactions.

SCENARIO C : A common live interaction pattern is the chat Q&A during and at the end of the class. This pattern is fundamentally similar to the interaction pattern presented and elaborated in Section 7.2 (Trafi seminar production), but the role configuration is significantly simpler since there are only teacher and student roles. Students and teachers emphasize that the anonymity is an important feature because it lowers the threshold for asking[143]. What is interesting is that some teachers leave the chat channel on after the classroom and persuade students to also ask questions between classes. Sometimes the break between classes can go over the winter holidays, but the chat thread is still active even though messages are anonymous. One of the rooms has had interactions during 300 days, and there are five sessions that have had over 200 active days. Such use is not anymore performance-centric. Still in these cases performance has a significant role, since it is important that the chat session is initiated during the classroom performance. We call this kind of use as onboarding. The teacher initiates a chat interaction as a live audience interaction setup, but the interaction is then continued outside the performance context. Hence, live audience interaction is a catalyst environment to invite and initiate persistent chat discussion. Table 7.3c summarizes the different interaction patterns, role details and additional remarks found in each of these case scenarios.

143)
We have been analyzing anonymity further for example in Nelimarkka et al (2014)

FIGURE 7.3B :    USE STATISTICS OF PRESEMO AT THE UNIVERSITY OF HELSINKI. THE FIGURE SHOWS HOW MANY PARTICIPANTS THERE ARE IN ALL OF THE UNIVERSITY OF HELSINKI PRESEMO SESSIONS DAILY.

| USE CASE SCENARIO | INTERACTION PATTERN | ROLES AND CONTEXT DETAILS. | REMARKS AND CHALLENGES. |
|---|---|---|---|
| A : Clicker replacement | Poll interaction patterns. Over 30 interaction activity instances. | Presentation situation with a single teacher. | Current control interface is not ideal for large amount of interaction activities. |
| B : Group-work assignments | Open ended-question pattern. Extended with group discussion and potentially also peer review. | Students discussing among each other in a regular educational context. | Group work phase produces more and better contributions than individual contemplation. |
| C : Chat on-boarding | Chat activity used over days and weeks. Discussion initiated during a classroom performance. | Teacher role established with moderator messages in an anonymous backchannel. | Anonymity is an important feature for chat and live audience interaction provides context and a frame for anonymous chat in a way that could not be realized without a live performance. |

The three case examples show that Presemo has been adopted for different uses in the University. This is connected to the first core requirement (support for different interaction patterns) for a live audience interaction design framework as well as research objective of making a framework that is generic. Even though the different interaction activities are not realized within the same session, they are realized within the same case environment. The teachers, support staff and students are accustomed to using Presemo as a tool for different audience interaction needs. The role configuration in these use case scenarios is much simpler than the Screen.io event production case study. In this sense, the educational context does not provide validation for the second requirement (support for different roles). Also, the third requirement (support for different and parallel functions) is fulfilled only partially. Most educational use cases of live audience interaction use only one interaction activity function at the time, and while live audience interaction supports many different kinds of pedagogical approaches these approaches are not parallel in the same class. The next section will demonstrate how these different use cases can be presented within the LAIX-score state control matrix.

### 7.3.4 Applying LAIX-score to Case Production

The LAIX-score state control matrices for the three use case scenarios presented in the previous section are fundamentally simple. There is no need for even the four channels supported by the basic Presemo system. A three-channel setup is adequate for the use case scenarios as illustrated in the Figure 7.3d. Actually, in scenario C, a big part of the interaction is realized with only two channels. For this reason, the analysis perspective for the Presemo at the University case study should not be in analyzing how the LAIX-score state control matrix scales to large productions and complex live audience interaction setups, but how LAIX-score is still practical and useful in smaller productions and constrained role configurations.

FIGURE 7.3D :    LAIX-SCORE STATE CONTROL MATRIXES FOR THE THREE USE CASE SCENARIOS IDENTIFIED IN THE PRESEMO AT THE UNIVERSITY CASE STUDY. THE ILLUSTRATION SHOWS HOW THREE-CHANNEL CONFIGURATION OF PRESEMO HAS BEEN ADEQUATE FOR THE THREE COMMON USE CASES IN THE UNIVERISTY.
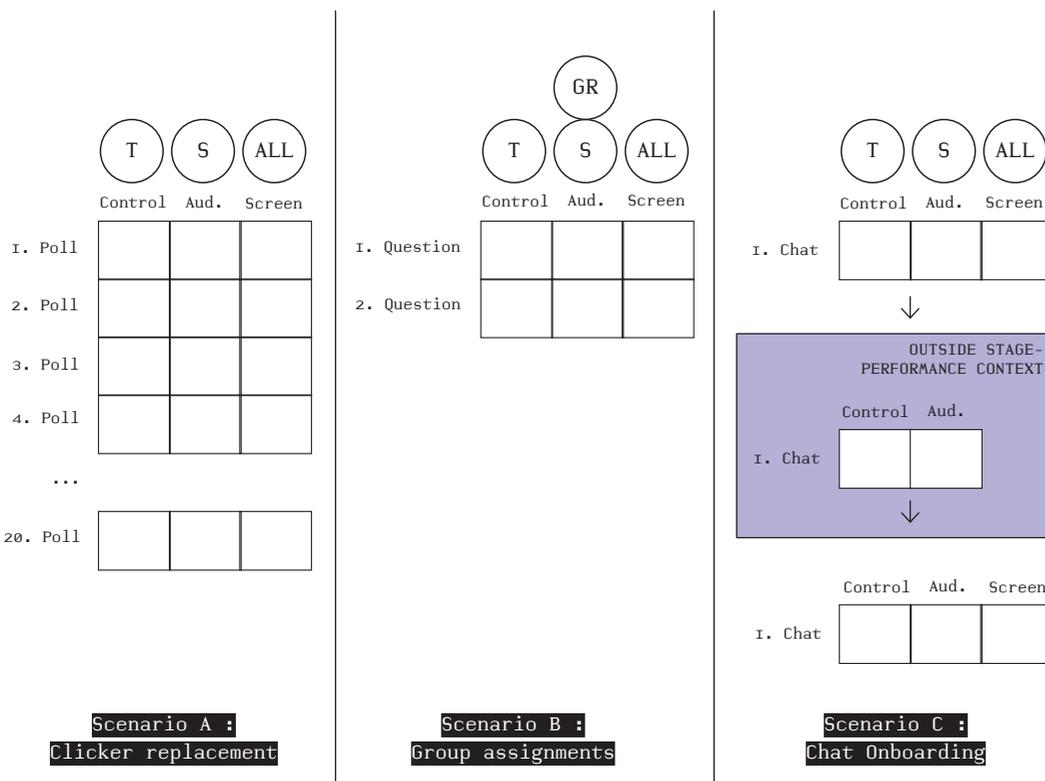


152

When we introduced the first version of the LAIX-score framework-based Presemo in the educational context there was criticism from some teachers that the system with three interfaces is unnecessarily complex. For example, there was a teacher who complained that the system does not work, and when arrived to support him, we realized that he was not using the combined moderator and control interface at all, but tried to control the live interaction with the screen and audience interface only. Another teacher commented directly that the design should be simplified to having a two-channel system such as some other live audience interaction systems for the educational context have[144].

After proper training procedures, improved interface designs and a long appropriation process at the University, the current Presemo setup with three interfaces no longer receives complaints, but rather, the system receives good feedback and teachers consider the system relatively easy-to-use. Only a few teachers or staff members in the University use the fourth interface (stage-interface) of the basic Presemo system. The fourth interface is not mentioned for example in the standard tutorial material or introduced in the basic training for teachers, but it is technically available for all.

It is possible to also envision more complex role configurations for the educational context (such as group roles and assistants), but in reality, teachers usually manage both the performer and orchestrator roles alone. The LAIX-score design framework is developed to support different interaction activities, different role configurations and parallel functions. The requirements for different roles and parallel functions, in particular, are not that important in the educational domain, so why is the LAIX-score framework still a useful basis for live audience interaction in this domain? There are two perspectives that demonstrate the relevance of the LAIX-score design framework in the educational domain: Efficient appropriation and flexible visibility management.

LAIX-score design framework provides efficient appropriation of live audience interaction practices in educational context because there are multiple different educational use cases for live audience interaction and the LAIX-score design framework supports all these different use cases. The University can manage these use cases by appropriating one single new tool instead of supporting several different applications and tools. This is a significant advantage that the LAIX-score design framework delivers. Providing a well-documented and well-supported as well as flexible framework also allows teachers to innovate new uses such as Scenario B and C described in the previous section.

153

Flexible visibility management means that the visibility in different interface channels can be managed independently. This allows, for example, asking multiple questions simultaneously, but acknowledging answers one-by-one, or for flexible organization of different group work procedures. Figure 7.3e demonstrates how flexible visibility management is applied in scenario A. Similarly, it could be applied in scenario B.

ILLUSTRATION OF FLEXIBLE VISIBILITY MANAGEMENT EXAMPLES WITH THE LAIX-SCORE DESIGN FRAMEWORK. THE SCENARIO A.1 SHOWS SINGLE POLL WITH REAL-TIME RESULTS. SCENARIO A.2 ILLUSTRATES HOW ANSWER AND VISUALIZING RESULTS CAN BE DETACHED. SCENARIO A.3 ILLUSTRATES HOW STUDENTS CAN BE ASKED FIRST MULTIPLE QUESTIONS, AND THEN ANSWERS CAN BE ACKNOWLEDGED ONE-BY-ONE.



SCENARIO A.1 :
One poll with real-time results

SCENARIO A.2 :
Two-step poll, first poll and then results

SCENARIO A.3 :
Multiple polls at the time, Results shown one by one
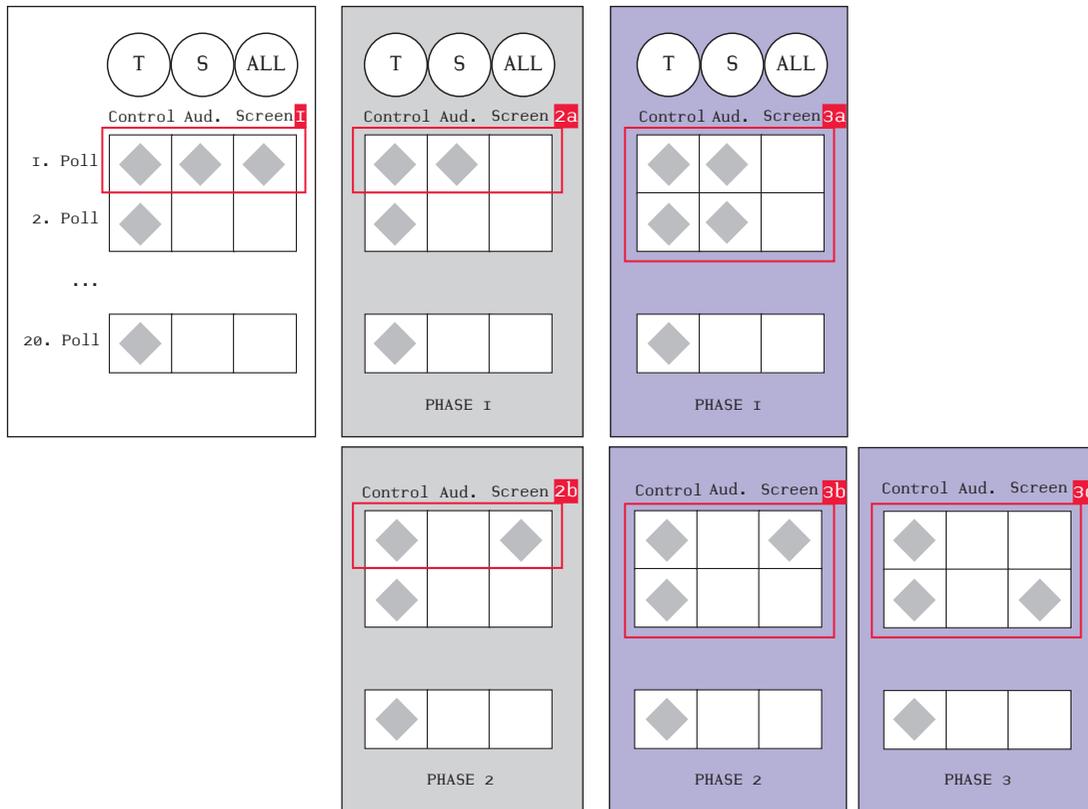
The following use patterns are common in the educational context as well as in other contexts. The first variation (scenario A.1 in the Figure 7.3e) shows how the results are shown at the same time as the questions are asked (1). This is exactly the problem that the students also noted in their negative feedback presented at the end of Section 7.3.2. In the next scenario variation (scenario A.2), the flexible visibility management is utilized to first ask the question (A.2a) and then show the results (A.2b). Finally, scenario A.3 demonstrates the unique benefit of the LAIX-score framework and how it supports multiple parallel interaction activities. The teacher can simultaneously ask multiple questions (A.3a) (in this case only two, but there could be three or more), and then show the results and acknowledge each question one-by-one (A.3b and A.3c). These two questions can be based on different interaction patterns. The flexible visibility management allows for more efficient phasing of large question sets. The audience does not have to repetitively shift between active contemplation and listening modes, but can realize multiple tasks within one contemplation episode and still presenters can acknowledge each interaction activity independently.

### 7.3.5 Additional Requirements Identified During the Case Production

The Presemo at the University case is an important reference case for the live audience interaction framework, as it consists significant amount of use. Teachers are relatively active in proposing new improvements to the system. We have identified four new additional requirements based on this case study. The *Functional cue list* and *session templates* are features that have become relevant only after the system has been in persistent use over years and teachers have started to optimize their audience interaction performance. *Anonymity as a feature* and *access management functions* have became important features only after we have gained more real-world experience with the students' behavior in real classroom environment.

CUE LIST AS A FUNCTION (ADDITIONAL REQUIREMENT 6)

In the previous chapter, there was an additional requirement (number 4) that proposed support for a technical cue list for the LAIX-score design framework. In the educational domain, the requirement for a cue list is extended further. Teachers would prefer that the Presemo system

would have a functional cue list that would allow defi-
nition of visibility presets and then execution of these
presets instead of managing each state control matrix cell
independently (the case with the basic Presemo version).
Functional cue list as a feature is related to the sequen-
tial design approach presented in Section 4.2. As well as
the cue list presented in Section 7.2.5. In this sequential
design approach, there is one interaction at a time, and
like in a playlist, the orchestrator or presenter can move
forward directly to the next interaction activity. This
approach is limited as it can support only one interac-
tion activity at a time, and provides limited support for
reactivity during the performance. However, this approach
is useful for cases when managing live audience interaction
with the LAIX-score state control matrix is too complex,
and when the interaction flow is fixed as is the case with
some pedagogical patterns. It is however important that the
cue list presets do not eliminate the possibility for flex-
ible and real-time visibility management. This is a similar
division between presets and programming mode as found with
light control environments (discussed in Section 4.5).

The cue list design could satisfy the needs of teachers who manage
a significant amount of different interaction activities such as
those discussed in scenario A. The cue list should be provided as
an extension to the framework so that orchestrators and present-
ers can use it if needed. Using the cue list should not eliminate
the possibility of using the state control matrix directly. Hence,
the cue list should provide shortcuts for modifying several state
control matrix elements simultaneously.

SESSION TEMPLATE FOR SESSION REUSE AND
DISTRIBUTION (ADDITIONAL REQUIREMENT 7)

The cue list function can also solve another feature
expected by teachers. Teachers would like to save, reuse
and share their pedagogical patterns. This means that they
can create a template with multiple interaction activities
and then use this same template again next year as well as
share this same template with other teachers. For example,
Kahoot[145] has a popular quiz sharing feature, which basi-
cally satisfies the same sharing need. For Presemo, the
reuse requirement is somewhat satisfied with the reset and
duplicate features visualized in Figure 7.3f. This is, how-
ever, a very limited realization for this requirement and
teachers expect a more comprehensive session template and
sharing feature. The cue list should contain specifications
of all interaction activities (names, headlines and pattern
specific control settings) and the sequential flow between
different interactions. Providing tools for saving, import-
ing and exporting cue lists could satisfy also the sharing
requirement and this way the cue list could function as a
session template for reuse and distribution.

145)
kahoot.it

FIGURE 7.3F :

BASIC PRESEMO RESET AND DUPLICATE FEATURES
THAT HELP TEACHERS TO REUSE SESSIONS
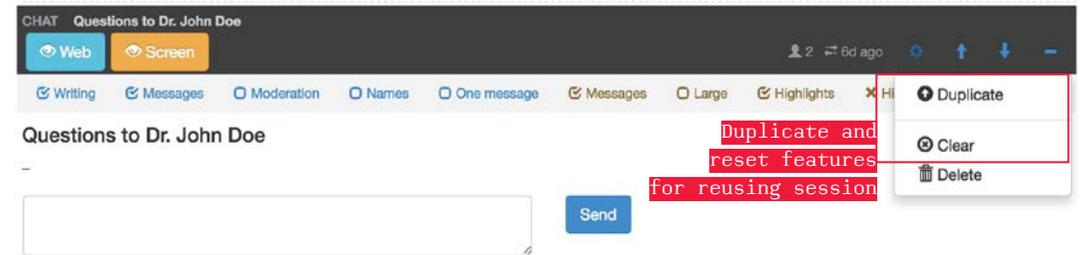


ENABLE ANONYMITY (ADDITIONAL REQUIREMENT 8)

The current version of Presemo supports sending anonymous
messages. As shown already in the student feedback[146] and
also in our earlier studies[147] anonymity is an important
feature for students because it lowers the threshold for
participation. According to our studies, anonymous live
audience interaction is more democratic than interaction
with names. Anonymity can be realized at different lev-
els. Comments can be completely anonymized (each comment
unique), or they can be anonymized from the interface, but
pseudonymized in the analytics. The names and profiles can
be visible only for the teacher, but messages are anonymous
on the screen. Or, students can choose their own pseudonym
for participation, or then there can be an authentication
and identification system that provides real or persistent
identity for the users. Hence, anonymity can be realized in
many ways. Some teachers say that anonymity is one of the
core features of Presemo. For example, Scenario C is unique
since the chat is anonymous, instead of utilizing IRC or
other pseudonymous or authenticated chat environments. In
the case of Scenario B, the anonymity enables a flexible
transition between using the same screen for group contri-
butions and then in the next phase for individual rank-
ings. As such, anonymity is a simple property for the live
audience interaction system, but if the system is extended
with profiles, cookies and account systems, the anonymity
quality of the system is basically broken.

MANAGE ACCESS TO INTERFACE CHANNELS
(ADDITIONAL REQUIREMENT 9)

The anonymity is important feature, but it can also cause
problems, as students can send illicit messages and tease
the teacher without risk for being exposed or penalized for
this illicit behavior. In a large lecture, only one student
may significantly compromise the flow of the lecture and
shift attention to irrelevant issues if they start sending
illicit messages[148]. This is a matter that has been dis-
cussed in all training sessions and meetings and we have
been exposed to such behavior in several classroom ses-

146)
Helsinki (2014)

147)
Nelimarkka (2014)

148)
Du (2012)

sions, but only a few times in the professional context such as Trafi seminar production presented in Section 7.2.

Content management and presentation management features (see more in Section 6.3) can be used to limit the illicit messaging problem, but not eliminate it. Teacher can also interact directly with the student in a way that may mitigate the problem. The most efficient approach for limiting the illicit messaging problem is to disable anonymous messages or utilize an authentication procedure. We have integrated for example social media authentication systems as an authorization proxy to minimize illicit messaging[149]. The result of applying authentication function is that the number of message and generally audience contribution is significantly lower. This might be due to the usability compromise (one additional step in initiation) as well as the elimination of the freedom of commenting that comes with anonymity.

The anonymity as a feature is emphasized in the educational context but it also applies in other contexts as well. Anonymity and access management are related and somewhat opposite features. Currently, in the basic version of the Presemo, only the control, moderation and stage interface channels require a pin-code for managing access. This pin is never exposed to the audience. This is really a simple and limited access management solution, but critically important. In addition, Presemo supports nicknames, but this nickname feature cannot be used for authentication. Anonymity and access management are generally also related to identity management, which opens doors for privacy and data protection issues that are becoming more and more important in the design of new interactive systems[150].

### 7.3.6 Case Evaluation and Elaboration Summary

This case presented the experiences of using Presemo and applying the LAIX-score framework in the educational context at a large University. The case study demonstrated how the role configuration and interface channel requirements in the educational context are simpler than in high-profile events such as presented in Section 7.2. The case study shows that the Presemo system and the LAIX-score design approach can be realized so that the control framework also supports simple use cases. The main benefits of the LAIX-score design framework in the educational context are support for an efficient appropriation of live

149)
This means that students have to login to their social media accounts before they can access the LAIMS.

150)
Privace and data protection are important topics for example because of new EU legistlation (EU GDPR). (EU 2016)

audience interaction practices and flexible visibility management. The LAIX-score framework supports different kinds of interaction patterns, which makes different pedagogical approaches feasible, which in turn makes the organizational appropriation in the educational context more effective.

This case study demonstrates how the LAIX-score design framework is a generic approach for live audience interaction and how Presemo is a generic live audience interaction tool. For the education domain, the 3-interface channel configuration is the primary setup, and there are also cases when Presemo is applied in 2-channel mode. The case study leads to the conclusion that the LAIX-score design framework interface channel structure should support operations in these limited channel configurations. Support for parallel functions (req. 3) is not an important requirement in the educational domain. The teacher often appropriates live audience interaction for single use cases at a time.

The Presemo at the University case study also introduces four important additional requirements for the LAIX-score design framework. The cue list function should be extended as a functional feature for creating predefined short cuts (presets) to the state control matrix configuration that correspond to the different phases in the pedagogical processes. This feature helps management of live audience interaction especially when there is a significant amount of different interactions and only a single performer who must also manage the situation. This same cue list function can be also used for saving, importing and exporting live audience interaction session templates, which is an important feature for teachers who want to reuse or share their lectures and pedagogical practices.

Another important requirement for the live audience interaction framework is that it supports anonymous contributions. Depending on the session and context there might be different anonymity and identification configurations. Anonymity enables democratic participation. Anonymity is also connected to access management, which is further related to session identity management, as well as privacy and data protection issues. Anonymity and access management are also related to what kind of group work practices can be supported by the live audience interaction system. Hence, anonymity, identification and access management are central elements for live audience interaction patterns and should be also considered in the LAIX-score design framework. Different anonymity and identification features may significantly change user behavior in different live audience interaction situations and affect the management of interaction patterns as well.

## 7.4 Metagroups
## Hybrid Scalable Workshops

### 7.4.1 Live Audience Interaction in Workshops

A workshop is a meeting where a group of people engages in intensive collaboration and discussion on a particular subject or project. Workshops are actively used in all kinds of organizational processes to gather information and involve stakeholders in various design and decision-making tasks. Common challenges with workshops are that they are time consuming, facilitating a workshop requires resources and the workshop deliverables require post-processing as the workshop data is usually recorded in either a sketchy or in verbal format. The term workshop can mean different things; it can be a space, a creative process or a social knowledge production process. This chapter focuses on workshops that involve social knowledge production[151].

From an event production perspective workshops can be the primary format of an event, or a workshop can be part of an event program similar to the way in which panels and presentations are part of the event program[152]. There are two perspectives regarding how live audience interaction can be applied in workshops. Workshops can be enhanced and scaled-up with live audience interaction or, alternatively, a live audience interaction management system can be used to convert a traditional presentation and seminar into a workshop or embed small workshop-like activities within seminar productions.

The objective for organizing a workshop can vary significantly. Organizing a workshop requires facilitation resources, organizational competencies as well as a significant amount of social resources. Co-design, participatory decision-making and participatory design processes for example often utilize workshops. The procedure used during a workshop has a significant role in determining how efficient and productive the workshop is. Live audience interaction is a method and LAIMS is a tool that can help workshops to be more efficient and productive[153].

Computers are commonly used to facilitate collaboration and group work. Electronic brainstorming research[154], decision-making systems research[155] and computer-supported collaborative work (CSCW)[156] are examples of research fields that have been studying for years the use of computers to support human group work. Live audience interaction, as presented in this study, is related to these research disciplines, but is particularly focused on situations where there is a performer facilitating the workshop

151)
Workshop is also referred to a room for manufacturing and repairing that implies to production connotation.

152)
For example, in academic conferences it is common to divide the program in to talks, keynotes, workshops, tutorials demonstrations and poster sessions.

153)
See Kaario (2012) for case introduction of experimental co-design workshop process that we developed while developing our live audience interaction system and Summanen (2013) as an example how Presemo has been applied in co-design project.

154)
For electronic brainstorming see for example Dennis (1996, 2007).

155)
See for example (1983 and 1996)

156)
For information regarding Computer-supported collaborative work see for example CSCW (2015) conference series.

157)
See more Liikkanen (2011)

158)
See more arguments and research on how group size affects the performance from Hackmann (1970), Kerr (2004), Mille (1956) and Plowman (1994)

159)
Development of Metagroups was initiated already 2011 together with Liikkanen et al (2011), and continued further together with co-creation focused research group Simlab (simlab.aalto.fi)

160)
First Metagroups production was organized October 2012, and the two other productions in focus 2014 and 2015.

161)
More detailed dissemination of the first Metagroups production can be found from Kuikaniemi (2013).

and the size of the workshop exceeds at least 10 participants, but possibly contains more than 100, participants.

Workshop procedures usually require freeform discussion and contemplation. During professional events with more than 100 people, it is hard to engage the full audience synchronously in a collaborative discussion even if the discussion were computer facilitated. A common way to tackle this problem is to divide people into different sized groups. In live audience interaction, the audience is also often split into groups as explained in scenario B in the previous chapter (7.3.3 Group-work in Educational Context) as well as in our early experiments during the domain exploration[157]. Often groups with more than 10 people are chaotic and cannot maintain collectiveness between all group members[158]. Hence, in a conference with 100 participants, a workshop session should have at least 10 groups in order to function effectively. However, disseminating the results of more than 10 groups is difficult and time consuming task, yet increasing the size of the groups just makes individual groups harder to manage. Hence, the balance between group configuration, workshop scale and workshop activities often contains compromises and is a central challenge in the area of workshop design.

