Social Control Experience Design

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A Cross-Domain Investigation on Media

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presented by

Melanie Berger

Department of Industrial Design
Eindhoven University of Technology

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All our dreams can come true,
if we have the courage to pursue them.

Walt Disney

I dedicate my thesis
to my beloved parents.

Abstract

Integrating smart devices into everyday life has driven the development of various interactive systems. While smart systems make life more convenient for the individual, they can also influence the experience of others when used in shared spaces. This particularly applies to consuming media in private, shared spaces such as the office, car, or living room. Selecting music, choosing a movie, or changing the radio channel is still largely confined to a single person. As a result, reaching an agreement is limited to communication, which can imply power dynamics and dependencies on the dominant user. However, decisions affect everyone's experience in the room. Thus, depending on the choices made, interpersonal conflicts may arise which can negatively impact the sense of belonging and the creation of group experiences.

This thesis researches whether and how interactive, collaborative media systems can promote multi-user control to enhance group experience and togetherness. Under the notation of social control experience design, the thesis focuses on designing interactive, collaborative media systems that share control over functions among co-located users in everyday shared spaces. This is anticipated to promote fairness and active participation, ultimately leading to an enriched shared experience and social engagement while sustaining team performance. Through a cross-domain intervention of collaborative media systems in the automotive and smart home domains, it discusses the interplay between human-computer interaction and interactive system design. Based on the analysis and its state-of-the-art, it outlines the theoretical requirements of social control experience design. Following a user-centered design approach, this thesis explores designing social control experience for media through various design interventions, experimentally assessed in the car or the living room. The insights culminate in recommendations and design support tools for the design of the next generations' interactive media systems with shared control – toward enriched social control experience.

Preface

This thesis is the result of the research conducted at the *Eindhoven University of Technology*. Completing this dissertation would not have been possible without the support and guidance of many colleagues and my advisors at the university. Moreover, the research conducted profited from input and insights from various researchers who specialize in the field of collaborative system design, interaction design, or automotive and smart home experience design. Throughout my research process, I benefited significantly from engaging in scientific exchange with researchers and practitioners at conferences and workshops. As an outcome, I chose to write this thesis using the scientific plural to reflect the collaborative nature of the research. The presented work grounds on published peer-reviewed scientific papers that were developed through collaboration with colleagues and students. Publications thus are referenced at the beginning of each relevant chapter.

The research involved human subjects and was approved by the Ethical Review Board of the Eindhoven University of Technology, reference numbers ERB2020ID50, ERB2020ID177, and ERB2022ID53. The research carried out was fully funded by the company *ruwido austria GmbH*, project number 10027549.

Summary

The research field of Human-Computer Interaction (HCI) shows a growing interest in the design of interactive systems to facilitate collaboration. However, the majority of interactive systems available in private, shared spaces such as offices, homes, or cars can only be operated by one user at a time. Examples include selecting music or a movie or adjusting the lights. This means that one user can control and change the state of a system, which can affect the experience of others in the room too, not necessarily in a positive way. Research shows that users want to be actively involved in decisions that affect them. However, everyday technologies used in the company of others, such as media systems, televisions, or sound systems, restrict multi-user control, which limits group decision-making to verbal agreements. This can lead to frustration, a sense of exclusion, and a negative impact on social exchange, belongingness, affiliation, and togetherness.

Thus, this thesis describes research that looks into the design of interactive, collaborative multi-user media systems with shared control to enrich individuals' experience in a co-located group setting. We characterize this as designing for social control experience. Through a cross-domain investigation of collaborative media systems in the automotive and smart home domains, it explores aspects that drive social control experience in terms of individuals' perceived social connectedness, co-experience, fairness, and team performance. The work starts by identifying the background concerning human collaboration and the requirements of interactive system design. Subsequently, the work addresses six research questions related to understanding, defining, conceptualizing, designing, investigating, and reflecting on social control experience design for media: (1) *What is and what constitutes social control experience?* (2) *What impacts social control experience?* (3) *What are the different modes of shared control to design for social control experience?* (4) *How do the various modes of shared control affect the social control experience in the automotive and smart home domains?* (5) *How do the insights across the two domains compare and what are the key differences and emerging patterns regarding the design for social control experience?* (6) *How do the modes for social experience transfer to other application domains and how to support the design for social control experience in the future?*

Part I, Chapter 1 introduces the research domain and describes the motivation behind the social control experience design for media, investigated through a cross-domain research approach in the car and in the home. In Chapter 2, we specify the scope of the thesis, outline the research questions and explain the general methodological approach. We conclude this thesis part by providing a holistic overview of the entire work.

In Part II, we present two chapters that provide theoretical background and insights into prior work relevant to this thesis research. Chapter 3, reports on what impacts human collaboration and interactions in shared spaces. We extend this theoretical knowledge in Chapter 4 by summarizing aspects of interactive system design with a focus on collaborative multi-user systems.

In Part III, Chapter 5, we define what constitutes and influences social control experience based on the theoretical work presented in Part II. Further, we propose a taxonomy that comprises five modes of how control over functions can be shared among co-located users. These modes, called *Consensual control, Hierarchical control, Anarchic control, Autocratic control*, and *Token-Ring control* define ways to design social control experience for media. The part concludes with a detailed scope of the social control experience investigations of this thesis in the automotive and smart home domains.

In Part IV, we investigate social control experience in the automotive domain. Therefore Chapter 6 provides background related to collaboration in the car and motivates the use cases of the investigations in the automotive domain. Consequently, Chapter 7 reports on a simulator study promoting driver-passenger collaboration in manually driven cars. We applied the five modes from the taxonomy to an In-Vehicle Infotainment System (IVIS), to enable the passenger to take over media-oriented non-driving-related activities (NDRAs) from the driver. There is evidence that how control over NDRAs gets distributed among a driver and a front-seat passenger – the mode – significantly affects the social control experience. While all concepts have unique characteristics that constitute social control experience, users prefer trivial and conventional modes of shared control such as *Anarchic*, *Hierarchical*, and *Autocratic control* rather than innovative concepts (*Consensual*, *Token-Ring*). Reasons link to higher perceived safety, less driver distraction, and the possibility of performing tasks quicker. However, there is proof that providing front-seat passengers with easy access to NDRAs promotes social control experience (*Hierarchical*, *Anarchic mode*), and can reduce drivers' mental workload. In Chapter 8, we extend these insights by deploying the taxonomy in a fully automated vehicle (AV) to facilitate passengers to create a music playlist together. Experimental insights unveiled that there is a significant difference between the modes in evoked social control experience. *Consensual control* is best for establishing a social bond among passengers. Both the *Consensual* and *Autocratic modes* help passengers feel comfortable and sustain a group, working towards an overarching goal. Providing every passenger with equal control (*Anarchic, Token-Ring, Consensual*) improves fairness but reduces team performance. Taken together, the insights from the investigations disclose characteristics of each mode that constitute social control experience. It is evident that providing every user with access to functions, enabling them to control, enriches the social control experience. Prevailing, we conclude this part with Chapter 9, reviewing the important findings of each investigation and outlining characteristics that support social control experience design in the automotive domain.

Part V explores social control experience in the smart home domain. Chapter 10 scopes the investigations on collaborative media control in the living room. Hence, we started by exploring how the various modes from the taxonomy can support the collaborative selection of a movie among groups of three (Chapter 11). We present how the *Consensual*, and *Hierarchical modes* enable simultaneous TV control and how they perform compared to the standard in current homes, the *Autocratic mode*. Insights from a lab study unveil that all modes constitute social control experience. Yet, there is evidence that simultaneous interaction with a TV (*Consensual*, and *Hierarchical control*) increases co-experience and is preferred by users. In Chapter 12 we expanded these insights with a focus on promoting collaborative genre selection through physical genre tokens with a follow-up *Autocratic* or *Consensual* way of movie selection. The experimental assessment in groups of three in a living room lab environment shows that the *Consensual mode* is the users' preferred choice. Even though this mode takes the longest to decide on a movie, it significantly enhances co-experience. Taken together, shared control of a TV enriches the social control experience and also promotes the selection of a movie everyone is more satisfied with. This part concludes with Chapter 13, reviewing the insights gained and outlining important findings derived from the home investigations that constitute social control experience design.

In Part VI, Chapter 14, we summarize the findings from the automotive and smart home investigations. We discuss each mode's implications on social control experience design and reflect on the differences between the domains. We generalize our findings in Chapter 15 and posit five design recommendations for the design of social control experience for future media use cases in various domains.

With Part VII, we provide design tools to support researchers, designers, as well as practitioners from the industry with designing for social control experience. Therefore, we

report on value-based personas in Chapter 16 to promote the design of collaborative, interactive media systems for a diverse group of users in terms of values. Further, we report on a card-based design toolkit in Chapter 17. This toolkit bridges the gap between the theory and practice of social control experience design for media, making the taxonomy and the design recommendations easily accessible to ideate, design, and reflect on future interactive, collaborative media systems with shared control in various domains.

We finish this thesis with Part VIII where we discuss the insights from multiple perspectives and reflect on the research approach, methodology, design artifacts, and use cases designed (Chapter 18). We conclude the thesis with Chapter 19, where we answer our research questions, summarize the contributions, and outline opportunities for future research directions.

In this thesis, we showed that the design for shared control of media is a viable approach to enrich the social control experience – the individuals' experience in a group setting. Even though we could not identify a single mode from the taxonomy to best enrich social control experience, it is evident that controlling media in everyday shared spaces requires more than communication. Sharing control among co-located users enables active participation, stimulates discussions around individuals' preferences, and promotes the selection of media content everyone is satisfied with, consequently enriching social control experience. Our investigations in the automotive and smart home domains identified essential patterns that constitute designing for social control experience. Building upon them, we contribute design recommendations as well as design tools to support social control experience design for media, in other domains, beyond the car and the living room. Overall, this thesis contributes to the design of interactive, collaborative multi-user media systems in everyday, private shared spaces.

Table of Contents

Acronyms

AIT	Absolute-Indirect-Touch
ANOVA	Analysis of Variance
AV	Automated Vehicle
CSCW	Computer-Supported Cooperative Work
HCI	Human-Computer Interaction
IVIS	In-Vehicle Infotainment System
MQTT	Message Queuing Telementry Transport
NDRA	Non-Driving-Related Activity
SDLP	Standard Deviation of Lateral Position
TV	Television
UCD	User-Centered Design
UI	User Interface
UX	User Experience

I

Introduction

Part I, **Introduction**, introduces the research concerning social control experience design – the design of collaborative, interactive media systems with shared control to enrich individuals' experience in a co-located group setting. It outlines the research questions addressed and the research approach considered.

Chapter 1 – Introduction & Motivation, motivates the research of social control experience design through a cross-domain approach for media.

Chapter 2 – Research Objectives & Approach, reports the research questions, methods applied, and provides an overview of the thesis content.

CHAPTER 1

Introduction & Motivation

Interacting with others, being social, is a fundamental aspect of human life [223], as it plays a crucial role in fulfilling one of the most basic human needs: the need to connect with others [165]. Through social interactions, individuals are able to form connections [57], learn social norms [57], and establish their own values [252]. Furthermore, interacting with others can have a positive impact on mental and physical well-being [148, 217]. Similarly, it supports the regulation of emotions [252] and improves communication and problem-solving skills [252] while promoting a sense of community, belonging, and self-worth [148]. In private, shared spaces, social engagement among people that know and like each other is more readily available [152, 186]. Being together in a car [30] or a living room [152] invites people to interact with each other, engage in conversations, share their thoughts, and jointly perform tasks. Particularly when physically close, people strive for social connectedness – a sense of community, belongingness, connectedness, and affiliation to feel safe, comfortable, and appreciated [148]. As a result, the perception of social connectedness among individuals who work or live in shared spaces is vital in creating an environment that facilitates sharing ideas, seeking support, generating shared experiences, and collaborating with others

The field of Human-Computer Interaction (HCI) has seen a growing interest in the design of interactive systems for collaborative usage in shared spaces to promote user engagement and teamwork and to enhance productivity (e.g., [142, 175, 186]). Overall, collaborative system design facilitates communication, coordination, and collaboration of tasks among users [46, 161]. Additionally, promoting individual participation in decision-making processes can support efficient and effective collaboration [136, 159], which can positively influence the groups' success [200]. One approach to achieving this is by introducing coordination policies in interactive systems [180]. These policies aim to balance control authority to facilitate structured decision-making among co-located users. The policies can take various forms, such as voting for changes [168, 180], providing users with different control/access levels [77, 180], assigning dedicated functions to specific users [77, 180], or having a key user who makes decisions on behalf of the group [168, 180].

HCI research has explored the appliance of such coordination policies in a wide range of domains, including safety-critical environments (e.g., [77]) and office settings (e.g., [186]), as well as on media and leisure-oriented activities (e.g., [2, 168, 179, 207]). Insights related to everyday media and leisure activities show that controlling music or movie functions democratically through individual input devices encourages group communication [168]. However, achieving consensus can be time-consuming and thus perceived as inefficient [207]. Providing users with different access levels to content can facilitate structured collaboration [179]. Yet it is sensed as unfair and inducing power roles [168, 207]. Switching the role of a single responsible team member [180], such as through the handing over of input devices, can sustain fairness and inclusion [168]. Although implementing coordination policies can help to promote collaboration and establish a structured decision-making process by balancing access to functions, it also poses the risk of conflicts arising from perceived unfairness and exclusion [133, 168, 179, 207].

Those arising conflicts during collaboration can impact social engagement and thus negatively affect belongingness and affiliation among users in a shared space. This is particularly detrimental when performing tasks or activities that can influence others' experiences in a shared space [17], such as using switches to adjust the office lights [186], changing the music in the car, or navigating through a movie library using a Television (TV) remote control [22]. Even newer interaction modalities, such as voice or gestures, restrict usage to one user at a dedicated time due to technical limitations. According to recent statistics, 76% of household members would like to share devices [138] or use them simultaneously, especially for leisure or family bonding activities [85]. However, devices or systems currently on the market often limit multi-user control [78] or do not consider users with different skills or interests [77]. As a result, the overall atmosphere in the room can change due to a single user's interaction. At the same time, other people in the same space cannot actively intervene or participate

in control decisions [22, 185]. This can affect inclusion and fairness and may evoke adverse reactions through disagreeing decisions or decisions that negatively impact the overall group experience.

Research efforts on the support of co-located collaboration have shown that different strategies for managing access to control impact the nature of collaboration, particularly about the frequency of communication and the efficient performance of tasks [168, 179, 207]. However, there exists a lack of understanding of how sharing control among co-located users can shape and improve social engagement, bonding, and group experiences in day-to-day privately shared spaces. Despite the potential benefits of utilizing coordination policies to improve collaboration [180] there has been little exploration of how the distribution of control among individuals in a group setting that know or like each other can enrich perceived social connectedness, co-experience, and fairness while establishing team performance. In light of this, this thesis focuses on how to design for a so-called „*social control experience*".

Social Control Experience Design

We define social control experience design as the design of collaborative, interactive systems with shared control to enrich individuals' experience in a co-located group setting. In relation to this, we characterize the experience generated in a group setting as the individuals' perceived social connectedness (how much someone feels to belong to a group [148]), team performance (whether the group perceives themselves as a single entity working toward an overarching goal [200]), fairness (the perceived justice and promotion of rights [189]), and co-experience (shared experience through others' interactions with a product/system [17]). Considering this, we investigate how to share control over functions to enable individual participation in decision-making in order to enrich the social control experience among users that know or like each other in everyday, private, shared spaces. Therefore, we aim to design collaborative, interactive systems that implement coordination policies [180] to share control authority [77] and to balance the decision-makers involved – those user(s) who make decisions on behalf of the group [159].

A Cross-Domain Investigation for Media

While social control experience design may be a relevant concept for a broad range of use cases, in this thesis, we focus specifically on leisure tasks related to media consumption. Media, in general, is the primary way how people receive both information and entertainment [197], primarily through audio (e.g., music streaming, radio, and podcast), video (e.g., TV, video on demand, and video sharing platforms), news, social media (e.g., Facebook, Instagram), games or digital communities (e.g., Reddit) [244]. Moreover, the consumption of media is a social activity [132] that builds up communities, connects people over generations [56], and positively contributes to well-being [32]. Recent statistics show that adults spend 30 hours a week consuming video content [70] on various platforms and listening to music for an average duration of 156 minutes a day [176] with a significant portion of media consumed in the company of others [85, 176]. However, established media products are not yet developed with multi-user control in mind. Thus, we see the focus on designing media systems for collaborative usage as a viable strategy to initially study how to design for social control experience among co-located users.

Overall, media gets mainly consumed in the car (70%) but also at home (63%) [176] to relax and to socialize with friends or household members [85, 176]. Especially in the car, media provides entertainment and constitutes a more convenient ride for both the driver and passengers [30]. Whether it is through the car's sound system or a personal device, media can help to pass the time, enhance comfort, and provide a satisfying car ride [30, 93]. At home, the television is a main source of entertainment and relaxation [129]. Streaming services and

video games offer a range of options for downtime, allowing individuals to escape the stress of daily life [32]. At the same time, watching movies together can enrich the viewing experience and serve as a tool for family bonding [132]. However, most devices and systems deployed in cars or homes for consuming media do not allow multi-user control or collaborative content selection [22, 78]. For example, when selecting a movie on the Television (TV), controlling music streamed through a personal smartphone, or changing the radio channel in the car. This limits the possibility of active involvement in collaboration [78] on media content which has a potentially negative impact on individuals' experience generated in a shared space. Hence, the struggle with lack of participation is a daily occurrence in the home but also in a car when considering that the average European household has 2.2 members [71] and a driver has at least one passenger during every other ride [254].

Thus, we see the exploration of social control experience design for media in the automotive and smart home domains as a viable approach to research the evoked experience through interactive systems with shared control. Moreover, adopting a cross-domain research approach offers the opportunity to identify effective design strategies and techniques while gaining a comprehensive understanding of the role of the context and use case when designing toward social control experience. In addition, it enables a more eminent ability to transfer and generalize findings to other application areas. This will benefit research and industry to more easily create media products and services for improved social control experiences. To investigate the design for social control experience, our study adopts a user-centered design approach, focusing on the role of technology and users in facilitating task collaboration through interactive, multi-user media systems in everyday shared spaces.

An Industry Perspective on Social Control Experience for Media

Enabling multi-user control of everyday interactive media products in private, shared spaces will create new experiences for the individual in a group setting, consequently influencing group experiences. Although motivated by prior research, social control experience design is also relevant to the industry focused on developing media and control products. New ways of interacting with devices will emerge as multi-user control of everyday interactive products becomes possible in private, shared spaces. Furthermore, designing for social control experience encourages active participation in control decisions, which is expected to enrich individuals' experiences in shared spaces. Thus, new end-user experiences that generate new business values can be stimulated by designing and developing devices, services, and products that provide social control experience. This thesis research is funded by *ruwido austria GmbH*[1], a leading company in the field of premium input devices such as remote controls and keyboards. Thus, the focus of this dissertation research is not only on the academic contribution of social control experience design but also addresses the industrial aspect. It explores how products for the near future can be designed with current, established technological capabilities to facilitate shared media control in everyday shared spaces. It provides insights into the design, implementation, and realization of shared control among multiple co-located users, bridging the gap between research theory and industrial practice.

1 ruwido austria GmbH: https://ruwido.com, last accessed: 2023-04-06

CHAPTER 2

Research Objectives & Approach

2.1 Objectives, Research Questions & Approach

The objective of this thesis is to research how to design social control experience for media through a cross-domain approach considering the automotive and smart home domains. To systematically accomplish this, we defined six interconnected research questions (RQs). These questions focus on understanding, defining, conceptualizing, designing, implementing, evaluating, and reflecting on social control experience and on generalizing the insights toward social control experience design (Table 2.1). In the following, we provide an overview of the RQs and the approach taken to address the research presented in this thesis, focusing on social control experience for media.

Research Questions to investigate social control experience for media		Focus
RQ1	What is and what constitutes social control experience?	Understanding & Definition
RQ2	What impacts social control experience?	
RQ3	What are the different modes of shared control to design for social control experience?	Conceptualization
RQ4	How do the various modes of shared control affect the social control experience in the automotive and smart home domains?	Design, Implementation & Evaluation
RQ4.a	To what extent do various modes affect social control experience in terms of social connectedness, team performance, and fairness in the car?	
RQ4.b	To what extent do various modes affect social control experience in terms of social connectedness, team performance, and co-experience in the living room?	
RQ5	How do the insights across the two domains compare, and what are key differences and emerging patterns regarding the design for social control experience?	Reflection & Discussion
RQ6	How do the modes for social control experience transfer to other application domains, and how to support the design for social control experience in the future?	Generalization

Table 2.1: Overview of the research questions addressed in this thesis

RQ1 & **RQ2** focus on **understanding and defining** social control experience for media. While RQ1 concentrates on the background and requirements for the design, RQ2 looks deeper into possible influencing factors in collaborative settings. To answer RQ1 and RQ2, we conducted a desk literature review within the research field of social psychology and Human-Computer Interaction. We particularly looked into what constitutes and influences interacting with others in a group setting of co-located users. Additionally, we explored prior work on the design of interactive, collaborative multi-user systems in general and with a focus on media applications.

RQ3 refers to the **conceptualization** of the design space in the form of a taxonomy towards social control experience. Through the insights from RQ1 and RQ2, we systematically outline technological aspects and validate insights that need to be considered when designing for social control experience. This systematic summary is the base for the proposed taxonomy of social control experience which constitutes five diverse modes of shared control among co-located users.

RQ4 guides the **design, implementation, and evaluation** of the taxonomy of social control experience for media through the cross-domain investigation in the automotive and smart home domains. To answer this question, we apply the various social control modes from

RQ3 to the most prominent media use cases in the car (RQ4.a) and the living room (RQ4.b) to study their effect on perceived social control experience. Therefore, we defined two sub-research questions (RQ4.a and RQ4.b). Due to the development of the research trajectory and the differences between the domains, the questions vary in the assessed characteristics of social control experience.

RQ4.a To what extent do various modes affect social control experience in terms of social connectedness, team performance, and fairness in the car?
RQ4.b To what extent do various modes affect social control experience in terms of social connectedness, team performance, and co-experience in the living room?

To assess these questions, we followed a user-centered design approach [209]. Therefore, we first identified media use cases through literature research and various case studies. We then iteratively designed for social control experience in two media use cases per domain. To answer RQ4.a & b, we conducted controlled mixed-method experiments in lab environments with each final design.

RQ5 directs to the **reflection and discussion** on insights gained related to the design for social control experience for media. By comparing the cross-domain insights, we reflect and summarize what constitutes social control experience. We particularly focus on the individual modes, their characteristics, the measurements performed, and the contextual factors of the car and the smart home domain.

RQ6 refers to the **generalization** of the insights to other areas and domains. Therefore, we outline design recommendations and provide design support tools to make the research insights transferable. To do this, we first review the taxonomy, the specific domains, the media use cases we have considered, and the outcomes achieved regarding general applicability. We then compile this information into design recommendations. To more effortlessly support researchers, designers, and practitioners from the industry to design for social control experience for media, we provide design tools, including a card-based design toolkit.

2.2 Methodology

For an effective exploration of social control experience design, this work needed to combine insights and practices from various fields, including engineering, computer science, industrial design, social psychology, and automotive and smart home system design. The interdisciplinary nature of the research was tackled through a thorough literature review and close collaboration with other researchers and industry experts. We followed a bottom-up approach to successfully facilitate collaboration among users in shared spaces. This means we started with identifying general design principles before refining those in the context of media applications in the car and the home. We identified interaction patterns and challenges in collaborative settings and applied user-centered design principles to guide the design and development of media systems toward social control experience. The main methodology elements applied to answer the underlying research question are discussed below and visualized in Figure 2.1.