### 7.4.2 Introduction to the Metagroups Case Study

Metagroups is a workshop concept that we developed together with our research colleagues[159]. This case study focuses on analyzing three Metagroups productions performed between 2012 and 2014[160]. The initial motivation for the first Metagroups production was to create a procedure, which would combine communication in smaller face-to-face groups with computer-enabled communication between groups. Inter-groups communication has also limited capacity and for this reason also inter-group communication can be further divided as groups of groups, which we call Metagroups (MG). There can be several parallel Metagroups in a production. A Metagroup structure is created when the number of face-to-face groups is too high for maintaining balanced communication between groups. The Metagroups method is based on four core design principles[161]:

- Single face-to-face group
  size is maximum 15 persons

- Single groups are bundled together
  as Metagroups (MGs), consisting of
  no more than 10 face-to-face groups[162]

- Within a MG, assignments are worked
  on simultaneously and transparently and
  orchestrated by the group secretary and
  master of the workshop

- In one workshop, there can be several
  MGs working on different topics just as
  in traditional workshops there can be
  several groups working on different topics.

162)
See for example
Littlepage &
Silibiger (1994)

The first Metagroups workshop was organized at a large international networking event and conference. The event lasted for two days and consisted of a traditional seminar in addition to the workshop part. The seminar part also utilized live audience interaction. The workshop session was organized during the first day, lasted for 1.5 hours and had 145 participants. The overall event had more than 200 participants, hence significant amount of event participants also attended the workshop. The workshop topic was to create a strategy and future plans for an international research organization.

The workshop was divided in to three topic areas. There was a Metagroup focusing on each topic. In each of the Metagroups, there were 30–55 participants. Each of these Metagroups was further divided into smaller groups of 3–12 persons. Hence, in this production there was a three-level social hierarchy: Metagroups, face-to-face groups and individual participants. The role configuration in the production was relatively complex since each face-to-face group had a chair and secretary, and in addition there was the host and main orchestrator who coordinated the inter-group interaction. An important detail in the Metagroups design was that each face-to-face group was in its own physical space and there was no shared space for the Metagroups. During the seminar part, all participants gathered back in the one large seminar hall. In practice, the Metagroups production could be produced as a combination of several satellite locations. The role configuration and organization of the groups is illustrated and described in more detail in Section 7.4.4.

The Metagroups workshop production applied an interaction pattern in which the face-to-face groups were first asked to contemplate on a topic in a face-to-face group, then collect and share ideas through the live audience interaction system,

163)
simlab.aalto.fi

and finally review each idea individually within the Metagroup. We refer this live audience interaction pattern as *idea collection with peer-review*. The pattern is discussed in more detail in Section 7.4.3. The seminar part of the event mainly utilized a Q&A-chat and poll interaction patterns. One of the poll interaction activities was used to gather topic preferences from individuals, which defined the group arrangements. In addition, there was a *lottery interaction pattern* applied during the second day morning of the workshop.

The Metagroups production utilized an early version of the Presemo LAIMS that predates the version introduced in Chapter 6, but fundamentally has a similar structure and core features. Presemo was used for collecting feedback for the workshop (N=27). The feedback format was relatively open and there was no numerical evaluation. Respondents commented specifically on the use of the live audience interaction system and the workshop arrangements: *"Nicely organized, and this –workshop tool – is a really good thing - - worth thinking how to get more value out of it"*, *"this meeting was really well organized and choreographed"* and *"Excellent organization and program"*, and some mixed comments: *"Interesting using –workshop tool unfortunately people then worked on their laptops instead of listening"*. Generally, audience and organizer feedback was positive for this production.

The first Metagroups production was a complex and challenging production, mainly because of the complicated role arrangements. The production demonstrated how the live audience interaction approach can be used to organize complex group interactions. The outcome of the first production was so encouraging that we decided to continue the development of live audience interaction system facilitated workshop practices and organize two new workshop sessions that would focus on elaborating and further developing the primary interaction patterns utilized in the first Metagroup production. For these two sessions, we collaborated with another research organization called Simlab[163] that took responsibility for producing the event, preparing the content, inviting the participants and collecting data from the sessions. The follow-up cases utilized parts of the Metagroups approach but instead of having the three level Metagroup hierarchy these productions had only one Metagroup. The primary reason for this was that the follow-up cases were smaller and there was no need to further divide the audience into multiple Metagroups. These follow-up cases were primarily research experiments extending the original Metagroups, whereas the original Metagroups were organized as part of an established event production. My role in all Metagroups pro-

ductions was to function as a main orchestrator and facilitator of inter-group interaction.

The second Metagroups production was focused on co-designing a new school campus. This workshop production had 45 participants, three different locations (core location and two satellite locations)[164] and five face-to-face groups. The session lasted for over three hours. According to the post production questionnaire (N=16) the use of Presemo LAIMS was considered very useful (4.9/5.0) and the quality of the user experience was also high (4.6/5.0). Hence, overall this production received very positive feedback. The workshop in general was considered very positive (4.5/5.0). According to the evaluation, the workshop received a good rating in *achieved mutual understanding* (4.1/5.0) and *production of new ideas* (4.25/5.0). Hence, the workshop production approach received better scores than the production outcome. Figures 7.4a and 7.4b visualize the arrangements of this production.

FIGURE 7.4A :     FACILITATING PERFORMER AT THE CORE LOCATION
                  IN THE SECOND METAGROUPS PRODUCTION



FIGURE 7.4B :     ONE OF THE SATELLITE LOCATIONS IN
                  THE SECOND METAGROUPS PRODUCTION

The third production was a revised setup of the second Metagroups production. The third production had only 21 participants, two locations (core location and one satellite) and four face-to-face groups. The third production was focused on co-designing common activities for a co-working space. The second and third workshop utilized the basic Presemo with revised interaction patterns and export features. Table 7.4c summarizes the core characteristics of these three productions.

TABLE 7.4C :               SUMMARY OF METAGROUPS WORKSHOP PRODUCTIONS

|  | FIRST METAGROUPS | SECOND METAGROUPS | THIRD METAGROUP |
|---|---|---|---|
| Topic | Strategy formulation | Co-design of building and related activities | Co-creation of common activities for co-working space |
| Participants | 145 / 200 | 45 | 21 |
| Metagroups | 3 | 1 | 1 |
| Duration | 1.5 hours | 3 hours | 3 hours |
| Production context | Part of larger seminar / event production | Unique workshop production | Unique workshop production |
| Interaction activities | Idea collection with peer-review Seminar, polls, Q&A, lottery and feedback, orchestrator chat | Polls, idea collection with peer-review (different formats), feedback, orchestrator chat | Polls, idea collection with peer-review (different formats), feedback |
| Physical organization | 12 rooms in one building | Three different physical sites and rooms. | Two different sites. |

The second and third productions had additional organizational resources, because developing and studying a new computer-supported workshop methodology requires specialized researcher observants. The production staff cannot focus on evaluation. For this reason, the second and third productions were also studied and disseminated more extensively[165]. After these three sessions, we have been organizing several similar workshop productions or workshop episodes in the commercial event production, and through these experiences it has become evident that the lessons learned from these research cases can also be generalized to commercial productions.

### 7.4.3 Core Audience Interactions in the Case: Idea Collection with Peer-review

The primary interaction pattern in all Metagroups productions was the idea (response) collection with *peer-review*. This interaction pattern action can be divided in to five phases. Figure 7.4d visualizes the pattern in more detail.

FIGURE 7.4E :          IDEA COLLECTION WITH PEER-REVIEW INTERACTION PATTERN



| 1. Introduce and define the assignment  HOST AND GROUP CHAIR | 2. Contemplate and discuss about the assignment  ALL GROUP MEMBERS AND CHAIR | 3. Collect ideas and responses  SECRETARIES OR GROUP MEMBERS | 4. Peer-review ideas and responses  GROUP MEMBERS / AUDIENCE | 5. Acknowledge results  CHAIR AND HOST |
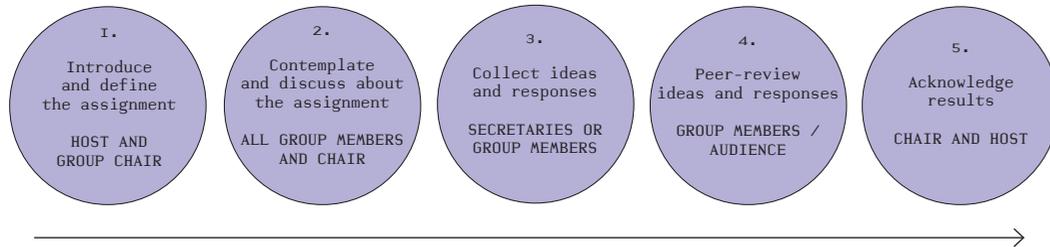
In the first meta-groups production, there were four interaction activities that followed this same interaction pattern. Overall, there were 270 ideas produced during the session, and the 145 participants contributed over 400 peer-reviewing interactions, which resulted in 2.8 contributions per participant. In the second Metagroups production, there were 730 messages (most of them were ideas) and 542 peer-reviewing interactions, which meant that on average each participant contributed 28 times during the session (45 participants). Hence, the amount of contributions per participant increased almost tenfold from the first to second production. In the third production, participants sent 204 messages and produced 928 peer-reviewing interactions, hence each participant produced on average 54 contributions (21 participants).

The main reason for why the number of contributions increased from the first production to the second was that in the revised workshop structure and approach utilized in the second production, there was a different facilitation procedure. For example, in the second production, facilitators were more focused on persuading all participants to interact. The second production lasted longer (3 hours) than the first production (1.5 hours) and there were more interaction activities in the second production (8 and 4). The reason why the number of contributions per participant significantly increased from the

166)
Instead of "choose the best" or "review on Likert scale" it is possible to also utilize some other review scale than Likert, or assign resource points for audience members that they can distribute freely to the ideas (one idea can receive many resource points). Peer-review can have also negative score (just as Bit Bang production presented in the section 3.3), or peer-review can be based on comparing or ordering ideas.

second Metagroups production to the third was the change in the design of the peer-reviewing interaction pattern. The first two productions used a "*choose the best ideas*" -pattern for reviewing, whereas the third production used a "*rank all ideas in a Likert-scale*" -pattern. In the second production participants chose a few ideas that they preferred, while in the third production participants ranked all the ideas and while doing this they produced significantly more contributions.

Peer-review is a useful audience interaction pattern for workshops as it enables fast review of user generated ideas. Evaluating ideas by discussing or by selecting a few core ideas for voting would take significantly more time. This pattern demonstrates well the potential of live audience interaction in knowledge production. The same pattern has also been used in an educational context and for example in scenario B in Section 7.3.3 is sometimes realized with this interaction pattern. The difference in the educational context is that the group arrangements are more informal and ad-hoc whereas in the case of Metagroups the group identities and arrangements are established.

During the development of live audience interaction, we have identified several different peer-evaluation patterns[166]. Studying different peer-reviewing patterns is important, as different patterns can work optimally depending on the group size, topic, context and expectations. Idea collection interaction patterns that utilize peer-review are an important methodological approach when applying live audience interaction to workshop productions.

Peer-review patterns are also important interaction patterns for the LAIX-score framework as they demonstrate how the LAIX-score can be applied in workshops. This interaction pattern also further confirms why the LAIX-score framework should support dynamic visibility management of the interaction pattern. Dynamic visibility management was discussed already in the Section 7.3.4.

### 7.4.4 Applying LAIX-score to the Case Production

The core challenge in the Metagroups productions is organization of the groups. The first Metagroups had a three level group hierarchy, and this structure can be considered as the core idea behind the Metagroups format. The Metagroups group hierarchy is visualized in Figure 7.4d.

FIGURE 7.4D :

ROLE CONFIGURATION AND GROUP STRUCTURE IN THE FIRST
METAGROUPS PRODUCTION (SEMINAR PART ABOVE AND WORKSHOP
PART BELOW). F2F REFERS TO FACE-TO-FACE FGROUP, AND MG
REFERS TO METAGROUP.



Seminar part



Workshop part
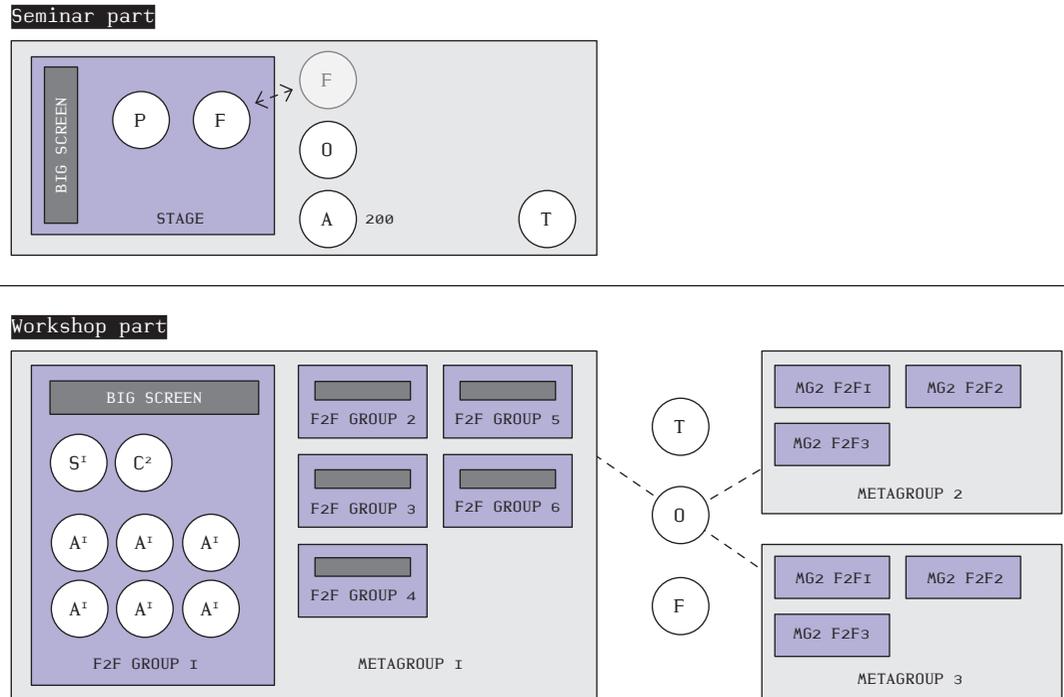
Overall, there were seven different roles in the first Metagroups production (number of individuals in their respective role in brackets).

A. Participants (group members and members of the audience) (145/200)

B. Group chair (group presenter) (12)

C. Group secretary and support (support orchestrator) (12)

D. Main orchestrator (orchestrating moderator) (1)

E. Main facilitator and host (1)

F. Presenters (4)

G. Technical support (2)

The first Metagroups production utilized several different kinds of interaction patterns. In addition to the idea collection with

peer review pattern (explained in previous section), the production also utilized basic polls, Q&A, feedback collection and trivia patterns. In addition to the audience interaction activities, the group secretaries (S) also used orchestration chat (*orch. chat* in the picture) to communicate with each other. We called this as coordination channel. This is a unique type of interaction pattern that was critical in the Metagroups production as there were many support orchestrators (S) and without the coordination channel it would have not been possible to coordinate the work between groups. We had similar use for chat also in the Trafi Seminar production. These support orchestrators are almost in an audience role as they contribute to the discussion while also coordinating the work. Figure 7.4f visualizes the LAIX-score design framework for the first Metagroups production also including the seminar part of the production.

FIGURE 7.4F :     LAIX-SCORE DESIGN FRAMEWORK FOR METAGROUPS PRODUCTIONS
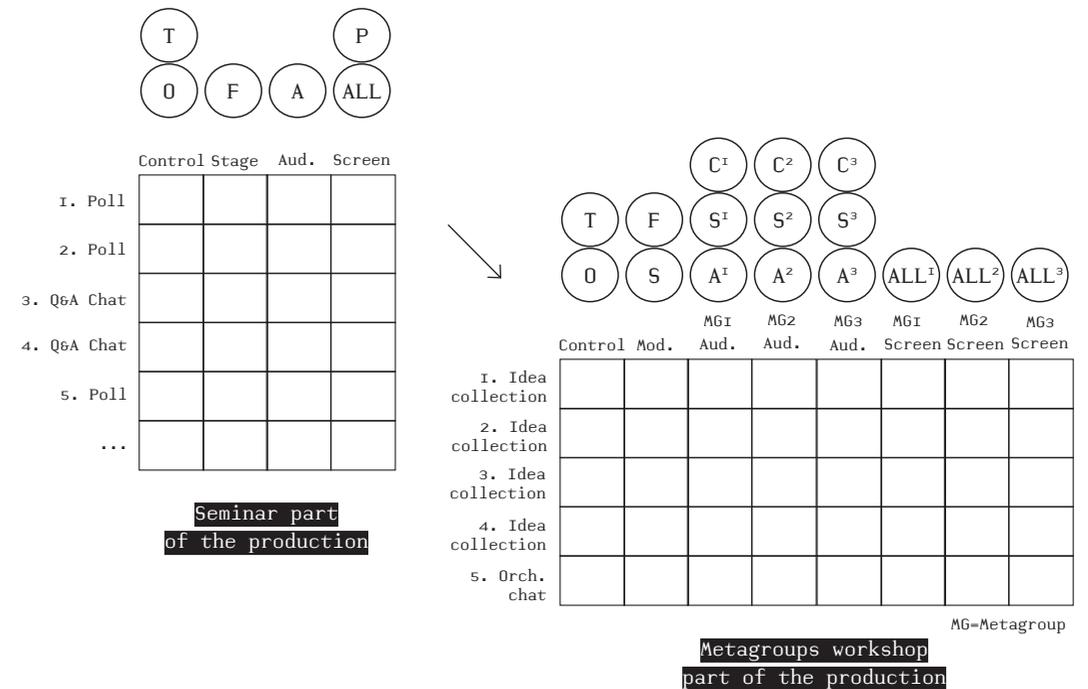


The seminar part of the production utilized the basic 4-channel Presemo system. The seminar part of the production had similar challenges as the Screen.io case study (Trafi seminar production), which means that neither the presenters nor the technical support people had a unique monitor interface. The seminar production did not have support moderators for two

reasons: the number of audience comments in the Q&A patterns was relatively low (70 overall during the first day) and we did not have competence to propose and assign this role in the production (the first Metagroups production predated the Screen.io case study production).

The workshop part of the production was realized with a modified version of Presemo that combined three Presemo sessions into one system and one audience interface. Basically, each metagroup interface had its own tab in the audience interface channel. Embedding all interface allowed participants to freely choose between the groups they were expected to participate in. The orchestrator chat was realized with yet another Presemo session with only one persistent chat activity. This modification allowed us to create several audience and screen interface channels and go beyond the limitations of the basic Presemo versions. The compromise with this approach was that assigning interface channels to individuals was not streamlined and the transition between the seminar part and the workshop part was less than optimal.

Potentially, the Metagroups production could have applied a 19 interface channels LAIX-score state control matrix configuration in a case where each role would have had a unique interface (orchestrator, technical support, host, support moderators, group support moderators (3), group chair (3), audience, group audience (3), screen, group screen (3) and monitor). In the Metagroups production, individuals needed to transition from one channel to another (audience channel to group audience channel, audience channel to group support moderator channel, audience channel to session chair channel) because they changed roles during the production. The Metagroups productions demonstrate well how the LAIX-score framework can be applied to workshop productions and how the LAIX-score framework functions when there are more than four interface channels.

## 7.4.5 Additional Requirements Identified During the Case Production

The observations and findings from the Metagroups production support and extend the additional requirements introduced in the previous chapters. The *cue list function* (requirements 4 and 6) would have made the organization of interaction activities significantly easier in the Metagroups production. The organizers in this production required also *session documentation* (require-

ment 5). The Metagroups production reveals that even more *detailed documentation* is needed in order to enable analysis of the different contributions after the production. *Anonymity* (requirement 8) is also an issue in the Metagroups format, as the peer-review process should take place anonymously. *Group formation* may require *access management* and *identity management* features as well as *user profiling* functions.

SESSION RECORD FOR POST ANALYSIS
(ADDITIONAL REQUIREMENT 10)

Analyzing workshop results requires detailed access to session data. Idea collection with peer-review, especially in cases of Likert-scale peer-review often requires direct access to data that has a unique identifier for each participant. Likert-scale evaluations can be normalized because different participants may utilize the scale in different ways. It is not always the highest and lowest peer-review scores that are the most relevant. The idea that receives the largest rating variance may be interesting because this is the idea that the audience disagrees upon most. Hence, text form session documentation is not adequate (additional requirement 5) for post-processing live audience interaction that focuses on knowledge generation, but the documentation should be provided also in a data format with appropriate identifiers.

SUPPORT FOR GROUP FORMATION (ADDITIONAL REQUIREMENT 11)

One core aspect of the Metagroup workshops productions was how a live audience interaction system could facilitate idea collection from multiple groups as well as communication and reviewing ideas between groups. Group support is an important feature for workshop formats and workshop like productions. One important extension to the group support is how live audience interaction systems can support group formation. In the first Metagroups production, we used a simple poll interaction activity as a form of profiling that defined to which group participants should be assigned. In general, group formation can be based on group preferences or based on generated user profiles. Figure 7.4g demonstrates how group formation is structured on an abstract level. The data collected from previous interaction and user profiles can be sorted either manually or with the computer. In the Metagroups production, individuals navigated independently to the right group channel, but the system could also support automatic assignment of the right interface channel.
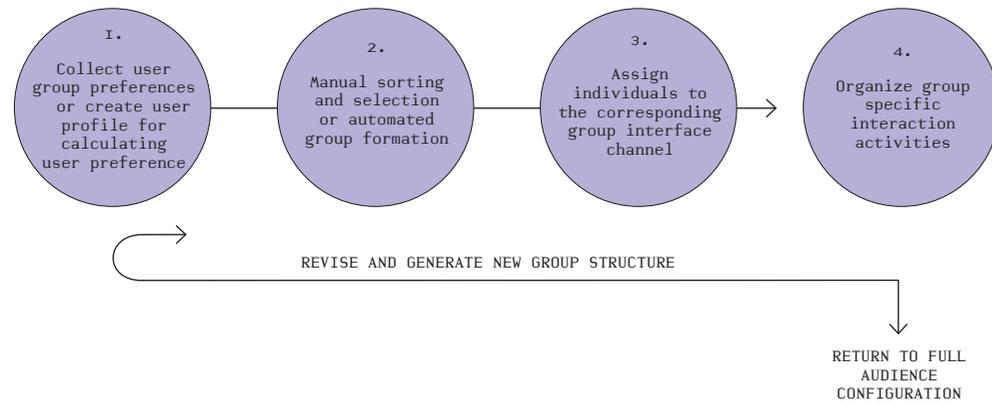
As discussed in our earlier studies[167], in a live audience interaction production there can be several different group structures. Similarly, as the LAIX-score live audience interaction framework enables multiple different interaction activities within one production, live audience interaction control framework should also support also multiple different group configurations. In a normal workshop event, the production change between one group configuration to another configuration may take significant time, but with an optimal live audience interaction setup, a new group configuration can be achieved in minutes, which can significantly increase the efficiency of workshop production as well as open up possibilities for new workshop procedures.

USER PROFILING (ADDITIONAL REQUIREMENT I2)

Group formation is an important use case for user profiling. There are also other uses for the user profiling. For example, post analysis can also utilize user profiles. During the domain exploration phase of this study, we organized productions that utilized cross-references of the poll results with the user profiles[168]. In the Metagroups production, we used the user profile of individuals to generate results and data evaluation. For example, we noticed that in the Metagroups 2 production, teachers, politicians and public servants produced significantly more contributions than guests such as company representatives and parents of pupils. In the Metagroups 3 production, company guests produced significantly less contributions than the hosts. The number of participants was too low to make statistically significant conclusions, but these results indicate that generally guests are less active contributors than those participants that are part of host organization or closely related to it. Such a finding can significantly influence the group formation strategies.

I67)
Liikkanen (2011)
Presemo Brainstormer utilized and related workshop production utilized for example individual work, pair work, group work and large group work in a single production

I68)
See for example Sometime 2012 presented in Section 3.3

User profiling is an important capability for a LAIMS system. User profiling can be realized if the user has the same identifier for all of the contributions. Overall, profiling is an important aspect of live audience interaction, as profiling can enable new kinds of interaction patterns (for example cross-referencing), better analytics and support group formation. Then again, user profiling compromises anonymity and raises data protection related questions. In the LAIX-score design framework, user profiling should be considered as broadly including support for anonymity, group formation, post-production analytics and interaction patterns that utilize user profiles.

### 7.4.6 Case Summary

The Metagroups productions demonstrate how live audience interaction can be applied for creating large computer-supported workshops. Workshops are important social functions for planning, knowledge gathering, co-creation, collaborative decision-making and social activation. The case study demonstrates how live audience interaction can make organizing workshops easier and more efficient with new kinds of group configurations, computerized idea collections and inter-group interactions.

Metagroups productions validate the core requirements for the LAIX-score design framework workshops as the production utilizes several different interaction activities and demands different types of role configurations. The first production provides a strong validation for the need to support multiple functions, when a seminar production is converted into a workshop production and when the live audience interaction serves for basic seminar use, group formation, workshop support, audience engagement and event orchestration activities. All the different function does not take place parallel, but they do overlap in places, and overall there is clearly need for parallel function in the Metagroups productions.

Group formation is a central feature that helps live audience interaction to support workshops. Small face-to-face groups enable freeform communication and deliberation, which is the core activity in most workshops. A live audience interaction system enables communication between groups and large-scale peer-evaluation of the output of face-to-face communication. Different group configurations can be realized in the LAIX-score framework by adding new interface channels and providing functions that automate the assignment of individuals from one channel to another. The Metagroups case study also demonstrate how groups can have several other roles such as

those of group chair and group secretary.

The Metagroups case study introduces the idea collection with peer-review interaction pattern. This pattern can efficiently facilitate interaction between groups and overall demonstrates how more complex interaction patterns combine several different types of contributions (open text idea collection and choice-based review interactions). There are several peer-review interaction patterns active simultenously requiring dynamic visibility management, which can effectively be realized with the state control matrix.

The Metagroups case study also introduces new additional requirements for the LAIX-score framework. The design framework should provide also quantitative session documentation that enables post-production data analysis. This kind of data deliverable should include data about each contribution and if possible according to the session data protection policies, each contribution should be identified so that it is possible to also perform profiling. Profiling is also important for group formation, analytics and special interaction activities such as gamification, which is described in more detail in the next section.

## 7.5 Lost Lab Pervasive Adventure

### 7.5.1 Introduction to Pervasive Gaming

Pervasive games are an emerging digital gaming domain that has only recently[169] had commercial success, but there is a significant amount of research on pervasive gaming[170]. From a computing point of view pervasive gaming is a sub-category of pervasive computing[171], but as an experience it is a unique gaming domain. Pervasive games can be a independent production or then pervasive gaming elements can be applied in enhancing events, experientializing physical shopping experiences and public spaces, new kinds of advertisement campaigns, and creating storytelling cultural sites, just to name a few examples. Pervasive computing and gaming techniques can enable new forms of storytelling, play and performativity in our everyday experiences[172].

Live audience interaction and pervasive games have at least three things in common: (1) they are performative productions, (2) they utilize computer-support and often mobile devices and big screen interfaces, and (3) they are usually collocated experiences. For example, a live audience interaction production that utilizes playful interaction patterns, storytelling and

169)
Pokemon Go (pokemongo.com) can be considered as a pervasive game and it has gained significant commercial success.

170)
See for example Waern and Montola (2009)

171)
Pervasive computing is basically synonymous to ubituitous computing that was originally coined by Mark Weiser (1996)

172)
See for example Kuikkaniemi (2011)

173)
We have created for example live audience interaction for musical performances and explored live audience interaction as an artistic performance in the Carpa conference (carpa.teak.fi)

174)
Presenters can simultaneously act verbally on-stage and interact with the audience through chat.

175)
Millennium Technology Prize (taf.fi)

176)
Tree-act structure is a common structure in storytelling and screenwriting (beginning, middle and end or setup, confrontation and resolution)

gamification can be also a pervasive game. Then again, live audience interaction workshop focusing on knowledge production without any playful or gamified element (like the Metagroups productions described in the previous chapter) is not a pervasive game. Therefore, pervasive games and live audience interaction have some conceptual intersections.

Pervasive game productions are often large and involve a significant amount of orchestration. Pervasive games have actors, development of proprietary digital systems that support the game, development of the storyline and story design, setting up the physical locations, as well as planning the orchestration procedures for the live situation. Live audience interaction techniques and systems can be applied in pervasive game productions, but they are only part of the resources required for the production.

Pervasive games are also a form of artistic production and an example of how live audience interaction can be applied in the artistic domain. During the seven years of studying and exploring live audience interaction productions, we have conducted several experiments in the artistic domain[173]. Our experiences in the artistic domain have revealed that live audience interaction techniques can be applied as a storytelling medium and it has unique creative and expressive qualities that are not that visible in traditional event productions[174]. Generally, artistic and entertainment productions are often the most demanding productions for the live light design and live audio design. For this reason, it is expected that the most demanding applications for live audience interaction and the LAIX-score design framework can be also found from the artistic productions.

### 7.5.2 Introduction to Lost Lab Case Study

The Lost Lab (of Professor Millennium) was a pervasive gaming production that was built on top of the Presemo LAIMS system. It was organized in the downtown of Helsinki as an educational and entertainment experience for K-12 students. The core site was installed in a temporary pavilion facility for 500 visitors that was built around a technology prize ceremony[175]. The other sites were central office building and music house venue in the Helsinki centrum. The objective of the production was to activate students to become more curious about the possibilities of novel computer technologies and engage in studying technology.

The Lost Lab production was divided into three acts[176]. The first act was a stage performance-centric part that took place in the central venue. The second act was the core adventure

and exploration part and the students were outside the central venue exploring the surrounding spaces and navigating with the help of an augmented reality navigation system through 14 checkpoints (visualized in Figure 7.5a). The third act was the conclusion that took place again in the pavilion. During this final celebration act students responded to the feedback questionnaire and browsed their experiences on a large interactive touch screen that we called as memory wall.

FIGURE 7.5A :   STORYTELLING STRUCTURE AND ELEMENTS OF THE LOST LAB PRODUCTION



FIRST ACT
Stage performance

SECOND ACT
Site exploration

THIRD ACT
Final celebration

At the pavilion Professor Millennium appears to students on video

Students navigate through checkpoints with the help of augmented reality map and markers

Students return back pavilion for last activities and for celebration and memorabilia

A. Linus chat initiated while host introduces the game rules

B. Chat actors interacting with students and guiding through checkpoints

C. Feedback poll asked before inviting students on stage for memory wall

176

The core storyline of the Lost Lab (of Professor Millennium) was following: Professor Millennium's laboratory had exploded and all her ingenious inventions were scattered all over the place. The Professor is asking for the students' help for gathering back all her inventions. The professor's assistants and the professor's pet fish Linus will help students to find these "lost" technologies, hence the name *Lost Lab*. The core narrative framework was

built on top of students interacting with the Linus fish via chat interface, exploring the sites physically and through the mobile device, and interacting with the checkpoint hosts. There were four chat actors who acted as the Linus during the experience.

The Presemo LAIMS was used for five (5) functions during the production. (1) It was used as an introduction and engagement tool during the first act in the pavilion and as onboarding mechanism (see Figure 7.5a). (2) Presemo was the user interface framework for the checkpoints. (3) Presemo was also used as a continuous communication and help channel during the checkpoints. (4) Presemo was also used as a coordination and monitoring device for the orchestrators. (5) Finally, Presemo was also used as an engagement and feedback tool during the final celebratory performance in the pavilion.

The navigation between checkpoints was realized with an augmented reality route guidance feature of the mobile application and an augmented reality map[177]. Each checkpoint consisted of a task for students. The tasks were initiated with Presemo, but realized in the physical world. Some examples of the checkpoint and navigation techniques are shown in Figure 7.5b. Students were organized into 2-4 person groups. Each group had a small tablet device for interaction. The checkpoint procedure will be elaborated in more detail in Section 7.5.3.

FIGURE 7.5B :   CHECKPOINT EXAMPLES OF THE LOST LAB PRODUCTION (TRANSPARENT DISPLAY AND MUSICAL INTERACTION) ARE VISUALIZED ON THE LEFT AND NAVIGATION TECHNIQUES (AUGMENTED REALITY NAVIGATION MARKERS AND AUGMENTED REALITY MAP) ARE VISUALIZED ON THE RIGHT



177
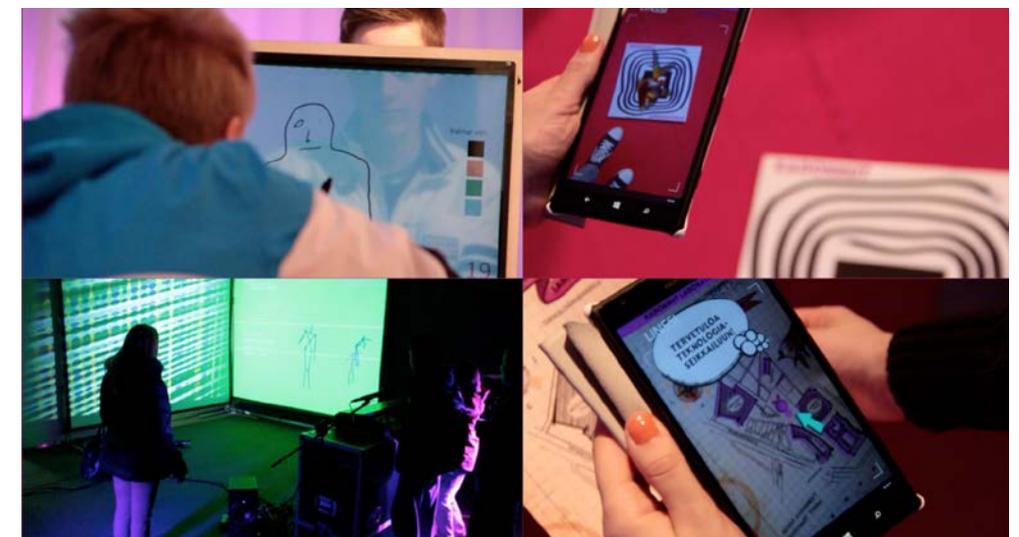
Overall there were 13 Lost Lab sessions and each session had 20-45 student participants. The pre-production of the Lost Lab production lasted for 10 months. The pre-production team consisted of 10 team members, and overall almost 40 persons took part in creating the production. Hence, this was a relatively large event production. I was co-designer, producer and research coordinator for the Lost Lab production. I was also the master of ceremony (host) and the main orchestrator during the live performance.

We collected data from the production using questionnaires and observations. There were researchers shadowing the groups, but the researchers could observe only how students interacted with the device and with the navigation system. We asked the students to evaluate the experience by using the game experience questionnaire (GEQ)[178]. The results indicate that the experience produced a low flow state, but generally kids reported that the adventure was a pleasant experience[179]. Students were actively interested about the identity of the character of Linus and how the role of Linus had been portrayed. Hence, the technical details behind the storytelling and the production were not obvious for students. Teachers and other stakeholders provided generally good or very good feedback related to the production. One teacher commented that this was the best educational experience that had occurred in a decade for the classes she had taught.

The technical architecture of the Lost Lab production consisted of several modules. The Presemo LAIMS was used as a game platform, as well as a control and communication server for interaction activities. The Presemo web-based audience interface was embedded into mobile applications that provided the navigation system. We had to use native client in order to produce an augmented reality map and augmented reality wayfinding markers. These components are shown on the right side of Figure 7.5b. Technically, the augmented reality navigation system was an important element of the production as it enabled a personalized route experience, as well as a shared start time for all of the groups, and the minimization of waiting times. After the Lost Lab production, this dynamic route guidance technique has been developed further as an independent technology called Bitsign[180].

The Presemo system was modified in four ways. First of all, the audience (student) interface was embedded into the native mobile phone client software, which enabled the integration of functions such as picture taking and augmented reality views that cannot be easily realized with a web client. The second modification was that the interface design was changed sig-

178)
GEQ is developed by Poels et al. (2007)

179)
More detailed dissemination of the Lost Lab production can be found from Kuikkaniemi (2014a)

180)
See more Bitsign.info

181)
The local server was based on Spaceify platform (Savolainen 2013 and Vepsäläinen 2015)

182)
Different servers had significantly different functions. Some had point cloud augmented reality, another had transparent displays and some utilized sound generated visuals.

183)
See more Coutrix (2012), Kuikkaniemi (2013b) and Kuikkaniemi (2014b)

nificantly to match the productions visual design and mobile applications visual theme. The third modification was the creation of new interaction patterns that utilized on-site activities within the Presemo, and finally an identity system was developed and added to Presemo to support gamification and track user group achievements. In addition to the LAIMS system and a specific native mobile phone client that supported augmented reality navigation and augmented reality visuals, the Lost Lab technical system also had a local server functionality[181], specific interaction functions for the checkpoints[182], and an interactive multitouch wall interface for displaying memorabilia[183] (memory wall). Figure 7.5c demonstrates the overall technical architecture of the Lost Lab production.

FIGURE 7.5C :          THE TECHNICAL ARCHITECTURE OF THE LOST LAB PRODUCTION
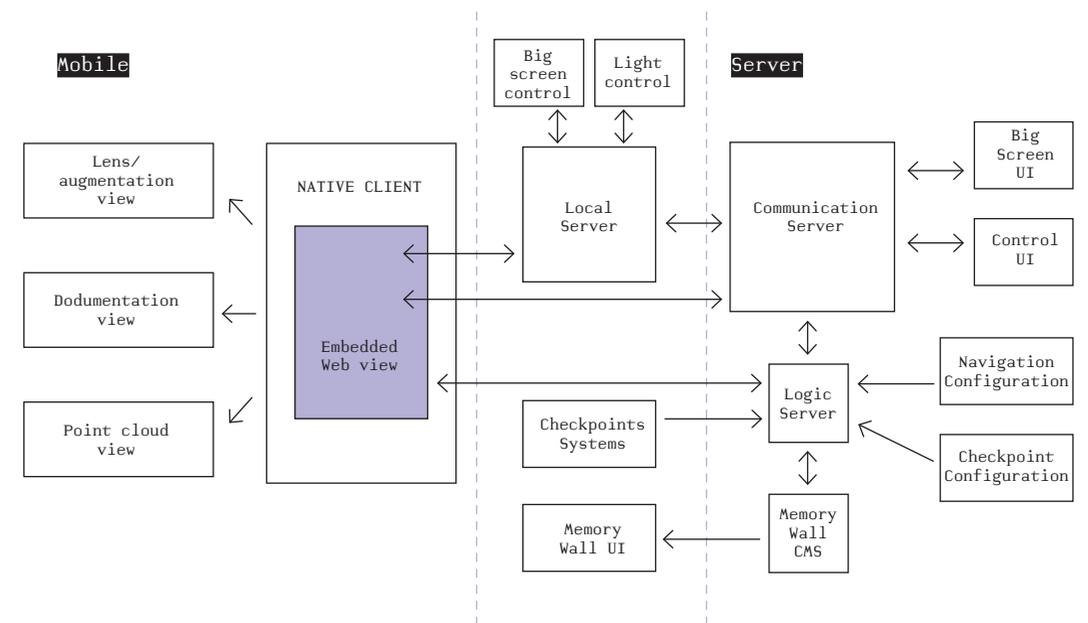


The Lost Lab production can be considered as a successful pervasive adventure production, where the Presemo LAIMS was applied in a different way than in previous case studies. Presemo was one, but still a central, component in a relatively complex technical production framework. For example, if the Lost lab production would have been developed with a purposefully built proprietary server system, the several live audience interaction functions (polls and generic chat functions) would have prob-

ably been omitted, as they were not initially central features for the production, but only included in to the production design during the final stages of the pre-production. Similarly, the control of the on-site interactions utilized the LAIX-score framework (described in more detail in Section 7.5.4). This was not an obvious choice and not an intended use for the LAIX-score, but ultimately functioned well and allowed chat actors to also apply other features of Presemo such as moderation and visibility management. If these features would have not been available directly through the platform, there would have not been time to develop these features.

## 7.5.3 Core Live Audience Interactions in the Case:

The core interaction activity in this production was the chat interaction between chat actors (support orchestrators who acted as Linus) and the student groups.

The fish Linus was chosen as the core live interaction character because as a fictional and non-human character it could be presented in different mediums and distributed for multiple parallel actors. Linus appears on the video presentation, chat, map, guidance markers, and on the memory wall. Figure 7.5 visualizes this core interaction between live chat actors and students in more detail.

The production host (A) initiated the chat interaction between the actors and student groups. We refer to this approach as onboarding and it was already described in Section 7.3 (Scenario C)[184]. The persistent chat (B) functioned as a support channel for students who asked for help from Linus but some students also live acted with Linus for entertainment reasons. 6 out of 14 checkpoints were hosted by the chat actors (C). The other 8 checkpoints were realized with the onsite checkpoint hosts. The chat actor would ask site-specific questions from the student groups and once they were ready then the group was granted completion of the checkpoint. The groups activated the checkpoint by reading a physical marker (D). There could be multiple groups at a single checkpoint at a time. Chat actors realized completion from the control interface and onsite checkpoint host with physical markers.

During the 16 productions student groups and chat actors sent on average 500 messages per production (ranging from 300—800). The message frequency between Linus and group varied significantly. Most active groups sent more than 50 messages. Some students were very curious about who Linus

Host

ONBOARDING (A)

Host (and main orchestrator) introduces game rules onboards student groups to interaction and supervises game progress.

Live chat actors

Chat actors utilized control interface for managing checkpoint completion and for chat

(B) PERSISTENT SUPPORT CHAT WITH LINUS

Students could interact with Linus at any point and get help for guidance and game rules

(C) CHECKPOINT SPECIFIC CHAT WITH LINUS

During 6 checkpoints (out of 14) Linus asked questions from students and granted completion to students

(D) CHECKPOINT ACTIVITY ACTIVATED WITH MARKER

All checkpoints are active for student interface channels, but become visible only when students read checkpoint marker.

Student groups

Students had one persistent chat interaction activity and checkpoint specific chat activities with the Linus

was and how the character of Linus was realized. For students, it *was* not evident that there were multiple people acting as one Linus character and therefore, the story immersion can be considered as successful. According to the feedback, for some student groups the interaction with the Linus character was the core part of the experience.

This kind of performing through digital channels is a well-known approach in pervasive gaming productions. The Lost Lab production demonstrates that this kind of live acting can also be realized with Presemo and within the LAIX-score framework. After the Lost Lab production, we have also applied a similar interaction pattern in the seminar context, where orchestrators or performers who are not on stage take an active role in

responding to the audience's questions. Hence, this pattern is a very important example of how chat interactions can be orchestrated, planned and scaled to larger audiences. On stage, multiple performers cannot verbally respond in parallel to audience questions, but off-stage multiple chat performers can respond in parallel to the audience's comments.

Overall, the Lost Lab production is an example of combining different kinds of computer-supported interaction activities within the same interaction framework and within the same production. In addition to the traditional Q&A and poll interaction pattern, the Lost Lab production utilized virtual chat acting, and checkpoint activities that combined LAIX-score state control and physical interaction activity initiation (this technique will be described more in the next section). At each checkpoint, students were also asked to take a picture as a souvenir, which were collected on the memory wall and in this sense the production also applied a simple picture taking interaction pattern. Many of these audience interaction functions took place in parallel. Hence, the Lost Lab production is a good example of a live audience interaction production that utilized different interaction activities (requirement 1) and hosted multiple parallel functions (requirement 3). The role configuration of this production was relatively simple in comparison to the Screen. io event production (section 7.2) or the Metagroups (section 7.4) role configurations, but in the Lost Lab production as well, there were more roles than those of orchestrator, a presenter and the audience.

## 7.5.4 Applying the LAIX-Score to the Production

The Lost Lab production extends the traditional LAIX-score state control matrix. The state control matrix in the Lost Lab production is not focused only on defining the on-off visibility state and the order of interaction activities, but there is also a new type of visibility configuration that requires user activation. Figure 7.5e visualizes the LAIX-score matrix for the Lost Lab production.

All the checkpoints were set to conditionally visible in the Presemo system (1). Users had to activate the checkpoint in order to make them visible. Hence, in this sense there was a layered visibility management system (i. state control matrix and ii. user activation). The checkpoint was deactivated from the audience interface channel when the checkpoint host granted checkpoint completion for the student group. This is an example of how the LAIX-score design framework can be used for inter-

action management also for off-stage interactions. During the development of the production, the LAIX-score was beneficial as we could flexibly take out some checkpoints and develop new checkpoints with the dynamic interaction activity management features of the Presemo[185]. Hence, the checkpoint configuration (interaction activities) was not static between productions.

The support chat (2) was active on all channels most of the time. The big screen was mainly showing the support chat. This time the support chat was shared between all groups, but there could have also been a one-on-one messaging feature. We decided to use the many-to-many chat because we expected that it will enhanced co-experience and facilitate between groups interaction. In addition, the introductory poll and feedback polls were shown on the big screen. Potentially, individual check-

points could also have been shown on the big screen and this way provide more spectator experience (teachers and some staff were spectating the experience), but we did not have resources to develop big screen support for the checkpoint activities (4).

The support chat (3) was a persistent channel between orchestrators (O) and support orchestrators (S). This was realized by integrating another Presemo room into the production. The support orchestrators would have benefitted if they would have had some visibility to the system at least for their own checkpoint part, hence a multi-channel LAIMS would have been useful for this production instead of the standard 4-channel Presemo. The chat actors (L) utilized the same control interface as the orchestrator (O). In an optimal scenario, the chat actors would have had an interface with limited control features that included interaction pattern specific controls and content management, but not the state control matrix or presentation management features. It was not an optimal scenario that I functioned both as the host (O) and the orchestrator (O). I used the stage interface in only a limited way, because as an orchestrator I had to use the control interface. If there would have been a separate host then she would have been more actively using the stage interface.

Even though this production had a group arrangement, Presemo did not provide any group functionalities or support. Group functionalities were not needed because we did not have the resources to provide a personal device for all of the students and ultimately the groups (2-4 students per group) had only one device, which they shared. In an optimal scenario, all students would have had their own device and the system would have supported a group interactions. The application of the LAIX-score to the Lost Lab production demonstrates how the framework can be applied in different kinds of productions and also appropriated to unexpected uses.

### 7.5.5 Additional Requirements Identified During the Case Production

The Lost Lab production extended the concept of identity in live audience interaction significantly. The production did not utilize anonymous messaging even though participants were students who previously had reported favoring anonymous messaging[186]. The production showed mechanisms for how participants can *establish identity* and extend the experience with *memorabilia*. The production also demonstrated how *gamification* can be realized with a live audience interaction system.

186)
See more about anonymous messaging from case study 7.3

ESTABLISH IDENTITY AND CREATE MEMORABILIA (ADDITIONAL REQUIREMENT I3)

In the Lost Lab production student groups established their identity in four ways:

- Group name
- Group photo
- Group promoting itself in the support chat channel
- Group taking memorabilia to the public memory wall

As the first checkpoint activity, students were asked to create the group's name and take a photo about their group. Both names as well as photos were often very inventive. Some groups appropriated the chat channel and the big screen for promoting their group's identity. They often sent messages that claimed how their groups were going to win the competition or made other announcements about the achievements or identity of their group. Groups were asked to take pictures after each checkpoint activity. The pictures were collected and shared on the multi-touch memory wall, which is visualized in Figure 7.5f.

FIGURE 7.5F :        VISUALIZING MEMORABILIA ON THE MEMORY WALL



Memory wall and big screen collocated on stage

Checkpoint specific browsing of memorabilia

Linus swimming in the memory wall

Group specific browsing of memorabilia
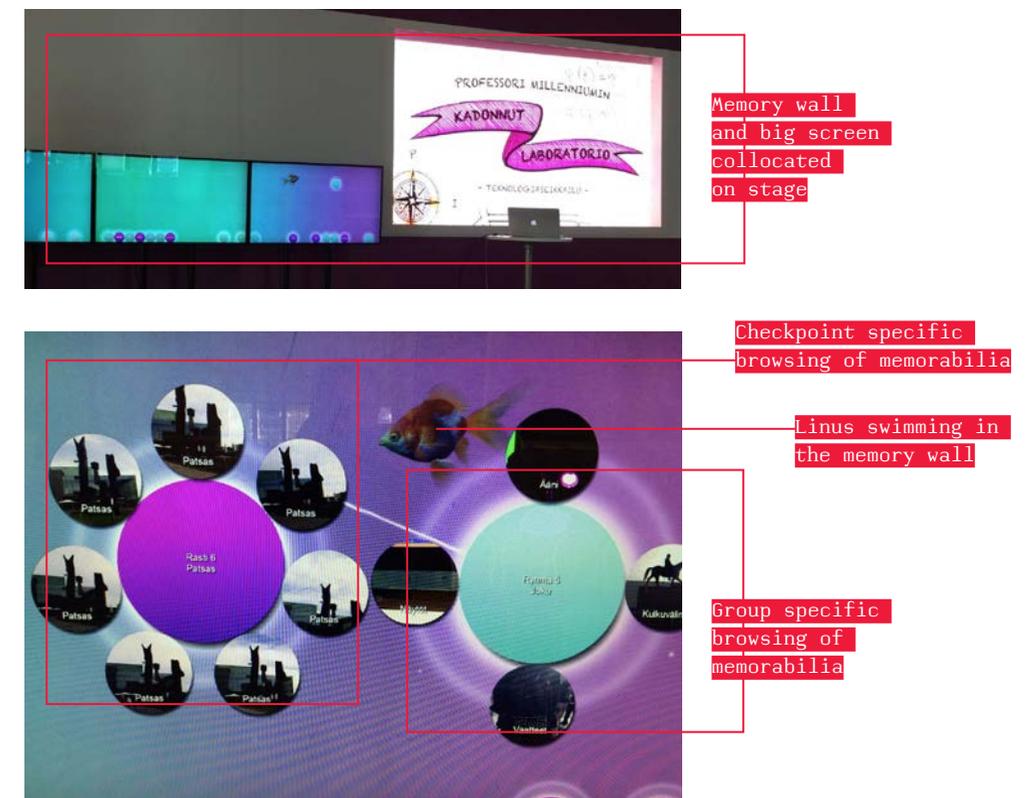
For the Lost Lab production, the identity promotion and memorabilia features were very important. Without identity and memorabilia, the experience would not have had similar playfulness. Also in many networking event productions, clients have requested features that help establish identity. The LAIX-score should acknowledge that persistent identities with different identity attributes are an integral and central part of some live audience interaction productions. Identity management should enable balance between anonymity and established identities.

GAMIFICATION (ADDITIONAL REQUIREMENT 14)

Generally, the Lost Lab production received positive feedback from students and especially from teachers. The most frequent critique among students was that the adventure should have been more of a game than a general adventure with achievements. Students thought that an experience like this should obviously be a competitive game.

We originally designed the Lost Lab as "a non-competitive adventure", and often contemplated whether it should be a game or more of a collaborative play experience. Since the Presemo LAIMS has been extended with features for gamification we could convert the Lost Lab production into a game relatively easily. Hence, the first productions were organized without gamification whereas the last productions were competitive games. Gamification turned out to be an appropriate modification to the original experience design. The Presemo gamification feature is relatively simple and extends the identity management concept. Each contribution and achievement can be scored and in addition, the control interface has functions that provide orchestrators with the possibility to rank and reward contributions manually. This is a flexible gamification approach that has also been applied in many other live audience interaction productions[187]. In this production, the gamification interface and progress board functions were integrated as one feature. The progress board function was critical for the host who initiated the call back[188] and supervised the production generally. The progress board showed how students groups are advancing from one checkpoint to another.