Understanding, Exploring & Defining - RQ 1 & 2

We started with a literature review to get a direction of the state of the art. Subsequently, we outlined factors that constitute and influence social engagement and collaboration among co-located users. At the center of developing collaborative systems are the users and their needs – in our case, drivers and passengers (automotive domain) and household members or friends (smart home domain). Applying the principle of user-centered design [209], we placed the efforts in our research around user feedback. We started by conducting interviews, surveys, brainstorming sessions, and focus groups. We did so with both domain

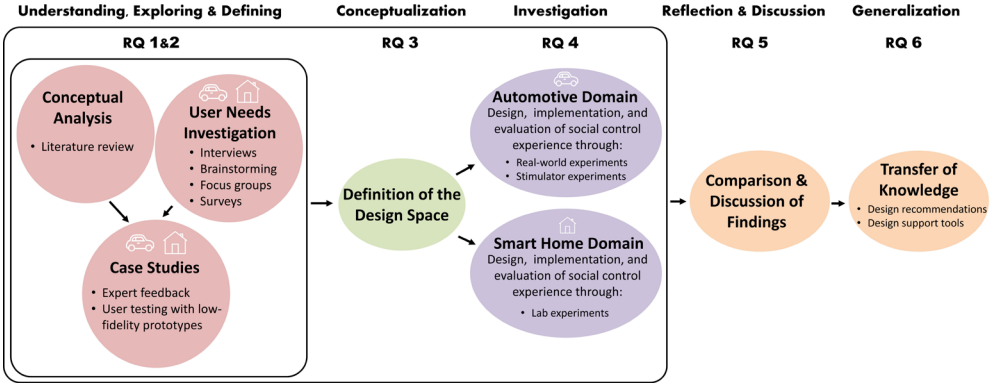


Figure 2.1: Visual overview of the methods applied in the different stages of this thesis research in order to answer the various research questions.

experts and users to gain a deeper knowledge of design requirements and explore users' needs related to media and the specific domain. Further, we explored the design space of collaborative, interactive system design in the car and at home through several case studies. Under the user-centered design principles [209], we developed interactive media systems for in-car and home environments that we evaluated in user studies mainly through low-fidelity prototypes. This exploration phase resulted in several publications (i.e.: [22, 26, 27, 29, 30]) that, due to their extensive length, cannot be provided in detail. Therefore, this thesis builds upon the insights gained by referencing the relevant work.

Conceptualization & Investigation - RQ 3 & 4

With the insights from the exploration phase in combination with the theoretical background, we conceptualized the design space for designing social control experience for media. Moreover, the needs investigations and case studies supported the selection of cases to investigate and evaluate social control experience in the automotive and smart home domains. After expert and user feedback on the designs for the individual use cases, we implemented fully working, high-fidelity prototypes that we evaluated through user studies on their evoked social control experience.

As such, we conducted controlled experiments in both laboratory and real-world settings. It can be challenging to balance conducting realistic studies that achieve high ecological validity and studying the effects of group experiences under controlled conditions with high internal validity to minimize confounding factors. Thus, we made choices based on the specific research questions. Overall, the experiments comprised a wide range of methods, including interviews, surveys, questionnaires, and data logging (e.g., time efficiency) in order to study social control experience. Each empirical study was combined with subjective feedback from the participants which was used for qualitative analyses. We evaluated the evoked social control experience by means of validated questionnaires (the specific questionnaires used are outlined in the scoping Section 5.4 of this thesis and reported in the individual method sections of the investigations). Overall, we collected objective, subjective as well as quantitative, and qualitative data. For statistical analysis of quantitative data, we applied both parametric and non-parametric tests. In the following, we provide more details on the approaches taken for the study setup and the respective implementation of the prototypes.

Approaches to Study Setup

We built several prototypes to study social control experience for media in controlled settings.

Prototyping: The prototypes were designed, and their fidelity was defined based on the research question. In general, we aimed for fully functioning, high-fidelity prototypes to enable the assessment of social control experience under realistic scenarios. Therefore, the prototypes needed to ensure robustness, reliability, and high usability. Moreover, the automotive-specific prototypes were designed under consideration of in-car user interface guidelines to adhere to the safety standards of the automotive industry. The design of collaborative systems demands user-friendliness and the handling of multiple inputs from several users at once. Therefore, the technical realization of collaborative systems required a multidisciplinary approach combining user interface design with technical expertise in network technology, software development, and embedded systems design. For the graphical user interfaces, we first generated mock-ups where we sought expert feedback and implemented the final design using *Unity 3D*[1] (Chapter 7, 8, 11) or *Processing3*[2] (Chapter 12). In the case of an involved physical interaction technique (e.g., remote controls to control the TV), we either built them ourselves by combining 3D printing parts with an *Arduino* (Chapter 12) or let them be produced by the industry partner, *ruwido austria GmbH* (Chapter 11).

Automotive Domain – Controlled Real-World and Simulator Study: We empirically studied the social control experience for media among occupants in a car with an emphasis on the safety of the participants, even if this required accepting certain limitations. While a study on in-car interaction should be ideally performed in the most realistic driving environment to ensure ecological validity, it poses a risk to participants. Therefore, it is ethically not justifiable [49]. Therefore, we conducted the experiments in either a parked car (Chapter 8) or in a driving simulator (Chapter 7). Even though insights from a simulated environment are limited in terms of realism because participants are aware they are not exposed to any risks (e.g., no accidents), we argue that simulator studies are an ecologically valid approach to initially investigate collaboration and social control experience in cars. We are able to observe the interactions and test our prototype's influence on the experience generated as well as on driving performance in an equivalent to a naturalistic environment while ensuring the safety of all participants. Moreover, this method enables strictly setting up replicating scenes in terms of traffic which limits confounding factors while also being more affordable compared to on-road controlled investigations [49].

Smart Home Domain – Controlled Lab Study: To study the social control experience for media among household members or friends in shared living spaces, we performed experiments in a living room lab (Chapter 11 & 12). This allowed us to have a controlled, technical setup among experimental rounds to ensure high internal validity for the initial investigation of social control experience. It limits possible distractions that can come from dynamic conditions, such as in the field. Moreover, the lab environment provides easy observation opportunities and allows to record of high-quality audio and to monitor participants' social engagement and their interactions with the design artifact in more detail.

Reflection & Generalization - RQ 5 & 6

The empirical insights from the two domains are discussed in Chapter 14. Through this reflection and the patterns identified, we posit design recommendations to support the future design of social control experience (Chapter 15). To make the findings and recommendations easily accessible for researchers, designers, and practitioners and to more effortlessly support social control experience design for media, we provide design tools that include value-based personas (Chapter 16) and a card-based design toolkit (Chapter 17).

1 https://unity.com/de, last accessed: 2023-03-26

2 https://processing.org/, last accessed: 2023-03-26

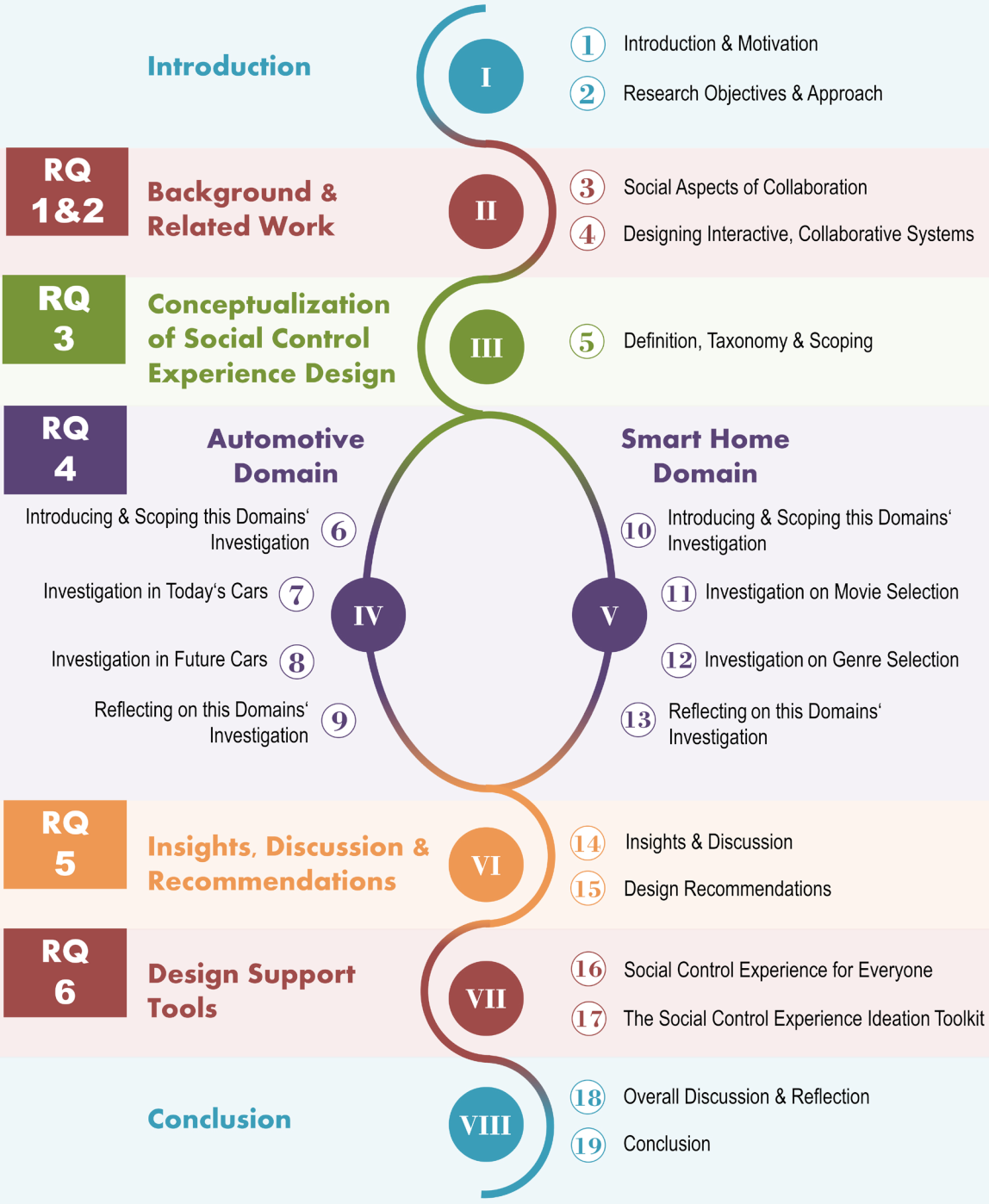


Figure 2.2: Visual overview of the thesis. It presents which chapters are linked to which part and the research questions addressed.

2.3 Thesis Outline

To address the six research questions outlined in Section 2.1, this thesis consists of 19 chapters arranged in eight parts (Figure 2.2). Firstly, (Part II) *Background & Related Work* addresses RQ1 & 2, lays the theoretical background and aims to outline essential aspects of designing for social control experience. Secondly, (Part III) *Conceptualization of Social Control Experience Design* defines what constitutes and influences social control experience and proposes a taxonomy for the systematic investigation of social control experience (RQ3). Thirdly, (Part IV) *Social Control Experience in the Automotive Domain* focuses on RQ4 by exploring collaboration in the car. It constitutes studies that explore the taxonomy in current passenger cars and in future fully automated vehicles. Fourthly, (Part V) *Social Control Experience in the Smart Home Domain* comprises the exploration of collaboration in the home environment and outlines studies of how the taxonomy affects social control experience in the living room (RQ4). Then, (Part VI) *Insights, Discussion & Recommendations* summarizes the findings and posits design recommendations (RQ5). Further, (Part VII) *Design Support Tools towards Social Control Experience* provides tools for the design of social control experience for future media use cases in various domains (RQ6). Lastly, (Part VIII) *Conclusion* discusses the thesis insights, approach, and methods applied, provides a detailed overview of the contributions of this thesis, and lays the groundwork for future research.

Part II: Background & Related Work

Chapter 3 – Social Aspects of Collaboration: When it comes to collaboration, the way how people interact and engage with one another is a vital component. Particularly the amount of communication, but also coordination and cooperation with one another are essential elements toward efficient and effective task performance in a group setting. While the ability of individuals to interact effectively with each other is a key factor in the success of collaborative processes, the context, individuals' experiences, and personality traits can also influence how tasks are achieved together. This chapter looks into the human aspects of collaboration, provides insights into group performance, and reports on influential aspects of collaboration.

Chapter 4 – Designing Interactive, Collaborative Systems: Designing interactive systems can promote collaboration and have an impact on team performance. In Chapter 4, we report on related work concerning interactive system design, the promotion of collaboration mediated through technology, and dive into sharing control among co-located users. Therefore, we review prior work from the research fields of Human-Computer Interaction (HCI) and Computer-Supported Cooperative Work (CSCW), which lies the background toward the thesis objective of designing social control experience for media.

Part III: Conceptualization of Social Control Experience Design

Chapter 5 – Definition, Taxonomy & Scoping: This chapter defines social control experience for media under related work derived from Part II and outlines possible influencing factors on the design of social control experience. Based on the definition and influencing factors, a taxonomy is proposed, consisting of five modes that share control among multiple users in shared spaces. Every mode reflects individual characteristics related to the balance of decision-makers and an underlying coordination policy to promote collaboration among co-located users. The chapter concludes by scoping the investigations of social control experience through the automotive (Part IV) and smart home (Part V) domains.

Part IV: Social Control Experience in the Automotive Domain

Several recent studies that explored in-car experiences outline the importance of performing Non-Driving-Related Activities (NDRA) while driving since they contribute toward a more

convenient and enjoyable ride for drivers and passengers. Such activities can range from information systems to media and entertainment services. In the first chapter, **Chapter 6**, we scope the investigation in the automotive domain.

Chapter 7 – Investigation in Today's Cars: Research outlines, that the performance of NDRA by a driver while operating the car enhances distraction and increases crash risk. Whereas, the empowerment of a front-seat passenger to take over certain NDRAs has the potential to counteract this effect and ensure safety. This chapter explores how the diverse modes of social control experience can enhance driver-passenger collaboration in manually driven cars in order to enhance the in-car experience and reduce driver distraction. We applied the various modes to an In-Vehicle Infotainment System (IVIS) to balance access to NDRAs between a driver and a front-seat passenger. Through an experimental assessment of the five modes from the taxonomy in a driving simulator, we studied drivers' and passengers' perceived social connectedness, team performance, and fairness under monitoring the driving performance in terms of lane position, speed variance, and eyes-off-the-road time. We discuss the implications of the individual modes of social control experience and outline recommendations for the design of future IVIS toward collaborative usage.

Chapter 8 – Investigation in Future Cars: In the event of fully automated driving, there is no need to stay situational ware, since all occupants become passengers. This will turn the car into a highly interactive environment and allows everyone to fully engage in NDRAs. Since music is among the most frequently performed activities in today's cars and is envisioned to still be relevant in future cars, we explore in this chapter how the modes from the taxonomy promote social control experience among passengers in an Automated Vehicle (AV). Based on the creation of a music playlist, we studied in a parked car among groups of three passengers, the modes' impact on perceived social connectedness, fairness, and team performance. Considering the findings, the implications of the individual modes are discussed. Moreover, recommendations are outlined for designing collaborative NDRAs in AVs.

Part IV concludes with **Chapter 9**, which reflects on the insights gained in Chapter 7 and 8 and provides a summary of the important findings from the automotive domain.

Part V: Social Control Experience in the Smart Home Domain

The consumption of media in shared living spaces, particularly in the living room, connects people and is a common approach to family bonding. In this part of the thesis, we investigate social control experience for media in the smart home domain. We take into account the insights gained from the automotive domain (Part IV) and research whether those insights transfer to collaboration on media in shared living spaces. We start scoping the investigations in **Chapter 10**.

Chapter 11 – Investigation on Movie Selection: Research reports that the decision on what movie to watch can be a lengthy process which likely leads to the selection of a movie, not everyone is interested in watching. Therefore, in this part of the thesis, we illustrate how the modes from the taxonomy can promote three users to select a movie together. Therefore, we provide the group with individual remote controls to enable simultaneous interaction with a TV. Through a controlled lab experiment, we report on the modes' effect on individuals' perceived social connectedness, co-experience, and team performance. We discuss the implications of collaborative movie selection on social control experience in the living room.

Chapter 12 – Investigation on Genre Selection: Choosing a movie can be a particularly difficult task for a group with diverse attitudes and values, as genre preferences are often shaped by individuals' personalities. Thus, this chapter demonstrates how the modes of social control experience can support a group of three in picking a movie through collaborative genre selection facilitated by tangible genre tokens. In a controlled lab environment in groups of three, we studied the evoked social control experience by assessing individuals' perceived

social connectedness, co-experience, and team performance. Through the insights gained, we discuss the implications of tangible tokens and the collaborative genre selection on social control experience.

This part concludes with **Chapter 13**, which provides a summary of social control experience for media in the smart home domain.

Part VI: Insights, Discussion & Recommendations

Through the media-based investigations in the automotive and smart home domains, we gained a thorough understanding of whether and how shared control stimulates social control experience in everyday shared spaces. In this thesis part, we summarize the findings, discuss the insights gained and posit design recommendations for social control experience design.

Chapter 14 – Insights & Discussion: The experimental assessments of the modes from the taxonomy provided detailed insights into the evoked social control experience. This chapter summarizes and discusses the main important findings with regard to the taxonomy and the domains. Further, it outlines overall patterns that constitute social control experience design for media.

Chapter 15 – Design Recommendations towards Social Control Experience: Based on the overall patterns observed that constitute social control experience in Chapter 14, this chapter posits design recommendations. These recommendations can be used as a direction when designing social control experiences for various media use cases in diverse domains, beyond the car and the living room.

Part VII: Design Support Tools towards Social Control Experience

Designing social control experience, particularly for media, is a complex interplay between users, tasks, environments, and technology. In combination with the design recommendations provided, it can be a challenge to design for an enriched social control experience. Thus, this thesis part provides design support tools for researchers, designers, as well as practitioners from the industry.

Chapter 16 – Social Control Experience for Everyone: Considering Users' Values: To address diverse media behaviors of users and to support the design of social control experience among a diverse group of users, this chapter proposes value-based personas. These personas, on the one hand, can guide a standard human-centered design approach while they also form the base of the card-based toolkit.

Chapter 17 – The Social Control Experience Ideation Toolkit: This chapter builds upon the design recommendations and value-based personas. It presents a card-based design toolkit that bridges the gap between the theory and practice of social control experience design for media. The toolkit consists of 45 cards grouped into five categories, supported by a physical think space.

Part VIII: Conclusion

The final part of this thesis discusses the objectives, answers the research questions, and outlines directions for future work.

Chapter 18 – Overall Discussion & Reflections: This chapter discusses the insights and implications of this thesis. It reflects on the approach taken, design decisions, contextual factors considered, and reports on general limitations.

Chapter 19 – Conclusion: The conclusion answers the research questions and outlines a detailed summary of the research contributions of this thesis. Further, it reports on potential areas for future work concerning social control experience design for media and beyond.

II

Background & Related Work

Part II, **Background & Related Work**, presents two chapters that provide background into the human aspect of collaboration and outlines important strategies for the design of collaborative, interactive systems. Thus, this part lays the groundwork for the research questions ***RQ1 – What is and what constitutes social control experience?*** and ***RQ2 – What impacts social control experience?*** The goal is to construct a theoretical background that aids toward the challenge of designing social control experience for media. More precisely, providing considerations to enable shared control of media applications to promote individual participation and enrich social engagement.

Chapter 3 – Social Aspects of Collaboration, reviews literature within the context of human collaboration and outlines social aspects that constitute group experience or impact collaboration among co-located users.

Chapter 4 – Designing Interactive, Collaborative Systems, provides a condensed overview concerning related work on interactive system design, multi-user control, and the promotion of collaboration mediated through technology.

Exploring HCI and CSCW

This thesis builds upon insights from the research fields of Human-Computer Interaction (HCI) and Computer-Supported Cooperative Work (CSCW). HCI is concerned with the interaction between humans and computer systems, focusing on the design, evaluation, and improvement of user interfaces (UIs) and experiences to enhance usability, accessibility, and individual user satisfaction [240]. Whereas CSCW represents an interdisciplinary field of research that specifically investigates how people collaborate and accomplish tasks using technology, regardless of the physical proximity of users or temporal synchronization [194].

With social control experience design for media, we focus on the design of collaborative, interactive systems with shared control to enrich individuals' experience in a co-located group setting. This involves understanding unique challenges when designing and evaluating interactive systems for individual users (HCI) and creating technology that facilitates effective collaboration (CSCW) through shared control. In this thesis part, we report on prior work in the research fields of both HCI and CSCW to investigate how to create (media) UIs that facilitate collaboration and joint activities among co-located users. We first look into the human aspect of collaboration, users' needs in a group setting, what constitutes collaboration in general, and what role the context plays (Chapter 3). Furthermore, we report on what makes UI design challenging and how to generate a satisfying interaction between an individual user and technology (Chapter 4). We expand these insights by looking at collaborative system design to seek information on how control can be shared among co-located users to support effective group collaboration (Chapter 4). Consequently, we bridge the knowledge from HCI and CSCW to research what constitutes and how to design for social control experience.

CHAPTER 3

Social Aspects of Collaboration

A collaborative circle is a primary group consisting of peers who share similar occupational goals and who, through long periods of dialogue and collaboration, negotiate a common vision that guides their work.
Michael P. Farrell, pp. 11 [72]

3

Abstract

Interacting with others is a fundamental aspect when it comes to human collaboration. Particularly communication, coordination, and cooperation play a crucial role in efficient and effective task performance. The success of collaborative task performance largely depends on the ability of individuals to interact effectively with each other. Moreover, the context, individuals' experiences, and personality traits can influence how tasks get completed together. In this chapter, we look into the human aspects of collaboration. We outline how decisions are made in a group setting and how the decision-making process can impact the performance of a group. Moreover, we provide insights into the role that individuals' personalities, skills, and behavior have in collaborative settings. Further, we demonstrate how the environment – the context changes the way how users collaborate and socially engage with one another.

3.1 The Process of Collaboration among Humans

Collaboration among people is a recursive process, defined as working together to reach a common goal [161]. Thus, the people involved rely on one another and share resources to achieve their common objective [161]. Collaboration involves solving problems, reaching agreements, and making decisions under negotiated outcomes [46]. Hence, collaboration is a complex interpersonal procedure requiring ongoing communication, coordination, and cooperation among individuals. Literature refers therefore also to the 3C model [69, 83] (see Figure 3.1). For effective collaboration, the people involved need to share information. This demands communication which relates to the "*exchange of information among people*" [83], both verbally and non-verbally [246]. Overall, the "*effectiveness of communication and collaboration can be enhanced if group's activities are coordinated*" [69]. Therefore, coordination in a collaborative group setting directs the management of people's behavior to fit their actions into an intended pattern, allowing for reaching the expected group goal [14, 83]. This also demands understanding the actions required and adjusting to one another

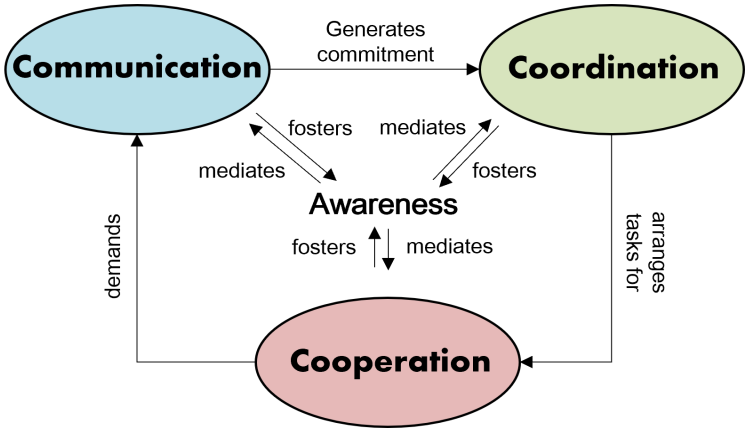


Figure 3.1: The 3C collaboration model according to Ellis et al [69]. Visual representation adapted from Fuks et al. [83].

interpersonal [14]. Through the continuous interplay of coordination, cooperation, and communication, the group is able to establish awareness of one another and receive an overview of the current collaborative status [69, 83].