187)
During the last four years, we have been organizing for example seminar gamification and networking game gamification

188)
Call back was a function that aborted checkpoint activities and changed the route guidance so that all groups could return home
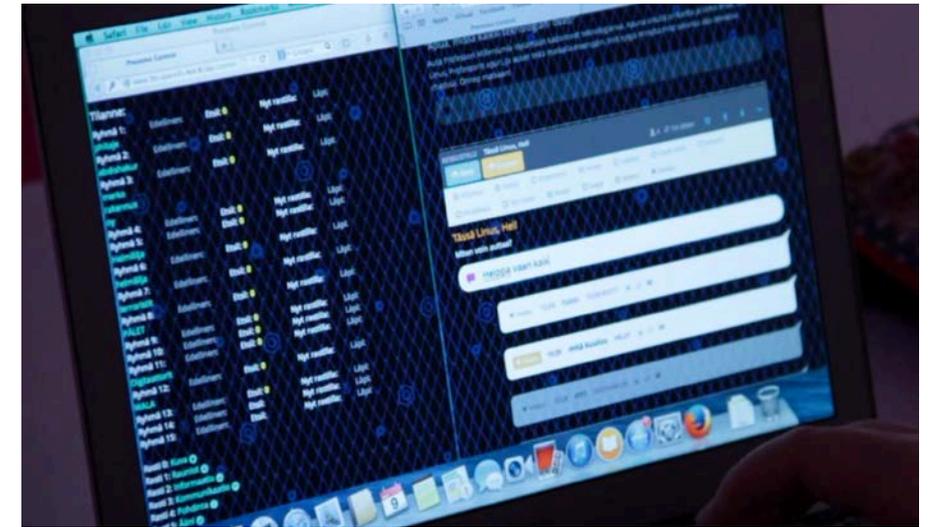
### 7.5.6 Case Summary

The Lost Lab production is an example of how the Presemo LAIMS and the LAIX-score framework can be applied in a larger and more complex artistic pervasive gaming production. The case demonstrates for example how LAIMS can be used to facilitate performative audience interactions that are off-stage and how the LAIX-score state control matrix can scale to off-stage experiences by introducing user activation mechanisms for interaction activities. There are many use cases in events for off-stage interaction activities. Actually, in the case of Lost Lab, the off-stage interaction activities are the primary interaction, and the on-stage interaction activities are used for *onboarding* the audience to action. Off-stage interaction actions can be considered as live interactions in some cases.

Overall Lost Lab is a case example of a production that validates all three core requirements presented in Chapter 3. The production utilized different interaction activities, had different kind of role configurations and applied LAIMS for parallel different functions. In addition, the case shows how the LAIX-score framework should be extended with features that support identity building and memorabilia. The case also exemplifies how gamification should be a core feature for a LAIMS and acknowledged as an element in the LAIX-score design framework.

The production generally demonstrates how in a large event production the LAIMS is only one technical system, and should

be designed to integrate with many other technical systems. For example, the production demonstrates how the Presemo system is not specific to web-based interfaces but can be extended with native clients that support different kinds of interaction patterns. The practical production experiences also concretize what the benefit of a generic control platform for live audience interaction is. Some of the live audience interaction patterns and control features turned out to be very important for realizing the production, but they were not originally expected and planned during the early stages of the pre-production. These features could be appropriated into use only because they were available off-the-shelf in the Presemo system. Also, the configuration between different productions changed, which again highlighted the importance of a generic and practical control framework for live audience interaction.

# 7.6 Evaluation Summary of the Case Studies

This chapter concludes the case studies. The first section (7.6.1) summarizes how the case studies correspond to the core requirements identified in Chapter 3. The second section (7.6.2) summarizes how the Presemo LAIMS has been applied in the production. The third section elaborates how the LAIX-score state control matrices have been applied in the production and (7.6.3) concludes the case study chapter by introducing a revised LAIX-score design framework that has been extended with a detailed interface channel structure. The next Chapter (8) will elaborate in detail the additional requirements identified during the case studies and finalize the LAIX-score design framework.

### 7.6.1 Reflecting upon the Core Requirements Based on Cases

Chapter 3 introduced three core requirements (1. support for different interactions, 2. support for different role configurations and 3. support for different and parallel functions) for the live audience interaction design framework. These requirements were first used as a baseline for reviewing existing live audience interaction designs (Section 4.2) and then as a basis for introducing the LAIX-score design framework (Chapter 5).

Each case study has reflected and analyzed the significance of these three core requirements. As a synthesis and validation check Table 7.6a summarizes how each case study contributes for validating each requirement. Based on the analysis the cases can provide either some validation or strong validation for the core requirement or then be neutral.

The Screen.io event production provides strong validation for the second requirement to support different role configurations. The case had eight different roles for the live audience interaction. The case also provided some validation for the first requirement to support different interaction patterns since the

TABLE 7.6A :   HOW CASE STUDY PRODUCTION REFLECTS ON THE CORE REQUIREMENTS

| | REQUIREMENT 1 : Support for different inter-action patterns | REQUIREMENT 2 : Support for different role configurations | REQUIREMENT 3 : Support for different and parallel function |
|---|---|---|---|
| CASE 1 : Screen.io event production | Validation | Strong Validation | Validation |
| CASE 2 : Presemo at the University | Validation | - | Validation |
| CASE 3 : Metagroups | Strong validation | Strong Validation | Validation |
| CASE 4 : Lost Lab | Strong validation | Validation | Strong Validation |

case utilized Q&A, feedback and poll interaction patterns. Poll and Q&A coexist and in this sense the case also validates the requirement for parallel and different functions. The validation for the first and third requirements ares not strong in this case production.

The second case study – Presemo at the University – provides validation for the first core requirement. The case shows how teachers apply different interaction patterns in education. The validation is not strong since teachers have not had the possibility to utilize more than relatively basic interaction patterns in their classroom productions. The importance of the second case study is in demonstrating how the Presemo system that is built based on the LAIX-score design framework is feasible in use in both simple and more constrained use cases. In order to make LAIX-score a generic and practical design framework, it must be also a feasible and preferable system in productions that have limited

resources. Actually, the University applies Presemo for multiple different functions, but the multiple function requirement does not usually realize in a single production. Overall, the benefits of the LAIX-score in this case are realized when the appropriation of the LAIX-score is done on an organizational level. Developing organizational support for live audience interaction is easier when one system can fulfill multiple functions and use cases.

The third case study introduces the Metagroups workshop production. The case demonstrates another type of complex role configuration based on and dividing the audience into groups. For this reason, the case also provides a strong validation for Requirement 2. There is some evidence in the case study 2 (Scenario B) and also in case study 4 that support for group organization is generally an important feature of the live audience interaction. Groups can consist of those with orchestrator roles in addition to audience roles. The Metagroups case also provides validation to requirement 1 since it utilizes multiple different interaction patterns, and requirement 3, especially in the case of the first Metagroups production where the workshop was realized as part of larger seminar-type event program. We have seen more and more productions that combine seminars and workshops. Commonly, a seminar requires other types of functions and interaction patterns than a workshop.

The fourth case study – Lost Lab – introduces pervasive adventure production, which applies live audience interaction as part of larger interaction framework. Whereas in other cases the live audience interaction system has been functioning independently, in the case of Lost Lab the Presemo LAIMS is integrated with many other interactive systems. The case demonstrates new kinds of interaction activity patterns that connect off-stage activities and chat actors to Presemo; the case also utilizes a picture taking pattern and the common chat and poll interaction patterns. Hence, the case provides validation for the first requirement. The case study utilizes live audience interaction as an integration platform for off-stage activities, support communication channel, orchestration support, onboarding mechanism and feedback collection system. Therefore, the case also provides strong validation for the third requirement.

None of the case studies provide a strong validation for all of the core requirements, but on aggregate they provide strong validation to the core requirements. Based on the case studies it is possible to say that the core requirements identified during the domain exploration are valid under more detailed case analysis when considering a wide range of applications for live audience interaction.

## 7.6.2 Applying LAIX-score Design Framework to Case Production

All of the cases studies utilized Presemo, but with somewhat different configurations. Presemo functioned also as a research instrument and hypothesis for the initial version of the LAIX-score design framework. Table 7.6b summarizes how the productions used Presemo, what kind of modifications were made to Presemo and whether there were any issues or missing features in Presemo.

The Presemo system was not static during the case productions. Many of the features presented and developed during

TABLE 7.6B :                    USE OF PRESEMO IN EACH CASE STUDY PRODUCTION

| Case production | Presemo version | Modifications and extensions | Additional requirements and other identified problems |
|---|---|---|---|
| Case 1: Screen.io event production | Standard 4-channel Presemo | Standard version complemented with orchestrator chat | More orchestrator channels needed. (related to core requirement 2). Integrate LAIX-score with the event managers technical cue list. (Req. 4) Include mechanism for system record. (Req. 5) |
| Case 2: Presemo at the University | Presemo in 3-channel mode | Standard version with the room creator | Cue list function should be functional (Req. 6) and support also session import and export (Req. 7). Need for access management, identification (Req. 9) while maintaining possibility to host anonymous interaction (Req. 8) |
| Case 3: Metagroups | 3 Presemo rooms integrated together | Three rooms integrated as a tab interface for the audience. Additional orchestrator chat. | Session record should provide also detailed data with identifiers and not only contributions. (Req. 10) LAIX-score should support organizing in groups and group formation. (Req. 11) LAIX-score should support user profiling (Req. 12) |
| Case 4: Lost Lab | Standard 4-channel Presemo as core. | Presemo integrated to native client and extended with AR-markers, camera, orchestrator chat, gamification and identity management. | More orchestrator channels needed. Support for memorabilia and establishing identity (Reg. 13) Support for gamification (Req. 14) |

the case studies were not in place in the first web-based Presemo version (first version number 3 was introduced already in 2012) that was applied for example in the first Metagroups production. Most of the modifications have been appropriated as part of the generic Presemo system. The evolution of Presemo indicates that live audience interaction management systems should be considered as platforms that provide basic functionalities for control and production, but can be easily extended, integrated and modified for production specific needs.

The basic version of Presemo is a fixed 4-channel live audience interaction system. In some productions, there is a need only for 3 or even 2 channels, when some productions required significantly more interface channels. In case productions requiring more interface channels, the requirement was met by using multiple Presemo rooms together in one production. This is a simple work-around to the channel limitation but makes the system control significantly more complex and overall is a significantly more inflexible solution than a LAIMS that has native support for more interface channels. The next section will analyze further how the interface channel structure should be modeled based on the lessons learned from these case studies.

### 7.6.3 Defining Detailed Structure for the Interface Channels in the LAIX-score Design Framework

Chapter 6 explained how based on the Presemo design the interaction activity control structure can be divided into five parts (1. Creation, 2. State control, 3. Interaction pattern specific control, 4. Content management, 5. Presentation management). However, as Presemo is fixed as a 4-channel LAIMS system, it provided only limited possibilities to analyze what is the detailed interface channel structure of the LAIX-score framework. In the case study chapter, we presented a hypothesis of what would have been the idealized LAIX-score design framework for this particular case. Figure 7.6c summarizes these LAIX-score column structure of each of these state control matrices. Based on analyzing these LAIX-score state control matrices and other relevant details of the case studies we propose a three-part interface channel structure for the LAIX-score design framework, where the three channels are named as organizer channels, audience channels and screen channels. The left side of Figure 7.6c shows the idealized LAIX-score interface channel structure presented in the case studies and the right side shows the revised version of these LAIX-score state control matrices with this three-part interface channel structure in place.

FIGURE 7.6C : SUMMARY OF IDEALIZED INTERFACE CHANNEL STRUCTURES OF THE LAIX-SCORE STATE CONTROL MATRICES BASED THE CASE STUDIES (LEFT). REVISED VERSION OF THE LAIX-SCORE STATE MATRICES WHICH INCLUDES THE THREE-PART DETAILED STRUCTURE FOR THE INTERFACE CHANNELS (RIGHT). THE THREE-PART STRUCTURE DEVIDES INTERFACE CHANNELS AS ORGANIZER CHALLENS, AUDIENCE CHANNELS AND SCREEN CHANNELS.
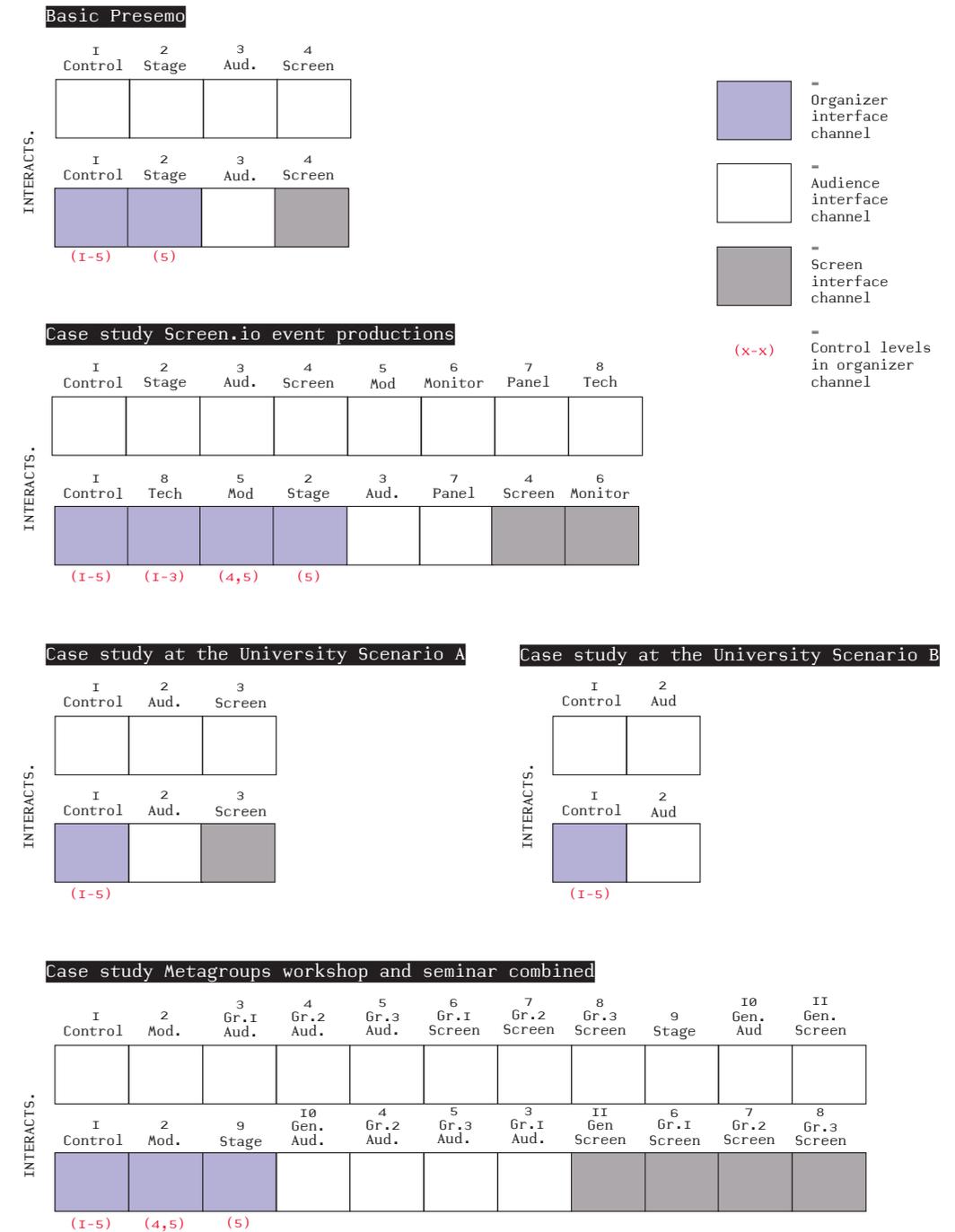
Defining these three interface channel types makes the LAIX-score framework more constrained in comparison with the initial model that had a dynamic number of similar interface channels. The constraint basically is that all new interface channels must fall in to one of these three categories. Then again, this structure is analogous to the output channel structure in live audio mixing environments (see Section 4.4) where the output channels are usually divided into master channels, auxiliary channels, monitor channels and effect channels. Hence, this kind of channel division has some empirical and practical analogy. The reason why a more detailed structure is needed is to provide practical guidance for implementing dynamic interface channel support for the Presemo and create more practical control for the different channels. Hence, instead of extending a setup with any channel, live audience interaction producer creates one of these three channels and in case of organizer channel assigns appropriate interaction activity control rights for the channel. The particular LAIMS implementation may have some limitations on how may organizer, audience or screen channel it can support.

Organizer and audience interface channels are personal interface channels. The screen interface is shared. Organizer interface channels are different from audience channels as they consist control functions. Each organizer channel can have control rights for any of the five interaction activity control levels, which were presented and discussed in detail in Section 6.4 (and marked with red color in Figure 7.6c). In every production, there must be control channels that cover all control levels. In the case of basic Presemo (version 4) there are two organizer interface channels – moderator interface channel has all five control levels and the stage has only level five (presentation management) control. The organizers cover all orchestrator and performer roles.

Audience interface channels are basically groups. Organizer channels can also be connected to the audience groups. Groups can be overlap. Hence, the same audience member can belong to multiple groups. Figure 7.6d visualizes how the new three-part interface channel structure extends the LAIX-score design framework presented in Chapter 5 and Chapter 6. Basically, the LAIX-score implementation does not require a screen channel, but it can also accommodate many screen channels if needed. The model also applies to cases that have one organizer channel and one screen channel. In an abstract level the LAIX-score design framework does not impose any limit to the number of interface channels, but in practical implementation and practical production configurations the interface channels number

of interface channels are limited since adding more interface channels increase both technical system complexity as well as makes the management somewhat more complex.

FIGURE 7.6D :   UPDATED VERSION OF THE LAIX-SCORE DESIGN FRAMEWORK WITH THE DETAILED INTERFACE CHANNEL STRUCTURE DEVIDED TO ORGANIZER, AUDIENCE AND SCREEN CHANNELS.



Interface channels

CONTROL LEVELS
1-5

ORGHANIZER CHANNELS | AUDIENCE CHANNELS | SCREEN CHANNELS
Org Ch.1  Org Ch.X | Aud Ch.1  Aud Ch.X | Scr Ch.1  Scr Ch.X

Activity 1 (Poll)
Activity 2 (Question)
Activity 3 (Chat)
Activity 4 (Rank)
Activity 5 (...)

State Control Matrix

GROUP MANAGEMENT

Based on the case studies, the interface channels are divided to three parts: Organizer channels, audience channels and screen channels. Organizer channels have different interaction activity control levels.

Audience channels can be divided in to groups, which need to have separate management function.

Interaction activities

1. Creation and deletion
2. State control
3. Pattern specific activity management
4. Content management
5. Presentation management

+ Contributions

CONTROL LEVELS

# 8.

# Revised LAIX—score Design Framework

# 8.1 Synthesizing Additional Requirements

The first version of the LAIX-score design framework was presented in Chapter 5. This version included three core elements (interaction activities, interface channels and state control matrix). Chapter 6 presented further details of the interaction activities based on the Presemo LAIMS design. The case (Chapter 7) evaluation validated the core requirements that were used to define the LAIX-score design framework, demonstrated how the LAIX-score can be used in practice by utilizing the Presemo LAIMS, and presented further detailed structuring of the interface channels. The case studies also produced new *additional requirements* for the LAIX-score, which were not satisfied using the current three core elements of the LAIX-score design framework. In this chapter, these additional requirements are synthesized as two new core elements for the LAIX-score framework: *temporal management* and *identity management*. These two new core elements extend the LAIX-score framework and make the design framework comprehensive according to the four different case studies' productions presented in the previous chapter. Hence, the revised five core elements of the LAIX-score design framework are:

```
–       Interaction activities,
–       Interface channels,
–       State control matrix,
–       Temporal management, and
–       Identity management.
```

The case study chapter identified 11 additional requirements that complement the three core requirements introduced in Chapter 3. Figure 8.1a lists these 11 additional requirements and illustrates how the additional requirements are grouped under the *temporal management* and *identity management* core elements.

| | |
|---|---|
| CASE I. | Req4. Cue list for communication and coordination tool |
| CASE I. | Req5. Session documentation |
| CASE 2. | Req6. Cue list as a function |
| CASE 2. | Req7. Session template for session reuse and distribution |
| CASE 3. | ReqI0. Session record for post analysis |

→ `Temporal Management`

| | |
|---|---|
| CASE 2. | Req8. Support anonymity |
| CASE 2. | Req9. Manage access to interface channels |
| CASE 3. | ReqII. Group formation and management feature |
| CASE 3. | ReqI2.User profiling |
| CASE 4. | ReqI3. Support for establishing identity and creation of memorabilia |
| CASE 4. | ReqI4. Support for gamification |

→ `Identity Management`

The temporal management element of the LAIX-score design framework is divided into *the past*, *the present* and *the future*. Identity management is fundamentally a simple table, which combines a participant's name, access rights to *interface channels, group membership, privacy settings* and generally all *identity attributes*. The identity attributes can then be utilized in interaction activities in various ways, such as for scoring and for cross-referencing.

Figure 8.1b visualizes the LAIX-score design framework with all five core elements. This is the revised LAIX-score design framework and the core deliverable of this thesis. The following two sections (8.2 and 8.3) further elaborate on the two new core elements and explain in further detail how they implement the *additional requirements* presented in Chapter 7. Section 8.4 summarizes the framework and explains the relationship between these core elements in detail.

FIGURE 8.IB :       REVISED LAIX-SCORE DESIGN FRAMEWORK
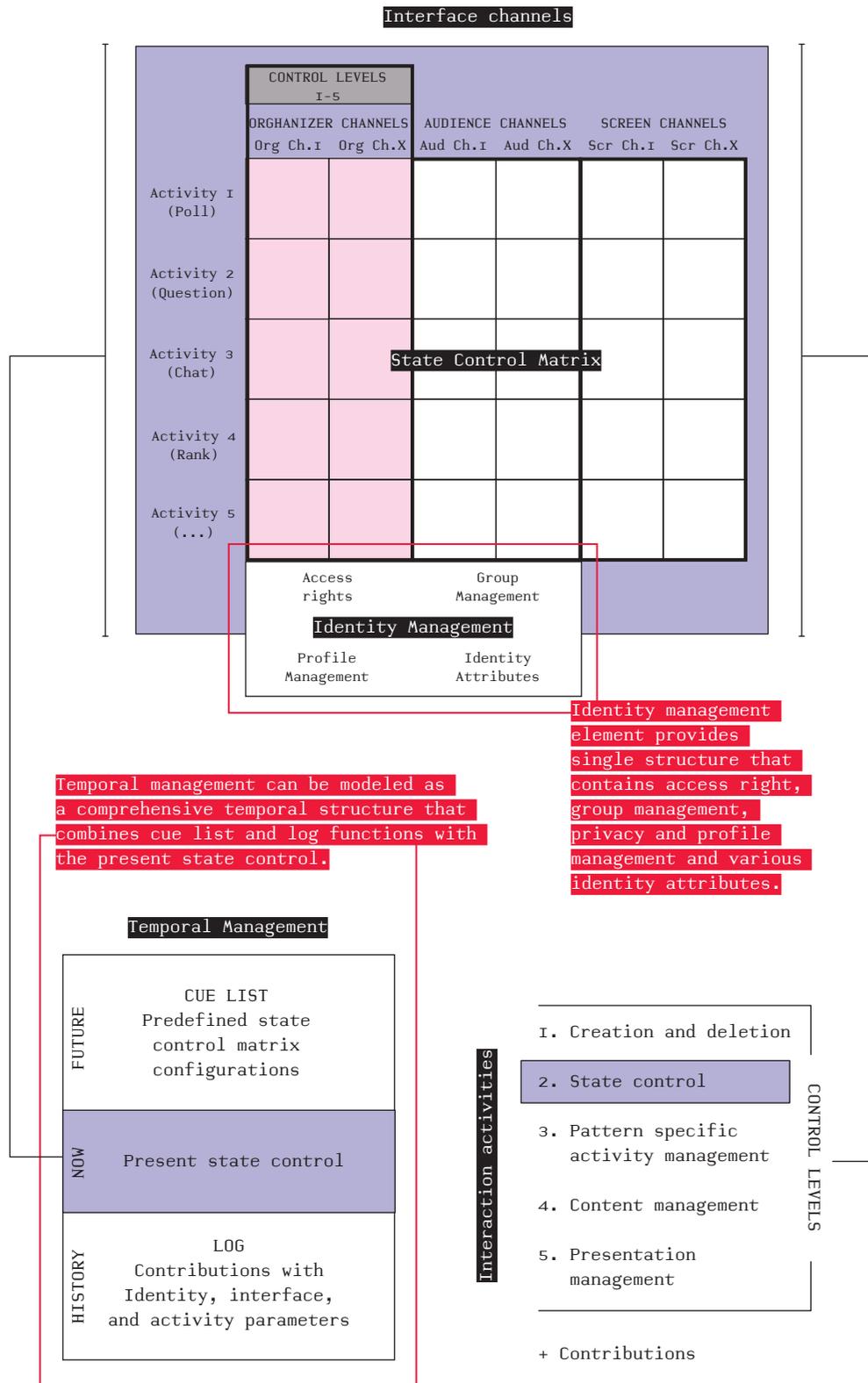
Interface channels

CONTROL LEVELS
I-5

ORGHANIZER CHANNELS | AUDIENCE CHANNELS | SCREEN CHANNELS
Org Ch.I  Org Ch.X | Aud Ch.I  Aud Ch.X | Scr Ch.I  Scr Ch.X

Activity I
(Poll)

Activity 2
(Question)

Activity 3
(Chat)

State Control Matrix

Activity 4
(Rank)

Activity 5
(...)

Access           Group
rights           Management

Identity Management

Profile           Identity
Management        Attributes

Identity management element provides single structure that contains access right, group management, privacy and profile management and various identity attributes.

Temporal management can be modeled as a comprehensive temporal structure that combines cue list and log functions with the present state control.