Making Decisions Together & Performing Tasks

While communication, coordination, and cooperation form the groundwork for collaboration, it still demands making decisions and executing tasks to reach a joint goal. Whether the collaboration will be efficient and effective depends on the tasks being performed [98]. Hackman et al. [98] classify tasks in general into three major types: First, the production task, which is about the "*production and presentation of ideas*" [98]. Secondly, the discussion task, which refers to the evaluation of the issue, and lastly, the problem-solving task, which "*requires specification of a course of action to be followed*" [98]. McGrath expands this task classification by developing the so-called *Group-Task Circumplex* [169] (see Figure 3.2). This framework categorizes tasks performed in a collaborative setting into eight types, arranged in four clusters (quadrants) to support the understanding and analysis of task performance in a group setting. Quadrant I, „*generate*", incorporates Hackman's problem-solving task and production task and can be associated with the generation of plans and ideas through an action-oriented or creative approach [169]. Quadrant II, „*choose*", presents the selection of a problem-solving strategy that can be derived from one definite solution (solving a problem) or out of a selection of possible solutions that in an optimum way reflect the groups' preferred choice (deciding issues) [169]. In Quadrant III, „*negotiate*", the model demonstrates an extension of Quadrant II, where group members verbally discuss viewpoints and try to resolve conflicts. The Quadrant IV, „*execute*", reflects the aim of the task which relates to collaborating for victory (performance tasks), or for performance results which emerges a winner and a loser (resolving conflicts of power) [169].

Apart from this theoretical classification, the execution of any task depends on the decision-makers involved – those group member(s) who decide on behalf of the group and execute tasks or part of a task. Overall, Marakas [159] defines three major types of decision-makers: *Multiple decision makers*, where group members have equal authority in making decisions,

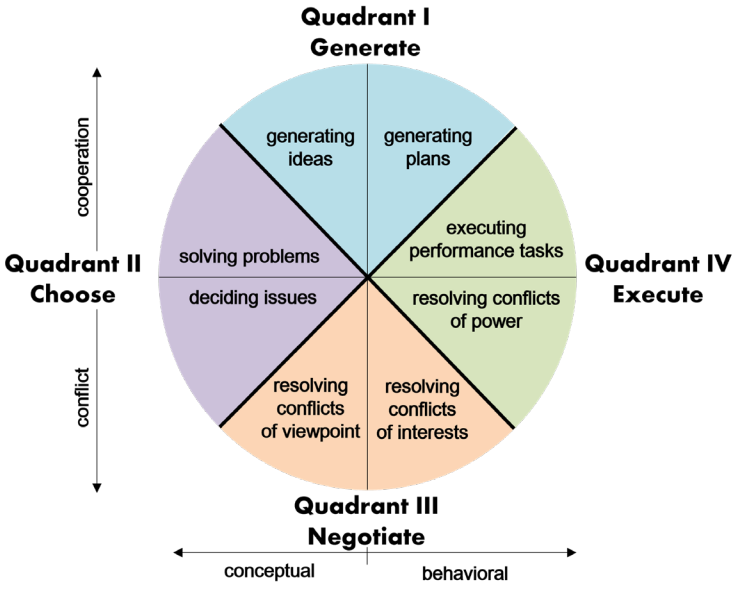


Figure 3.2: Visual representation of the group-task circumplex. Adapted from McGrath [169].

but none of them have enough authority to make all decisions alone [159]. *Group decision makers* are defined as each group member having equal weight in making decisions [159]. The *team decision makers* are characterized by an individual decision-maker with authority to make final decisions under negotiated outcome [159]. In contrast to group decision-makers, there is the situation of *individual decision makers*, where every group member decides alone under the focus on achieving a common goal without continuous group negotiation [10].

3.2 Impacts & Considerations on Collaboration

Even though humans are used to making decisions together, collaboration is a complex and dynamic psychological phenomenon. Every individual shapes the group and, thus, contributes toward a unique group dynamic and influences the overall experience [169]. When two or more people cooperate on a task, a complex set of processes gets initiated. Accordingly, McGrath [169] defines three main patterns: The type of communication and particularly their pattern related to, e.g., when, how, how often, illustrate the communication process [169]. Depending on the type of task [113], every collaborative interaction incorporates both the task to be performed to achieve a goal and the interpersonal relations with one another [169]. Thus, the three patterns arising (communication, task performance, and interpersonal pattern) have an effect on one another and also on the individuals involved. The impacts emerging influence the process, which "*involves the outcomes or consequences of the interaction for the participants, for their relationship to one another, for their task performance and for their subsequent communications*" [169].

Looking in more detail into the human side of collaboration, every group member brings

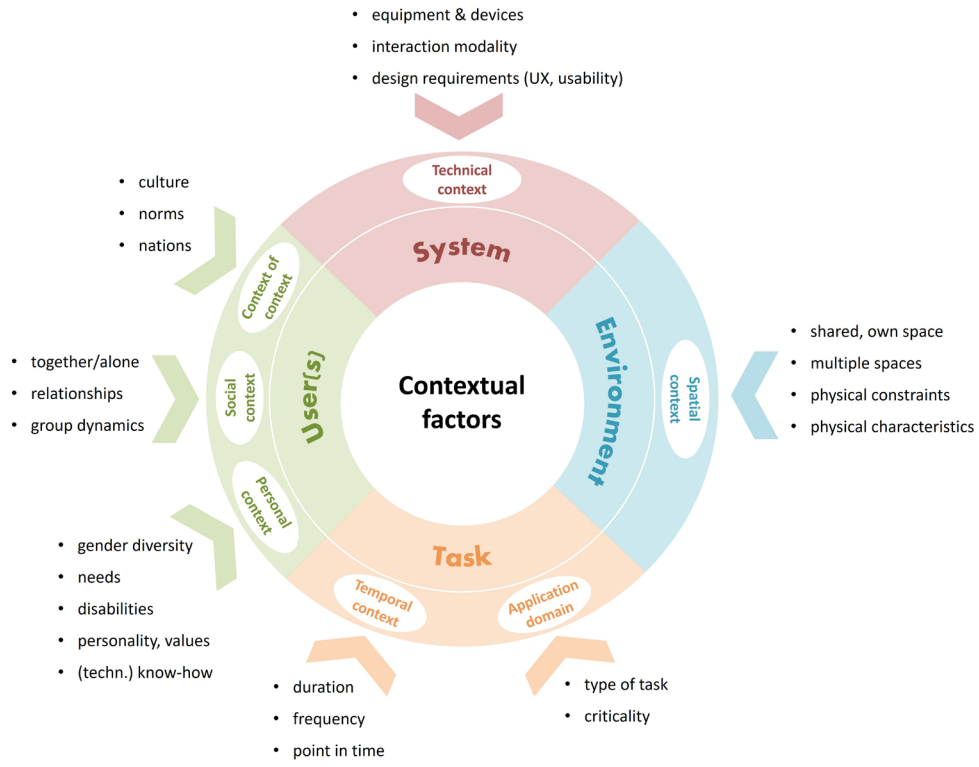


Figure 3.3: A general, visual overview of the different contextual dimensions that can influence collaboration: users, system, environment, task. It outlines examples for every contextual factor.

in unique experiences, behavior patterns, personality traits as well as expectations that form and develop the group [14, 113]. Thus, they shape the collaboration patterns [169] while also being a possible cause for disagreements, social conflicts, and frustration [66]. Still, groups develop and learn over time, leading to changes in relationships and impacting how ideas are invented, or decisions are made [14]. Coping with such changes requires coordination of local dynamics in order to pursue the groups' functions [14]. When individuals engage with each other, particularly in collaborative settings, their interactions are influenced by the situation and context [230], often involving implicit messages that can affect behavior, abilities, and efficiency [14, 113, 123]. Moreover, the group can also be affected by changing contextual conditions in terms of "*physical, cultural, organizational, and temporal*" [14] transformations which demand continuous adaptation to the surroundings.

The Role of Context and Tasks in Collaborative Settings

Schmidt et al. define context as the "*situation and the environment a device or user is in*" [231]. Therefore, context reflects the *environment*, the *tasks*, the *users*, the *technology* involved, and their individual situation, status, and surroundings [190, 231, 256]. Starting from a user perspective, the context involves the information on the users [231], also defined as the *personal context* [190]. It relates to the actors in a collaborative setting [113], defining their individual knowledge, needs, physiological states, disabilities, and so on [190, 231]. Further, there is the *social context* which refers to the "*the social structure*" [190] among occupants. It includes the co-location of others and their relationships (e.g., family, friends, work colleagues, strangers), specific social interactions as well as emerging group dynamics [190, 231].

Moreover, the user aspects incorporate the socio-cultural context, declared as the *context of the context*, referring to cultural backgrounds, norms, and nations [190]. The environment or the *spatial context* is structured into the location where users collaborate (e.g., shared spaces, several rooms), the provided infrastructure, and physical characteristics or constraints (e.g., space, position, arrangement of users, light, noise) [190, 231]. The context also characterizes the density of technologies and systems in a space summarized as the *technical context* [190, 256]. A system can be attributed to the equipment and devices (both integrated into the environment or brought in) and certain services provided. Lastly, some tasks are performed by user(s) in a certain environment supported by technology. In general, a task can have characteristics depending on the *application domain*. Further, tasks can have a *temporal context* defining their duration [37], frequency, or point in time of performance (e.g., day/night, summer/winter) [190]. Overall, collaboration is a complex interplay between users involved that meet in a certain environment, using a dedicated system to accomplish tasks together. In Figure 3.3, we visualize the contextual factors and outline possible examples of the contextual characteristics.

3.3 Group Dynamics & Social Interaction

While the context itself plays a significant role in collaboration, also the generated group dynamics through interactions among users influence the success of the collaboration. Overall, the dynamic of a group significantly changes with the number of members. Prior research shows evidence that users become less satisfied and less productive the bigger the group is [120, 222], notably with six or more members [10, 222]. This phenomenon is also defined as social loafing [188]. Individuals tend to reduce their input as group size increases [144, 188]. A likely reason, therefore, is the perceived personal accountability because it gets more challenging to identify contributions of individuals [144]. Furthermore, individuals might perceive their input as not necessary enough, having not enough time to contribute, while there can also be a lack of sensed responsibility due to too many users involved in the collaborative process [259]. Also, concerns about the personal image may

arise to get negatively judged by others if a contribution is seen as insufficient or incorrect [259]. Whether or not such feelings arise can be influenced by personality traits [227]. While introverts appear keener in understanding complex concepts and tend to invest more time before making a decision, more extroverted people prefer to explore diverse solutions [4] and thus tend to engage in discussions more easily. Moreover, individuals' values – learned beliefs that act as guiding principles in a person's life – can be seen as active motivators to reach a certain goal [199]. Recent research shows that values, for instance, significantly influence what users prefer to buy [7], but also on what type of media they consume when and how [31]. Furthermore, the decision capabilities of individuals in a group can be limited and not always equally distributed (role differentiation, user authority), which is likely to be perceived as unfair [180, 207], generating conflicts, causing frustration [66], and thus lowering social interactions.

Social Interaction among Co-Located Users

Socially interacting with others is fundamental for us humans [223]. Especially when collaborating to achieve a goal, the social exchange provides the possibility to exchange thoughts and visions that promote the establishment of common ground within a group [57].

Research reports on various factors that contribute to whether and how a user feels comfortable expressing themselves in a collaborative setting. First, users need to feel that they relate and belong to the group, which incorporates feelings of group belongingness, affiliation, connectedness, and companionship – defined as social connectedness [10, 148]. A high level of companionship supports well-being, helps to reduce stress, and enhances social satisfaction [217] while affiliation supports social engagement and helps to maintain a social bond [261]. Furthermore, the perceived team performance as a combination of coordination effectiveness and team cohesion [200]. Coordination effectiveness refers to the manifest of a specific goal while team cohesion captures "*individuals within a group coming together as a perceived single entity with shared norms, values, and goals*" [200]. A high team cohesion affects the performance of the team and makes collaboration more efficient and effective [200]. To establish collaboration and to generate a space of high team performance and social connectedness, fairness is an essential factor [253]. Without fairness – the perceived justice and promotion of rights – users might not be able to build up a feeling of belongingness [189]. This prevents them from sharing similar norms, which can impact collaboration, and particularly team performance negatively [253]. These individual perceptions also play a significant role towards co-experience – "*the experience which is created in social interaction*" [17]. Especially when collaborating on media-oriented tasks, the co-experience gets influenced by others' interactions [17], and by the direct presence of people (social experience) [111], and the therewith created experience through systems, services or with one another.

Taken together, promoting users' feeling of social connectedness [10, 148], team performance [200], and co-experience [17], while providing the possibility to contribute actively toward the group goal [78] can affect social interaction.

3.4 Summary & Outlook

In this chapter, we reported on the complex dynamic structure of human collaboration. We outlined that optimal collaboration among users demands continuous communication, coordination, and cooperation. However, the success and efficiency of collaboration depend on the decision-makers involved – those users who tend to make decisions and execute tasks on behalf of the group. Even though the roles within a group are clear, the group dynamics and the way how tasks get performed change with contextual circumstances. The environment can induce certain group structures but also physical limitations that require adaptation from the

group on how tasks get executed collaboratively, which can have an effect on the experience generated when designing social control experience for media (detailed discussed in Section 5.2). Also, the users bring in certain values and norms, partly induced by their culture but also due to their personality traits and experiences which shape the dynamics of a group. While the first-time collaboration may require adaptation to one another, the more often a group collaborates, the easier it gets to make decisions. Through more interactions, people become familiar with each other and generate experiences that promote efficiency and effectiveness. Nonetheless, collaboration is a complex structure, and the diversity of users involved can have a significant impact on the group dynamic, affecting how individuals feel appreciated and welcomed. This, in turn, can determine whether users are comfortable expressing themselves and engaging socially during collaboration. Given the fundamental role of social interaction in human life, promoting togetherness, the exchange of thoughts and visions, and sustaining well-being, the promotion of social exchange can positively influence the success of the group. Thus, we see the need through the design of social control experience to research how collaboration on media content, mediated by technology, can enhance social engagement, subsequently promoting togetherness and group experience. More precisely, to research how interactive media systems can be designed to promote a sense of belonging, affiliation, and social bond among users (social connectedness), supporting the performance of the team toward shared goals and norms (team performance) while generating positive shared experience through others' interactions (co-experience). Thus, as a next step, we look into how to share control among co-located users in shared spaces through interactive, collaborative system design to enable social control experience.

CHAPTER 4

Designing Interactive, Collaborative Systems

Abstract

Designing interactive systems to support multiple users in achieving a goal together requires the support of communication, collaboration, and coordination of tasks [136]. In this chapter, we look at the complex dynamics of individual users interacting with a system and groups collaborating by means of technology which addresses the intersection of HCI and CSCW. While HCI research provides details on the interaction between an individual user and systems, CSCW's research work highlights how technology can support collaborative task performance and group activities for co-located users. Therefore, they design and research so-called groupware as an artifact to leverage collaboration. Ellis et al. define groupware as "computer-based systems that support groups of people engaged in a common goal that provides an interface to a shared environment" [69] with the goal to "assist groups in communicating, in collaborating, and in coordinating their activities" [69]. Overall, the design of groupware can include software, hardware, or services that support group processes [136]. The important characteristic of any groupware system lies in connecting users by enhancing visibility and awareness of group members in general, and particularly their actions [136]. This chapter dives into the design of interactive, collaborative systems focusing on co-located collaboration. It provides detailed insights into design considerations and typologies to balance input from multiple users to support structured and efficient collaboration in shared spaces.

4.1 Application Areas of Collaborative Systems

Interactive, collaborative systems aim to help groups in making decisions by supporting them with the processes of communication, collaboration, and coordination of tasks [136]. Since collaboration can happen online, distributed among locations but also in shared spaces, literature reports on the typology of collaborative systems which guides the space and time of collaboration (see Figure 4.1) [69]. This categorization represents systems designed to support collaborating at the same place or distributed across different places either at the same time or asynchronously, at different times [69, 95]. Particularly for co-located collaboration, relevant to this thesis, a prominent example of same-time collaboration refers to working together in a shared room, such as selecting a movie in the living room or sitting together in the car, creating a music playlist (1st quadrant). Even though document co-editing services (e.g., Google Docs[1]) are not limited to the use in shared spaces, they are one of the most prominent inventions for facilitating group work asynchronously. These examples show, that a collaborative system can fall into one dedicated category, while it is also possible that inventions overlap and cover several quadrants [95]. Thus, designing collaborative systems

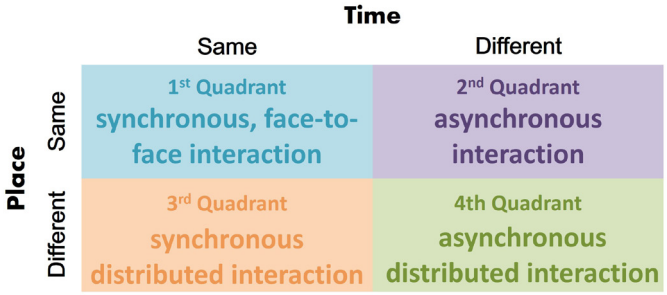


Figure 4.1: Time space taxonomy of groupware systems according to Ellis et al. [69].

1 Google Docs: https://www.google.com/intl/en-GB/docs/about/, last access: 2023-06-05

requires a thorough definition of their underlying space and time constellation because designing for one specific typology too narrowly can limit the applicability and usefulness of a final product [95].

4.2 Collaboration through Multi-User Control

Despite the classification of a collaborative system based on the time-space taxonomy, there is a need to provide access to a system or an application and to let users control functions in order to perform/complete tasks.

Providing Control to a User

When talking about control, we use Flemisch et al.'s definition of "*control means to influence the situation so that it develops or keeps in a way preferred by the controlling entity*" [77]. Giving a single user control over a machine, system, or function requires the assessment of the ability, which refers to the assessment of means or skills to do or change something [77]. Based on the ability, a user can be granted authority – receiving the allowance to control, to perform a specific task [77]. Flemisch et al. distinguish between Control authority, which refers to the execution of control, and Control Change authority, having the authority to change or assign somebody else with control authority [77]. A user then needs to perceive responsibility to motivate certain control actions. Taken together, depending on the abilities (e.g., skills, competencies) needed to perform a task, a system grants or restricts the use of functions (authority). Granted authority provides access to controlling entities that can be executed. The most evident relationship thereof lies between ability and control because control is not possible without sufficient ability. Second, authority is needed to allow control while a users' responsibility is important to ultimately motivate the execution of control [77]. In the situation of flying an aircraft, for instance, both pilots have the ability to fly an aircraft and feel responsible for arriving safely. While the co-pilot's role is about assisting the pilot (low authority), the actual pilot can always take over control at any time (high authority) [77].

Facilitating Multi-User Control

The design of a system or device that enables collaboration needs to provide multi-user control. A key aspect is if a task is even suitable to be performed collaboratively [179]. If that is the case, users can be assigned responsibilities considering their abilities to grant authority for control [77]. This means, in designing for collaborative control, a system needs to grant authority (levels) to multiple users at once, which demands balanced access to functions. Moreover, it needs to be ensured that control actions are executed in a structured way and promote collaboration to avoid conflicts [180]. A possible approach to balance users' authority under considering their abilities refers to introducing of so-called coordination policies [180]. Those policies balance access to functions among multiple users by enabling them to vote for changes, providing users with different access levels, assigning dedicated functions to specific users, providing everyone with access to everything, or having one key user who decides on behalf of the group [180, 207].

Master or key user: Having one so-called master or key user who decides on behalf of the group is among the most prominent available coordination policies [207]. Thus, functions can only be executed by one user at a specific time, while others cannot intervene. Prominent examples are the control of a TV with a single remote control or the use of an in-car infotainment system by one user.

Anytime: This coordination policy allows every group member to perform actions independently at any time [180]. While every user can execute every function, it enables

ulimited, equal contributions while also providing the possibility to overrule others' decisions, which can increase frustration and conflicts.

Different access/control levels: This policy provides users with different privileges in terms of access to functions or documents [180]. Thus, it relies on different levels of control possibilities per group member [207] where not every user has the chance to perform every available function (limited access) [77, 184]. An approach, therefore, refers to different access privileges with three main (risk) levels [125]: Level 3 is also called a high-risk level where functions are available that can lead to unwanted situations [125]. Users assigned with this privilege may be, for instance, able to perform discreet functions (e.g., access personal data, purchasing something). The medium risk, Level 2, most commonly involves the personalization of one account or the adjustment of specific settings while Level 1, or low risk, provides only access to functions that have little consequences or features public information [125]. Usually, those access privileges are provided and mapped to certain user roles such as a *primary user* who has the privilege to all functions, an alternate primary user who has in certain scenarios access to all functions, *secondary users* that are restricted in access and thus their interactions depend on primary users (e.g., children, untrustworthy people), or a *guest user* who „visits" the group and thus can use minimal functions [125]. Additionally, those user roles can but do not need to be connected to certain privileges or access levels [125]. The most common example of different access levels is implemented in co-editing services where users can edit, comment, or only view certain documents [89, 196].

Assigning dedicated functions to users: Distributing access to functions among group members combines the key-user policy with assigning different access levels. Overall, this policy provides one or more users access to a dedicated function [180]. This means some users can perform additional functions while others cannot. The big difference compared to having specific access levels lies in the possibility of passing these dedicated functions to someone else [180]. Thus, the privilege of being a key user for a specific function can change over time. This might encourage more discussion among users and create awareness of certain functions' impact on the overall group task.

Voting for changes: Voting for changes allows one to make decisions only under democracy by e.g., voting for or against changes [180]. Every group member thus has the chance to posit a vote and be actively involved in the decision-making [159, 180]. However, a function can never be executed by one user only. Thus, group members rely on one another to accomplish a goal.

Co-Located Collaboration through Coordination Policies

Previous work explored how these diverse coordination policies support co-located collaboration in various situations such as in the living room (e.g., [168, 179, 207]), in public spaces (e.g., [192]), in air vehicles (e.g., [65]), or in the dining area (e.g., [2]). McGill et al. [168] investigated a voting system for movie selection in the home using smartphones to encourage participation [168]. Their results show that it induces a high level of frustration and a high mental workload while resulting in a low perceived usability [168]. Current research reports that using personal devices, such as smartphones to collaborate in a shared environment, detaches users despite being physically close [152]. Based on an online survey and the scenario of controlling the TV simultaneously in a group using gesture interaction, Plaumann et al. [207] report that voting for a movie supports fairness [207] and is perceived as entertaining [207]. Moreover, voting on songs in public spaces (e.g., restaurants or bars) acts as a conversation starter among strangers and thus can be seen as a support of social interaction [192]. However, voting is also time-consuming and, thus, users describe it as tedious for frequently used tasks [207]. Having a single key user instead who controls on be-

half of others shows high usability and low frustration [168]. It is described as not ambiguous, encouraging storytelling, and ensuring conversations [2]. Additionally, Plaumann et al. report based on controlling a TV in a group setting that this approach also avoids control conflicts and prevents technical problems during simultaneous interactions [207]. Nevertheless, it increases interpersonal conflicts, especially when the key user does not perform the changes others request. Overall, the most common approach refers to providing different access levels (e.g., view, comment, edit) in a system [180, 207] or switching key users from time to time (e.g., by means of a rotating access token [2, 168]). While particularly hierarchical levels sound promising in involving all users actively, they can provoke unbalanced power dynamics and have the potential to increase interpersonal conflicts [207]. The investigations of various coordination policies in diverse use cases and domains outline the advantages and disadvantages of designing collaborative systems with a focus on efficient, effective, and structured decision-making. However, it is not yet clear whether the introduction of such coordination policies promotes social engagement among co-located users and how they impact the overall generated group experience.