Temporal Management

FUTURE — CUE LIST
Predefined state control matrix configurations

NOW — Present state control

HISTORY — LOG
Contributions with Identity, interface, and activity parameters

Interaction activities

I. Creation and deletion

2. State control

3. Pattern specific activity management

4. Content management

5. Presentation management

+ Contributions

CONTROL LEVELS

200

---

# 8.2 Temporal Management in the LAIX-score Design Framework

Temporal management is an important element involved in the coordination of live action and performances. For example, musical notation is a temporal management framework for musical performance. The core references of the LAIX-score – frameworks for live audio mixing and live light control – have been also extended with temporal management[189]. Most contemporary live audience interaction frameworks have some form of temporal management framework, as presented in section 4.2. Temporal management is also an important aspect in the related research frameworks[190]. In contrast, the event timetable is probably the most common design artefact for most events. Overall, temporal management is a common organizational element in all kinds performances and events, and this general notion ultimately shows why this is a unique element in the LAIX-score design framework.

THE TEMPORAL MANAGEMENT ELEMENT SATISFIES
FIVE OF THE ADDITIONAL REQUIREMENTS:

REQUIREMENT 4 : The design framework should be compatible with the event management cue list for the temporal planning of event action.

Requirement 5 : The design framework should provide a structure for documenting the production.

Requirement 6 : The design framework should enable the predefinition of LAIX-score states for the simple operation of a live audience interaction management system in terms of a functional cue list.

Requirement 7 : The design framework should provide a structure for saving the session as a template for reuse.

Requirement I0 : The design framework should provide a structure for recording interactions for post-production analysis.

Temporal management in the LAIX-score design framework is divided into three parts: *future, present* and *history*. The *state control matrix* (presented in section 5.1) is real-time control structure that defines the state of interaction activities in the respective interface channels. For this reason the state control

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matrix can be directly used to define the present state. In addition, each interaction activity has a detailed state (control levels 3-5, section 6.4) and individual audience members and other actors also have a present state, which are not directly defined by the state control matrix. These elements can be considered details that fall under the state control matrix, which is the primary present state structure. As such, the present state management is not related to any of the additional requirements.
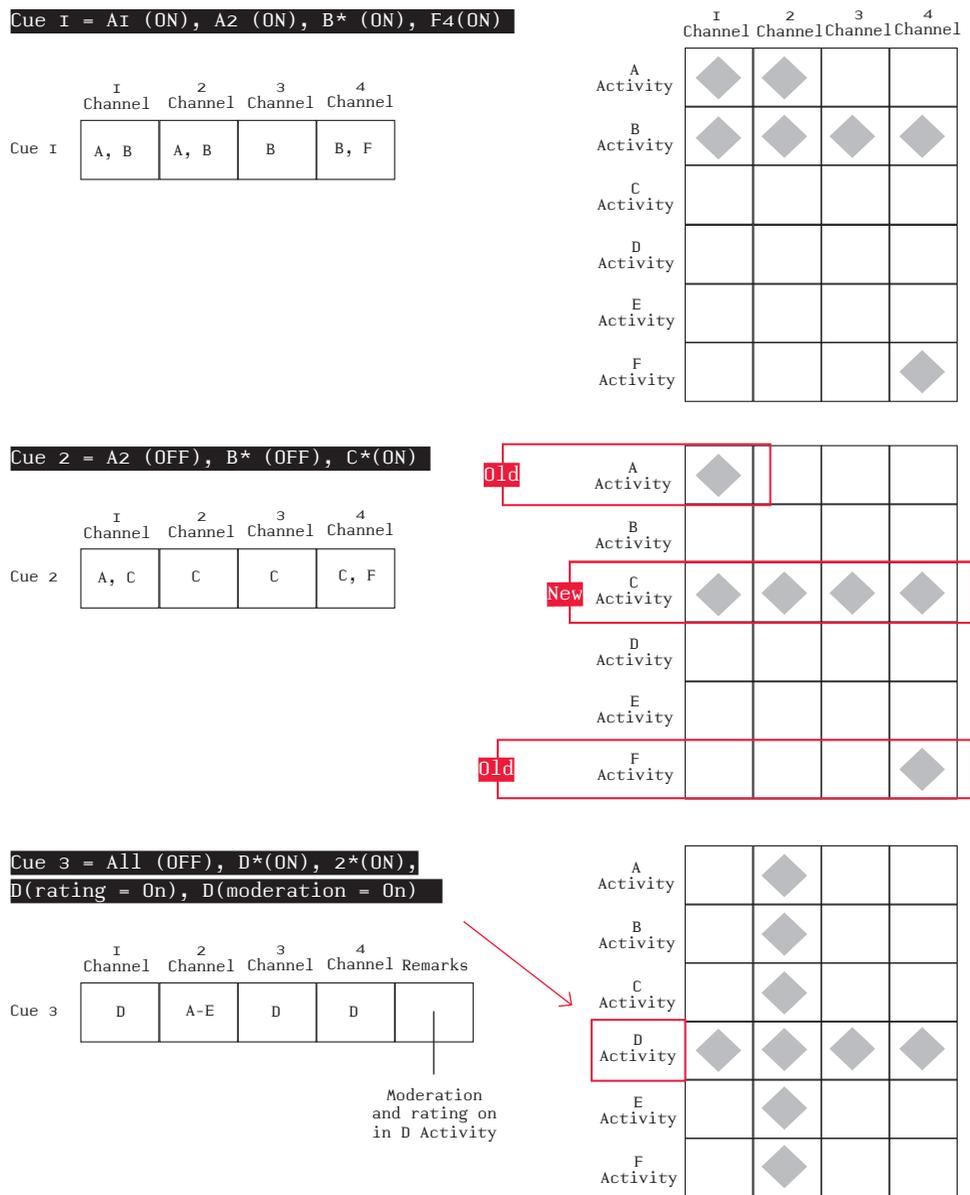
The future state is managed using the cue *list function*. A cue list[191] is fundamentally a predefined list of future LAIX-score control matrix configurations. The cue list function satisfies additional requirements 4, 6 and 7. Requirement 4 defines that there should be a notational convention for live audience interaction for the event management cue list. The LAIX-score cue list can be appended to the event producer's cue list table. Figure 8.2a illustrates how the cue list can be formalized with the LAIX-score as a chain of simple textual notation.

The cue list commences from an empty state control matrix and defines the *first cue (1)*, making three interaction activities visible: Interaction activity A is visible on interface channels 1 and 2, activity B is visible on all channels (* is used to cover all channels), and activity F is visible only on channel 4. The *second cue* (2) disables activity A from channel 2 and activity B from all channels, and instead sets activity C as visible in all channels. Activity A remains visible on channel 1 and activity F stays visible in channel 4. *Cue 3* first deactivates everything, and then sets activity D as visible in all channels, and all activities as visible on the second channel. Cue 3 also defines in detail the interaction pattern specific controls for activity D (e.g., activating rating and moderation). This is a simple textual notation for the functional cue list (*requirement 6*) that can also be used in the written cue list notation (*requirement 4*). The activity and channel labels (letters and numbers) can also be replaced with other kinds of identifiers.

The simple textual notation is useful because it allows collapsing of the two-dimensional cue LAIX-score state control matrix into a single row in a cue list table. The same table function can be appended with other kinds of instructions, such as changes to the interaction activity state. The table format cue list and the state control matrix satisfy *requirement 7*, which provides a structure for saving and reusing the session. In this case, the state control matrix definition must include a definition of interaction activities and interface channels (control levels 1-3). These elements are a necessary baseline for reproducing the event interaction patterns. A combination of a state control matrix and cue list can be called a *session template*. The template feature is important for teachers who want to repeat a lecture or want to distribute their pedagogical procedures to other teachers. The template feature could be also used to distribute for example workshop procedures. Figure 8.2b visualizes the session template.

FIGURE 8.2A : LAIX-SCORE CUE LIST SIMPLE TEXTUAL NOTATION, CHANNEL SPECIFIC NOTATION FOR EVENT MANAGERS LIST, AND STATE CONTROL MATRIX REFERENCE

VISUALIZING SESSION TEMPLATE WITH ON STATE CONTROL MATRIX AND CUE LIST TABLE. TEMPLATE CAN BE USED FOR REUSE, IMPORT AND EXPORT.

**Session Template**

State control matrix with Interaction Activity specific defaults and content.

| | 1 Channel Mod. 1-5 | 2 Channel Stage 4-5 | 3 Channel Aud. | 4 Channel Screen | DEFAULT | TITLES + CONTENT |
|---|---|---|---|---|---|---|
| A. Poll | | | | | Multiple option (Off) | Are you excited about our event? Yes, No |
| B. Chat | | | | | Moderation (On) Messages (On) Writing (On) | Questions and comments to speaker? |
| C. Profile Poll | | | | | Multiple option (On) | Are you? Leader, expert, support |
| D. Question | | | | | Rating (Off) | What is the most important development target for our company? |
| E. Feedback | | | | | Message (Off) | Give feedback about the event? |
| F. Orch. chat | | | | | Messages (On) Writing (On) Moderation (Off) Notifications (On) | Orchestrators chat for coordination? |

Cue list table with Interaction Activity control specific additional column.

| | 1 Channel | 2 Channel | 3 Channel | 4 Channel | Other |
|---|---|---|---|---|---|
| Cue1 | A-F | A,B,F | A,B | A | |
| Cue2 | A-F | A,B,F | B | B | |
| Cue3 | A-F | B,F | C,B | C | |
| Cue4 | A-F | D,B,F | D,B | B | |
| Cue5 | A-F | D,B,F | D,B | D | D(Rating(ON)) |
| Cue6 | A-F | E,B,F,D | E,B | B | |
| Cue7 | A-F | A-F | B | B | |

Figure 8.2b illustrates a hypothetical production example. The left side shows the state control matrix, with four channels and additional columns for interaction activity default settings and interaction activity content. The right side of Figure 8.2b details the cue list table, which lists seven cues used for realizing the temporal management during the session. Moderator and stage channel control level rights are individually defined for each interface channel. In this hypothetical example, the first interface channel (Moderator) has all interaction activities visible at all times (A-F in the first column in the cue list table). Stage interface also has an orchestration chat visible at all times (F). Cue 5 has interaction pattern specific control, because the peer review (rating) is enabled for this cue for activity D (Question). This is a simple example; the number of interaction activities, inter-

face channels and cues could be much larger, and the default settings and content could be more elaborated and extensive. Currently, the LAIX-score does not define any syntax for interaction activity pattern specific controls. The example has other fields that describe in free form some activity pattern specific controls. It is also notable that with this cue list configuration it is possible that the orchestrator can directly manipulate visibility from the state control matrix control UI. Hence, the cue list provides a core overview for interactions that can be changed in a live situation if needed.

The final part of temporal management is the *session history*. The session history is collected and stored on the session log. The log satisfies *requirements* 5 and 10. The core part of the session log is the *contribution log*, which includes the timestamp, contributor ID, content (contribution data such as text, contribution type and potentially some contribution parameters) and context (interaction activity, interface channel). In addition, there are also two other log elements: *control log* and *cue list log*. The control log records all organizer interface channel control actions that are unrelated to audience contributions. The cue list log records when a specific cue list has been activated. Figure 8.2c illustrates the session log structure for the LAIX-score design framework.

LAIX-SCORE DESIGN FRAMEWORK SESSION LOG STRUCTURE, INCLUDING THE CONTRIBUTION LOG, CONTROL LOG AND CUE LIST LOG. EACH ROW REPRESENTS INDIVIDUAL AUDIENCE CONTRIBUTIONS SUCH AS A SENT MESSAGE OR SENT VOTE.

**Session log**

CONTRIBUTION LOG

| | Time | UserID | Context Activity Channel | Content Type Parameters |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| ... | | | | |

CONTROL LOG

| Time | UserID | Context Activity Channel | Content Type Parameters |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

CUE LIST LOG

| Time | UserID | Context Activity Channel |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
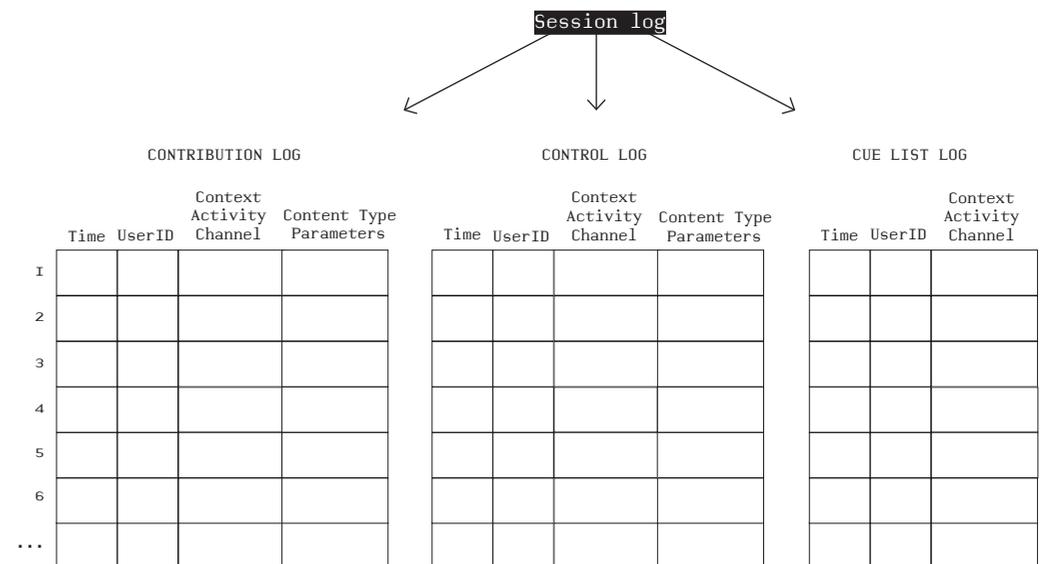
The contribution log can hold thousands of records. In some productions that have for example a large amount of peer-review interaction activities, we have had over 10,000 rows in the contribution log. The size of the contribution log can be used as a core measure for a live audience interaction production, similar to the number of messages (subset of contributions), number of participants or duration of the production. In cases of peer-review interaction patterns (section 7.4.3), the contribution log content parameters must reference the original contribution that was peer reviewed. The control log is similar to the contribution log. The log records significantly depend on the control type, which is defined by the control level. Content management and presentation management must reference contribution ID, as is done for peer-review contributions. The control log should also record identity management actions. The cue list log is a simple record of when a respective cue was activated.

Primarily, the session log is a digital file that is continuously amended as a session progresses. The session log is used to create different types of session deliverables. Some deliverables are related to post-production analytics, and some deliverables are part of post-production communications. The statistical figures produced by the interaction activity are often inadequate for the post-production documentation. In this case, the figures are produced from the session log. In some cases, user privacy preferences limit what kind of session log can be recorded. If participants are promised full anonymity, the session log cannot store user identifiers. The session log can also be applied to generate identity attributes. User contributions can be processed and converted to user identity attributes. Overall, *identity attributes* and the contribution log are integrally related. The identity attributes will be described in more detail in the next chapter as part of the identity management element of the LAIX-score design framework.

## 8.3 Identity Management in the LAIX-score Design Framework

Identity management is an important aspect of many digital systems. Digital services usually provide some kind of user account or require user authentication. The conventional live audience interaction systems presented in section 4.2 also have some kind of account system, at least for the orchestrators or teachers. Basic Presemo does not have an account system; rather, it only has the possibility of storing a name designated as the

```
192)
We have been
realizing Presemo
accounts, for
example, with
simple hardcoded
pin codes. In a
few cases, we have
been utilizing the
Facebook login for
access management
in an educational
setting.
```

user ID. In some of our professional productions, the Presemo has been extended with simple access management and identity management features[192]. Identity management and user account is generally important for digital services for several reasons. Identity management features and account systems enable personalization, a service to remember the user and the storage of user-specific data. With accounts and identity systems, users can return with different devices. The identity system also enables advanced analytics, integration with other digital identities and the creation of persistent digital relationships between users. These may also be important features for live audience interaction; however, live audience interaction has some specific identity management-related requirements that are described in the six additional requirements identified during the case studies:

```
Requirement 8 : Manage access to interface channels,

Requirement 9 : Enable anonymity and privacy management,

Requirement 11: Support group formation and
               group management,

Requirement 12: Enable user profiling,

Requirement 13: Support for establishing identity, and

Requirement 14: Support Support for gamification.
```

The primary solution for all these requirements in the LAIX-score design framework is an identity management system that can be controlled with an *identity management table* that hosts a list of different identity attributes for each user. The *identity management table* is a core control view in the LAIX-score framework parallel to *the state control matrix* and the cue list table. Figure 8.3a provides a simple visualization of the identity management table.

| IDENTITY PARAMETER | DETAILS AND CONTROL | REQ. NRO. | LINK TO OTHER CORE ELEMENTS |
|---|---|---|---|
| Name (A) | Public and human understandable identifiers. Not necessary unique. The participant writes or is exported as an external identity attribute from the external identity management system. | 9, I3 | Interaction activity can read. |
| Group (B) | Groups have identifiers and participants belong to these groups. The organizer defines the group to which a participant belongs. | II | Interface channel group |
| Access right (C) | Whether participants generally have the right to access this session, group or organizer interface channel. | 8 | Access to interface channel |
| Privacy settings and preferences (D) | Data protection contracts for the session. There can be a general contract for the session or for use of unique parameters. | 9 | Profile visibility in interaction activity. Right to write to log. |
| Activity based profiling parameter (E) | Well-structured or quantifiable parameter such as gender, age, or position that originates from an individual profiling interaction activity such as a poll. | I2, I3 | Originates from profiling activity such as poll. Interaction activity can read. |
| Profile information (F) | User profile information similar to name. User defines. Can be free-form text or a selected option. | I2, I3 | Interaction activity can read. |
| External identity attribute (G) | The existing identity management system such as social media can be used to export identity attributes such as full name, profession, friends, or photos. | 9, I2, I3 | Interaction activity can read. |
| Score (H) | Simple number parameter. New entry increases the previous score. | I4 | Scoring based on contribution or control actions. |

The LAIX-score design framework defines several different identity attributes. Each column in the table defines a type of identity attribute. There can be specific identity parameters such as name, score and access rights, or more free-form identity attributes that can be user generated, activity generated, or exported from an external user account system. Figure 8.3a visualizes how these identity attributes are connected to the additional requirements. The table as such should not be considered a complete list of all possible identity parameters. The current list of attributes reflects the needs identified during our practical productions.

Table 8.3b summarizes the different identity attributes and elaborates how these attributes can be managed, to which additional requirement they are related, and how they are connected to other core elements of the LAIX-score design framework.

Figure 8.3a and Table 8.3b demonstrate how the identity management table covers all additional requirements for identity management. Different identity parameters have different control techniques and connections to other elements of the LAIX-score design framework. Name (A) is basically a specific form of profile information (F) that is commonly used in different interaction activities and is the core public identifier for the participants. Profile information and privacy preferences (D) must be either directly or indirectly participant defined. Group

(B) and access right (C) parameters are defined by the organizer. There should be an easy-to-use interface that enables dynamic manipulation of these parameters. There can be unique interaction activities that define specific identity parameters (E). This feature can be used for example for realizing cross-references of different activities. For example, a special poll interaction pattern can be used to generate a profiling parameter. Scoring (H) can be simply based on a number of contributions, or a unique

game engine can be used that defines more elaborated scoring. Control actions can also define the score. The score parameter is additive; hence, it increases based on each new scoring-related event. Optionally, the score can be calculated in real-time from the contribution log.

External identity attributes (G) are related to the use of established identity services for access management and enriching identity. Live events are unique in a sense that the same people do not necessarily meet again, and the account created for one particular event will not be useful at another time. New solutions are emerging in the authentication and identity management domain. New authentication solutions enable the utilization of an established digital identity in several different services. Common examples are Facebook Connect and Google+ digital identities[193]; other possibilities are also available. By using an existing digital identity, there is no need to create a new identity for a particular live interaction session or event. The identity management of live audience interaction may support these authentication services.

In addition to the control features, the identity management table can also be used as a presentation element in audience and screen interfaces. In an audience interface, a variation of identity list can be used as a participant list. In a screen interface, a variation of the identity list can be used for example as a high-score list or participant demographics visualization. A live audience interaction identity management system should be able to import identity parameters (G). The live audience interaction system should also be able to export identity attributes in some cases. For example, according to new EU legislation, audience members should be able to control the flow of their personal information to different identity services, as well as be able to download all personally-identifiable information[194].

Identity management is an important extension of the LAIX-score design framework. Identity management enables more complex live audience interaction scenarios, different kinds of live audience interaction patterns, as well as integration of live audience integration with other digital services. Audience data is a key asset in the creation of better analytics and more complex communication formats. The case examples presented in Chapter 7 provide only a limited view of the possibilities related to combining live audience interaction with identity management. While developing more advanced approaches to live audience interaction that utilize identity attributes, it is also important to remember that some live audience interaction scenarios require anonymity and that the core feature of identity management is to disconnect all identity tracking and support complete anonymity.

193)
Open ID Connect is a popular identity reuse protocol used by Facebook Connect and Google+ login services.
openid.net/connect/

194)
ec.europa.eu/justice/data-protection/reform/index_en.htm

## 8.4 Overview of the Revised LAIX-score Design Framework

The revised LAIX-score design framework is composed of five interconnected core elements. These five core elements realize a control framework for live audience interaction that can enable different kinds of interaction patterns for different types of live audience interaction productions. Sections 8.2 and 8.3 elaborated upon the two new core elements: temporal management and identity management. Figure 8.4a summarizes these five elements as the core visualization of the LAIX-score design framework.

FIGURE 8.4A :          OVERVIEW OF THE LAIX-SCORE DESIGN FRAMEWORK
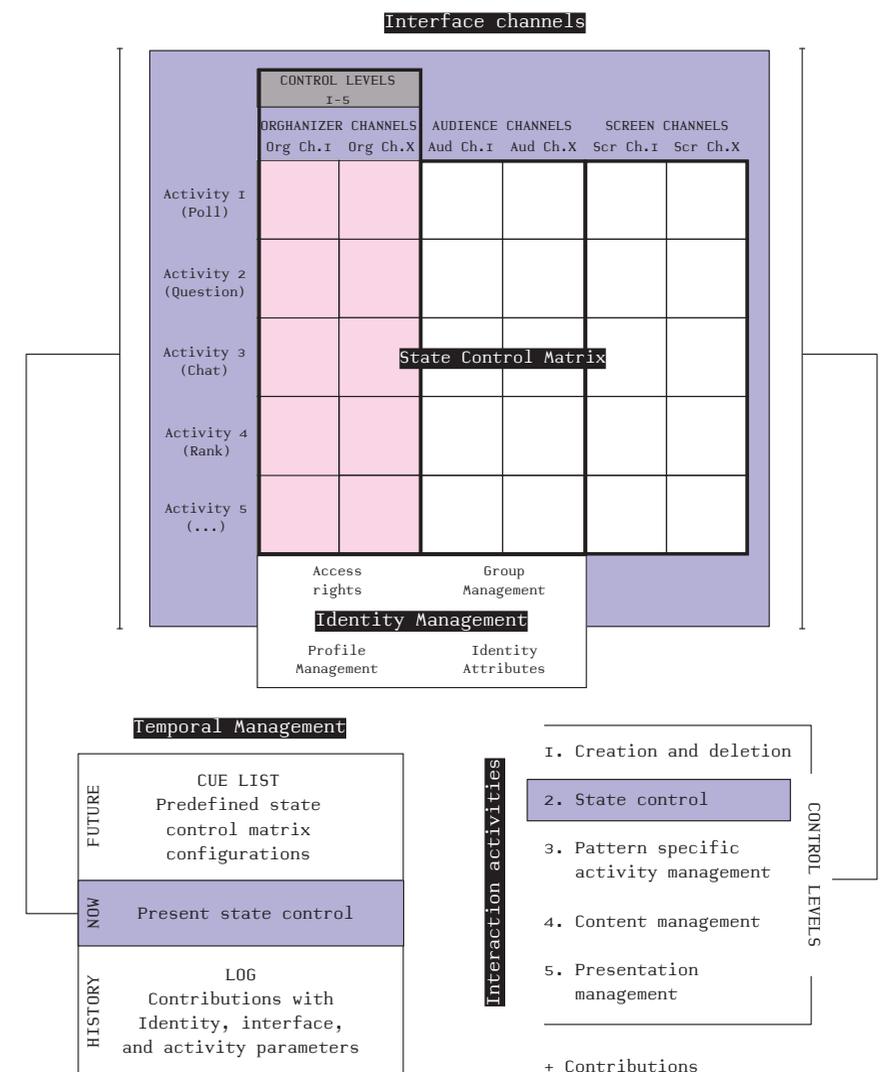
Each of these core elements have a more refined structure. The interaction activities are divided based on five control levels (section 6.4). Interface channels are divided into organizer, audience and screen channels (section 7.6). Temporal management is divided into present state control, cue list (future) and log (history) (section 8.2). Identity management can be divided into profile management (name, user defined attributes and privacy preferences), identity attributes (including other identity attributes and scoring), group management and access management (section 8.3). The state control matrix primarily defines the visibility of interaction activities in interface channels; however, visibility can have specific orientation parameters or specific visibility features such as user activation (section 7.5). Figure 8.4a provides a framework visualization that describes how the different elements form one comprehensive framework. Figure 8.4b simplifies the visual elements of the framework and lists the core elements with their internal structure.

The different elements of the LAIX-score design framework are related to each other in an integral way. Figure 8.4c summarizes the connections and dependencies between the different elements. The fact that the connections are not symmetrical implies that each connection has a special significance and unique practical relevance.

FIGURE 8.4B :        CONCEPTUAL OVERVIEW OF THE LAIX-SCORE DESIGN FRAMEWORK

**INTERFACE CHANNELS**
Division to Organizer, Audience and Screen channels. Organizer channels have different control righta to interaction activities.

**TEMPORAL MANAGEMENT**
Present state defined in the State control matrix. Future state in the cue list. Past contributions collected in the aggregated in the session log.

**STATE CONTROL MATRIX**
Defines what is the state of an interaction activity in the respective interface channel.

**IDENTITY MANAGEMENT**
Access rights and group management define interface channel access. Identity attributes are utilized by the interaction activities. Profile management establishes digital identity and defines privacy setting.

**INTERACTION ACTIVITIES**
Interaction activities have five control levels. Audience creates contributions to the interaction activities.

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FIGURE 8.4C :        CONNECTIONS BETWEEN THE CORE ELEMENTS OF THE LAIX-SCORE DESIGN FRAMEWORK.

Interaction activity control levels provide categorization to different organizer interface channels

State Control Matrix

Interface Channels

Interaction activities

Cue list provides management to state control matrix

Cue list manage also Interaction pattern specific controls

Access management Assigning groups

Writes and updates Identity attributes

Reads name and Identity attributes

Temporal Management

Identity Management

Parameter in the log. Log is composed from contributions in interaction activities.

This is the final iteration of the LAIX-score design framework within this thesis. The LAIX-score is a generic and practical design framework for a live audience interaction management system. Basically, this proposes a control framework for live audience interaction that is interaction pattern agnostic. With a control platform based on the LAIX-score design framework, it is possible to manage a wide range of different interaction patterns. The generic quality of the platform can also accommodate future interaction patterns that cannot currently be foreseen.

Chapter 9 will evaluate the novelty, relevance and reliability of this design framework. Chapter 10 will then elaborate upon how the framework could be developed further, what kind of complementary research topics have been revealed by the development of the framework and explains what the development of the framework has revealed about the live audience interaction practice in general.

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# 9.

# Evaluation of the Research

# 9.1 Relevance of the Research

THE RELEVANCE OF THIS RESEARCH CAN
BE EVALUATED FROM FOUR PERSPECTIVES:

A.    Relevance using an example of a
      live audience interaction case study,

B.    Relevance as a design
      framework for a LAIMS system,

C.    Relevance as a generic design framework
      for live audience interaction, and

D.    Relevance as a research framework.

This research describes in detail the design model for a live audience interaction system called Presemo, proposes further evolution for this design and describes in practice how the system has been used and adopted in different case study productions that are organized in different contexts. Presenting the system is a concrete outcome of this research. Presenting case studies that apply the same system is a concrete example that supports further productions and research. Hence, the Presemo system and case studies are relevant references for research and developers (perspective A) of live audience interaction. Currently, there are no other studies that introduce and evaluate in such detail the design of a live audience interaction system and demonstrate how the same system can be used in such a varied context for audience interaction.

This book is only one deliverable of this research. The software, the business and the case productions are also significant research deliverables. Considering the core objectives of the research, it is possible that the software and examples can function as a more efficient form of dissemination than this book. This study is also an important milestone for the development of the Presemo. Presemo is our fourth live audience interaction system. We are currently developing the next iteration. Through this study, we have increased general knowledge regarding the requirements (perspective B) for the next Presemo version. Through Presemo, the LAIX-score design framework is directly applied in advancing a business, and in this way the research has concrete and direct practical relevance. Through Presemo, the results of the research are distributed and made practically available for various live audience interaction productions.

The core objective of this study was to develop a framework that is both generic and practical, and can be adopted as a basis for practices and tools for live audience interaction productions. Concretely, this research (perspective C) can impact industry practices only if the framework is widely adopted by developers, service providers and practitioners in the domain. Achieving wide adoption requires years of technical and business development. The case studies demonstrate that the LAIX-score design is generic, as the design framework and Presemo can be used in different contexts and differently sized productions. Case studies provide only a limited snapshot of the different productions realized by the framework; including more productions would have only further validated the generality of the approach. Commercial appropriation of the system is a critical milestone for wider adoption. Time will be required before we can evaluate whether the LAIX-score design framework will ultimately achieve the grand objectives for wide generic adoption among live audience interaction practice. This thesis is one documentation milestone in a long research and development process that will continue into the future, and will include both research deliverables as well as development deliverables and new productions.

As such, this thesis does not focus on developing a framework that would be directly used in research for describing live audience interaction (perspective D) practices. The design framework focuses on developing computing system and management practices, and not a theoretical research framework that would be used to analyze human behaviour in live audience interactions. Future research should focus on analysing different interaction patterns and human behaviours around these patterns. Such research would support advancing the LAIX-score and complement this research. Human behaviours during live audience interaction productions should be modelled with a framework that describes human and social factors in additional to performative and technical elements, such as the framework described by Lundgren (2015). Understanding performers and orchestrator behaviours during live audience interaction productions should also be the focus of live audience interaction studies. For such research, the LAIX-score framework may be an important reference. The five LAIX-score elements and underlying requirements indirectly describe some of the performers and orchestrators tasks in live audience interaction. The LAIX-score framework is most valuable in case studies that directly utilize Presemo, since in these cases the LAIX-score is not only a design framework, but a design framework that defines the design strategy behind the technical implementation. Presemo has been used to enable research experiments in live audience interaction, and Presemo functions as a platform for experi-

mental live audience interaction patterns[194]. Hence, possibly the most direct relevance of this study for future research is the introduction of a versatile research platform for enabling new live audience interaction studies.

## 9.2 Reliability of the LAIX-score Framework

The core elements of the LAIX-score design framework have different reliability levels. The state control matrix, interaction activities and interface channels are elements that have been deployed in Presemo and tested successfully in real productions. From this perspective, these three core elements of the LAIX-score design framework can be considered as having high relevance and for these parts the LAIX-score design framework can be considered reliable. Hence, for these parts the elements can be implemented in a functional system that provides practical functionality and satisfies the core objectives as shown by the real-life use cases. The two other core elements (temporal management and identity management) are not similarly tested and implemented, and for this reason the design framework has a lower reliability.

The detailed interaction activity control level structure (five control levels) is aligned with the Presemo design, although it is not comprehensively implemented as a feature within Presemo. Hence, this part requires some further validation. Furthermore, the more detailed interface channel structure (division into organizer, audience and screen channels) is not a similarly reliable element of the framework, since the proposed structure has not been implemented in the Presemo. However, the interface channel structure is experimentally realized in the case study productions by executing certain modifications to the Presemo, and the final model is based on a systematic analysis of the presented cases.

Some of the temporal management and identity management elements have been designed and tested; however, there is no overall comprehensive implementation or repetitive deployment of these elements in in the wild productions. These two core elements emerged from identified additional requirements and have been conceptually analyzed. These two elements are presented at this point as hypotheses. Since the two elements are more unreliable, the question arises regarding whether it would

194)
For example, the case studies' metagroups and Lost Lab are Presemo and LAIX-score enabled research; however, other studies, such as Nelimarkka (2014, 2015 and 2016) and Liikkanen (2011), were enabled by Presemo.

be better to exclude these elements from the framework. In this sense, the current study is a compromise between reliability and comprehensives. If the reader prefers a higher reliability for the model, it is better to ignore the revised version of the framework and focus on the more reliable version presented in either section 6.4 or section 7.5 (with the detailed interface channel structure). The revised framework has been proposed since, based on the research findings, each of these five core elements have practical relevance, are generic and complement each other. Each of these five core elements also have concrete and direct relevance to the design of a live audience interaction management system.

## 9.3 Evaluation of the Research Methodology

This research had methodological strengths and weaknesses. The core strengths of this study were the significant amount of case experience, the significant number of complementary studies performed and concrete and commercial-grade implementation of the design framework. The weaknesses of the study were the limited number of academic references available supporting the core elements of the framework, the data collection in the case studies was not systematic, and the two new core elements (temporal management and identity management) of the revised LAIX-score design framework were not evaluated and implemented in a similar way as the three other parts.

There were a further few important methodological limitations to the study. Implementing a large-scale live audience interaction production was a major undertaking. As described in section 2.3.4, the practical relevance of the in the wild research is fundamentally different to related laboratory research, especially when the research focuses on social interaction with computing systems. In this study, practical relevance was prioritized above methodological accuracy. For example, in this case it was practically impossible to deploy the same systematic data collection approach in all case productions with the available resources. The data collection features of Presemo improved throughout the study, and during the final productions the data collection capabilities were significantly more advanced than in the initial case studies. Developing systematic data collection was challenging for two reasons. First, the event producers in

high profile event productions do not want to engage the audience in additional tasks. They desire to maximize audience attention to the performance and any additional tasks, such as research interventions, are considered a nuisance. Generally, our own experience[196] is that when the production is flexible and can accommodate extensive data collection and manipulation, these productions also provide fewer insights. Another reason is that as a producer for live audience interaction we have been fully engaged with the productions tasks and have a limited capability to focus on data collection during such productions. For these reasons, we have often relied on automatic data collection and applying post-production reflection methods in research. One way to bypass this challenge would have been to outsource research data collection to other researchers or take the researcher role in some productions instead of the practitioner role. Recruiting a researcher to case productions is a resource and coordination challenge. Outsourcing a practitioner perspective would have been challenging, since few individuals are available who have the appropriate competence (professional experience in live audience interaction). Developing systematic data collection can be realized in one study, but focusing on one study alone is inadequate when analysing the generalizability of the framework, which was a core objective for the development of the framework. The live audience interaction domain developed rapidly during the study. In a more mature domain, these practices would have been more stable, and it would have been easier to develop repetitive and systematic research interventions around these established practices.

The six McNamara rules for practice-led research were presented in Chapter 2. The practice-led qualities of the study can be evaluated by examining McNamara's list:

1.      Eliminate – or at the very least, limit –
        the use of the first-person pronoun,

2.      Avoid recourse to one's own experience as
        the basis or justification of the research
        ambition,

3.      Avoid PLR instrumental relations between
        theory and practice; and avoid conflating
        practice with research,

4.      Always write an abstract that equally
        encompasses one's creative practice and
        the exegesis and/or thesis component,

196)
For example,
the difference
between the first
and other Meta-
groups productions.
The first produc-
tion had limited
data collection,
but the production
itself was much
more interesting
than the other two.

197)
First pronoun (I)
is used in limited
ways mainly only to
describe what was
my role in the case
study productions.
The fourth pronoun
(We) is used more,
but not only to
eliminate the first
pronoun, but since
the research is
collective effort
and the referred
actions and obser-
vations have been
collective efforts.

5.      Good PLR can acknowledge
        other research paradigms, and

6.      Avoid defining PLR as more self-
        reflexive than other research methods.

1.      This research applies the first-person pronoun
in only a limited way[197]. Overall, the research productions
were collective efforts and more than 10 other researchers
were actively involved in the research efforts. The col-
lective nature of the research minimized the bias that can
emerge from the first-person focus on practice-led orien-
tation, as used in this study.

2.      The study presents a background for live audience
interaction and explains how the phenomenon is generic and
will possibly become more significant in the future. This
study has direct commercial relevance and the results have
already been utilized by several organizations. Hence,
this research was not justified by personal ambitions, but
was rather motivated by solid reasoning and market demand.

3.      The underlying theory was a weak part of this
research. The research structure was systematic, and
the study involved systematic, empiric data collection.
The core reference frameworks were not academic, but
were widely established and relevant to the domain.
The research was built on the results of case studies,
which is not a single established methodology, but merely
a research approach.

4.      The study presents several productions, and only
some of the productions had a creative (artistic) moti-
vation. The artistic element of the research is therefore
not central. All of the core findings were grounded in
analytical reasoning or evaluation. The study acknowledges
the artistic context as an important application area and
an important resource for further insights into live audi-
ence interaction. For these reasons, the fourth element
in McNamara's list was not practically relevant to this
study.

5.      This study was implemented in collaboration with
researchers in different disciplines. This research inter-
faced with for example design research, learning research,
human computer interaction research and performance design
research. The early stages of the research also inter-
acted with affective computing research and service design
research. Hence, this study acknowledged several differ-
ent approaches and disciplines. This investigation made
an action research intervention through developing soft-
ware as a hypothesis , and evaluated the outcome of this
intervention.

6.      The core empirical parts of this study were not
self-reflexive but based on documented productions and

analysis of functional production systems. During the
study we applied several different established research
methods and approaches while conducting focused research
arrangements. Conducting several methodologically inde-
pendent studies within one larger research theme is
aligned with the Benford's practice-led research in
the wild framework presented in Section 2.2.2.

After evaluating the current study against that performed by
McNamara's (2012), the claim that this study does not have
major structural problems as a practice-led research is justified.
This study was systematically structured. The outcomes were con-
crete and implemented in real systems. Overall, the research was
well-resourced and extensive. However, this domain is emerging
and relatively complex. Developing production in this domain
requires orchestration of several people and production capabil-
ities in intensive and time-constrained conditions. Although the
methodological compromise may decrease the research relevance
as an academic reference (perspective A, section 9.1) or applica-
tion of the LAIX-score as a research framework (perspective D,
section 9.1), its focus on constructive development, exploring
new case studies and its generally wide empirical validation was
justified when considering that the core objective of the research
was to develop a LAIX-score framework as a generic framework
for practitioners (perspective C, section 9.1) and advance the
development of live audience interaction management systems
such as Presemo (perspective B, section 9.1).

# 10.

# Further Development and Research Topics

## 10.1 Improving the LAIX-score Design Framework

The revised LAIX-score design framework has five core elements. The framework also defines a more elaborate structure for each element. As such, the LAIX-score design framework is presented as comprehensive model for the management layer (or the platform layer) for live audience interaction (section 9.1). As the research relevance section (9.2) concludes, the LAIX-score framework can be ultimately evaluated against the core objectives only after a significant amount of further business and technical development. We have identified that the current LAIX-Score design framework can be advanced in four ways:

1.      Promote and establish the framework,

2.      Validate the framework with further
        research and experiments,

3.      Concretize the framework with more
        advanced implementations, and

4.      Refine and create more details to
        each element and establish framework
        as a standard.

1.      The core motivation of the LAIX-score design
framework is to advance live audience interaction practice
(discussed further in section 10.3). The framework becomes
effective and useful when more people apply it in prac-
tice and the elements of the framework become well-known
and established concepts in practice. This thesis promotes
this framework and increases the awareness of event pro-
ducers of live audience interaction-related possibilities.

2.      Chapter 9 explains how this study has several
methodological compromises. Further research may further
validate the LAIX-score framework. Two of the new core
elements (temporal management and identity management)
particularly require further validation. Section 10.3
introduces several further research topics. It is also
possible that further research would identify new core
elements for the LAIX-score framework.

3.      Concretization of the framework as software has
been a major focus in our research. The current version
of the Presemo has been released as open source software.
Open source allows other practitioners and developers to
further advance the system. We are continuously developing
new systems; however, LAIMS is a complex software system

and development takes time and resources. Separation of
interaction patterns from the control framework was a cen-
tral outcome of this research. This division emerged from
the first core requirement. We designated this an inter-
action pattern agnostic approach for live audience inter-
action management. The approach and its implications are
discussed in more detail in section 10.2.

4.      The LAIX-score has been described as a design
framework. In order to achieve more concrete practi-
cal applicability, the cue list and log formats could
be established as the file type standard. Overall, all
elements in the LAIX-score framework could be defined
at a more detailed technical level.

## 10.2 Implications of the Interaction Agnostic Approach

The LAIX-score design framework was developed as a generic framework for live audience interaction. The core requirements imply that the framework must support different interaction patterns, roles and functions. When a design framework based on these requirements is developed as a software system, the software system must basically be a modular platform.

Conventional live audience interaction systems (presented in section 4.2) are basically software solutions built on top of specific interaction patterns. The core features and control inherent in these systems is tightly integrated with specific interaction patterns, and as such these software systems do not have platform qualities. The LAIX-score design framework and the Presemo LAIMS as an (limited) implementation of this framework, is an interaction pattern agnostic, which enables introduction of new independent interaction modules. Figure 10.1a visualizes the difference between these two approaches.

LAIX-SCORE DESIGN FRAMEWORK INTRODUCES A MODULAR APPROACH (AN INTERACTION PATTERN AGNOSTIC) FOR THE DESIGN OF LIVE AUDIENCE INTERACTION SYSTEM

Single System Approach

Interaction Feature

Interaction Feature

LIVE AUDIENCE INTERACTION SYSTEM

Modular Approach

Interaction Module

Interaction Module

Interaction Module

LIVE AUDIENCE INTERACTION MANAGEMENT SYSTEM (PLATFORM)

LAIX-score Design Framework
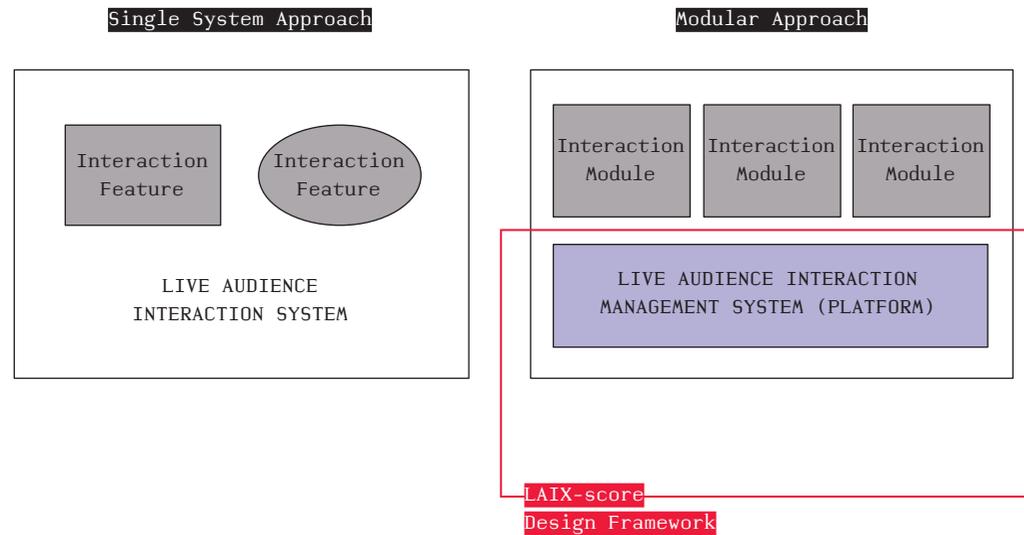
This modular, or interaction pattern agnostic, approach provides at least four important benefits for live audience interaction practice. (1) First, the modular approach allows an easier development of new interaction patterns, and there is no need to develop different management features while introducing new interaction patterns. This is especially important when the new interaction pattern is developed by a third party. This is equivalent to cases in which there is no need to develop a new light control system for a new light fixture (section 4.3). For example, led lights were introduced only recently; however, they can be controlled with old light control systems. Based on our research experience, we claim that the development of management features is a significantly larger challenge than the development of an interaction pattern.

Another (2) important benefit of the interaction agnostic approach and the LAIX-score design framework is that the platform can support both new and old interaction patterns using the same system. It would be a major challenge for event production if participants would be required to change between systems during the production. A major challenge in many productions (such as the Screen.io event productions in section 7.2 and the Lost Lab in section 7.5) is to onboard the audience into the system, and once the event organizer has managed to

onboard the audience, the same system should be applied to all possible interactions.

The third (3) benefit of the modularization is that it allows the development of a common language among practitioners and establishes professional practices for the domain. Presemo, in the University case study, demonstrated how organizations prefer one platform that can serve multiple functions. For organizations, it is infeasible to create organizational conventions for promoting and supporting the use of multiple similar systems. Appropriation of a single dominant framework is also relevant to communities of practice, because the framework provides the basis for defining concepts within the practice. The software platform and skills for using such a platform may also become the foundation for establishing a professional identity among live audience interaction producers.

The fourth (4) aspect is related to the evolution of the live audience interaction domain. A long time is required to develop organizational practices, tutorial material and technical integrations. In order to support evolution, it is important to create a relatively stable platform so that new incremental advancements can be developed with relative ease and without influencing the old systems (backwards interoperability). Standardizing, stabilizing and establishing the control framework enables a focused future development. In short, the development of a modularization layer may support sustainable system evolution and establishment of management practices. This is the equivalent to how the development of a computer system requires the development of operating system platforms, browser platforms and recently mobile and cloud platforms.

However, the modular approach adds complexity and constraints. The design challenge for the modular approach is to create a framework that is adequately comprehensive and generic enough to become the dominant approach while remaining simple enough for practical appropriation. Presemo, in the University case study (section 7.3), demonstrated that the LAIX-score framework scales also work for smaller productions, since teachers have appropriated the system to use in the classroom without any support orchestrators. This finding indicates that the LAIX-score framework does not add an insurmountable amount of complexity for simple uses. We have published Presemo as open source and have organized tutorials for 3rd party Presemo developers. Current impressions indicate that the current Presemo does not provide a good developer experience[199]. It is not, however, possible to evaluate whether the issue of attracting new developers pertains to the quality of the software code of the

I99)
Presemo v.4 open source was launched at the Mindtrek 2015 conference (mindtrek.org). Mindtrek also hosted one tutorial workshop for developers. No new developers commenced extending Presemo after this workshop.

current system, a lack of marketing or in the general structure of the LAIX-score framework. Hence, advancing the appropriation of the framework and the Presemo LAIMS platform among other developers requires further attention and research.

Currently, no other research frameworks or commercial products exist that propose a generic approach for live audience interaction systems. This research focused on the challenge of identifying the requirements and structures for this new layer (the LAIX-score design framework), while maintaining an overall simple and focused design framework. This chapter has explained the practical benefits of such a generic approach. The development of a functional LAIMS system, and the successful execution of several commercial productions in various contexts indicate that a generic approach may be feasible. However, real appropriation and further evolution of the framework will depend on marketing and business development actions.

# 10.3 Further Research Topics for Live Audience Interaction

During this long practice-led investigation into live audience interaction, we have identified several interesting research topics that do not lie within the scope of the LAIX-score design framework. One of the core challenges of this study was identifying the core scope of the research, focus on the development of the practical design framework, and to identify which research topics lay outside the scope of the study. Table 10.3 summarizes the excluded, important research topics. The list defines the research topic, provides a small overview of the topic and briefly introduces how the topic was originally identified.

| FURTHER RESEARCH TOPIC | TOPIC OVERVIEW AND CORE RESEARCH QUESTIONS | ORIGIN OF THE TOPIC IN THIS RESEARCH |
|---|---|---|
| Motivational factors<br>What kind of motivational factors are related to audience participating in live audience interaction? | he audience can be motivated to participate in different ways. There can be intrinsic (e.g., learning) and extrinsic (e.g., reward) motivational factors. | In early production, we struggled to engage the audience in participating in live audience interaction. We have since developed new techniques such as gamification to motivate an audience. |
| Manipulation<br>How can live audience interaction be used to manipulate an audience? | A simple example is that the choice of options in the multiple choice poll defines the answer and function as communication. Overall, organizers have significant power to control audience communication in live audience interaction. | We have systematically developed tools for moderation and guidance for framing questions so that the organizer can meet the communication objectives. The live audience interaction as presented in this thesis is not democratic, but is rather a structured and hierarchical form of communication. |
| Acknowledgement<br>How can the performer be supported to acknowledge audience contributions? | The performer should acknowledge audience contributions. Otherwise, the audience interaction is irrelevant. In a larger event, performers and organizers struggle to acknowledge these interactions, especially text-based contributions. | Performers, orchestrators and audiences continuously complain that there are too many messages and that presenters cannot appropriately address the correct questions. |
| Computational methods<br>How can machine learning and other computational methods be used for sorting and reviewing audience contributions? | Rather than having several moderators and orchestrators, machines can support performers to sort and review audience contributions. | We have been exploring various computation approaches in order to tackle the performers' acknowledgement challenge (see topic above). However, we realized that computational methods can also be used to facilitate group work. |
| Combining physical and digital interaction activities<br>How can physical and digital interactions be combined? | There is physical interaction between audience members and between the audience and presenters that complements or builds on the computer-supported interaction. There are several challenges involved in combining physical and digital interactions, such as how the session can be documented if part of the interaction is physical. | Lost Lab and Metagroups are examples of productions that have a significant amount of physical interaction. |

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| **Integration with the performance**<br>How can live audience interaction be integrated with other performative components? | Live audience interaction is often just one component in the performance. It is sometimes challenging to integrate different performative components. | Chat in production is often used for questions and answers; however, if the presenter or host does not acknowledge audience comments, the chat discussion may become a backchannel, disconnected from the performance. |
| **Big screen**<br>What is the role of a big screen in live audience interaction (the audience manifestation theory)? | Big screens seem to have a major influence on audience engagement and in helping performers to acknowledge audience contributions. | The degree of audience contribution is significantly lower in productions that do not have a big screen or when the big screen in use is not actively visible. The audience is basically made manifest to the performance through the big screen. |
| **Remote participation**<br>How are remote participants integrated with live audience interaction? | How is remote participation different to on-site participation? How can collaboration between remote participants be supported? How can satellite participation be supported? How to can the interaction between remote participants and on-site participation be supported? How does live audience interaction interact with webinar and broadcasting techniques? | Most large audience events have real-time, video-streaming and remote participants. For example, Metagroups had remote participation. An increasing number of future events may be hybrid events. |
| **Social media**<br>How is live audience interaction integrated with and utilizing social media platforms? | How can presentation and management layers be created in addition to social media contributions? How do social media messaging and internal live audience interaction system messaging differ and support each other? How can social media profiles be applied? How should results and messages from live audience interaction system be published with the event identity? | Many event productions utilize for example Twitter for internal and external communications. We have integrated Twitter with Presemo. There has also been a need to integrate social media identities into Presemo. |
| **Functions**<br>Which kind of functions can live audience interaction have? | Live audience interaction can have multiple functions. Research should establish, analyze and extend these functions. | Core requirement 3 elaborates some of the functions of live audience interaction. In addition, there is for example the onboarding function, which has not yet been analyzed in detail. |

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| **Appropriation**<br>How can organizations be supported to appropriate live audience interaction? | Live audience interaction is a complex practice and our experience is that it takes a long time for organizations to appropriate the practice and utilize all of the possible benefits. | Some of our collaboration organizations have been learning to use the system for years and are still struggling to take advantage of all the potential of Presemo. |
| **New interaction patterns**<br>Develop new live audience interaction patterns. | Many possibilities exist to develop new kinds of live audience interaction patterns. | Core requirement 1 was described together with some potential live audience interaction patterns, but there are potentially many more. |
| **Advancing common interaction patterns**<br>Further development of established interaction patterns. | Current common patterns, including poll and chat, can be further developed and extended with more elaborate features. | There is a significant number of new features regarding how for example a chat component can be further developed in the Presemo system. |
| **Interaction between different patterns**<br>Which kind of more elaborate dramaturgical and procedural patterns emerge for live audience interaction in addition to individual interaction patterns? | Live audience interaction patterns can be combined in multiple ways. Some patterns may function as a catalyst. Multiple patterns can be combined for example as a pedagogical structure or a competition. | Live audience interaction patterns can be combined in multiple ways. Some patterns may function as a catalyst. Multiple patterns can be combined for example as a pedagogical structure or a competition. |
| **Anonymity and privacy management behavior**<br>How is anonymity realized in live audience interaction? Why is this important? | Audiences prefer anonymous contributions in certain performative situations. Further research is required into the effect of anonymity and how it should be managed. Data protection and privacy management are also related. | Users and event producers commented that anonymous messages are a preferred feature. Originally, this feature was developed due to a lack of identity management features in the first Presemo. |
| **Domain specific research**<br>Live audience interaction in education. Live audience in business organizations. Live audience interaction in political events. | Forms of meaningful student engagement. Learning outcomes of the application of live audience interaction. Participatory decision making and planning in organizations with live audience interaction. | We have noticed during our case productions that different contexts have different requirements for live audience interaction. An educational context differs from corporate and political contexts. The same approach and platform can be applied to these different contexts. |

The topics presented above would all benefit from a unique in-depth study. During this investigation, we have been advancing and investigating these topics; however, we will leave a more detailed investigation and presentation to other studies. The main motivation for presenting these further research topics as part of the thesis was to demonstrate how wide a topic the live audience interaction is, and how much uncharted territory there is in this domain for future research.