4.3 The Design of Collaborative User Interfaces

As outlined in Section 3.2, the technology used or involved in collaboration can influence the success of a group in reaching their common goal. Thus, the design of the system with regard to collaboration support e.g., the interaction modalities, the user interface design, the usability of the system, and generated User Experience (UX) play a role in enabling collaboration in a dedicated environment such as in the car or the living, as relevant in this thesis research. In the following, we look into the definition and variety of interaction modalities applied to various media applications with a main focus on the automotive and smart home domains. Further, we report on the important aspects of designing user interfaces to enable collaboration.

Interaction Modalities for Media

An interaction modality enables users to interact with a system or device using one or more sensory channels such as touch, sight, sound, or voice to achieve certain tasks [64]. It encompasses both (physical) input methods (e.g., tapping a screen or pressing a button) as well as the associated sensory feedback (output) (e.g., visual, auditory, haptic response) [64]. Looking into the scope of this thesis, interaction modalities to control various forms of media in everyday contexts are rapidly advancing. Classic input modalities to control media (e.g., music, the TV) are typical tangible representations like physical buttons or sliders [106]. Another prominent example refers to remote controls, enabling to provide input over distance to various devices (indirect interaction [79]), most commonly a TV [34]. While typical remote controls are equipped with buttons only, also touch-based remotes (e.g., *Apple Siri Remote*[2]) or remotes with a tactile touch surface are currently on the market (e.g., the *TicTacTile* remote control by ruwido austria GmbH[3]). In recent years, particularly gesture and voice commands as input modalities got established in various contexts, including the home [96] and the car [130, 213]. Various gestures allow for selecting a TV channel [179] or controlling media in the car [213, 247] to name a few examples. Moreover, voice interactions are seen as a convenient way to skip the current song, call someone while driving the car [213], or search for a specific movie or song in an online library [96]. However, the most common input interaction refers to touch-based interaction such as tapping, swiping, or pinching on a touchscreen [101]. Yet a touchscreen can be classified as an input and output device [130]. Since receiving feedback is limited to the human senses [64], output modalities are majorly designed around visual, acoustic, or haptic feedback while in some contexts research

2 Apple Siri Remote 1st. Generation https://support.apple.com/en-us/HT205329, last accessed: 2023-04-03

3 https://www.red-dot.org/de/project/tictactile-system-12388-12388, last accessed: 2023-04-04

also focuses on providing olfactory feedback (e.g., in the car to overcome motion sickness [228]). Visual feedback can be provided for instance through analog representations (e.g., radio frequency), lights, symbols, or on high-resolution displays (e.g., TV, smartphones). To provide haptic feedback a device for instance can vibrate or provide force feedback [84, 126]. Auditory feedback gets offered via speakers, that are most commonly already integrated into devices [8].

Prevailing, interaction modalities aim to make technology or the execution of certain tasks more intuitive, efficient, and accessible to everyone. While there exist a numerous variety of combinations of input and output modalities whose combination can provide more immersive ways of interacting with media systems, research stresses the significance of an interaction modality to provide high usability (e.g., [39, 99, 168]). Since interaction modalities when applied in safety-critical environments such as in the car can also be a cause of distraction and increase mental workload (e.g., [204, 248]), the interaction design needs to carefully consider the application domain. Moreover, it is essential to keep the users in the loop [137] and enable them to control functions in an efficient, accessible, and easy way [34] while also evoking UX under considering possible effects on privacy [160] and safety [204].

Design Considerations & the Role of User Experience

The design of interactive systems for co-located collaboration requires real-time interaction and real-time feedback [50]. Moreover, the interface/product demands high UX and usability, which can get influenced by the social setting that occurs around the users [99]. The UX evoked through an interactive, collaborative system has also an effect on the success or failure of collaboration [99]. Overall, UX can be defined as "*technology that fulfills more than just instrumental needs in a way that acknowledges its use as a subjective, situated, complex and dynamic encounter*" [104]. It reflects a holistic perception and evaluation of a person's interaction and engagement with a product, system, or service. It encompasses a user's internal state (e.g., expectations, needs, motivations), the characteristics of the system itself (e.g., purpose, usability, functionality, design, accessibility), emotional impact, and in which context the interaction happens [104]. Moreover, the UX of interactive products can be evaluated based on two qualities, the pragmatic and hedonic quality [103]. While the pragmatic quality focuses on the task itself and providing the ability to achieve a desired goal with the product [103], the hedonic qualities direct to the pursuit of pleasure, originality of the design or the beauty of a product [103, 145] and has also a major influence on long-term UX [140]. Overall, high UX, particularly the support of long-term UX provides users with a seamless and enjoyable interaction with a product, ultimately leading to increase satisfaction and loyalty.

Designing for a high UX in a collaborative setting requires intuitive and usable products and interfaces [99]. Additionally, supporting awareness [97, 185] of others' interaction and providing information about the importance of someone's interaction contribute positively towards collaboration [186]. Moreover, sharing information [99] and visualizing the current collaborative status [97] is key to efficiency. Further, introducing new collaborative approaches in shared spaces can require physical adjustments (e.g., of technology but also sitting arrangements) [99]. Therefore, it is important to evaluate whether and how physical interaction and communication get affected [99]. Particularly when it comes to tasks that require high cognitive effort, users tend to use the environment as a support system by e.g., placing sticky notes [150]. Since collaboration directs the performance of sequential tasks to reach a desired goal, the systems' usability [99] but also the mental effort [168] have a high impact on performance. Usability, defined as the "*extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use*" [122], can impact ergonomics, mental effort, performance, acceptability and easy-of-use [40] of a product which in turn can influence collaboration.

4.4 Summay & Outlook

In this chapter, we looked into the general design of collaborative, interactive systems for co-located users. We demonstrated the typology of systems promoting either synchronous or asynchronous collaboration in shared spaces. Taken together, designing collaborative, interactive systems, particularly for co-located users, requires focusing on enabling communication, collaboration, and coordination of tasks in order to foster efficient and effective goal achievement. To enable collaboration mediated through technology, the system needs to grant control authority to multiple users at once. The user interface and the provided input/output modalities, therefore, need to ensure real-time collaboration and high usability while clearly showing the status of the collaboration. This demands a precise specification of the technology and interaction modality used to support collaboration on a certain task in a specific environment. Moreover, it needs to be carefully evaluated how to distribute control authority and responsibility over functions among users to facilitate contribution-making and engagement to enrich the group experience. A viable approach to enable input from multiple users lies in introducing and implementing coordination policies. While prior work reports on technical feasibility, and their impact on workload, individual perceived UX, and usability under various media and non-media use cases, we see the value of investigating how those coordination policies can be used to promote social control experience among co-located users. More precisely, we see the need to research how these policies in combination with synchronous/asynchronous collaboration can promote social interaction and enrich group experiences – enhancing experiences beyond individuals' UX, evoked through a system or service, subsequently generating social control experience. In the next Chapter, we are defining the design of social control experience for media under the insights gained from related work (Chapters 3 and 4) and outline a taxonomy for its design.

III

Conceptualization of Social Control Experience Design

Part III, **Conceptualization of Social Control Experience Design**, consists of one chapter which defines social control experience for media and proposes a taxonomy for its design. Further, it scopes the investigation of social control experience for media through a cross-domain approach in the automotive and smart home domains. The research question addressed in this part refers to *RQ3 – What are the different modes of shared control to design for social control experience?* Overall, the goal is to conceptualize the design space through the insights gained in Part II – Background & Related Work and to lay the groundwork for the exploration, implementation, and investigation of social control experience for media.

Chapter 5 – Definition, Taxonomy & Scoping, provides a thorough definition of what constitutes and influences social control experience through the insights gained in Chapter 3 and 4. Moreover, it outlines a taxonomy for the design of social control experience, consisting of five modes that share control among multiple users. The chapter concludes with the scoping of this thesis' investigations.

CHAPTER 5

Definition, Taxonomy & Scoping

Parts of this chapter are based on:

Melanie Berger, Bahareh Barati, Bastian Pfleging, and Regina Bernhaupt. 2022. Design for Social Control of Shared Media: A Comparative Study of Five Concepts. In *Nordic Human-Computer Interaction Conference (NordiCHI, 22).* Association for Computing Machinery, New York, NY, USA, Article 14, 1–13. https://doi.org/10.1145/3546155.3546694

Abstract

Collaborative systems can contribute to group work and improve team performance to support reaching a group-based goal. Former research proves its potential in various application domains such as office work, safety-critical environments, or leisure activities. While a deep understanding of technical feasibility and the impact on efficient and effective collaboration exists, little is known about whether and how collaborative systems enrich social engagement and group experience. However, collaboration involves humans, and notably, in shared spaces structure and success of collaboration are influenced by socially interacting. In this chapter, we look deeper into why social engagement and participation in collaborative settings where people know or like each other matter and how collaborative systems can promote shared control. Subsequently, we define social control experience through reflections on the insights gained in Part II. Moreover, we conceptualize the design space and propose a taxonomy for social control experience design. Under considering the aspect of decision-makers involved, time-based collaboration, and coordination policies, we outline five modes towards enriching social control experience. These modes differ regarding shared control over menus/functions among co-located users. Following, we scope the investigation of social control experience design for media use cases in the automotive and smart home domains.

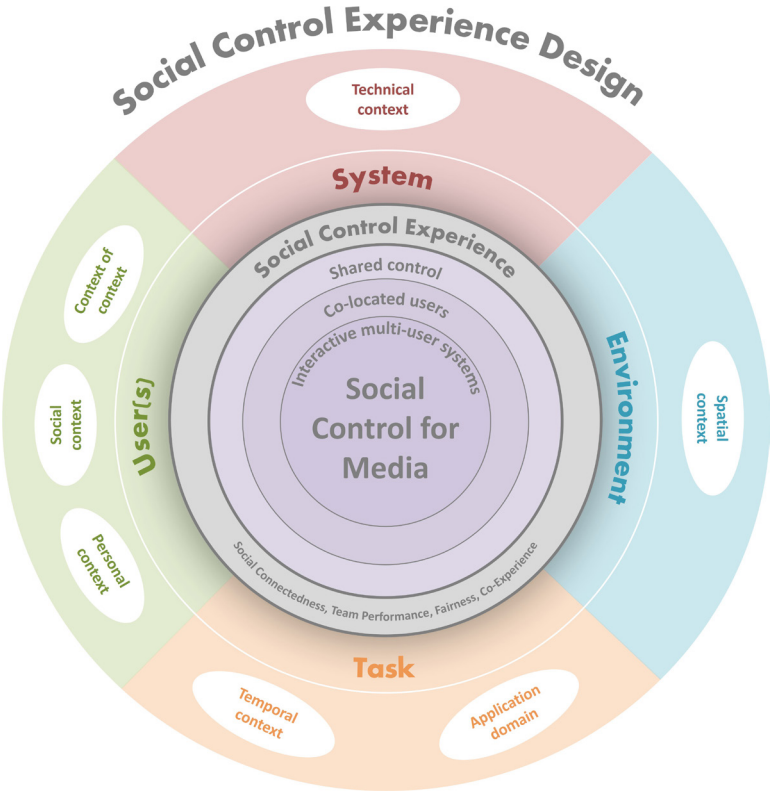


Figure 5.1: A visual overview of what constitutes and influences social control experience design. The inner three circles (purple) demonstrate social control for media as an interactive, multi-user system for co-located users with shared control. The fourth circle (gray) outlines the experience generated through social control. The quadrants (outer two circles) represent the influencing factors on social control experience, including users, tasks, systems, and the environment.

5.1 Defining Social Control Experience for Media

We define social control experience design as the design of collaborative, interactive systems with shared control to enrich individuals' experience in a co-located group setting. In relation to this definition, we characterize the experience generated as the individuals' perceived social connectedness (how much someone feels to belong to a group [148]), team performance (whether the group perceives themselves as a single entity working toward an overarching goal [200]), fairness (the perceived justice and promotion of rights [189]), and co-experience (shared experience through others' interactions [17]).

Providing a single user with the ability to control, allowing to change a system's status to fulfill needs can generate positive experiences, satisfaction, and gratitude [105]. Yet, changing the status of a system that is used in shared spaces can affect the experience of others in the room too, not necessarily positively [17]. Prior research demonstrates that users strive to be actively involved in decision-making processes of their interests particularly when surrounded by people they know or like [10, 184]. Yet, everyday technologies used in the company of others, such as media systems, TVs, or sound systems, restrict control to one user at a specific time [22, 78, 186], consequently limiting decision-making through shared control. This means other users in everyday, private shared spaces cannot actively intervene or contribute toward control decisions. Nevertheless, changes ultimately impact the atmosphere and experiences of everyone in the room [22, 186]. Those limited or restricted interventions in control can emerge frustration [66], which negatively influences group bonding, consequently lowering social engagement, interaction, and group experience.

However, interacting socially is fundamental [223], contributes to well-being [148, 217], and defines whether someone feels comfortable expressing their needs, expectations, and visions. The perceived social connectedness, fairness, team performance, and co-experience are indicators of social interaction and inclusion in a group setting as outlined in Section 3.3. While social connectedness relates to the belongingness and affiliation toward the group [10, 148] and indicates the strength of the group's social bond [261] (belongingness, affiliation, connectedness, companionship), team performance extends these insights with information concerning whether the group perceives themselves as a single entity working toward an overarching goal [200] (team cohesion, coordination effectiveness). Further, fairness can impact team performance and the perception of belonging and inclusiveness [189, 253]. Moreover, the group experience can be affected by others' interactions and by the direct presence of people, characterized as co-experience [17] (user experience, social experience). Therefore, we centralize social control experience around the evoked social connectedness, co-experience, fairness, and team performance.

Taken together, we research in this thesis under the notation of social control experience design how control over media functions can be shared among co-located users in everyday, private shared spaces, consequently supporting collaborative decision-making among users that know and like each other. The main focus lies on enabling active participation to enrich social control experience. Social control experience refers to the experience evoked through using a media product/service together and the stimulated social interaction among co-located users in private, shared spaces through shared media control. We define social control experience as the individuals' perceived:

- **Fairness:** the perceived justice and promotion of rights [189] in terms of access to control.
- **Social Connectedness:** how someone feels to belong to a group [148] (affiliation, belongingness, connectedness, and companionship).
- **Co-Experience:** the shared experience evoked through others' interactions in a room or with a product/system [17] (social experience [111], UX [234]).
- **Team Performance:** whether the group perceives themselves as a single entity working toward a shared goal [200] (coordination effectiveness and team cohesion).

5.2 Influences on Social Control Experience

The collaborative execution of tasks is a dynamic process that gets influenced by the users involved [169], the characteristics of the task [98, 113], the environmental conditions, and technology involved [190, 231]. As detailed outlined in Section 3.2, research reports that the social structure and relationships among occupants, defined as *social context*, influence the quality and success of the collaboration [14, 113, 152]. Moreover, every user's characteristics such as knowledge, needs, personality traits, values, cultural backgrounds, and norms can impact social engagement as well as the efficiency of task performance [190]. Apart from the non-influential, social dynamic aspects of the user group, the *spatial context* (physical environment), the *temporal context* (e.g., duration, frequency of task performance) as well as the *technological context*, play a crucial role when collaborating on a task [113, 190].

The latter means that the design of interactive multi-user systems impacts whether and how social control experience gets promoted. Since the design for social control experience aims to enrich individuals' group experience among co-located users (see Section 5.1), it demands the design of special groupware applications with a main emphasis on team support [136] in the spatial context of private, shared spaces [95, 190]. While any interactive system requires high usability [99], the mental effort required [168] and the provided awareness [97, 185] of other users' interactions affect the success or failure of task performance, as outlined in Section 4.3. Moreover, prior work reports that making decisions in a group setting depends on the *decision-makers* involved – those user(s) that tend to decide on behalf of the group [159]. Social control experience is about sharing control to promote active involvement in decision-making. This demands a structured way of decision-making as well as a structured execution of control. This can be supported by the introduction of *coordination policies* [180] (Section 4.2). Those policies promote the assignment of authority levels to (certain) users, depending on their abilities [77, 180]. Since collaboration and contribution-making can happen synchronously or asynchronously one after the other, it needs to be carefully decided which *time-based collaboration* a system allows and implements [95] to promote social control experience.

Taken together, social control experience can be influenced by the nature of the task, the users involved, the environmental dimensions under which collaboration happens, and the technology provided (see Figure 5.1). From a technology perspective to enable shared control, we argue under related work that balancing *decision-makers*, considering time-based collaboration, and *introducing coordination policies* are the main driving forces of designing for social control experience.

5.3 A Taxonomy for Social Control Experience Design

In everyday, private, shared spaces such as at home or inside a car, media technology often limits the control and execution of functions to one user at a specific time. This authoritarian way of control is very natural, and users overcome its limitation through verbal or non-verbal communication. However, verbally expressed needs are not necessarily considered by the user in charge of the system, consequently impacting the experience and social engagement among users in shared spaces. To overcome this, we look into designing for social control experience.

To systematically design social control experience for media – sharing control among co-located users in everyday, private shared spaces, we propose a taxonomy. This taxonomy defines modes of how control over functions/menus can be shared to allow for multi-user control (multiple users have access to control) and individual contribution-making in group decision-making. Collaborative systems need to mediate communication, coordination, and collaboration [69, 83] of tasks among multiple users [136]. This demands real-time interaction [50]. To ensure this, and to align with the definition of social control experience design,

the taxonomy is guided by the aspects derived from prior work, outlined in Section 5.2 which refer to *structure the decision-makers*, considering *time-based collaboration*, and introducing *coordination-policies* to promote collaborative task performance through multi-user control access and enabling individual contribution making. In the following, we first outline the exploration of various variations for shared control and then report on the final taxonomy consisting of five modes towards social control experience design.

Exploration of Variations for Social Control Experience Design

To understand how social control experience design can be performed, we systematically explored how control over functions and menus can be shared among co-located users. Therefore, we looked at the logical combination of the following three characteristics:

- **Access to control** [77, 125] with 1 = everyone access to all functions, 0 = only one having access to all functions, – = so me having restricted access.
- **Control contribution making** [77, 184] with A = no consent from someone else is required (alone), T = together only where consent from other people is required.
- **The time-based collaboration** the system provides [95] with 1 = synchronous collaboration, 0 = asynchronous collaboration.

Var.	Characteristics					
	time-based collaboration (synchronous = 1, asynchronous = 0)	access to control functions (everyone all = 1, only one = 0, restricted = –)	control contribution making (alone = A, together = T)	decision-makers	supported coordination policy	explored in this thesis (yes/no)
1	**0**	**0**	**A**	team & individual	dedicated functions	**yes** (Token-Ring)
2	**0**	**1**	**A**	not possible		no
3	**0**	**–**	**A**	combination of Variation 1 & 6		no
4	**1**	**0**	**A**	team	key-user	**yes** (Autocratic)
5	**1**	**1**	**A**	group	anytime	**yes** (Anarchic)
6	**1**	**–**	**A**	group & team	access levels	**yes** (Hierarchical)
7	**0**	**0**	**T**	not possible		no
8	**0**	**1**	**T**	not possible		no
9	**0**	**–**	**T**	not possible		no
10	**1**	**0**	**T**	not possible		no
11	**1**	**1**	**T**	multiple	voting	**yes** (Consensual)
12	**1**	**–**	**T**	not possible		no

Table 5.1: Overview of the variations that resulted from the combination of time-based collaboration (synchronous, asynchronous) [95], access to control (everyone all, only one, restricted) [77, 125], and control contribution making (alone, together) [77, 184] and the underlying decision-makers involved [10, 159], and supported coordination policy [180]

Table 5.1 highlights possible variations (12 in total) for our goal to support designing for social control experience, which resulted in 5 modes to be explored (*Consensual, Hierarchical, Token-Ring, Anarchic, Autocratic*). We mapped the 12 variations with literature concerning decision-makers involved [10, 159] (multiple, group, team, individual decision-makers) and required coordination policies to technically implement [180] shared control (key-user, anytime, access levels, dedicated functions, voting). Looking more in detail at the individual variations, we identified that Variations 7 – 10, and 12 have contradicting characteristics. While they should support contribution-making together only = T, either access to functions is not always guaranteed for every user due to asynchronous collaboration (Variations 7, 8, and 9), or some users have no or restricted access to control (Variation 10 and 12) which ultimately limits making control decisions together. Also, Variation 2, providing every user access to all functions = 1 in an asynchronous = 0 way, is contradictory and thus an invalid combination of the characteristics. This results in a remaining set of 6 Variations. Looking closer at Variation 3, we see a combination of Variation 1 and 6, providing restricted access to control asynchronously. Hence, we decided to exclude Variation 3, focusing on clearly distinguishable Variations in terms of their characteristics. Even though Variation 4 reflects the established authoritarian way of executing control functions in a group setting, we decided to keep it for completeness. These five remaining variations form the taxonomy of social control experience design that we explore in this thesis further. We detailed describe these five modes below.

The Five Modes towards Social Control Experience Design

The combination of *time-based collaboration* [95], *access to control* [77, 125], and *contribution-making* [77, 184] from Section 5.3, resulted in five modes (see Figure 5.2). These five modes reflect possibilities of shared control that balance the variety of decision-makers [10, 159] in a group setting, implemented through a diverse set of coordination policies [180]. Table 5.2 provides a condensed, complete overview of the five modes' characteristics, including a visual overview of the evolving decision-making structure. The taxonomy of five modes guides this thesis' research concerning social control experience design for media. Below, we provide a detailed description of each mode about its characteristics.

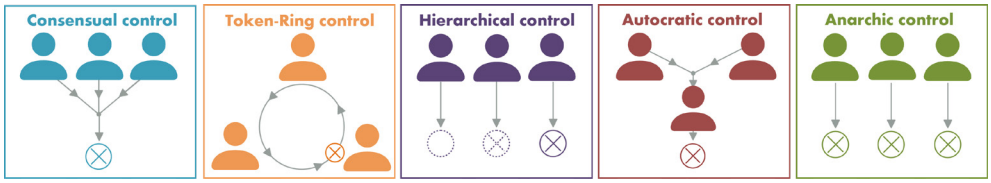


Figure 5.2: Visual overview of the taxonomy consisting of five modes toward social control experience design. Left to right: *Consensual control* allows group members to make a decision jointly, *Token-Ring control* allows one member at a time to make a decision, *Hierarchical control* designates different access levels to members to make decisions at once, *Autocratic control* limits access to only one member to make a decision (for the group), *Anarchic control* allows group members to make any decision all at once. (Bootstrap Icons)

Consensual Control Mode

The *Consensual control mode* balances for *multiple decision makers* [159]. This means that every user has the same authority in making decisions, but no user can make decisions alone [159]. To technically enable this, the interactive system requires the implementation of the coordination policy of voting [180], defined as "*all users need to vote to execute an underlying function*" [168, 180, 207]. This implies that a control decision can only be made when every member agrees on the action to be performed. This reflects a synchronous way of collaboration and facilitates everyone to contribute towards the group goal actively. Since

nobody can execute a function by themselves, every user must have access to all available functions and menus. Thus, access to menus and functions is unrestricted for all group members.

Anarchic Control Mode

The *Anarchic control mode* implements the *group decision maker*, meaning every group member has equal weight in making decisions [159]. Therefore, every user has unlimited access to functions and can control everything alone. This implies the coordination policy of anytime [180], which enables synchronous collaboration [95] and contribution-making by everyone. Taken together, every group member can make individual control decisions, which can affect decisions made by others since the last action always overrules all precedent actions.

Token-Ring Control Mode

The *Token-Ring control mode* reflects either the *individual decision maker* [10] or the *team decision maker* [159]. Due to the asynchronous way of collaboration [95], the decision-maker changes over time. This means the person in charge of the functions/menus might either act as an individual decision maker – deciding alone under the focus of achieving the group goal [10] or performing as a team decision maker [159], discussing with others before making choices. We expect the role of the decision-maker to be established depending on the group dynamics while also expecting the role to change over time. Overall, this mode means that only one group member has access to all functions at a specific time, while the other users cannot control any functions. Therefore, it reflects the coordination policy of *dedicated functions* in a unique way of rotating between full access to functions and no access to functions. Due to the rotation, every user can make individual contributions under an asynchronous mode of collaboration.

Hierarchical Control Mode

The *Hierarchical control mode* combines the *group decision maker* and the *team decision maker* [159]. This means not every group member can access all functions (restricted access). Still, every user has access to some functions [77, 184] which demands different levels of control possibilities per group member [207]. To ensure active contribution and a structured way of synchronous collaboration [95], we define that the *Hierarchical control* mode requires at least one user with access to all functions all the time. Moreover, all other users should have access to at least one single function. It implies that there is never a group member who has no access to functions at all. Implementing this requires the consideration of the coordination policy *access levels* [180].

Autocratic Control Mode

The *Autocratic control mode* reflects the *team decision maker* [159], which means that there is one group member who decides on behalf of the group. Thus, the other group members cannot actively contribute to the group goal by other means than verbal or non-verbal negotiation. This implies the coordination policy of a key-user [180]. Taken together, the *Autocratic control mode* supports synchronous collaboration while restricting group members from contributing individually by limiting access to menus/functions [77, 184]. This mode is the current, most established way of control in private, shared spaces. We integrated this 'conventional' mode as a baseline to compare its established collaboration experience with the more novel ones outlined above.

5.4 Scoping: Rational of the Cross-Domain Investigation for Media

We conduct a cross-domain investigation to challenge the design of social control experience for media. This offers the opportunity to identify effective design strategies and techniques while gaining a thorough understanding of the role of the context and use case when designing toward enriched social control experience. To answer RQ4 – *How do the five modes of shared control (Consensual, Hierarchical, Token-Ring, Anarchic, and Autocratic control) affect social control experience?*, we explore collaborative media systems in the automotive and smart home domains. Through the two domains' diverse environmental characteristics, we can gain a comprehensive overview of social control experience, allowing us to transfer and generalize findings to other application areas.

Media consumption is a social activity [132] that has the characteristics of connecting people over generations [56] and gets majorly consumed in a social environment [85, 176]. Therefore, we see media as a viable strategy to study social control experience since it is already recognized as a social activity. Further, media is well established in the car and at

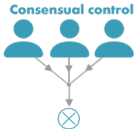
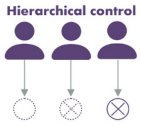
Mode	Characteristics				
	decision-makers [10, 159]	supported coordination policy [180]	time-based [95]	access to control [77, 125]	control contribution making [77, 184]
	**multiple**	**voting**	**synchronous**	**everyone all**	**together**
	**group**	**anytime**	**synchronous**	**everyone all**	**alone**
	**team & individual**	**dedicated functions**	**asynchronous**	**only one**	**alone**
	**group & team**	**access levels**	**synchronous**	**restricted**	**alone**
	**team**	**key-user**	**asynchronous**	**only one**	**alone**

Table 5.2: Overview of the main characteristics of each mode of social control experience with regard to the underlying balanced decision-maker [10, 159], supported coordination policy [180], time-based collaboration [95]) and the aspect of access to control [77, 125] and the way of contribution making [77, 184] by an individual group member. (Bootstrap Icons)

home because it allows one to relax [5, 30], enhance well-being [32], and is perceived as convenient [5, 30]. However, media technologies commonly available in the car or at home are still restricted to one user [22, 78]. Examples include an in-car display (In-Vehicle Infotainment System (IVIS)) or the TV. Therefore, we see the research in the automotive and smart home domains as timely and appropriate because it allows studying social control experience in an everyday shared space where shared control is currently limited. This provides the possibility to investigate the enrichment of individuals' experiences in a group setting through the taxonomy of social control experience.

Contextual Characteristics

The investigation of social control experience is scoped with the following contextual dimensions (see Figure 5.3): First, the physical *Environment* as a shared space in either a passenger car or in the living room. These two domains vary in environmental characteristics. The car can be characterized as a safety-critical moving environment [134], with restricted movement capabilities of occupants [262], limited space [262], and (pre) defined seating

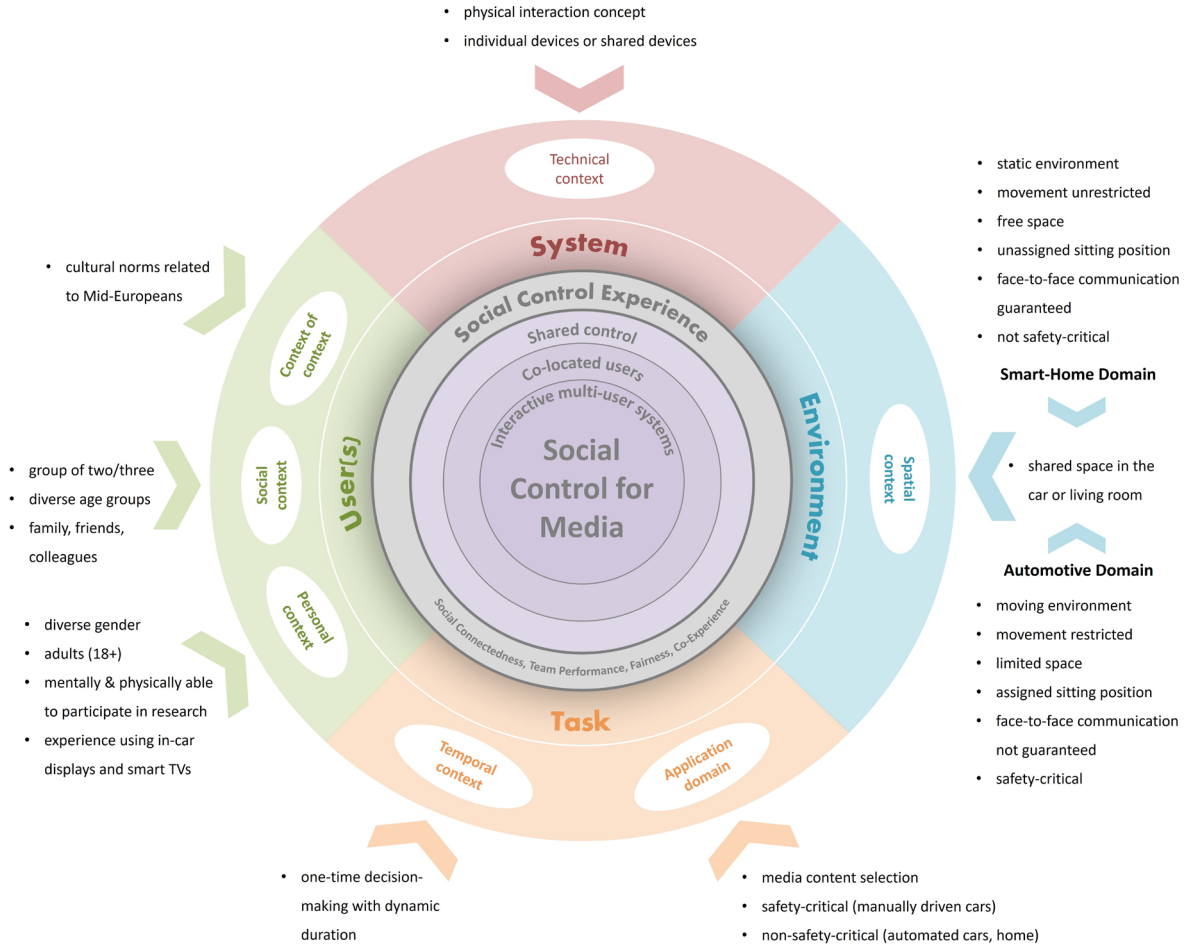


Figure 5.3: Visual overview of the scoping of the investigation. It outlines the contextual characteristics under which we design, implement, and investigate social control experience for media in this thesis.

arrangements [211]. Due to the placement of the seats (limited eye contact) and background noise, communication is hard to maintain [156]. The living room, in comparison, is a static environment, not defined as safety critical. In general, users can freely move within the space. Sitting possibilities can vary among homes, are not (necessarily) predefined, and positions can be changed easily [256]. This provides the opportunity to communicate more effortlessly by also maintaining eye contact. Secondly, the *Tasks* are related to media. Due to the experimental assessment of social control experience in controlled environments, we focus on the one-time decision-making process while providing enough time for collaboration. However, due to the safety-critical characteristics of the car, some tasks might be time-critical since safety needs to be maintained. Thirdly, the *Users*. Social control experience tackles co-located users that know or like each other in promoting control decision-making. Thus, we focus on family, friends, and colleagues collaborating in a group of two to three members since the average household size comprises 2.2 people [71]. To maintain a most natural collaborative environment, we concentrate on adults aged 18 or above (due to ethical limitations) without gender or personality restrictions to reflect the diversity naturally occurring within groups. However, we exclude mentally and physically impaired users. To avoid confounding factors due to limited technological know-how, we explicitly recruit users with prior experience using in-car displays or smart TVs. The cultural norms reflect Mid-Europeans collaborating. Lastly, the *System* defines the technology designed and used in collaborative settings. To systematically approach this, we focus in this thesis on extending currently available services or systems in the car or at home. This means we extend the most natural interaction with a TV or an in-car screen towards collaborative usage. Therefore, we concentrate on employing physical interaction modalities to private or shared devices (e.g., touchscreens, remote controls). Detailed technical considerations concerning the design of social control experience, particularly related to product design or user interface design, are reported in detail in the individual chapters.

Assessment of Social Control Experience

To investigate how the modes from the taxonomy affect social control experience, we design, implement, and evaluate interactive media systems under the above-described contextual considerations.

In Section 5.1, we defined social control experience design as the design of collaborative, interactive media systems with shared control to enrich individuals' perceived social connectedness, team performance, fairness, and co-experience. To evaluate the experience evoked by each mode from the taxonomy, we deploy questionnaires to quantity users' perceptions. We measure **social connectedness** in terms of connectedness, companionship, and affiliation using the Social Connectedness Scale [148] and belongingness by means of the Inclusion of Community in Self-Scale [164]. Further, we use the team performance questionnaire from Paul et al. [200] to measure the evoked **team performance** in terms of individuals' perceived coordination effectiveness and team cohesion. To understand the evoked **fairness** related to shared control in combination with active participation, we rely on self-defined questions based on a 5-point Likert scale. Since **co-experience** is the experience that gets generated by others' interactions and by the direct presence of people [17], we decide to employ the short User Experience Questionnaire (UEQs) to understand the created experience through the system [234] and combine it with the questions attributed to social experience from the GAMEFULQUEST [111] to comprehend the influence of the users that are present. An overview of the questionnaires can be found in Appendix A. To comprehensively understand the generated experiences and interactions by the individual modes, we aim to combine the quantitative data with user feedback through semi-structured interviews. Depending on the use case, we define and extend the measures to deepen domain-specific insights and assess possible influencing factors. Details on the measurements are outlined and discussed in the corresponding chapters.

In the two follow-up parts of this thesis, we report on studies of social control experience design for media in the automotive (Part IV) and smart home domains (Part V). We look into the promotion of driver-passenger collaboration in manually driven cars (Chapter 7) and into passenger collaboration in fully automated vehicles (Chapter 8). Moreover, we report on the evoked social control experience through designing for collaborative movie selection (Chapter 11) and genre selection (Chapter 12) in the living room.

IV

Social Control Experience in the Automotive Domain

Part IV, **Social Control Experience in the Automotive Domain**, presents four chapters that scope, investigate, and reflect on social control experience design in the automotive domain. The research question for this part is *RQ4 – How do the various modes of shared control (Consensual, Hierarchical, Autocratic, Anarchic, Token-Ring) affect the social control experience in the automotive domain?*, more precisely, we look into *RQ4.a – To what extent do the modes affect social control experience in terms of social connectedness, team performance, and fairness in the car?* The goal is to understand whether and how the five modes from the taxonomy promote social control experience among occupants in a passenger car.

Chapter 6 – Introducing & Scoping this Domains' Investigation, introduces and outlines the scope of the research in the automotive domain.

Chapter 7 – Investigation in Today's Cars, illustrates how the diverse modes from the taxonomy can promote driver-passenger collaboration in manually driven cars through an In-Vehicle Infotainment System (IVIS). Based on the experimental assessment in a simulator study, it reports on drivers' and passengers' perceived social connectedness, team performance, and fairness.

Chapter 8 – Investigation in Future Cars, provides insights into how the five modes from the taxonomy promote collaborative music playlist creation among three passengers in a fully Automated Vehicle (AV). In a parked car, we investigated the individuals' evoked social connectedness, team performance, and fairness.

Chapter 9 – Reflecting on this Domains' Investigation, summarizes the insights gained through the experimental investigations in Chapter 7 & 8 and outlines the main, overall findings.

CHAPTER 6

Introducing & Scoping this Domains` Investigation

Abstract

In Chapter 5, we outlined a taxonomy for the design of social control experience for media. In this part, we aim to explore its effect inside a passenger car. Thus, as a next step, we design, implement, and evaluate the social control experience in the automotive domain based on two media use cases. In the following, we provide a brief introduction to automotive research, outline aspects of automotive system design, and demonstrate the importance of media inside the car. Under these insights, we scope the investigations of social control experience in today's cars (Chapter 7) and in a future, fully Automated Vehicle (AV) (Chapter 8).

6

The car is among the most prominent consumer goods [20] and has become indispensable in our lives [232]. It promotes individual mobility and allows one to easily carry goods [232]. When we take a closer look at today's cars, the unique selling point of a car is more and more defined around the in-car experience [20]. Even though a car provides a confined space with limited movement capabilities due to safety-critical requirements, it is established as a high-tech space [141]. Particularly over the past decade, the trend of in-car technologies has gone towards improving the in-car experience by introducing driving assistant functions and novel user interfaces (e.g., infotainment systems, interactive windows, and doors) [232, 238]. These developments increasingly change the car's role since inventions are no longer about addressing issues of mobility only. Due to these technical innovations, a modern, assisting car provides a place for a multitude of Non-Driving-Related Activities (NDRA) [205] which range from communication, and information access, to navigation, media, and entertaiment-oriented services [166, 205].

Therefore, we investigate social control experience design in the automotive domain , focusing on media-oriented NDRAs. More precisely, we concentrate on bringing social control experience into the car by considering established, safety-critical technology (i.e., integrated touchscreens) and adapting those toward collaborative usage. To do so, we anticipate designing concepts that align with safety regulations and can become more effortlessly market-ready while also not inducing bias towards social control experience due to a high novelty effect of the design cases themselves. For the quantitative assessment of social control experience in the automotive domain, we focus first on understanding whether and how the modes from the taxonomy are considered fair regarding shared control. Moreover, we anticipate comprehending the intensity of social engagement and evoked group belongings. Thus we examine the evoked social connectedness in terms of belongingness, affiliation, connectedness, and companionship. In a safety-critical environment, efficient and effective task performance is crucial for ensuring safety [134]. Thus, we place more emphasis on performance measures, specifically by evaluating perceived team performance in terms of coordination effectiveness and team cohesion. We extend the insights by measuring the task completion time to get a more thorough understanding of task performance. Since the automotive era is in the stage of transitioning from manual or assisted driving to fully automated driving [195], we see the need to research social control experience in both today's cars and inside a fully Automated Vehicle (AV).

Investigation in Today's Cars

To do so, we start by gaining insights through social control experience design in today's cars. To this date, the driver is still the essential person for in-car user interface concepts, as driving safety is crucial [238]. However, performing NDRAs, provided by, for instance, an In-Vehicle Infotainment System (IVIS) can be mentally demanding and distracting [248]. Statistics show that NDRAs performed by a driver can increase crash risk up to 4.6 times compared to pure driving [63]. Since 56% of all car rides happen with at least one additional passenger [254], research highlights the potential of designing for driver-passenger collaboration to reduce drivers' mental workload [93] and to enhance passengers' experience [30]. Moreover, passengers strive to assist the driver [30] and have active control and access to in-car functions [30, 118] to feel more empowered [30]. Further, socially interacting with other occupants, particularly with the driver, constitutes a positive in-car experience [30]. Nonetheless, passengers are often neglected when it comes to current IVIS designs (e.g., IVIS screens tilt towards the driver), which reduces the general trip experience and limits the possibility of providing assistance [30]. Thus, we argue that the use case of driver-passenger collaboration is a viable approach to investigate the taxonomy of social control experience. We expect that supporting collaborative task performance between a driver and a front-seat passenger can enhance the driving experience while also promoting driving safety. To do so, we applied the five modes from the taxonomy, as reported in Section 5.3, to promote collaboration by means of an IVIS. Through the collaborative performance of media and infotainment-oriented NDRAs (e.g., navigation, music, radio), we study in Chapter 7 their effect on social control experience in terms of social connectedness (belongingness, affiliation, connectedness, companionship), team performance (coordination effectiveness, team cohesion), and fairness.

Investigation in Future Cars

We expect that the transitioning from today's manual or assisted driving (SAE Level 1–2) [195] to fully automated driving (SAE Level 5 [195]) will change the experiences of individual transportation. While the driver's role will disappear, it enables every occupant to fully engage in NDRAs. Research outlines that the demand for various NDRAs in automated cars will increase since there is no necessity anymore to stay situational aware and keep attention on the road [205]. This forms a high-tech interactive space with the opportunity to research the creation of a unique in-car stimulation and riding experience [60]. While current cars mainly provide information services and entertainment functions [130], users expect that fully automated cars enhance well-being, promote office work, provide more entertainment, or facilitate interaction and activities with other occupants in the car [107, 206]. Since particularly listening to music is among the most prominent activities performed in today's cars [30] and is even envisioned to be still prominent in fully automated cars [206], we see the opportunity to promote social control experience through shared music control. To do so, we apply in Chapter 8 the five modes from the taxonomy to the NDRA of collaborative music playlist creation in an AV. More precisely, we focus on three passengers, each having access to an integrated in-car screen, to investigate individuals' perceived social connectedness (belongingness, affiliation, connectedness, companionship), team performance (coordination effectiveness, team cohesion), and fairness.

Part IV of this thesis concludes with a reflection and a condensed summary about social control experience design in the automotive domain (Chapter 9). Through the insights, we report on the effect of shared control among car occupants on individuals' perceived social connectedness, team performance, and fairness.


Navigation
FM
My Music
Phone
Message
Calender
Car Status
Settings
Logitech

CHAPTER 7

Investigation in Today`s Cars

This chapter is a combination of the following publications:

Melanie Berger*, Debargha Dey, Aditya Dandekar, Bahareh Barati, Regina Bernhaupt, and Bastian Pfleging. 2022. Together in the Car: A Comparison of Five Concepts to Support Driver-Passenger Collaboration. In *Proceedings of the 14th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI '22)*. Association for Computing Machinery, New York, NY, USA, 183–194. https://doi.org/10.1145/3543174.3544940 **(won the best paper award)**

Melanie Berger*, Debargha Dey, Aditya Dandekar, Bahareh Barati, Bastian Pfleging, and Regina Bernhaupt. 2023. Empowering Driver-Passenger Collaboration: Designing In-Car Systems with a focus on Social Connectedness, Fairness, and Team Performance. *International Journal of Human–Computer Interaction*. https://doi.org/10.1080/10447318.2023.2205769

Melanie Berger*, Patrick Ebel, Debargha Dey, Aditya Dandekar, Bahareh Barati, Bastian Pfleging, and Regina Bernhaupt. 2022. Together Distracted? The Effect of Driver-Passenger Collaboration on Workload, Glance Behavior, and Driving Performance. In *Adjunct Proceedings of the 14th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI '22)*. Association for Computing Machinery, New York, NY, USA, 67–72. https://doi.org/10.1145/3544999.3552318'22

* primary, responsible researcher

Abstract

Driving a car can be difficult when it comes to distractions caused by operating the In-Vehicle Infotainment System (IVIS). In-car passengers often help with performing IVIS-related tasks. However, an IVIS is often not designed with a focus on task collaboration. In this chapter, we focus on how to design in-car systems with the goal to support collaboration and social engagement between a driver and a front-seat passenger. Based on infotainment-oriented tasks, we explore how the five modes from the taxonomy of social control experience design can share access to IVIS functions. With the modes applied to the IVIS, we investigate how the promotion of collaboration affects the social control experience of the driver and the front-seat passenger. Results from a simulator study with 16 pairs (N = 32) show significant effects of the modes on perceived social connectedness (measured with sub-dimensions connectedness, affiliation, belongingness, companionship), team performance (coordination effectiveness and team cohesion), and fairness. We found that especially a dedicated passenger IVIS screen (in Consensual, Hierarchical, Token-Ring, and Anarchic mode) empowers front-seat passengers, reduces power dynamics, supports fairness, and minimizes driver distraction (caused by interacting passengers). We discuss the implications of these findings and posit recommendations to design future IVIS in passenger cars with improved driver-passenger collaboration and social control experience by explicitly designing for balanced power roles, situational awareness, active communication, and a balance between drivers' privacy and trust toward the passenger.

7.1 Introduction

Modern cars support a variety of Non-Driving-Related Activities (NDRA), ranging from navigation to media and entertainment-oriented services [15, 205]. However, when drivers perform NDRAs, their mental demand and distraction increases [248], which results in 4.6 times higher crash risk compared to pure driving [63]. Research, therefore, highlights the potential of designing for driver-passenger collaboration, to reduce drivers' mental workload on the one hand [93] and to enhance passengers' experience on the other hand [30, 118]. To support in-car collaboration, Maurer et al. proposed to highlight front-seat passengers' gaze on the windshield to help drivers to spot dangerous situations [167]. Other solutions focus on giving front-seat passengers better access to the In-Vehicle Infotainment System (IVIS) by providing a split-screen user interface that shows content on the passenger side of the screen (e.g., [67, 202, 215]), enabling to delegate the IVIS screen and tasks towards the front-seat passengers' side [29, 202] or by simply placing an additional screen on the passengers' dashboard (e.g., [18, 24, 202, 208]). Even when passengers' access to an IVIS is guaranteed, the likelihood of collaboration strongly depends on the relationship between drivers and passengers, the maintained social engagement, and perceived social connectedness [30, 93]. Especially direct communication enhances social exchange in the car [75, 202]. In addition, encouraging active participation [136, 159], supporting team performance [200], and enhancing social connectedness [10, 148] constitute towards a good group collaboration. While previous research imposes the driver/passenger with additional car-related information [24, 167, 208, 251] or enables the passenger with better access to IVIS functionalities [29, 67, 215], little is known about how to design for a higher level of social control experience to best support driver-passenger collaboration. To overcome this limitation, we see the need to investigate how different modes of driver-passenger collaboration by means of an IVIS influence team performance, perceived social connectedness, and fairness. Thus, we focus on answering the following research question (RQ):

How does driver-passenger collaboration through different collaborative IVIS modes affect team performance, social connectedness, and fairness in manually driven cars?