The topics presented in Table 10.2 all have a practice-oriented and constructive flavour. These were identified because they can directly advance the live audience interaction practice. Ultimately analysing, developing and researching the live audience interaction phenomenon is greatly dependent on which primary tools are used in the productions. For example, if different organizations actively apply live audience interaction in decision making, the decision-making applications become increasingly visible and available, and consequently the focus of the research may shift towards management studies and decision-making theories. Another example would be that live audience interaction features are appropriated in social media platforms and the whole practice conflates with social media. This would significantly influence the evolution and appropriation of the practice and direction of the related research. For example, onboarding live audiences to social media groups may become a very significant use case. The relevance of further research topics is largely dependent on the evolution of the practice and availability of research cases. This reasoning further emphasizes the importance of this research to focus on advancing live audience interaction practice and tools. As indicated earlier, we expect that this study will enable future, related research.

## 10.4 Advancing Live Audience Interaction Practice

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Since, this research is focused on advancing live audience interaction practice, it is appropriate to conclude the discussion by analyzing what the study reveals about the dynamics of the practice in general, and what are the future predictions regarding the development of the live audience interaction practice. The development of live audience interaction practice is shortly evaluated from seven perspectives:

1. Availability, accessibility and user experience,

2. New kinds of productions,

3. Development of production conventions,

4. New and more efficient interaction approaches and patterns,

5. Integration with organizational processes,

6. Markets and service developments, and

7. Professional skills for producing live audience interaction.

1. Availability has been a very important topic in the development of live audience interaction services. For example, a large part of the development of our second live audience interaction system (Slides & Polls) was focused on making the system easy to use, easy to manage and more widely available. Again, the decision to make Presemo a completely web-based system largely originated from the observation that web-based systems are more widely accessible and available. Also, as a case study of Presemo by the University of Helsinki revealed, teachers like Presemo because it is easy to use. Another important usability topic is how easily the audience can participate in a live audience interaction session. Achieving ease of use from the audience perspective is not trivial, and there are many design details that may influence this. For example, we prepared for local servers to be used that would utilize local networks for the sake of performance and security. However, when testing this we realized that, regarding easy-of-use and scalability, it is important that a user can choose their own network. In order to make the practice widely adopted, the live audience interaction system should be always available, and all members of the audience should be able to access the session with ease. An example of this is that free live audience interaction systems (such as Kahoot and Socrative) seem to be also the most widely deployed systems[200]. From the beginning of this study (2009) until now (2016), there have been major advancements in the accessibility and availability of live audience interaction. Still, improving availability, accessibility and overall user experience are domains that can be further improved, especially when considering more advanced forms of live audience interaction.

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2. This investigation commenced as an exploration of digitalized interactive cinema experiences and cinema games. The goal was originally to create interactive products for cinema theatre. These large, collocated interactive products form a unique entertainment genre. Experi-

ences gained through the case studies (such as Metagroups, section 7.4 and Lost Lab, section 7.5) demonstrate that live audience interaction can be a unique form of digital communication and entertainment. Currently, there are no established interactive media formats that focus on large collocated computer-supported experiences. My expectation is that unique formats will be developed in the future for both entertainment and professional use, which can be labelled as live audience interaction. These formats will likely be related to games or gamification. Our experience is that gamified events have higher degrees of audience participation, are suitable for all kinds of audiences, and that there are easy and intuitive ways to gamify live audience interaction. Newly established and branded formats will likely spearhead the development of live audience interaction practices.

3.      The LAIX-score framework integrates with common event production practices such as use of a technical cue list (section 7.2.6) and contributes to the final report after the event. The real problem with live audience interaction production is not how it integrates with current event production, but that live audience interaction may require new and more extensive planning and coordination frameworks for event production. Live audience interaction requires real-time coordination and reactivity in a relatively complex organizational configuration. Current performative practices in events originate from non-reactive live performances and hence do not have similar requirements. Instead of adopting practices from event management, the live audience interaction coordination practices could be adopted for example from live television. However, live television productions have much larger resources than most event productions, and for this reason the event production's practices must be more lightweight. A live audience interaction management framework such as the LAIX-score could be further developed as a coordination framework for entire event productions. Before this is relevant, live audience interaction must become more established and a more central part of event productions. Furthermore, event productions and performances will become digitalized. This means that technologies such as light, video, audio, registration and internal communication will be connected to internet and digitalized. IoT technologies may support the adoption of entirely digital and internet-based coordination and management frameworks for performances. This transition may also advance the adoption of adoption of computer-supported live audience interaction.

4.      The Metagroups production (section 7.4) is a good example of how, with some small improvements, it is possible to significantly increase the scale of audience participation. Our expectation is that current live audience interaction patterns such as idea collection with peer-review (section 7.4.3) are not optimal for most

circumstances. It is possible to create better interaction patterns that utilize different performative and orchestration practices, more sophisticated algorithms, computational support for analysing audience comments, different types of group structure orchestration and improved visualizations. Such new patterns can improve the efficiency of live audience interaction and lower the threshold for taking live audience interaction in use in various live situations. Furthermore, more skilled organizers, better integration with organizational processes, improved audience media literacy and popularized deliverable formats can also further establish the practice and advance the adoption of live audience interaction techniques as a large-scale social communication and participation technique.

5.      Organizations have many kinds of communication tools. Organizational use includes for example events, meetings, email, intranet, internal magazines, and webcasts for their communication needs. Live audience interaction affords new communication possibilities for organizations because it produces scalable, procedural and real-time orchestration of communication, and efficient management of audience attention and action. Live audience interaction practice becomes more significant when integrated with organizational processes. Hence, the design of live audience interaction productions should not focus on performance design and event design practices, but more generally on how the live audience interaction integrates with organizational communication processes.

6.      Live audience interaction services can be distributed in at least in four different ways. First, live audience interaction services can be a feature within existing communication platforms such as social media, event applications, intranet, content management system, learning management system or webcasting. Second, live audience interaction services can be sold as software, as a service through cloud computing platforms, or deployed as a server program in an organization's own computing environment. Presemo, at the University of Helsinki (section 7.3), is an example of this kind of distribution model. Third, live audience interaction services can be offered as a physical service, similar to other forms of event technology. Therefore, a professional orchestrates and operates the system on behalf of the event organizer. The Screen.io event services case study (section 7.2) is an example of this kind of distribution model. Fourth, live audience interaction services can also be distributed as productized event formats, as discussed in point 2 above. Currently, none of these commercialization pathways are globally established; however, development is occurring on all frontiers. It is possible and expected that advancements within one distribution model may lead to advancements in other marketing channels, as it increases the overall awareness of the benefits of live

audience interaction. Based on the experiences gained from this study, different event productions seem to have the need for different kinds of distribution models. For this reason, none of the four distribution models would become dominant. As concluded in section 10.2, the business and marketing development is the most important area for further development of the live audience interaction domain. Established production practices, developing new production formats, maximizing tool availability, integrating live audience interaction with organization processes and funding new technical developments are all dependent on commercial development. For this reason, it is important to understand and focus on different marketing approaches.

7.      Engaging the audience in live audience interaction requires unique skills. Performers must learn how to frame different interaction patterns and how to acknowledge contributions. Orchestrators must learn how to moderate contributions and support performers. Organizers must learn how to plan different interaction activities and create overall rhythm for the interactive live production. Live performers and orchestrators must be able to fluently use the system so that they can react and improvise during the production. Creating systems that are intuitive and material that supports appropriation and learning is important for the domain. Having access to good examples is likely the best way to learn. Most new productions have emerged when somebody has been in the audience and wants to try the same thing in a new context. Based on our experience, live audience interaction is more engaging and productive when it is focused and integrated with the content and follow-up action. Generic interactions such as Q&A may be beneficial, but often have marginal engagement and interest in comparison with the targeted activities. Creating targeted audience interactions requires the integration of the interaction and event designs. Achieving such integration requires that the people designing the events have live audience interaction skills.

Ultimately, what is required is a positive feedback loop where established practices create a more skilled event professional who can then design better interactive event productions. These productions function as a tutorial and example for others, who then appropriate the practice and create more demand for services and systems. Increased demand ultimately provides resources for further establishing the practice and creation of better tools for producing live audience interaction. We hope that the LAIX-score design framework can contribute to initiating this positive feedback loop.

# 11.

# Final Conclusion

When this thesis study was started, live audience interaction was not an established domain. Today there are several products available for live audience interaction and it is common that some kind of computer-supported interaction technique is used in an event. However, my prediction is that the markets for live audience interaction are still emerging. Also, the techniques, systems and practices can be developed much further. The LAIX-score design framework is developed based on the expectation that there is more demand for more complex live audience interaction patterns. Such interactions are especially useful when the outcome of audience interaction is an integral part of organizational processes. It will take time before organizations can adopt large-scale audience interaction for their needs because audience interaction is fundamentally a relatively complex social practice that requires skills and experience. My expectation is that new interactive live productions may become a significant new form of entertainment, improve organizational communication and practices, and also influence event productions practices. Presemo is a practical tool for live audience interaction based on LAIX-score design framework. Presemo is already in persistent use. If live audience interaction becomes more widely adopted approach there will also be more practical use for the LAIX-score design framework beyond Presemo.

# Appendixes

## a : Software Systems

This chapter presents software systems that we have been developing during this thesis research. There is a list of live audience interaction systems (Presemo, Slides&Polls, Q?, Screen.io web mixer) and then there is a chronological list of software systems that have functioned as enablers for live audience interaction productions or predate live audience interaction trials.

## LIVE AUDIENCE INTERACTION MANAGEMENT SYSTEMS (LAIMS)

PRESEMO (PRESEMO VERSION.1) (2009-2011)

| | |
|---|---|
| SYSTEM DESCRIPTION | Slides & Polls was based on XMPP messaging protocol and native Mac OSX client built on top of Conduit Framework for control interface. |
| USE | Presemo system supported various interactions such as polls and chatting. Presemo was also integrated to Google Docs for group working features and different kind of physiological sensors. |
| DEVELOPMENT PROCESS | Presemo was developed in a research projects by Pauli Ojala and Petri Lievonen. |
| DISSEMINATION | Original Presemo was partly disseminated by Liikkanen (2011) in CHI conference as part of Brainstormer dissemination. |

SLIDES & POLLS (BY SCREEN.IO, ALSO PRESEMO V.2) (2012-2013)

| | |
|---|---|
| SYSTEM DESCRIPTION | Slides & Polls was based on XMPP messaging protocol and native Mac OSX client built on top of Conduit Framework for control and session management. |
| USE | Presenters and teachers in for live participation in over 10 countries have used Slides & Polls. Slides & Polls has been the environment for many production during 2012 and still 2013 such as iKnow (in the section 7.2) and productions studied in the emerging norms of collocated chat (study case in the section 6.3) |
| DEVELOPMENT PROCESS | Slides & Polls was developed based on Presemo but as a commercial product in a research spinout. Main focus was on session preparation and configuration interfaces and control interfaces. |
| DISSEMINATION | Design of Slides & Polls has not been disseminated separately. Slides and Polls was released in Mac Appstore 2012. |

PRESEMO V.3A (2012-2013)

| | |
|---|---|
| SYSTEM DESCRIPTION | Web-based live participation platform that support simple choice questions and chatting. |
| USE | Presemo v.3 was used in some productions like the case study presented in Section 7.4 (Metagroups) and in some other production cases. |
| DEVELOPMENT PROCESS | Presemo v.3 was developed by Petri Lievonen. The system utilized the webmixer design, but was technically inadequate for professional productions. |
| DISSEMINATION | Referred only in the Metagroups dissemination |

PRESEMO V.3B OR Q? (2012-2013)

| | |
|---|---|
| SYSTEM DESCRIPTION | Web-based live participation platform that support simple choice questions and chatting. |
| USE | Q? was not used in any real production. The system design and features functioned as a benchmark for other parallel development. |
| DEVELOPMENT PROCESS | Q? was developed by a student project. I was a tutor and client for this project. |
| DISSEMINATION | Not disseminated publicly (part of Aalto internal student course review process) |

PRESEMO V.4 SCREEN.IO (PRESENTED AS PRESEMO IN THE STUDY,
ALSO KNOWN AS SCREEN.IO LIVE PARTICIPATION SYSTEM OR WEBMIXER) (2013-)

| | |
|---|---|
| SYSTEM DESCRIPTION | Screen.io Mixer is based on Node.js and various other Javascript libraries. All interfaces are web-based. The system is described in more detail in the section 11.2. |
| USE | Screen.io Mixer is the live participation system that we have been using for most of our productions after 2013. System has been used for example in the productions described in the sections 5.4, 6.2, 7.3, 8.3, 9.2 and 9.3. |
| DEVELOPMENT PROCESS | Screen.io Mixer has been developed by Petri Lievonen and supported by Jukka Reitmaa. I have been co-design the system, managing the development and related productions. Screen.io mixer is a new system developed based on research prototypes developed. Development is still ongoing. There has been new release of the Mixer platform every half a year. |
| DISSEMINATION | The design of Screen.io Mixer has been published as an open source (Mindtrek 2015 conference) and referred in publications such as Kuikkaniemi (2013a), Kuikkaniemi (2014b), Nelimarkka (2015), Nelimarkka (2016) and Leinonen (2014) |

# ENABLING SOFTWARE

## INTERACTIVE STORYTREE (2004)

| SYSTEM DESCRIPTION | Interactive network visualization for text snippets. Was developed on top of MUPE platform. (Suomela 2004) |
|---|---|
| USE | Idea of the interactive storytree was to evolve the idea of message walls and individual messages to message threads and connected stories. Everybody could post continuation to the story and fork the story. |
| DEVELOPMENT PROCESS | I did the interface development and design. Janne Vuorenmaa developed the backend. |
| DISSEMINATION | Presented in the ISEA (International Symbosium for Electronic Artist) 2004 |

## MAR TOOLKIT (MOBILE AUGMENTED-REALITY TOOLKIT) 2004-2005

| SYSTEM DESCRIPTION | Mobile augmented-reality toolkit consisted four technical elements – marker-reading, big screen component, map interface and silent communicator. Was developed on top of MUPE platform. (Suomela 2004) |
|---|---|
| USE | MAR toolkit was intended for developed pervasive gaming. System had a large big screen component. One game called Mupelandyard was developed on top of the platform. |
| DEVELOPMENT PROCESS | Developed by student project group (8 members). I was the tutor and project owner for the student group. |
| DISSEMINATION | Disseminated in MUM 2006 (Kuikkaniemi 2006) |

## SHIGERU PLATFORM (PALM BEACH AND GALACTIC TRIVIA) 2009-2010

| SYSTEM DESCRIPTION | Shigeru platform was developed on MUPE platform. (Suomela 2004). Was intended for making cinema games. 2 games were developed with the platform – Palm Beach and Galactic Trivia. |
|---|---|
| USE | Palm Beach and Galactic Trivia developed and tested in cinema setting. More about the project can be found from case description in the section 4.2. |
| DEVELOPMENT PROCESS | Developed by student project group (8 members). My role was the tutor and project owner for the student group. |
| DISSEMINATION | Disseminated only in Pervasive Gaming blog (2009) |

## KUPLA / FIZZYVIS (2010)

| SYSTEM DESCRIPTION | Original Kupla interface (also known as Fizzyvis at that time) was developed in |
|---|---|
| USE | Multiuser browsing environment for public places. Utilized physics modeled content widgets. Setup for example 2010 Pori Jazz festival (biggest music festival in Finland) and 2012 Cebit. |
| DEVELOPMENT PROCESS | I was project manager and co-designer. Designer and researcher Celine Coutrix. Developer Ivan Avdouevski. |
| DISSEMINATION | Disseminated in DPPI (Coutrix, Kuikkaniemi 2011) |

## MOON RUSH (2010-2012)

| SYSTEM DESCRIPTION | Moon Rush is a cinema game evolution based on Palm Beach. |
|---|---|
| USE | System was demonstrated in several venues and we organized for example Moon Rush study for testing cinema gaming in different physical context. |
| DEVELOPMENT PROCESS | Moon Rush was developed by Max Vilkki. I was a project manager and co-designer. The project lasted almost two years. The system and related study is presented in the section 4.3. |
| DISSEMINATION | Moon Rush has been demonstrated in several venues, but the system has not been disseminated in any academic venues. |

## KUPLA (2009-2012)

| SYSTEM DESCRIPTION | Original Kupla interface (also known as Fizzyvis at that time) was developed by using Cornerstone environment for Multitouch screens (Multitaction.com). |
|---|---|
| USE | Kupla was used in festivals and conferences as a walk-up-and-use playful information presentation display system. |
| DEVELOPMENT PROCESS | I was project manager and co-designer in the origingal Kupla development. Designer and researcher in the project was Celine Coutrix. System was developed by Ivan Avdouevski and Toni Laitinen. Kupla was integrated also to Presemo system. |
| DISSEMINATION | Disseminated in DPPI (Coutrix 2011) |

## KUPLA UNITY + CMS (2012-)

| | |
|---|---|
| SYSTEM DESCRIPTION | Kupla Unity is a revised version of the original Kupla. It follows similar design guideline, but technically is completely new system and includes also integrated content management system and support for multiple connected screens. |
| USE | Kupla Unity has been demonstrated in multiple venues such as Mobile World Congress 2013 and Cebit 2014. There are more 7 permanent Kupla Unity installations. Kupla support information browsing and ad-hoc presentations. Kupla functions as a example of direct manipulation big screen interface for live participation. |
| DEVELOPMENT PROCESS | I was project manager and designer in the Kupla Unity and responsible of most installations. Kupla Unity interface is developed by Jouni Ojala and content management system by Max Vilkki. |
| DISSEMINATION | Disseminated for example in TEI 2014 (Kuikkaniemi 2014) and ITS 2013 (Kuikkaniemi 2013b) |

## SPACEIFY (2013-)

| | |
|---|---|
| SYSTEM DESCRIPTION | Spaceify is cloud-edge-space system that supports collocated computing. It allows local computing and integration of personal computing devices with space resources such as big screens and sensors. |
| USE | Spaceify platform has been used for example in big screen gaming (Ducks and Pirates in the section 4.3) and pervasive gaming (Lost Lab in the section 7.3). |
| DEVELOPMENT PROCESS | I was project manager in the original Spaceify project and after that I have been involved in co-designing Spaceify system and different Spaceify applications. Project is currently continuing mainly with different big screen applications.<br><br>Original Spaceify project team: Professor Sumi Helal, Professor Giulio Jaccuci, Professor Marko Turpeinen, Professor Sasu Tarkoma, Mikko Rinne, Jukka Reitmaa<br><br>Spaceify development team:<br>Petri Savolainen, Jouni Vepsäläinen, Jouni Ojala |
| DISSEMINATION | Spaceify system has disseminated for example in Mobicom 2013 (Savolainen 2013) |

## LOST LAB SYSTEM (2013-2014)

| | |
|---|---|
| SYSTEM DESCRIPTION | HCE system is a environment for pervasive gaming that supports for example navigation (GPS, Augmented reality navigation markers), various checkpoints and remote control. The system is described in the section 7.3 Lost Lab study case. |
| USE | HCE system has been deployed once in the Millennium Prize pavilion for middle-school teenagers. |
| DEVELOPMENT PROCESS | I was the producer and co-designer in the project and led the dissemination. Project development started in 2013. Project was span in to Bitsign project (Bitsign.com)<br><br>Development team:<br>Mikko Gynther, Alain Boyer, Petri Lievonen, Max Vilkki , Jouni Ojala, David Lindbauer, Petri Savolainen<br><br>Design team:<br>Dorita Hannah, Maiju Loukola,<br>Mirka Uski, Kristina Sedlerova<br><br>Research team:<br>Andres Lucero, Valeria Orso,<br>Giulio Jacucci, Matti Nelimarkka |
| DISSEMINATION | Disseminated in ACE 2014 (Kuikkaniemi 2014b) |

## B : Publications

These are the academic papers that are directly related to the live audience interaction research.

Liikkanen, L. A., Kuikkaniemi, K., Lievonen, P., & Ojala, P. (2011, May). Next step in electronic brainstorming: collaborative creativity with the web. In CHI'11 Extended Abstracts on Human Factors in Computing Systems (pp. 2029-2034). ACM. (WIP conference paper)

Kuikkaniemi, K., Nelimarkka, M., Lievonen, P., Reitmaa, J. (2013): MetaGroups : a method for collective innovation at large conferences. CO-CREATE 2013. The Boundary Crossing Conference on Co-Design in Innovation. Aalto University Simlab publication.

Nelimarkka, M., Kuikkaniemi, K., & Jacucci, G. (2014, November). A Field Trial of an Anonymous Backchannel Among Primary School Pupils. In Proceedings of the 18th International Conference on Supporting Group Work (pp. 238-242). ACM.

Kai Kuikkaniemi, Andrés Lucero, Valeria Orso, Giulio Jacucci, and Marko Turpeinen (2014b). Lost lab of professor millennium: creating a pervasive adventure with augmented reality-based guidance. In Proceedings of the 11th Conference on Advances in Computer Entertainment Technology (ACE '14). ACM, New York, NY, USA

Nelimarkka, M., Lehtinen, V., Ukkonen, A., Kuikkaniemi, K., & Jacucci, G. (2015). Threading and conversation in co-located chats. Computers in Human Behavior, 53, 324-331.

Nelimarkka, M., Kuikkaniemi, K., Salovaara, A., & Jacucci, G. (2016, June). Live Participation: Augmenting Events with Audience-Performer Interaction Systems. In Proceedings of the 2016 ACM Conference on Designing Interactive Systems (pp. 509-520). ACM.

Related papers, organized workshop, workshop papers and book chapters. These are my secondary papers that have been enabling the live audience interaction research.

Kuikkaniemi, K., Turpeinen, M., Salovaara, A., Saari, T., & Vuorenmaa, J. (2006, December). Toolkit for user-created augmented reality games. In Proceedings of the 5th international conference on Mobile and ubiquitous multimedia (p. 6). ACM.

Nacke, L. E., Drachen, A., Kuikkaniemi, K., Niesenhaus, J., Korhonen, H. J., Hoogen, V. D. W., ... & Kort, Y. (2009). Playability and player experience research. In Proceedings of DiGRA. (panel presentation in a conference)

Kaario, P., Vaajakallio, K., Lehtinen, V., Kantola, V., & Kuikkaniemi, K. (2009, November). Someone Else's Shoes-Using Role-Playing Games in User-Centered Service Design. In CONFERENCE PROCEEDINGS ServDes. 2009 (p. 119). (full paper in a conference)

Kuikkaniemi, K., Laitinen, T., Turpeinen, M., Saari, T., Kosunen, I., & Ravaja, N. (2010a, April). The influence of implicit and explicit biofeedback in first-person shooter games. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 859-868). ACM. (Full paper in a conference)

Kuikkaniemi, K., Turpeinen, M., Korhonen, H., Ravaja, N., Chanel, G., & Nacke, L. (2010b). BioS-Play: Workshop on Multiuser and Social Biosignal Adaptive Games and Playful Applications. In Fun and Games 2010 Workshop. Leuven, Belgium. ACM.

Kuikkaniemi, K., Laitinen, T., Turpeinen, M., Saari, T., Kosunen, I., & Ravaja, N. (2010c, April). The influence of implicit and explicit biofeedback in first-person shooter games. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 859-868). ACM.

Chanel, G., Pelli, S., Ravaja, N., & Kuikkaniemi, K. (2010). Social interaction using mobile devices and biofeedback: effects on presence, attraction and emotions. In BioSPlay Workshop, Fun and Games Conference. (workshop paper)

Hinrichs, U., Valkanova, N., Kuikkaniemi, K., Jacucci, G., Carpendale, S., & Arroyo, E. (2011b, May). Large displays in urban life-from exhibition halls to media facades. In CHI'11 Extended Abstracts on Human Factors in Computing Systems (pp. 2433-2436). ACM. (organized workshop)

Coutrix, C., Kuikkaniemi, K., Kurvinen, E., Jacucci, G., Avdouevski, I., & Mäkelä, R. (2011, June). Fizzyvis: designing for playful information browsing on a multitouch public display. In Proceedings of the 2011 Conference on Designing Pleasurable Products and Interfaces (p. 27). ACM.