We designed five different types of IVIS concepts based on the five modes from the taxonomy of social control experience design (*Consensual, Token-Ring, Hierarchical, Autocratic*, and *Anarchic control*; details in Section 7.3) to support driver-passenger collaboration in a manually driven car. To evaluate their effect on team performance (coordination effectiveness, team cohesion), social connectedness (belongingness, connectedness, affiliation, companionship), and fairness, we conducted a mixed-design experiment in a simulator with driver-passenger pairs (*N = 32, 16 pairs*). Insights show that the single-display IVIS setup (*Autocratic control*) leads towards high belongingness, connectedness, and coordination effectiveness, while the majority of drivers feel distracted once a passenger interacts with the screen. Providing two IVIS screens (*Anarchic* or *Hierarchical control*) instead empowers front-seat passengers, reduces power dynamics, and minimizes driver distraction caused by interacting passengers.

Contribution Statement: With the insights gained through the experimental assessment of the five collaborative IVIS modes, we contribute to the design, implementation, and investigation towards social control experience. Moreover, we contribute recommendations to best support social connectedness, team performance, and fairness among a driver and a front-seat passenger to enhance collaboration in cars while minimizing driver distraction.

7.2 Background & Related Work

The drivers' main role in manually driven cars refers to the primary task of driving in combination with performing secondary driving tasks (e.g., setting the indicators) to increase overall road safety [130]. Especially with the introduction of IVIS, cars nowadays support a variety of tertiary tasks, which are also known as NDRAs that range from comfort functions to entertainment services [15, 205].

Since performing NDRAs is mentally demanding and increases driver distraction [248], prior research has focused on mitigating these effects by designing for driver-passenger collaboration [30, 93, 118]. Front-seat passengers' support is especially valued by providing turn-by-turn instructions while driving through unknown areas [80]. Since the passenger can process and review more information, several publications (e.g., [12, 173, 201]) propose to provide the front-seat passenger with detailed information concerning the route and destinations compared to what a standard navigation system offers (e.g., opening hours of buildings). Such details can then be verbally shared with the driver [173], which prevents navigation errors and enhances the chance of remembering the route [12]. While gaining more information about the route can be achieved using a smartphone, prior research outlines that passengers strive for assisting with more in-car related activities by using the IVIS [30, 118]. Most cars today are equipped with a single IVIS, dedicated for use by the driver. To enhance collaboration by means of an IVIS, Berger et al. introduced a moving IVIS screen [29] to provide the front-seat passenger with better access to functions. Additional concepts refer to user interfaces that demonstrate passenger-relevant functions on the passenger side of the screen (e.g., [67, 202, 215]) or by simply placing another screen in front of the passenger (e.g., [24, 67, 202, 208]). Apart from providing passengers with access to IVIS functions, research outlines that sharing information with the driver supports social engagement [172] and enhances in-car experience [24]. Possible use cases of information sharing can be enabling the passenger to propose intermediate stops, which can then be accepted/declined by the driver [18].

Even though research outlines a full range of possible solutions for supporting driver-passenger collaboration (e.g., [29, 172, 201]), the likelihood of collaboration relies on the driving situation/context [93] and also depends on the personal relationship and perceived social exchange between a driver and the passenger [30, 93]. To enhance driver-passenger collaboration in future cars, we see the need to investigate aspects that constitute a higher social control experience within the car. Therefore, we research whether and how the modes of social control experience can be applied to promote team performance, social connectedness, and fairness.

7.3 Social Control Experience: Designing for Collaborative IVIS

With the design of collaborative in-car systems, we aim to support social control experience, consequently enhancing driver-passenger collaboration in current cars. To structurally explore this topic, our initial focus lies on the conventional context of collaboration between a driver and a front-seat passenger by means of an In-Vehicle Infotainment System (IVIS). Thus, we investigate how the diverse modes from the taxonomy of social control experience design can be applied to our use case of driver-passenger collaboration by means of an IVIS. In the following, we outline five collaborative IVIS modes (see Figure 7.1) which implement the five modes from Section 5.3.

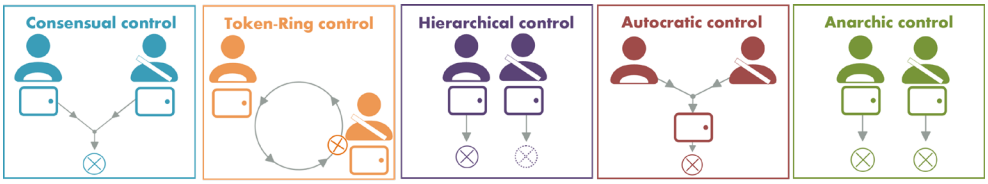


Figure 7.1: Adaptation of the visual representation of the five modes from the taxonomy of social control experience design. It demonstrates the modes applied to an in-vehicle infotainment system to promote driver-passenger collaboration (Bootstrap Icons).

Implementation of Five Collaborative IVIS Modes

For the general design of the IVIS User Interface (UI) (see Figure 7.2a), we took existing in-car UIs such as *BMW iDrive, Apple CarPlay* and *Android Auto* as inspiration and integrated access to standard in-car functions such as navigation, radio, music (collaborative functions), phone, messaging, calendar, settings (personalized functions) and car status (informative function). The individual modes and their corresponding UI designs are explained below.

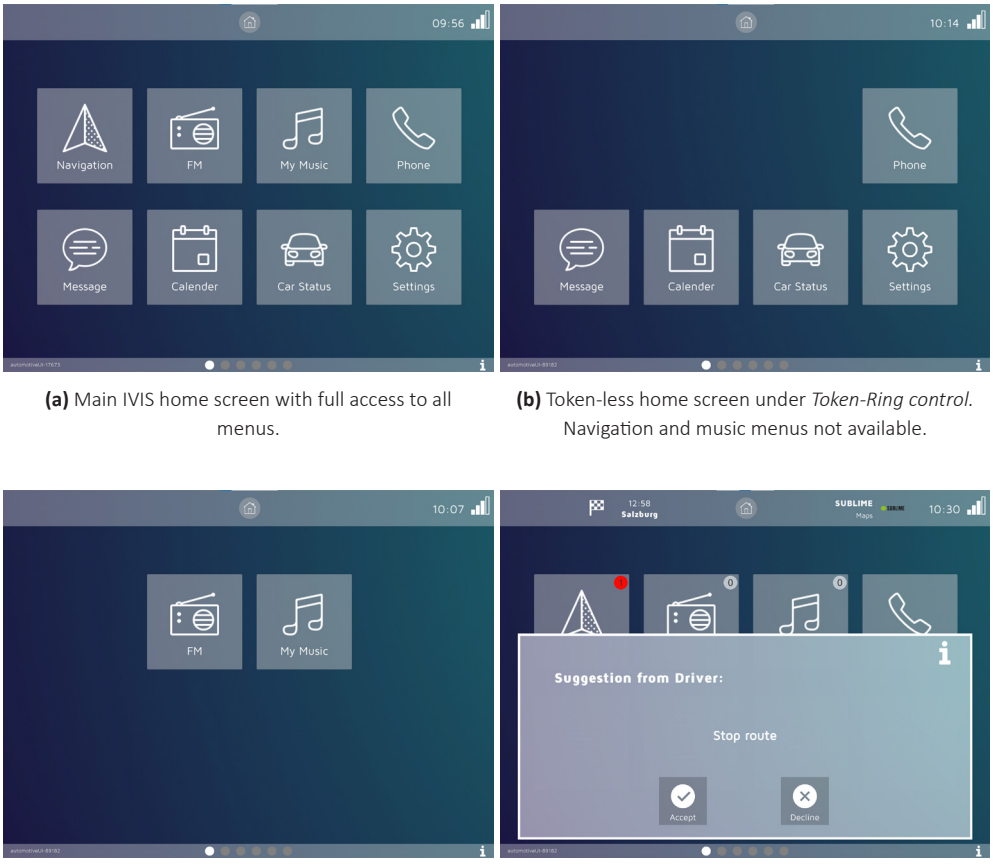
The Anarchic Control Mode: The driver and the front-seat passenger can make control decisions. To enable *Anarchic control*, the driver and the passenger are equipped with individual IVIS screens, similar to *Porsche's* passenger screen [251] while providing unrestricted access to IVIS menus (see Figure 7.2a).

The Consensual Control Mode: The driver and the front-seat passenger have unrestricted access to IVIS menus with their individual screen. However, a control decision (e.g., changing the radio channel, adding an intermediate stop) can only be made when both agree on an action to be performed. Whenever there is a control decision to be agreed on, the UI displays a pop-up notification for accepting or declining the decision (Figure 7.2d), similar to *BMW*'s concept of sending requests to the driver via the rear-seat IVIS [18]. The notification occurs on the drivers' screen for passenger decisions and on the passengers' screen for driver decisions. Thus, only those decisions get executed that want to be executed by both, while no one can control them individually.

The Token-Ring Control Mode: A virtual token moves between the driver and the front-seat passenger and takes away access to menus from the driver (e.g., during dense traffic) and instead provides the passenger with additional access. For the sake of our experiment, the token movement bases on Wizard-of-Oz [54], providing full menu access to the token holder (Figure 7.2.a) and limited access (no access to the collaborative menus such as navigation, radio, and music) to the user without the token (Figure 7.2b).

The Hierarchical Control Mode: The driver and the front-seat passenger have access to individual screens. The driver has full menu access (Figure 7.2a) and the passenger has limited access (Figure 7.2c). Overall, the mode is meant that the driver can decide before a journey on which IVIS menu the front-seat passenger can assist. For our investigation of this mode, we pre-assigned the menu function; radio, and music to the passenger which means, the passenger had restricted menu access. However, it was still possible for the passenger to reach the driver's screen if necessary.

The Autocratic Control Mode: It constitutes a single IVIS screen (Figure 7.2a), placed in the middle of the car's dashboard which reflects the current center console in cars. The driver can dictate control, while the front-seat passenger can only interact once the driver explicitly allows or requests for it. Thus, only one user can physically access the IVIS screen at a specific time. We integrated this 'conventional' setup as a baseline to compare this established collaboration mode with the more novel ones outlined above.



(a) Main IVIS home screen with full access to all menus.

(b) Token-less home screen under *Token-Ring control.* Navigation and music menus not available.

(c) Passenger home screen of *Hierarchical control.* Only music menus available.

(d) Pop-up notification under *Consensual control* to accept/decline decisions from another user.

Figure 7.2: Representation of the UI of the individual IVIS modes. (Icons by Icons8.com)

7.4 Research Question & Hypotheses

To explore how the collaborative IVIS modes support driver-passenger collaboration and enrich social control experience we ask:

How do the collaborative IVIS modes differ in the evoked social connectedness, fairness, and team performance when a driver and front-seat passenger collaborate on a task while riding in a standard car?

We want to explore whether there is a difference in the perceived social connectedness (H1), team performance (H2), and fairness (H3) depending on the type of collaborative mode.

H1 The type of collaborative IVIS has an effect on driver's/passenger's perceived social connectedness in terms of belongingness, affiliation, connectedness, and companionship.

H2 The type of collaborative IVIS has an effect on driver's/passenger's perceived team performance in terms of coordination effectiveness and team cohesion.

H3 The type of collaborative IVIS has an effect on driver's/passenger's perceived fairness.

7.5 Comparative Study

We conducted an exploratory, mixed-design experiment in a driving simulator with pairs of a driver and front-seat passenger (see Figure 7.3) to study the five modes' effects on social connectedness, team performance, and fairness.

Experimental Set-Up

Independent variables: As independent variables, we had the five collaborative IVIS modes as the within-subject variable (*Consensual, Token-Ring, Hierarchical, Autocratic,* and *Anarchic control*) and the sitting position/role as the between-subject variable (driver, front-seat passenger).

Figure 7.3: Demonstration of the simulator and study set-up with the mounted IVIS screens

Dependent variables/measurements: We measured driver's and passenger's perceived social connectedness in terms of connectedness, companionship, and affiliation using the Social Connectedness Scale [148] and belongingness by means of the Inclusion of Community in Self-Scale [164]. To assess perceived team performance in terms of coordination effectiveness and team cohesion, we applied the team performance questionnaire by Paul et al. [200] (three questions each). In addition, we assessed the perceived fairness by self-defined questions (Q1: I had the feeling that others had more operating options than I had; Q2: I think the distribution of the operating options among the group members was fair) based on a 5-point Likert scale (fully agree to do not agree at all). An overview of the questionnaires can be found in Appendix A. We used participants' qualitative feedback to determine the positive and negative characteristics of the different modes under investigation. In addition, we used subjective ranking to investigate users' preferences among the five modes. The interview questions are reported in Appendix B.

Due to the safety-critical event of driving, we assessed the following confounding factors: First, the perceived workload of the driver and the passenger by applying the NASA-TLX [102] in raw values format. Moreover, we measured the overall IVISs' UX (UEQ-Short [234]), the collaborative task completion time [s], and the driving performance. The collaborative task completion time refers to the first interaction of the driver with an IVIS on task 1 and ends with the completion of passenger task 4 (excluding audio instructions; see Table 7.1). For the driving performance, we recorded the vehicle speed [km/h] [255] and its lane position offset [m] [92] (the distance from the center of the car to the middle of the left driving lane on a 3.65 m wide lane) with a frequency of 60 Hz from the start of driving until the end of the last task. Concerning driver distraction, we measured the eyes-off-the-road time (percentage of task-completion-time in which the driver did not focus on the road [88]) with *SMI* eye-tracking glasses (ms).

Technical Set-Up

We implemented the driver/passenger IVIS UI (Figure 7.2.a) for a 12-inch tablet screen with a resolution of 2048 × 1536 using Unity 3D1. To exchange information among IVIS screens in real-time, we used the Message Queuing Telemetry Transport (MQTT) protocol2. To simulate the driving experience, we set up a manually driven left-hand drive car simulator with automatic gear shift and real car seats (see Figure 7.3). We mounted a wooden dashboard, steering wheel, and instrument cluster on a height-adjustable table that we moved to the lowest possible position to mimic the interior and demonstrate a realistic in-car experience. The dashboard size matched the standard C-segment car and had slots to mount the IVIS screens for the driver and the passenger. Another 12-inch screen was used as an instrument cluster and placed behind the steering wheel. As steering wheel and pedals we used the Logitech G25 gaming console. The overall driving scene was projected onto the wall in front of the simulator and a driving-related audio scenery was provided via speakers placed behind the dashboard (not visible to participants). The simulator software represented a two-lane fairly lean highway with traffic only on the right lane. Furthermore, the driving scene referred to a sunny drive during daylight without weather disturbances (an overview of the route participants had to follow can be found in Appendix B). The overall simulator was set up in an empty, dim-light lab.

Participants

We recruited participants within the university through e-mail invitations. For every recruited pair, one participant needed to have a valid driver's license. Overall, the experiment sample consisted of 16 driver-passenger pairs (a total of 32 participants, 7 same-gender pairs and 9 mixed-gender pairs), 13 male and 19 female, living in the Netherlands. Three pairs reported not knowing each other, while the remaining had either a friendship (6 pairs) or a working

relationship (7 pairs). Their age ranged from 21 to 46 (*M = 28.12 years, SD = 4.3 years*). In addition, 26 out of 32 participants reported prior experiences with an IVIS. All participants used touchscreen-based devices several times a week.

Procedure

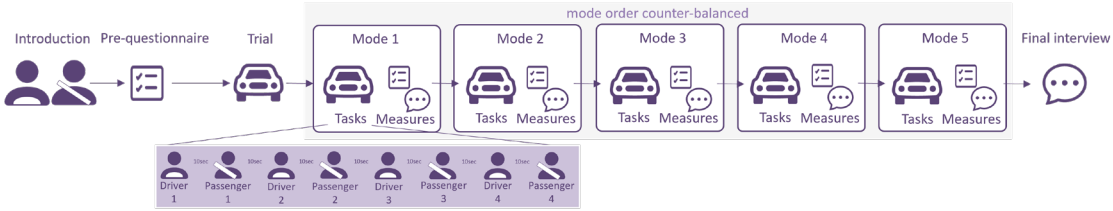


Figure 7.4: Simulator study procedure. The sequence of the modes was counterbalanced. (Bootstrap Icons)

First, we introduced the overall study goal and asked participants for their informed consent (Figure 7.4). After, we assigned the pair of participants to the driver or the passenger role and let them individually answer demographic questions. Once both took a seat in the simulator, we introduced the driver to the driving rules: driving on the left lane of a two-lane highway, maintaining a constant speed of 80 km/h, speeding was forbidden, and there was no other traffic on the left lane (traffic appeared only on the right). To assess the IVIS modes' impact on collaboration, we aimed for a controlled social situation in the car. Since we wanted to understand the collaborative nature rather than the level of self-explanatory, we orally introduced each mode and let the mode re-explain by participants to ensure every participant had the same knowledge about the mode. We also introduced the participants to a social, collaborative scenario of going on vacation, driving from Eindhoven to another city in Europe (Salzburg, Amsterdam, Utrecht, Rotterdam, Groningen). To make the ride as comfortable as possible, the driver and passenger had to collaborate and assist each other while operating the IVIS. We introduced the social scenario and the tasks by handing out cards prior to each mode test round. The task card contained the scenario description and a total set of eight tasks (4 driver tasks, 4 passenger tasks; an example task card can be found in Appendix B). The tasks were similar among the modes, only the destinations and items (e.g., song or radio channel) changed to avoid boredom and minimize learning effects. To avoid a high mental demand and a wrong task order, the participants were not asked to remember the tasks and recall them from memory; instead, we gave short audio instructions during the ride. Therefore, each task was introduced with „Hey driver" or „Hey passenger" followed by the task instruction, which lasted between 4 and 8 seconds.

The experiment started with a trial round to familiarize the participants with the driving simulator, the IVIS UI, and the procedure of the task-cards along with the audio of task descriptions (Figure 7.4). This was followed by a fully counterbalanced set of the five IVIS modes. For each mode, each participant had to perform four tasks (delegating all tasks to the passenger was not allowed). Table 7.1 presents the tasks and scenarios. Concerning the order, it was always the driver starting with task 1, followed by passenger task 1, and continued in alternating order. At the end of each mode condition, the participants filled out the questionnaires related to social connectedness, team performance, fairness, UX, and workload. In addition, the researchers asked about participants' positive and negative impressions of each mode. The experiment concluded with a subjective ranking of all five modes and a semi-structured interview about what they liked/disliked. The experiment lasted, on average, 1.25 hours, with around 6 minutes spent on each mode (from start to drive until the end of driving). The participants did not receive compensation. Since the experiment took place during the COVID-19 pandemic, we followed the most recent regulations of the university (FFP2 masks were obligatory, a vaccination certificate was required, and all devices were sanitized after each group).

7.6 Results & Findings

Data Analysis

We assessed the Likert Scale data for social connectedness [148, 164], team performance [200], workload (NASA-TLX) [102], and fairness across the different IVIS modes using Friedman tests. Due to ambiguous answers of the NASA-TLX we had to omit responses of two pairs resulting in *N=14* responses for driver and passenger. For the post-hoc pairwise comparisons, we performed Bonferroni-corrected Wilcoxon signed-rank tests to reduce Type I error. Due to the exploratory nature rather than conclusive nature of our study, we decided to partly report also on non-Bonferroni corrected pairwise comparisons [13]. Since this is to our knowledge the first study assessing the social aspects of in-car collaboration, it allows to explore the modes in more depth and provides more opportunities for future research [13]. In addition, we performed a repeated-measures ANOVA to investigate differences in time efficiency (collaboration completion time). To investigate the impact of being a driver or a passenger (independent between-subject variable), the impact of gender (same-gender pairs vs. mixed-gender pairs), and relationship status (working relationship vs. friendship) on social connectedness, team performance, and fairness, we performed Mann-Whitney U tests.

Order	Task	Scenario Description	Task Description & Audio Instruction
1	**Driver 1**	You want to visit [Amsterdam / Rotterdam / Utrecht / Groningen / Salzburg] together.	Start the route to [Amsterdam / Rotterdam / Utrecht / Groningen / Salzburg] city.
2	**Passenger 1**	Since you are into museums/national parks, you also want to visit the [Rijksmuseum / Kinderdijk / St John's Cathedral / Sallandse Heuvelrug / Lake Chiemsee].	Add the point of interest [Rijksmuseum / Kinderdijk / St John's Cathedral / Sallandse Heuvelrug / Lake Chiemsee] to the route.
3	**Driver 2**	While driving to the museum/national park you want to get entertained. Therefore, you want to listen to the radio.	Start listening to radio channel [SUBLIME / SKY / NPO Radio 3 / Slam / QMusic]
4	**Passenger 2**	You like to listen to music while riding. However, you are not satisfied with the current radio channel.	Change the radio channel to [QMusic / FunX / Sky / NPO Radio 1 / SUBLIME]
5	**Driver 3**	You are also not satisfied with the music. So you decide to select a song from your own music library	Go to my Music and select the song [Bang Bang / Get Lucky / A little Party / Sing / Crazy In Love] by [Jay-Z / Daft Punk / Jay-Z / Ed-Sheeran / Jay-Z]
6	**Passenger 3**	You also want to listen to one of your favorite songs.	Go to my music and add the song [Beyond / Touch / Lose Yourself / Kill and Run/ Don't] by [Daft Punk / Daft Punk / Daft Punk / Jay-Z / Ed Sheeran]
7	**Driver 4**	You decided to change your plans because you want to go for lunch first. This is why you want to cancel the current route.	Cancel the current route
8	**Passenger 4**	You are in charge of selecting the restaurant.	Start the route to the restaurant [Dutch / Shell / Beach / Italian / Burger place].

Table 7.1: Experimental tasks for driver and passenger. Destinations/items (stated in brackets) changed according to the mode to avoid boredom and reduce learnability effects. [*Anarchic / Autocratic / Hierarchical / Token-Ring/ Consensual*].

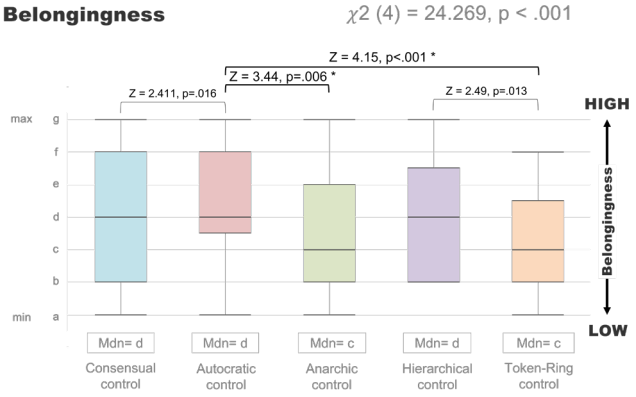


Figure 7.5: Belongingness measurements [164] across the different collaborative IVIS modes with pairwise comparisons. The scale ranges from a = min/low belongingness to g = max/high belongingness. Friedman test significant at p < .05. Bonferroni-corrected (α = .005) Wilcoxon signed-rank post-hoc tests marked with *.

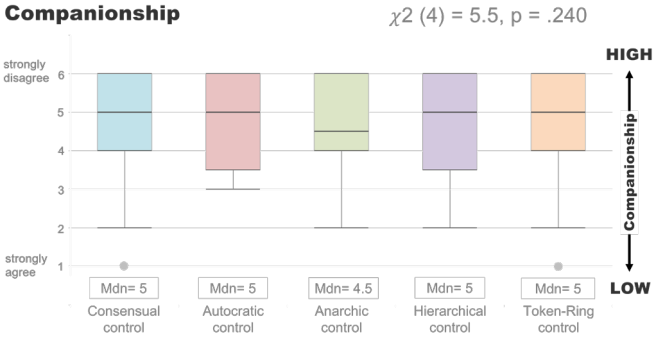


Figure 7.6: Companionship measurements [148] across the different collaborative IVIS modes with pairwise comparisons. The scale ranges from 1 = low companionship to 6 = high companionship. Friedman test significant at p < .05. *Q: Even around people I know, I don't feel that I really belong.*

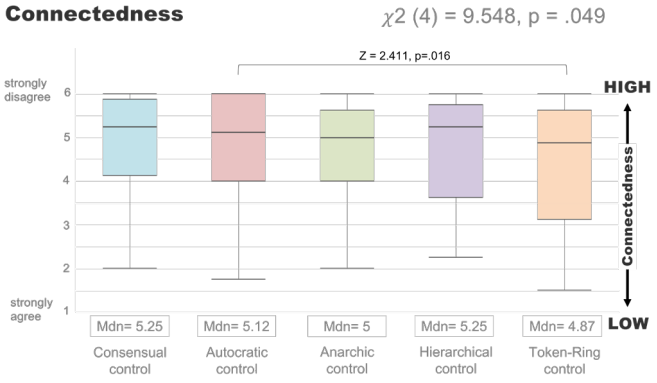


Figure 7.7: Average connectedness measurements [148] across the different collaborative IVIS modes with pairwise comparisons. The scale ranges from 1 = low connectedness to 6 = high connectedness. Friedman test significant at p < .05. *Q1: I feel so distant from the other people; Q2: I feel disconnected from the world around me; Q3: I don't feel related to anyone; Q4: I catch myself losing all sense of connectedness.*

To determine whether the nature of collaboration impacts the driver negatively, we assess the effect of the modes on driving performance (speed and SDLP) by conducting one-way repeated-measures ANOVA. To investigate the level of drivers' distraction (eyes-off-the-road time), we conducted a Friedman test due to non-normality of the data.

Social Connectedness - H1

Belongingness

A Friedman test shows that the effect of the IVIS modes on users' perceived group belongingness is statistically significant ($\chi^2(4) = 24.269, p < .001$). Bonferroni-corrected post-hoc tests show that *Autocratic control* results in statistically significantly higher group belongingness than *Anarchic control* ($Z = 3.44, p = .006$) and *Token-Ring control* ($Z = 4.15, p < .001$). Further, as highlighted in Figure 7.5, the mean group belongingness score is average for *Consensual control* (*Mdn=d*), *Autocratic control* (*Mdn=d*), and *Hierarchical control* (*Mdn=d*), while the *Anarchic control* (*Mdn=c*) and *Token-Ring control* (*Mdn=c*) scored below average (original scale ranges from a=no belongingness to g=max belongingness). Aditional pairwise comparisons outline higher group belongingness for *Autocratic control* than *Consensual control* and *Hierarchical control* compared to *Token-Ring control*. In summary, there is evidence that *Autocratic control* lets users belong significantly better in comparison to *Anarchic control* and *Token-Ring control*.

Companionship

A Friedman test reports no significant effect of the modes on the perceived companionship ($\chi^2(4) = 5.5, p = .240$; Figure 7.6). The median evoked companionship score is above average for all modes, with a median score of *Mdn=5* for *Consensual*, *Autocratic*, *Hierarchical*, *Token-Ring control*, and *Mdn=4.5* for *Anarchic control*.

Connectedness

As Figure 7.7 shows, the effect of the IVIS modes on evoked connectedness is statistically significant ($\chi^2(4) = 9.548, p = .049$). While Bonferroni-corrected post-hoc tests do not show any significant differences, there is a tendency of a higher connectedness for *Autocratic control* compared to *Token-Ring control*, as outlined by uncorrected pairwise comparisons. In addition, the median scores are above average for all the modes, with the highest score for *Consensual control* (*Mdn = 5.25*) and *Hierarchical control* (*Mdn = 5.25*), followed by *Autocratic control* (*Mdn = 5.12*), *Anarchic control* (*Mdn = 5*), and *Token-Ring control* (*Mdn = 4.87*).

Affiliation

The Friedman test does not indicate a statistically significant effect of the different modes on users' perceived affiliation ($\chi^2(4) = 8.736, p = .068$; Figure 7.8). Nevertheless, the data shows a mean evoked affiliation above average for all modes, with the highest affiliation for *Hierarchical control* (*Mdn = 5.17*).

Social connectedness, especially belongingness and connectedness get significantly influenced by the collaborative IVIS mode while this does not hold for companionship and affiliation which leads us to partially accept H1 – *the type of collaborative IVIS has an effect on social connectedness in terms of belongingness and connectedness.*

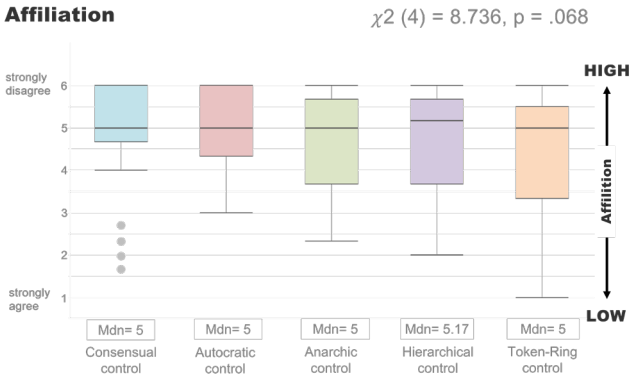


Figure 7.8: Average affiliation measurements [148] across the different collaborative IVIS modes with pairwise comparisons. The scale ranges from 1 = low affiliation to 6 = high affiliation. Friedman test significant at $p < .05$. *Q1: I don't feel I participate with anyone or any group; Q2: I have no sense of togetherness with my peers.; Q3: Even among my peers, there is no sense of brother/sisterhood.*

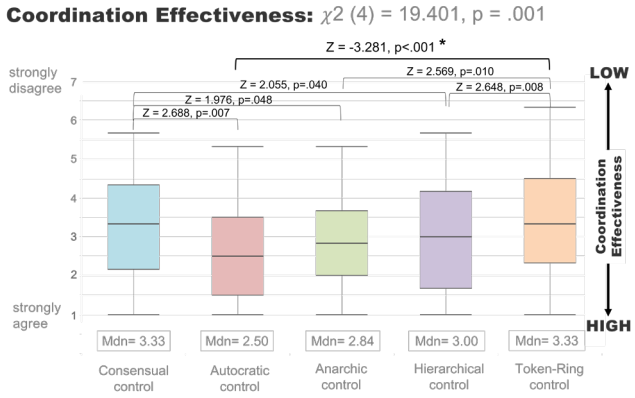


Figure 7.9: Distribution of the average evoked coordination effectiveness per IVIS mode [200]. Friedman test significant at $p < .05$. Bonferroni-corrected ($\alpha = .005$) Wilcoxon signed-rank post-hoc tests marked with *. Scale ranges from 1 = high coordination effectiveness to 7 = low coordination effectiveness. Q1: I am satisfied with my communication with the team members. Q2: There was a clear sense of direction during discussions with the team members. Q3: The interactions between the group members were well organized.

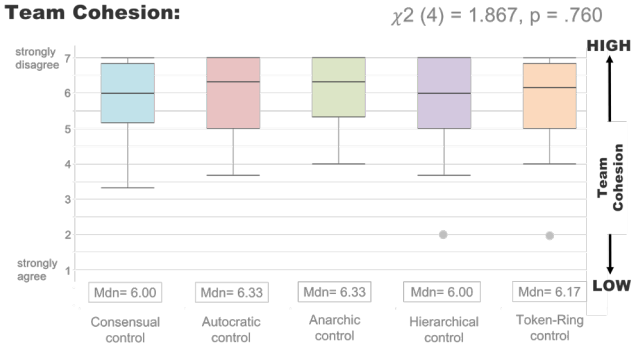


Figure 7.10: Distribution of the average evoked team cohesion per IVIS mode [200]. Scale ranges from 1 = low team cohesion to 7 = high team cohesion. Q1: Dealing with the members of the team often left me feeling irritated and frustrated. Q2: I had unpleasant experiences with the team. Q3: Negative feelings between me and the team tended to pull us apart.

Team Performance - H2

Coordination Effectiveness

As shown in Figure 7.9, the effect of the IVIS modes on users' perceived coordination effectiveness is statistically significant ($\chi^2(4) = 19.401, p = .001$). Bonferroni-corrected post-hoc tests show that the *Autocratic control* results in statistically higher effectiveness compared to *Token-Ring control* ($Z = -3.281, p < .001$). Further, the average coordination effectiveness is best for *Autocratic control* (*Mdn = 2.50*), followed by *Anarchic control* (*Mdn=2.84*), *Hierarchical control* (*Mdn=3*), *Token-Ring control* (*Mdn=3.33*), and *Consensual control* (*Mdn=3.33*). Pairwise comparison outlines that *Consensual control* leads towards lower coordination effectiveness compared to *Autocratic control*, *Anarchic control*, and *Hierarchical control*. Moreover, *Token-Ring control* evokes lower coordination effectiveness compared to *Anarchic control* and *Hierarchical control*. In summary, our results indicate that *Autocratic control* leads towards best coordination effectiveness, especially in comparison to *Token-Ring control.* Furthermore, *Consensual control* and *Token-Ring control* show the lowest coordination effectiveness among the modes, while still scoring above average.

Team Cohesion

The data outline no significant effect of the IVIS modes on the perceived team cohesion ($\chi2(4) = 1.867, p = .760$). As shown in Figure 7.10, all modes evoke a high team cohesion with the highest median scores for *Autocratic control* (*Mdn=6.33*) and *Anarchic control* (*Mdn=6.33*).

With regard to the two metrics of team performance, while the IVIS modes have an effect on coordination effectiveness, this does not apply to team cohesion. Thus, we partially accept *H2 – the type of collaborative IVIS has an effect on team performance in terms of coordination effectiveness.*

Fairness - H3

Perceived Fairness Support

There is a statistically significant effect of the modes on perceived fairness ($\chi^2(4) = 20.693, p < .001$), as shown in Figure 7.11. Bonferroni-corrected post-hoc tests show that *Autocratic control* ($Z = -3.123, p = .018$) and *Anarchic control* ($Z = -3.162, p = .016$) result in statistically significantly higher fairness than *Hierarchical control*. Thus, our results indicate a direction towards *Hierarchical control* to be perceived as most unfair.

These insights indicated that the modes have an effect on perceived fairness, which leads us to accept *H3 – the type of collaborative IVIS has an effect on perceived fairness.*

Perception of Different Control Possibilities

A Friedman test outlines no significant effect of the different IVIS modes on the perception of different control possibilities among the driver and the passenger ($\chi^2(4) = 5.76, p = .218$). Thus, our results indicate that users do not perceive differences in terms of control possibilities.

Effect of the Driver/Passenger Role, Gender Pairs, and Relationship Status

We conducted Mann-Whitney U tests to determine whether there are differences in evoked social connectedness, fairness, and team performance of the IVIS modes between the driver and a passenger. The median scores do not show significant differences between driver and passenger for any of the concepts for either social connectedness, team performance, or

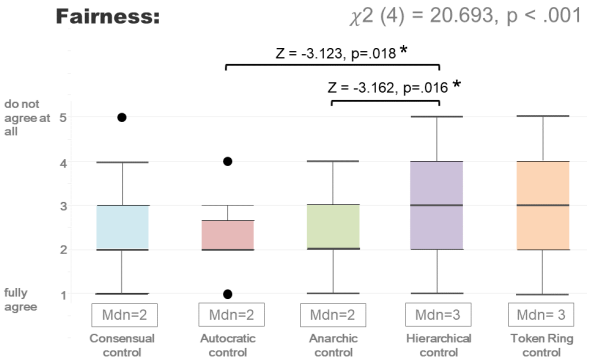


Figure 7.11: Distribution of the perceived fairness of each collaborative IVIS mode (1 = fully agree, 5 = do not agree at all) (Q: I think the distribution of the operating options among the group members was fair) Friedman test significant at $p < .05$. Bonferroni-corrected ($\alpha = .005$) Wilcoxon signed-rank post-hoc tests marked with *.

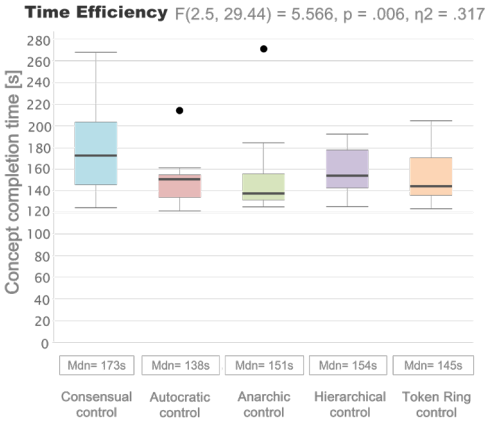


Figure 7.12: Distribution of the summary of time spent [s] on individual tasks per collaborative IVIS mode

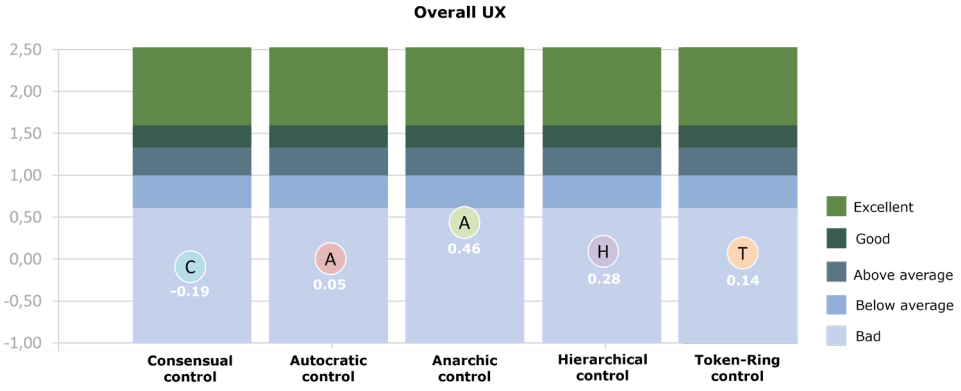


Figure 7.13: Results of the overall UX for each mode, derived from the User Experience Questionnaire [234]. The UX scale ranges from excellent (top) to bad (bottom).

fairness. Similarly, the test results do not show a statistically significant difference between same-gender pairs and mixed-gender pairs, indicating no evidence of gender pairs affecting the perceived social connectedness, team performance, or fairness. Moreover, there was also no significant difference observed between those driver-passenger pairs having a working relationship compared to the pairs indicating a friendship. This means there is also no evidence of the relationship affecting the perceived social connectedness, team performance, or fairness.

Influences on Collaboration & Driving Safety

Time Efficiency (Collaboration Completion Time)

A one-way repeated measures ANOVA (sphericity violated as assessed by Mauchly's test, $\chi^2(9) = 22.01$, $p = .01$ – Greenhouse-Geisser correction applied, $\varepsilon = 0.783$) revealed a statistically significant interaction between the modes and the collaboration completion time, $F(2.5, 29.44) = 5.566$, $p = .006$, $\eta^2 = .317$ (Figure 7.12). Post-hoc pairwise comparisons show a significant difference between *Consensual control* and *Token-Ring control* (+/– 37.54sec, $p = .007$). Overall, the *Consensual control* ($M = 187.38$ s, $SD = 11.28$ s) takes the longest time on average to reach a group-based goal, followed by *Hierarchical control* ($M = 159$, 84 s, $SD = 6.07$ s), *Anarchic control* ($M = 154.17$ s, $SD = 10 – 93$ s), *Token-Ring control* ($M = 149.85$ s, $SD = 6.35$ s), and *Autocratic control* ($M = 142.75$ s, $SD = 4.09$ s).

User Experience

A Friedmann test outlines significant differences in terms of overall UX among the five modes ($\chi^2(4) = 18.14$, $p = .001$). Post-hoc pairwise comparisons show a significantly higher UX for *Anarchic control* compared to *Consensual control* ($Z = -3.676$, $p = .002$). Overall, the UX is low for all modes with the lowest score for *Consensual control*, followed by *Autocratic control*, *Token-Ring control*, *Hierarchical control*, and *Anarchic control* (see Figure 7.13).

Perceived Workload

There was a significant difference in the perceived overall workload among the five collaborative IVIS modes as revealed by a Friedman test ($\chi^2(4) = 13.458$, $p = .009$) with a statistically higher workload of *Consensual control* compared to *Autocratic control* ($Z = 3.277$, $p = .001$). In addition, Mann-Whitney U tests show that the overall perceived workload is higher for drivers than for passengers for all modes, except *Autocratic control* (Figure 7.14).

Driving Performance

A one-way repeated measures ANOVA revealed (sphericity was not violated as assessed by Mauchly's test - $\chi^2(9) = 10.24$, $p = .337$), that there is a statistically significant effect of the IVIS modes on speed ($F(4, 48) = 3.21$, $p = .020$, $\eta^2 = .211$). However, Bonferroni-corrected post-hoc tests did not unveil statistically significant differences. Besides, there is no statistically significant effect of the IVIS modes on Standard Deviation of Lateral Position (SDLP), as assessed by an ANOVA ($F(1.23, 14.76) = 2.3$, $p = .148$, $\eta^2 = .161$; sphericity has been violated for SDLP, as assessed by Mauchly's test - $\chi^2(9) = 55.645$, $p < .001$; thus a Greenhouse-Geisser correction was applied: $\varepsilon = 0.308$).

Driver Distraction (Eye Tracking Data)

A Friedman test does not show a significant effect of the IVIS modes on drivers' eyes-off-the-road time ($\chi^2(4) = 6.057$, $p = .195$) on driver task execution. However, there is a

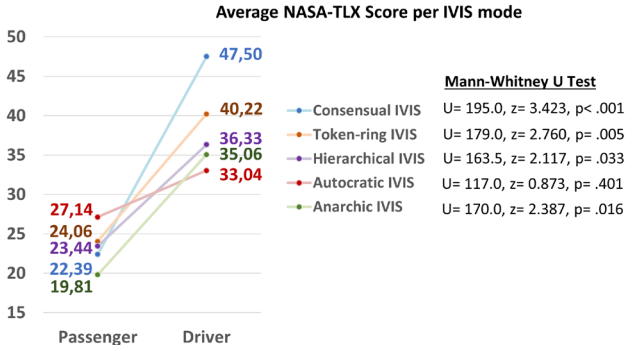


Figure 7.14: Results of the workload comparison between driver and passenger. Left: average NASA TLX workload score of drivers and passengers for each mode (0=no workload, 100=maximum workload). Right: statistical results of the Mann-Whitney U test.

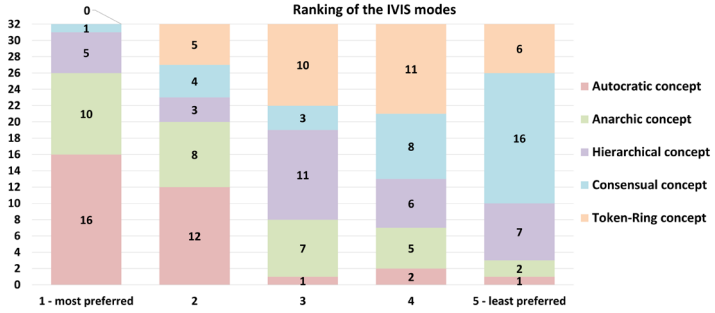


Figure 7.15: The subjective ranking of each collaborative IVIS mode

Mode	Positive aspects		Negative aspects	
	Category	#Cnt	Category	#Cnt
Consensual control	fosters collaboration control over decisions propose changes	11 6 5	high perceived distraction no decisions alone time consuming/not efficient stressful	20 17 12 9
Anarchic control	no interferences with driver/passenger doing things in parallel low perceived distraction gives passenger power no access limitation fosters collaboration	18 16 14 13 9 9	no overview what other user is doing feels disconnected from the other user	5 3
Autocratic control	fosters collaboration & connectedness shared physical device familiarity fosters communication	11 10 9 4	interference with driver/passenger high perceived distraction power dynamics does not allow to do things in parallel	11 11 7 4
Hierarchical control	shared access fosters collaboration & connectedness doing things in parallel shared physical device	13 9 6 5	interference with driver/passenger high perceived distraction limited access to functions no overview what other user is doing	9 9 7 3
Token-Ring control	one person controls at a time switching power over functions fosters communication	9 4 2	frustration limited access to functions high perceived distraction limits collaboration mentally demanding	9 9 8 6 4

Table 7.2: Overview of the qualitative feedback regarding positive aspects (left) and negative aspects (right) of each IVIS mode, along with the number of statements (#Cnt).

significant effect on drivers' eyes-off-the-road time when the passenger performs tasks ($\chi^2(4) = 11.657, p = .020$). Post-hoc-tests unveil that the time looked away from the road is statistically higher when using *Consensual control* compared to *Autocratic control* ($Z = 3.043, p = .002$). Overall, the *Consensual control* evokes the highest eyes-off-the road ratio ($M = 31.56\%, SD = 7.02\%$) when the driver performs tasks, followed by *Autocratic control* ($M = 31.03\%, SD = 8.38\%$), *Anarchic control* ($M = 29.88\%, SD = 7.36\%$), *Hierarchical control* ($M = 29.53\%, SD = 8.13\%$) and *Token-Ring control* ($M = 27.38\%, SD = 6.73\%$).

Qualitative Insights

Subjective Ranking

A Friedman test outlines that there is a statistically significant order of preference for the different IVIS modes ($\chi^2(4) = 43.625, p < .001$). Post-hoc pairwise comparison shows a significant higher preference for *Autocratic control* compared to *Hierarchical control* ($Z = -3.716, p = .002$), *Token-Ring control* ($Z = -4.585, p < .001$), and *Consensual control* ($Z = -5.850, p < .001$). Additionally, there is a significant higher preference for *Anarchic control* compared to *Token-Ring control* ($Z = -2.925, p = .034$) and *Consensual control* ($Z = -4.190, p < .001$). Figure 7.15 outlines the ranking per mode, ranging from 1 = most preferred to 5 = least preferred with a median score of *Mdn=2* for *Autocratic* and *Anarchic control*, media score of *Mdn=3* for *Hierarchical control*, *Mdn=4* for *Token-Ring control*, and *Mdn=5* for *Consensual control*.

Qualitative Feedback

The results from the thematic analysis [128] conducted with the responses of the open-ended questions concerning each mode (both individually and in the final interview) revealed both positive and negative aspects in relation to each mode which we summarize in Table 7.2.