Kuikkaniemi, K., Jacucci, G., Turpeinen, M., Hoggan, E., & Müller, J. (2011). From space to stage: How interactive screens will change urban life. Computer, (6), 40-47. ACM.

Savolainen, P., Helal, S., Reitmaa, J., Kuikkaniemi, K., Jacucci, G., Rinne, M., ... & Tarkoma, S. (2013, September). Spaceify: A client-edge-server ecosystem for mobile computing in smart spaces. In Proceedings of the 19th annual international conference on Mobile computing & networking (pp. 211-214). ACM. (Poster in a conference)

Kuikkaniemi, K., Vilkki, M., Ojala, J., Nelimarkka, M., & Jacucci, G. (2013b, October). Introducing Kupla UI: a generic interactive wall user interface based on physics modeled spherical content widgets. In Proceedings of the 2013 ACM international conference on Interactive tabletops and surfaces (pp. 301-304). ACM. (conference demonstration)

Leinonen, T.; Durall, E.; Kuikkaniemi, K.; Mikkonen, T.; Syvänen, A.; Nelimarkka, M.; Toikkanen, T. (2014): Design for Learning: Enhancing Participation in Learning through Design Thinking. World Conference on Educational Multimedia, Hypermedia and Telecommunications. (organized session in a conference)

Kuikkaniemi, K., Lehtinen, V., Nelimarkka, M., Vilkki, M., Ojala, J., & Jacucci, G. (2014, February). Designing for presenters at public walk-up-and-use displays. In Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction (pp. 225-232). ACM.

Vepsäläinen, J., Di Rienzo, A., Nelimarkka, M., Ojala, J. A., Savolainen, P., Kuikkaniemi, K., ... & Jacucci, G. (2015, November). Personal Device as a Controller for Interactive Surfaces: Usability and Utility of Different Connection Methods. In Proceedings of the 2015 International Conference on Interactive Tabletops & Surfaces (pp. 201-204). ACM.

Vepsäläinen, J., Savolainen, P., Ojala, J., Di Rienzo, A., Nelimarkka, M., Kuikkaniemi, K., ... & Jacucci, G. (2016). Web-Based Public-Screen Gaming: Insights from Deployments. IEEE Pervasive Computing, 15(3), 40-46.

## C : Research projects

This appendix lists all research projects that have been somehow related to the live participation research. Most projects have provided complementary resources, developed competencies related to enablers and insights that have supported live participation research. Research projects focusing directly on live participation are Emokeitai, S3, Lead, Marianne and Re:Know2.

| PROJECT NAME (YEAR) | FUNDING SOURCE | PROJECT LINK TO LIVE PARTICIPATION | TEAM AND MY ROLE |
|---|---|---|---|
| MC2 (mobile content communities) (2002-2004) | National / Tekes | Platform for exploring pervasive gaming and new designs for social games. Exposed to social gaming and mobile gaming. | Four research teams and 10 companies. |
| MoMUPE (2005-2007) | National / Tekes | Different public screen interaction developments. | Lead by Nokia, Several universities. I was managing development in Helsinki University of Technology side. |
| Fun of Gaming (FUGA) (2006-2009) | EU FP6 Fuga. aalto.fi | Development of game systems and game experience measurement systems. | 6 European universities Researcher, managing development project. |
| Extreme Design (2008-2010) | National / Tekes | New service design methodology. Exposing to workshop methods that can be translated to live participation. | Aalto Design Project manager and researcher |
| Games as services (GAS) (2008-2010) | National / Tekes / | Games business. Studies on arcade experience and collocated gaming experience. Development of Cinema games. | Researcher. Several researchers and company partners. |
| Emokeitai (2009-2011) | National / Tekes / Ubicomp | Development of first live participation systems. Development system for measuring collocated experiences. Integrating live participation and psychophysiology. | Project manager and researcher. Leading development of live participation systems. hiit.fi/emokeitai |
| S3 (2009-2011) | National / Tekes | Development and trialing live participation systems in different environments.. Development of Kupla system. | Project manager and researcher. Leading development of big screen interfaces. hiit.fi/s3 |

| | | | |
|---|---|---|---|
| Reweb (2011-2012) | National / Tekes | Development of different techniques for live participation. | Project manager. Smaller research project. |
| Fidipro / Sumi Helal (2011-2014) | National / Tekes / Fidipro | IoT systems and HCI. Development of Spaceify platform. | Project manager. Collaboration with professor Sumi Helal from University of Florida. |
| Public Living Labs (2011-2013) | EU / EIT ICT Labs | Experimenting use of large public screen interaction and performer interaction (Kupla). | Coordinating the development in Helsinki side. Large and long international collaboration with KTH Stockholm and TU Berlin. |
| EFX (EIT Office Experience) (2012) | EU / EIT ICT Labs | Developing new office space concepts that realize also live participation. | Project leader. |
| Play Society | National / Tekes / Next Media | Exploring differences between gamification and playification. | One of the researcher's in the project. Main collaboration with Nokia. |
| Interactive Shopping Window (2014) | EU / EIT ICT Labs | Development of Spaceify system and large interactive big screen systems. | One of the researcher's in the project. |
| Lead (2012-2014) | National / Tekes / Learning Solutions | Exploring live participation for educational and organization context. Digital learning environments. | One of the researcher's in the project. Reponsible of managing the live participation development. |
| Marianne (2013-2015) | Private fund | Experimenting with live participation and remote participation. | Live participation producer and co-designer in the productions. |
| Street Smart (2014) | EU / EIT ICT Labs | Developing Lost Lab production. Large pervasive experiences. | Producer and co-designer in the primary production of the project. |
| Re:Know2 (2015-) | National / Tekes / Strategic | Developing new live participation techniques that support computation, data management and remote participation. | Work package responsible. Responsible research in live participation research. |

# D : Glossary

DESIGN FRAMEWORK
In this study the design framework is focused on specifying the core structure and elements for a generic live audience interaction management system. The same framework can be also applied in development of production practices. In live audience interaction design framework could be also applied in the experience design or in the analysis of the experience.

INTERACTION ACTIVITY
Instance of an interaction pattern. Interaction activity is one of the core elements of the LAIX-score design framework. It is notable that in a same production there can be multiple interaction activities that are based on same interaction pattern, such as there can be many polls with different questions.

INTERFACE CHANNEL
Concept describing the user interfaces in the LAIX-score. Channel concepts refers to the live audio mixing and live light control systems and how LAIMS is designed for creating and managing the interface channels similarly as audio mixing control audio channels.

INTERACTION PATTERN (IN LIVE AUDIENCE INTERACTION):
The live audience interaction pattern is a repeatable and well-specified interaction approach that often expects specific support from live audience interaction management system. Generally, interaction design pattern is repeatable solution to some use case need or usability problem. The interpretation and treatment of interaction pattern is aligned with the game design patterns introduced by Björk and Holopainen (2004)

INTERACTION PATTERN AGNOSTIC DESIGN
Live audience interaction management system has an interaction pattern agnostic design, when the management features are not dependent on the details of any commonly used or known interaction pattern, but the same management system can be used for all kinds of interaction patterns.

(COMPUTER-SUPPORTED) LIVE AUDIENCE INTERACTION
Live audience situation, which involves some form of performance that facilitates audience interaction by utilizing the personal computing devices.

LIVE AUDIENCE INTERACTION MANAGEMENT SYSTEM (LAIMS)
Computer system that facilitates live audience interac-
tion. Commonly provides screen interface, management
features and an audience interface.

STATE CONTROL MATRIX
State control matrix defines the interaction activity
visibility in the corresponding interface channel. State
control matrix is the core control structure for the LAIX-
score design framework. State control matrix is core ele-
ment of the LAIX-score design framework.

## e : References

Atkinson, C. (2009). The backchannel: how audiences are using Twitter and social media and changing presentations forever.

New Riders.Benford, S., Crabtree, A., Reeves, S., Sheridan, J., Dix, A., Flintham, M., & Drozd, A. (2006, April). The frame of the game: blurring the boundary between fiction and reality in mobile experiences. In Proceedings of the SIGCHI conference on Human Factors in computing systems (pp. 427-436). ACM.

Benford, S., Giannachi, G., Koleva, B., & Rodden, T. (2009, April). From interaction to trajectories: designing coherent journeys through user experiences. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 709-718). ACM.

Benford, S., Greenhalgh, C., Crabtree, A., Flintham, M., Walker, B., Marshall, J., ... & Row Farr, J. (2013). Performance-led research in the wild. ACM Transactions on Computer-Human Interaction (TOCHI), 20(3), 14.

Bergstrom, T., Harris, A., & Karahalios, K. (2011). Encouraging initiative in the classroom with anonymous feedback. In Human-Computer Interaction–INTERACT 2011 (pp. 627-642). Springer Berlin Heidelberg.

Bonwell, C.; Eison, J. (1991). Active Learning: Creating Excitement in the Classroom AEHE-ERIC Higher Education Report No. 1. Washington, D.C.: Jossey-Bass.

Chanel, G., Pelli, S., Ravaja, N., & Kuikkaniemi, K. (2010). Social interaction using mobile devices and biofeedback: effects on presence, attraction and emotions. In BioSPlay Workshop, Fun and Games Conference.

Caldwell, J.E. (2007). Clickers in the large classroom: Current research and best-practice tips. Life Sciences Education, 6(1), 9-20.

Correia, N. N., & Kleimola, J. (2014, November). Web browser as platform for audiovisual performances. In Proceedings of the 11th Conference on Advances in Computer Entertainment Technology (p. 31). ACM.

Coutrix, C., Kuikkaniemi, K., Kurvinen, E., Jacucci, G., Avdouevski, I., & Mäkelä, R. (2011, June). Fizzyvis: designing for playful information browsing on a multitouch public display. In Proceedings of the 2011 Conference on Designing Pleasurable Products and Interfaces (p. 27). ACM.

Cruz e Costa J, Ojala T & Korhonen J (2008). Mobile Lecture Interaction: Making technology and learning click. Proc. Mobile Learning 2008, 11-13 April, Algarve, Portugal, 119-124.

Dalsgaard, P. (2010, November). Research in and through design: an interaction design research approach. In Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction (pp. 200-203). ACM.

Dellos, Ryan. "Kahoot! A digital game resource for learning." INSTRUCTIONAL TECHNOLOGY (2015): 49.

Dennis, A. R., Valacich, J. S., Connolly, T., & Wynne, B. E. (1996). Process structuring in electronic brainstorming. Information Systems Research, 7(2), 268-277.

Dennis, A., Pinsonneault, A., Hilmer, K. M., Huber, M., & Bellavance, F. (2007). Patterns in Electronic Brainstorming. Emerging e-collaboration concepts and applications, 193.

Du, H., Rosson, M. B., & Carroll, J. M. (2012, October). Augmenting classroom participation through public digital backchannels. In Proceedings of the 17th ACM international conference on Supporting group work (pp. 155-164). ACM.

Fallman, D. (2005) Why Research-oriented Design Isn't Design-oriented Research, Proceedings of Nordes: Nordic Design Research Conference, May 29-31, Copenhagen, Denmark.

Faste, T., & Faste, H. (2012). Demystifying "design research": Design is not research, research is design. Proceedings of the IDSA.

Geerts, D., Leenheer, R., De Grooff, D., Negenman, J., & Heijstraten, S. (2014, June). In front of and behind the second screen: viewer and producer perspectives on a companion app. In Proceedings of the 2014 ACM international conference on Interactive experiences for TV and online video (pp. 95-102). ACM.

Getz, D. (2013). Event studies. Routledge.

Goffman, E. (1949). Presentation of Self in Everyday Life. American Journal of Sociology, 55, 6-7.

Gouran, D. S. , & Hirokawa, R. Y. (1983). The role of communication in decision-making groups: A functional perspective. In M. S. Mander (Ed.), Communications in transition (pp. 168–185). New York: Praeger. (book)

Gouran, D. S. , & Hirokawa, R. Y. (1996). Functional theory and communication in decision-making and problem-solving groups: An expanded view. In R. Y. Hirokawa , ed. & M. S. Poole (Eds.), Communication and group decision making (2nd ed., pp. 55–80). Thousand Oaks, CA: Sage. (book)

Gray, C. (1996). Inquiry through practice: developing appropriate research strategies. No guru, no method, 28.

Hackman, J. R., & Vidmar, N. (1970). Effects of size and task type on group performance and member reactions. Sociometry, 37-54.

Hannula, M., Suoranta, J., Vadén, T., Griffiths, G., & Kölhi, K. (2005). Artistic research: Theories, methods and practices. Academy of Fine Arts.

Harry, D., Green, J., & Donath, J. (2009, April). Backchan. nl: integrating backchannels in physical space. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 1361-1370). ACM.

Harry, D. (2012). Designing complementary communication systems (Doctoral dissertation, Massachusetts Institute of Technology).

Hartson, H. R. (1998). Human–computer interaction: Interdisciplinary roots and trends. Journal of Systems and Software, 43(2), 103-118.

Herb, S. and Smith, L. "A review of Poll Everywhere audience response system." Journal of Technology in Human Services 29.3 (2011): 236-245.

Hinrichs, U., & Carpendale, S. (2011, May). Gestures in the wild: studying multi-touch gesture sequences on interactive tabletop exhibits. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 3023-3032). ACM.

Huotari, K. (2014). Experientializing–how C2C communication becomes part of the service experience. Svenska handelshögskolan, 2014

Hutchins, E. (1995). Cognition in the Wild. MIT press.

Jaaniste, Luke O. and Haseman, Bradley C. (2009) Practice-led research and the innovation agenda : beyond the postgraduate research degree in the arts, design and media. In: ACUADS 2009 Conference : Interventions in the Public Domain, 30 September - 2 October 2009, Queensland College of Art, Griffith University, Brisbane, Queensland.

Jacucci, G., Morrison, A., Richard, G. T., Kleimola, J., Peltonen, P., Parisi, L., & Laitinen, T. (2010, April). Worlds of information: designing for engagement at a public multi-touch display. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 2267-2276). ACM.

Johnson, R., Rogers, Y., van der Linden, J., & Bianchi-Berthouze, N. (2012, May). Being in the thick of in the wild studies: the challenges and insights of researcher participation. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1135-1144). ACM.

Kay, R. H., & LeSage, A. (2009). A strategic assessment of audience response systems used in higher education. Australasian Journal of Educational Technology, 25(2).

Kemmis, S., McTaggart, R., & Retallick, J. (Eds.). (2004). The action research planner (2nd ed. rev.). Karachi: Aga Khan University, Institute for Educational Development.

Kerr, N. L., & Tindale, R. S. (2004). Group performance and decision making. Annu. Rev. Psychol., 55, 623-655.

Koleva, B., Taylor, I., Benford, S., Fraser, M., Greenhalgh, C., Schnädelbach, H., ... & Adams, M. (2001, March). Orchestrating a mixed reality performance. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 38-45). ACM.

ten Koppel, M., Bailly, G., Müller, J., & Walter, R. (2012, May). Chained displays: configurations of public displays can be used to influence actor-, audience-, and passer-by behavior. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 317-326). ACM.

Kuikkaniemi, K., Turpeinen, M., Salovaara, A., Saari, T., & Vuorenmaa, J. (2006, December). Toolkit for user-created augmented reality games. In Proceedings of the 5th international conference on Mobile and ubiquitous multimedia (p. 6). ACM.

Kuikkaniemi, K., Laitinen, T., Turpeinen, M., Saari, T., Kosunen, I., & Ravaja, N. (2010, April). The influence of implicit and explicit biofeedback in first-person shooter games. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 859-868). ACM.

Kuikkaniemi, K., Jacucci, G., Turpeinen, M., Hoggan, E., & Müller, J. (2011). From space to stage: How interactive screens will change urban life. Computer, (6), 40-47. ACM.

Kuikkaniemi, K., Nelimarkka, M., Lievonen, P., Reitmaa, J. (2013): MetaGroups : a method for collective innovation at large conferences. CO-CREATE 2013. The Boundary Crossing Conference on Co-Design in Innovation. Aalto University Simlab publication.

Kuikkaniemi, K., Lucero, A., Orso, V., Jacucci, G., and Turpeinen, M. (2014a). Lost lab of professor millennium: creating a pervasive adventure with augmented reality-based guidance. In Proceedings of the 11th Conference on Advances in Computer Entertainment Technology (ACE '14). ACM, New York, NY, USA

Kuikkaniemi, K., Lehtinen, V., Nelimarkka, M., Vilkki, M., Ojala, J., & Jacucci, G. (2014b, February). Designing for presenters at public walk-up-and-use displays. In Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction (pp. 225-232). ACM.

Lane, D., & Atlas, R. (1996). The networked classroom. In meeting of Computers and Psychology.

Lazar, J., Feng, J. H., & Hochheiser, H. (2010). Research methods in human-computer interaction. John Wiley & Sons.

Teemu Leinonen, Tarmo Toikkanen, and Katrina Silfvast. (2008). Software as hypothesis: research-based design methodology. In Proceedings of the Tenth Anniversary Conference on Participatory Design 2008 (PDC '08). Indiana University, Indianapolis, IN, USA, 61-70.

Leinonen, T. (2010). Designing learning tools. Methodological insights. Aalto University.

Leinonen, T.; Durall, E.; Kuikkaniemi, K.; Mikkonen, T.; Syvänen, A.; Nelimarkka, M.; Toikkanen, T. (2014): Design for Learning: Enhancing Participation in Learning through Design Thinking. World Conference on Educational Multimedia, Hypermedia and Telecommunications. (organized session in a conference)

Liikkanen, L. A., Kuikkaniemi, K., Lievonen, P., & Ojala, P. (2011, May). Next step in electronic brainstorming: collaborative creativity with the web. In CHI'11 Extended Abstracts on Human Factors in Computing Systems (pp. 2029-2034). ACM. (WIP conference paper)

Ludvigsen, M. (2006, June). Designing for social interaction: an experimental design research project. In Proceedings of the 6th conference on Designing Interactive systems (pp. 348-349). ACM.

Lukka, K. (2000) The Key Issues of Applying the Constructive Approach to Field Research. In Reponen, T. (ed.) (2000) Management Expertise for the New Millenium. In Commemoration of the 50th Anniversary of the Turku School of Economics and Business Administration. Publications of the Turku School of Economics and Business Administration, A-1:2000, p.113-128.

Lundgren, S., Fischer, J. E., Reeves, S., & Torgersson, O. (2015, February). Designing mobile experiences for collocated interaction. In Proceedings of the 18th ACM Conference on Computer-supported Cooperative Work & Social Computing (pp. 496-507). ACM.

Marshall, P., Morris, R., Rogers, Y., Kreitmayer, S., & Davies, M. (2011, May). Rethinking 'multi-user': an in the wild study of how groups approach a walk-up-and-use tabletop interface. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 3033-3042). ACM.

Masters, J. (1995) The History of Action Research, in I. Hughes (ed) Action Research Electronic Reader, The University of Sydney, online http://www.behs.cchs.usyd.edu.au/arow/Reader/rmasters.htm

McCarthy, J. F. (2005, April). Digital backchannels in shared physical spaces: experiences at an academic conference. In CHI'05 extended abstracts on Human factors in computing systems (pp. 1641-1644). ACM.

McNamara, Andrew (2002), Six rules for practice-led research, Text Journal, http://www.textjournal.com.au/speciss/issue14/content.htm

Miller, G. A. (1956). "The magical number seven, plus or minus two: Some limits on our capacity for processing information". Psychological Review 63 (2): 81–97.

Montola, M., Stenros, J., & Waern, A. (2009). Pervasive games: theory and design. Morgan Kaufmann Publishers Inc.

Müller, J., Walter, R., Bailly, G., Nischt, M., & Alt, F. (2012, May). Looking glass: a field study on noticing interactivity of a shop window. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 297-306). ACM.

Nelimarkka, M., Kuikkaniemi, K., & Jacucci, G. (2014, November). A Field Trial of an Anonymous Backchannel Among Primary School Pupils. In Proceedings of the 18th International Conference on Supporting Group Work (pp. 238-242). ACM.

Nelimarkka, M., Lehtinen, V., Ukkonen, A., Kuikkaniemi, K., & Jacucci, G. (2015). Threading and conversation in co-located chats. Computers in Human Behavior, 53, 324-331.

Nelimarkka, M., Kuikkaniemi, K., Salovaara, A., & Jacucci, G. (2016, June). Live Participation: Augmenting Events with Audience-Performer Interaction Systems. In Proceedings of the 2016 ACM Conference on Designing Interactive Systems (pp. 509-520). ACM.

Nimkulrat, N. (2007). The role of documentation in practice-led research. Journal of Research Practice, 3(1), 6.

Peltonen, P., Kurvinen, E., Salovaara, A., Jacucci, G., Ilmonen, T., Evans, J., ... & Saarikko, P. (2008, April). It's Mine, Don't Touch!: interactions at a large multi-touch display in a city centre. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1285-1294). ACM.

Pears, N., Jackson, D. G. and Olivier, P. (2009) Smart Phone Interaction with Registered Displays, IEEE Pervasive Computing, v.8 n.2, p.14-21, April 2009

Pine, B. J., & Gilmore, J. H. (1999). The experience economy: Work is theatre & every business a stage. Harvard Business Press.

Plattner, H., Meinel, C., & Leifer, L. (2010). Design Thinking: Understand–Improve–Apply. Springer Science & Business Media.

Porter, M. E., & Millar, V. E. (1985). How information gives you competitive advantage. Free Press.

Poels, K., deKort, Y. A. W., & IJsselsteijn, W. A. (2007). Game experience questionnaire. Project deliverable for the EU IST project the fun of gaming.

Prince, M. (2004). Does Active Learning Work? A Review of the Research . Journal of Engineering Education, 93(3), 223-232.

Reeves, S., Benford, S., O'Malley, C., & Fraser, M. (2005, April). Designing the spectator experience. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 741-750). ACM.

Reeves, S., Sherwood, S., & Brown, B. (2010, October). Designing for crowds. In Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries (pp. 393-402). ACM.

Reeves, S. (2011). Designing interfaces in public settings: Understanding the role of the spectator in Human-Computer Interaction. Springer Science & Business Media.

Rogers, Y. (2011). Interaction design gone wild: striving for wild theory. Interactions, 18(4), 58-62.

Rogers, Y. (2012). HCI theory: classical, modern, and contemporary. Synthesis Lectures on Human-Centered Informatics, 5(2), 1-129.

Rowe, G. Peter (1987). Design Thinking. Cambridge: The MIT Press.

Salter, Chris. Entangled: technology and the transformation of performance. MIT Press, 2010.

Savolainen, P., Helal, S., Reitmaa, J., Kuikkaniemi, K., Jacucci, G., Rinne, M., ... & Tarkoma, S. (2013, September). Spaceify: A client-edge-server ecosystem for mobile computing in smart spaces. In Proceedings of the 19th annual international conference on Mobile computing & networking (pp. 211-214). ACM.

Seifert, J. (2015). Mobile mediated interaction with pervasive displays (Doctoral dissertation, Ulm, Universität Ulm, Diss., 2015).

Severt, D., Wang, Y., Chen, P. J., & Breiter, D. (2007). Examining the motivation, perceived performance, and behavioral intentions of convention attendees: Evidence from a regional conference. Tourism Management, 28(2), 399-408.

Summanen I., Liikkanen L., Laakso M. and Leisti-Szymczak A. (2013) Co-developing a new technology for product concept testing with remote users. To appear in the Proc. of Co-Create 2013. Espoo, Finland. 16-19 June. Pp. 685-696. -

Suomela, R., Räsänen, E., Koivisto, A., & Mattila, J. (2004). Open-source game development with the multi-user publishing environment (mupe) application platform. In Entertainment Computing–ICEC 2004 (pp. 308-320). Springer Berlin Heidelberg.

Swartz, C. S. (Ed.). (2004). Understanding digital cinema: a professional handbook. CRC Press.

Tikka, P. (2008). Enactive Cinema: Simulatorium Eisensteinense. Aalto University.

Uysal, M. and Li, X. (2008), "Trends and critical issues in festival & event motivation",in Aktas, A., Kesgin, M., Cengiz, E. and Yenidip, E. (Eds), International Cultural & Event Tourism: Issues and Debates, Detay Yayincilik, Ankara, pp. 10-20.

Vepsäläinen, J., Savolainen, P., Ojala, J., Di Rienzo, A., Nelimarkka, M., Kuikkaniemi, K., ... & Jacucci, G. (2016). Web-Based Public-Screen Gaming: Insights from Deployments. IEEE Pervasive Computing, 15(3), 40-46.

*Wang, A. I., Elvemo, A. A., & Gamnes, V. (2014). Three social classroom applications to improve student attitudes. Education Research International, 2014.*

*Wash, Pamela D. "Taking advantage of mobile devices: Using Socrative in the classroom." Journal of Teaching and Learning with Technology 3.1 (2014): 99-101.*

*Weiser, M. (1991). The computer for the 21st century. Scientific american, 265(3), 94-104.*

*Yardi, S. (2006, June). The role of the backchannel in collaborative learning environments. In Proceedings of the 7th international conference on Learning sciences (pp. 852-858). International Society of the Learning Sciences.*

*Zimmerman, J., Forlizzi, J., and Evenson, S. (2007). Research through design as a method for interaction design research in HCI. CHI07 Proceedings. New York, NY: ACM Press, 493-502.*

*Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010, August). An analysis and critique of Research through Design: towards a formalization of a research approach. In Proceedings of the 8th ACM Conference on Designing Interactive Systems (pp. 310-319). ACM.*

Live audience interaction with personal computing devices can significantly enhance events, workshops, lectures and artistic performances. Computer support can make events more engaging, productive and facilitate efficiently social network and learning. The book presents LAIX–score, which is generic, practical and versatile control approach for all kinds of live audience interaction situations. LAIX-score proposes tool for live situations similar to audio mixing consoles or live light controllers. The study presents the core elements of the LAIX-score framework in detail and explains how the framework can be implemented as a functional computer system for live audience interaction. The book explains the LAIX-score through four live audience interaction case studies. The book presents insights of over seven years of multidisciplinary and practice-led research on computer supported live audience interaction.

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