Participants remarked that experiencing limited access to functions influences collaboration in the car negatively because of exclusion and evoked frustration (e.g., "*I feel frustrated once the function is gone*", P#2). These feelings especially arise for *Token-Ring control*. Having equal control over functions instead by either sharing a screen with one another (*Autocratic* control), having an individual screen (*Anarchic* & *Hierarchical control*), or controlling consensual is overall perceived as fostering collaboration. However, insights outline that especially *Consensual control* is distracting the driver heavily due to the notifications (e.g., "*It was highly distracting, because of checking and approving "*, D#4). Further, drivers, as well as passengers, feel limited in their execution possibilities (e.g., "*I could just do my thing*", D#11) because they can not control functions alone which get perceived as time-consuming, not efficient, and a factor of stress increase (e.g., "*It takes so long to perform a task*", D#4). From a passenger's point of view, *Consensual control* enables to be involved in decision-making, feel to be more seen by the driver, and provides the possibility to propose changes (e.g., "*I can also share things and the system helps me to communicate with the driver*", P#12), especially in situations where negotiating is not able or appreciated (e.g., Uber or taxi rides, "*If we take a Uber, we can suggest things*", P#2). Providing drivers and passengers with the possibility to control functions in parallel (*Anarchic control* and to some extent *Hierarchical control*) reduces driver distraction because it avoids the situation that the passenger interferes with the drivers' vision when interacting with an IVIS. In addition, it gives passengers the feeling of having more power while sitting in the car (e.g., "*The two screens with the same functions are nice because I can decide at any moment what I want to work on and assist*", P#8).

From the driver's perspective, having two screens requires trust towards the passenger since there is no overview of what the passenger is doing at the moment. Also, using the driver screen sometimes feels more natural for the passenger and is faster in case the required menu is already open, even though the physical workload for reaching out to the display

remains higher (e.g., "*If feels more efficient to use the screen with the already opened menu*", P#6, "*The physical workload was higher when using the drivers' screen*", P#16). Additional insights show, that *Autocratic control* and *Hierarchical control* let the driver and passenger feel better connected due to the physically shared IVIS screen. Even though the *Autocratic control* is standard in current cars and the participants are most familiar with it, the feedback shows that drivers feel highly distracted whenever the passenger interacts with the single screen. In addition, passengers remark that they feel obligatory to ask for permission to use the screen which induces power dynamics and is perceived as the driver having a more influencing position (e.g., "*I was dependent on the driver*", P#4, "*It feels the driver has more power*", P#1).

7.7 Discussion

In this chapter, we report how the five modes from the taxonomy, applied to an In-Vehicle Infotainment System (IVIS) affects the collaboration and social control experience between a driver and a front-seat passenger. Our results show that the nature of the IVIS mode – how an IVIS is set up to facilitate collaboration – plays a significant role in drivers' and passengers' perceived team performance, social connectedness, and fairness. In this section, we discuss our insights and outline design recommendations for better driver-passenger collaboration in future cars.

Implications of Collaborative IVIS on Social Connectedness, Fairness, and Team Performance

As outlined by our results, social connectedness, fairness as well as team performance are independent of the driver/passenger role, relationship status, and gender-pair representation. Since each of the IVIS modes evokes a good affiliation and companionship, we argue that in relation to previous work, all modes allow for interacting socially [261], support the establishment of self-esteem [148], well-being [217], and are perceived as socially satisfying [217].

Even though each mode enables the driver and the passenger to connect with one another (connectedness), no mode supports a high feeling of belongingness. This can be potentially due to a limitation of our study set-up with reduced communication due to pre-defined tasks while it can also be induced by the in-car environment of sitting next to each other without maintained face-to-face communication [75]. In addition, *Token-Ring control* and *Anarchic control* scored lowest on belongingness which we relate due to qualitative insights to anticipated frustration and missing awareness of what the other user is currently doing on their screen (e.g., [250]). Nonetheless, collaboration gets promoted by all IVIS modes, as represented by high levels of team cohesion, although collaboration is not as effective for every mode. Especially *Token-Ring control* impacts effectiveness negatively due to restricted menu access, compared to *Autocratic control* that provides a shared screen with full menu access. In addition, *Consensual control* is least effective due to a high time consumption for task execution, which is in line with previous work [207].

An interesting point to note is that the *Autocratic control* (our baseline condition representing the status quo of IVIS setups) leads towards best coordination effectiveness, is users' preferred choice, and additionally scores high for social connectedness. However, eye-tracking data shows that this mode causes major driver distraction whenever the passenger interacts with the shared screen. We posit that the conventional single-screen setup is most natural and familiar to users [264] and thus fosters a sense of connectedness by default since the interaction takes place at a 'common ground'. However, since the passenger interacts on the driver's IVIS screen close to the driver's line of sight, this leads to the observed increased driver distraction.

In contrast, our data show that *Hierarchical control* also leads to high coordination

effectiveness and social connectedness, however, without any evidence of driving performance impact. Drivers also report a high perceived distraction when receiving pop-up notifications induced by *Consensual control*, which is in line with a high eyes-off-the-road time when passengers send requests and a longer collaboration completion time. In general, any IVIS mode where the passenger interaction happens in the vicinity of the driver's display, or explicitly requires driver attention, causes driver distraction, which is in alignment with prior work showing that IVIS interaction increases driver distraction [68, 248].

Even though the driver or passenger role itself has no effect on social connectedness, team performance, and fairness, our results indicate that the different IVIS modes have an influence on the overall perception of fairness. *Autocratic* and *Anarchic control* are perceived as most fair and additionally, these two modes are the most preferred ones. Based on qualitative insights, we argue that fairness relates, on the one hand, to unlimited access to menus, and on the other hand, to the synchronous execution of functions without time restrictions. However, participants' choices can be biased by their previous experiences concerning IVIS set-ups [264], since having a single IVIS screen only (*Autocratic control*) or two identical IVIS screens are the most prominent ones available on the market. Additionally, the presence of an IVIS in cars, along with participants' prior experiences with using such systems can have an impact on the user experience. Moreover, the features we offer combined with the UI were not novel per see which made the system familiar to the participants. This could be the reason for the rather low UX scores recorded. Nevertheless, all modes scored at least average on perceived social connectedness, team performance, and fairness. Thus, we argue that the UX evoked by the IVIS does not majorly influence driver-passenger collaboration.

Although participants tend to prefer the *Autocratic* and *Anarchic* IVIS over more novel collaborative IVIS approaches, both quantitative and qualitative data together highlight characteristics that support collaboration through social connectedness and team performance and mitigate driver distraction. We summarize this in the design recommendations below.

Challenges & Recommendations to Support Driver-Passenger Collaboration

One IVIS screen vs. two IVIS screens: While user preferences tend to favor a single IVIS screen because it lets them connect and belong better to one another, quantitative insights provide strong evidence that this highly distracts the driver when the passenger uses the screen. In addition, our insights are in line with previous research that highlights that people prefer familiar concepts with which they have already gained experience over novel concepts [264]. If we want to facilitate collaboration and social control experience by ensuring driving safety, we, therefore, recommend two IVIS screens. According to our insights, providing the front-seat passenger with an individual screen mitigates subjective driver distraction and fosters efficient assistance since tasks can be performed in parallel. Besides that, it makes a car ride more convenient [30] and enhances passenger experience [24, 93]. However, merely the presence of two IVIS screens does not guarantee optimal collaboration and a sense of connectedness, belongingness, or team spirit – as evidenced by our results.

Balancing power roles in the car: Having a single screen makes passengers feel obligated to ask for allowance/permission to use the screen. This induces power dynamics and limits collaboration from the passengers' perspective. Since the driver is, in most cases, the car's owner who needs to maintain safe driving, we recommend letting the driver decide which functions to delegate to the passengers. This enables passengers to assist with specific tasks, letting them feel empowered while it maintains the driver as the main user. Additionally, it allows the driver to request assistance for tasks where support is most urgently needed and prevents passengers from performing tasks subconsciously or without consent.

Create situational awareness: According to our results, drivers seek insights into changes the passenger is going to make. In addition, passengers tend to use the driver screen whenever the required menu is already opened there because it costs less effort and saves time. However, it increases driver distraction. To overcome this, we recommend designing for a higher situational awareness, which can generally reduce conflicts and support collaboration [66, 250]. A possible solution can be to manually enable the synchronization of the drivers' screen on the passenger screen. In addition, the driver requires feedback on changes made by the passenger, especially if there is no dedicated audio feedback available such as when changing the music or radio channel. Possible solutions might range from notifications on a head-up display or instrument cluster, which should be investigated in future work.

Active communication vs. technology-supported communication: An obvious and trivial way to enhance collaboration would be to communicate verbally and reach an agreement before either the driver or passenger interacts with the IVIS and makes an agreed-upon decision. However, in social, familiar driving settings, collaboration does not require active agreement of the driver since it is time-consuming and distracts the driver. In addition, changes cannot be anticipated quickly or alone, which might be required in dense traffic situations where the driver wants to explicitly seek passenger support. Thus, only active communication is preferred especially when the driver trusts the passenger [173]. However, in situations where communication is either limited, cannot be ensured (e.g., taxi ride) [118] or trust towards the passenger is limited (e.g., kids on board) [30, 118], technology can be used as a mediator to foster collaboration as we explored in this study. Subsequently, we recommend providing the possibility to send out recommendations and to accept/decline accordingly to enable passengers to request changes and let them be involved more.

Social adaptation to support fairness, privacy, and trust: Taken together, there is the need to balance fairness and privacy depending on the trust towards passengers to support optimal collaboration. While two screens with unlimited access to functions support fairness best and, in addition, mitigate perceived driver distraction, this set-up requires high trust towards the passenger, which might not be given in all riding scenarios [173]. Additionally, drivers do not want to unveil all types of data, especially private ones such as messages or contact details. Even though full menu access results in an efficient collaboration, it interferes with drivers' privacy needs and trust levels. A possible solution might be to allow for different modes of collaboration depending on the social situation in the car (e.g., the relationship between occupants, physical and mental ability to assist [30, 118]). Future research, therefore, is needed to investigate the effect of social riding scenarios on driver-passenger collaboration.

Limitations

Even though we did not observe any risky behavior or artificial situations due to the interaction in the car, a driving simulator study has a limitation when it comes to ecological validity. Especially the room situation might entice participants to not take the experimental set-up as seriously enough or to drive more riskily than in (more) realistic driving scenarios. Future work should therefore investigate how these modes perform in a real-world scenario, especially concerning driver distraction. In terms of external validity, the driving area and the perceived safety risks (street condition, environment) can thus have an impact on the applicability of our findings across cultural contexts. Additionally, our study was conducted in Mid-Europe under a limited exploration of contextual dimensions. Different contextual characteristics, for instance, different cultural backgrounds of users might relate to varying expectations of in-car collaboration and thus have a different impact on social collaboration.

7.8 Conclusion

In this chapter, we explored the role that social connectedness, fairness, and team performance have on social control experience in manually driven cars. We, therefore, designed five different collaborative IVIS modes to enrich driver-passenger collaboration. Through the results of a simulator study, we found that the type of collaborative IVIS mode influences the perceived social connectedness in terms of belongingness and connectedness, as well as fairness and team performance in terms of coordination effectiveness. Especially *Autocratic control* leads towards a high social connectedness and team performance. However, the majority of drivers feel distracted once a passenger interacts with the screen. Providing two IVIS screens under *Anarchic* or *Hierarchical control* instead, empowers front-seat passengers, reduces power dynamics, and minimizes driver distraction caused by interacting passengers. Especially *Anarchic control* is perceived as fair by passengers. However, drivers have concerns about privacy, especially inside their own cars. With this work, we contribute by highlighting design aspects to support driver-passenger collaboration in future cars by designing for a higher level of social connectedness, fairness, and team performance.

CHAPTER 8

Investigation in Future Cars

This chapter is a combination of the following publications:

Melanie Berger*, Bahareh Barati, Bastian Pfleging, and Regina Bernhaupt. 2022. Design for Social Control of Shared Media: A Comparative Study of Five Concepts. In *Nordic Human-Computer Interaction Conference (NordiCHI, 22).* Association for Computing Machinery, New York, NY, USA, Article 14, 1–13. https://doi.org/10.1145/3546155.3546694

Melanie Berger*, Debargha Dey, Bahareh Barati, Bastian Pfleging, and Regina Bernhaupt. 2023. Designing for Collaborative Non-Driving-Related Activities in Future Cars: Fairness and Team Performance. In *Proceedings of the ACM on Human-Computer Interaction, MobileHCI (MHCI),* (accepted, in press)

* primary, responsible researcher

Abstract

With the introduction of fully automated driving, the car will transform into a more social environment where passengers engage in any Non-Driving-Related Activities (NDRA). To support collaboration among occupants in an Automated Vehicle (AV), research suggests interactive systems controlled by several users at once. However, less is known about how exactly the distribution of control among multiple users shapes collaboration in AVs and influences social engagement among passengers. In this chapter, we investigate the five modes from the taxonomy applied to the exemplary NDRA of creating a shared music playlist using an in-car infotainment system. Testing the modes in a mixed-subject experiment (N=27), we assessed their effects on social connectedness, team performance, and fairness as an indication of social control experience. The results show that certain modes can promote or hinder social control experience and in turn, impact intra-vehicular collaboration. While both Consensual and Autocratic control improve social connectedness and the collaborative experience, Anarchic and Token-Ring control obstruct the perceived connectedness mainly due to overruling other users' decisions. Our observations also indicate that fairness is key to fostering social collaboration in AVs, while it does not naturally define a high team performance. Subsequently, we provide recommendations to guide future designs of collaborative NDRAs in AVs.

8

8.1 Introduction

Current trends in policy and research on Advanced Driver Assistance Systems (e.g., lane assistance, traffic jam assistance) suggest that vehicle automation is becoming mainstream, and will continue in the future with the progress in computational and sensor technology [193]. For instance, the Mercedes S-Class[1] is already equipped with SAE Level 3 automation systems [195], and trials for higher levels of automation are in progress with geo-fenced shuttles in various locations [62, 214]. With highly and fully automated vehicles (AVs), the drivers' role will gradually diminish, and the disappearing safety-critical task of driving will give way to experiencing the ride as a passenger in a moving living or working environment [86]. Among the arguments for the benefits of fully automated vehicles – in addition to mitigation of human errors and accidents, increased efficiency and traffic flow, energy savings, and mobility for the differently-abled [81] – is also the promise of increased productivity or opportunities for personal and social tasks through Non-Driving-Related Activities (NDRAs) [60, 205]. When it comes to the execution of NDRA in AVs, user acceptance [60] towards the AV needs to be maintained and passenger well-being and relaxation are essential needs [206]. In addition, prior research shows that passengers in AVs desire to be productive, entertained, or to perform activities together with people inside/outside the car [61, 107, 206]. Prior work has focused on new interior concepts to transform the car more towards a living room or office space [131, 226, 257] and provide general design aspects to support office work and individual well-being (e.g., [9, 76, 187, 225]). However, research on leisure and entertainment, particularly collaborative activities, which are equally desired activities [206] in fully automated vehicles is rather limited.

Within the context of entertainment-oriented activities in AVs, we explore the importance of collaboration. Collaboration as a concept is well-established in cars [30, 173], and has been shown to have the potential to enhance well-being [225], and open up an emotional [174] and communication space [86]. However, the design of co-located collaborative NDRA in AVs has not yet been investigated in detail. Previous research focused extensively on supporting driver-passenger collaboration in manually driven cars (e.g., [29, 86, 173]), or suggested

1 https://group.mercedes-benz.com/innovation/case/autonomous/drive-pilot-2.html, last accessed: 2023-06-05

concepts to adjust the interior toward better face-to-face conversations in AVs (e.g., [131, 226, 257]). In contrast, little is known about how to systematically design NDRA for a higher level of collaboration and social engagement in AVs. To bridge this knowledge gap, we applied the five modes from the taxonomy to design for the collaborative performance of NDRAs and to investigate how the modes impact social control experience. In this chapter, we focus on answering the following research question (RQ):

How do the five different modes from the taxonomy, applied to NDRAs in fully automated vehicles, impact perceived social connectedness, team performance, and fairness?

To answer this RQ, we chose the use case of passengers creating a shared music playlist to assess the modes, since music gets majorly consumed within a social environment [71, 254], is among the most prominent activities in nowadays cars [30] and envisioned to be still prominent in AVs [206]. To evaluate how the modes affect collaboration in terms of social connectedness, team performance, and fairness, we conducted a mixed-design experiment in a parked car with nine groups of three passengers (*N=27*). Results show that the modes affect passengers' perceived social control experience in terms of social connectedness, team performance, and fairness. We found that fairness and social connectedness are key to fostering collaboration in AVs and gets influenced by the level of control possibilities per passenger. Certain modes promote high social connectedness,and fairness but come at a cost of low team performance, which has implications in terms of collaborative experience. These insights are particularly crucial to consider when designing for collaboration in future AVs to optimize for collaboration and in-car experience.

Contribution Statement: Our contribution is two-fold: first, with the experimental assessment of the five collaborative NDRA modes, we provide evidence-based insights on users' perception of social connectedness, fairness, and team performance in the context of in-car collaboration. Secondly, based on these insights, we provide design recommendations to design for collaboration and enhanced social control experience in fully automated vehicles with multiple passengers.

8.2 Background & Related Work

Socially interacting with others and the exchange of thoughts and ideas are fundamental for humans and occur naturally when working on goals together [223]. Designing particularly for collaboration and social exchange in the automotive context has the potential to enhance occupants' well-being [225] and generates a space of belongingness [28].

In fully automated driving (SAE level 5 [195]), we expect the driver's role to disappear, leaving only the role of the passenger. Thus, we assume all passengers will have equal roles and opportunities with regard to in-car activities (e.g. engaging in Non-Driving-Related Activities). This transforms the car into a space with a high opportunity for social exchange and collaboration. With the introduction of AVs, both research and industry envision new interior concepts which incorporate vis-a-vis seats, tables (e.g., [131, 226, 257]), shared interactive door regions (e.g., [257]), and roofs (e.g., [171]). Additionally, passengers anticipate a more diverse set of NDRAs [107, 206], ranging from individual to social activities [61, 107]. Users rate feeling entertained and communicating with other occupants as essential for a pleasant experience [61]. They favor collaborative activities with others inside the car but also with the outside environment [61, 107, 206]. Overall, the performance of NDRA is seen as a clear benefit of automated driving to create unique driving experiences and more stimulation [60]. Due to this changed situation, passengers have the freedom to perform activities without having to pay attention to the possible distraction of the driver. However, it is not yet known how this new and unique in-car setting influences the way passengers interact with one another and how to design to support in-car collaboration. Additionally, it is not evident from today's research what effects different collaborative concepts that provide different levels of control authority (access to functions) will have among passengers in a fully

automated vehicle. In our study, we want to bridge this gap to understand how to design for the collaborative performance of NDRAs in fully automated vehicles in order to enrich social connectedness, team performance, and fairness.

Taken together, we expect that fully automated driving transforms the former cockpit of today's manually driven car into a new, co-located, collaborative environment. Since the safety-critical role of the driver is no longer present, passengers can freely engage in any activity. However, a key difference to co-located collaboration outside the vehicle (e.g., in the living room, office, or public space) is still that a vehicle is an environment that offers a very confined space and lacks freedom of movement for passengers while cruising at relatively high speeds. These contextual factors still pose safety-critical requirements for the design of in-car systems, which particularly relate to a) avoiding motion sickness, b) ensuring passenger safety (e.g., seat belts, not blocking airbags with portable devices), and c) having to deal with a limited amount of space.

8.3 Social Control Experience: Designing for Collaborative NDRAs

We aim for the design of collaborative non-driving-related activities (NDRAs) to support passengers of fully automated vehicles to interact with one another and achieve a joint goal. Our spotlight lies in applying the five modes from the taxonomy of social control experience to distribute control over certain functions across passengers to enhance social connectedness, team performance, and fairness. Therefore, we explore the five modes from Chapter 5 through the exemplary NDRA use case of music playlist creation by multiple passengers. In combination with the fact that collaboration can be best maintained in a small group [120], we focused on the NDRA of collaborative music control between three passengers (front-seat passenger, two back-seat passengers).

Implementation of the Five Collaborative NDRA Modes

For the interaction, we provided every passenger with an individual, in-car screen [216] to enable individual interaction with the system and awareness building [185, 250]. For the design of the synchronized, collaborative playlist User Interface (UI), we followed directions of established playlist applications such as *Amazon Music*[2] and *Spotify*[3]. Figure 8.2 demonstrates the general UI that (1) provides a search bar and user information, (2) access to a music library, (3) displays the collaborative music playlist, and (4) provides playlist-action buttons related to playback (play/pause, next/prev – using buttons and slider) and volume adjustment (up/down, mute/unmute). In the following, we outline details of the implementation of the five modes and their dedicated UIs (see also Figure 8.1).

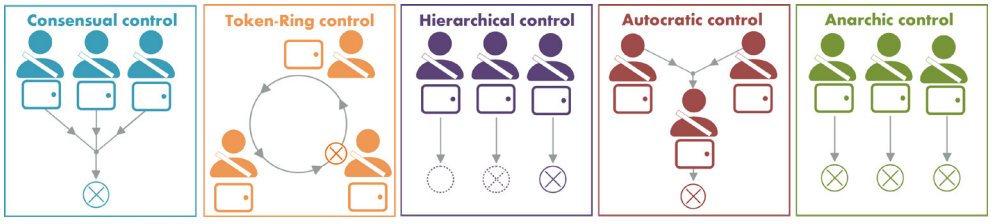


Figure 8.1: Adaptation of the visual representation of the five modes from the taxonomy of social control experience design. It demonstrates the modes applied to the NDRA of music playlist creation, where every passenger has a dedicated in-car screen (Bootstrap Icons).

2 Amazon Music: https://music.amazon.de/, last access 2023-05-22

3 Spotify: https://open.spotify.com/, last access 2023-05-22

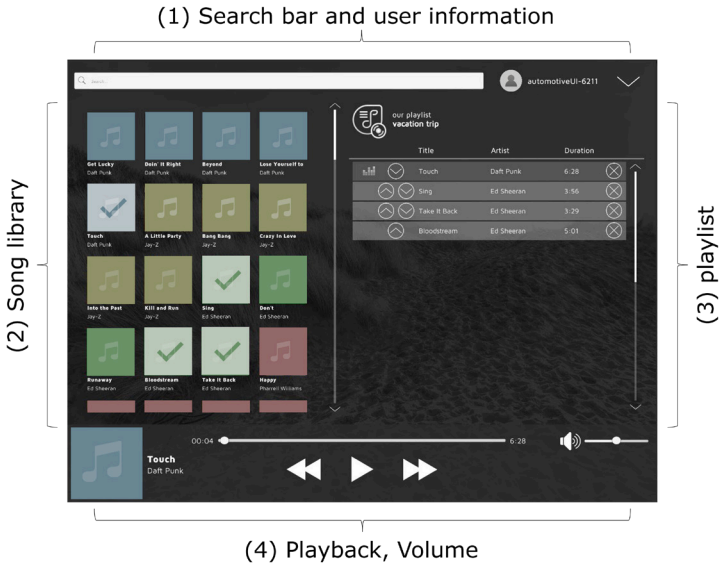


Figure 8.2: The user interface of the music playlist application (icons by Icons8.com)

The Autocratic Control concept: For our music playlist application, the front-seat passenger is the key user with a representative UI providing access to all functions (see Figure 8.2). To ensure workspace awareness [97], the two back-seat passengers can view the playlist. However, the play/pause, next/prev buttons are not visible while volume up/down, mute/unmute, and the sliders are grayed out and thus not functional.

The Anarchic Control concept: Every passenger can control everything all the time. The UI provides every passenger with unlimited access as presented in Figure 8.2.

The Consensual Control concept: Passengers need to vote in order to execute functions. To make the users aware of any input from another passenger [50, 109], every button is highlighted with a circle and number on the right upper corner, inspired by the smartphone app's chat notification bubbles[4]. The represented number informs how many passengers want to execute that action (Figure 8.3). To provide information about who selected what, the circle's background color changes: gray if nobody selected it (right song-cover), orange if another passenger selected it (middle song-cover), and green if the current user selected it (left song-cover). Pressing an action button again retracts the vote. In case every passenger selected the button, the action gets executed and the number turns back to zero.

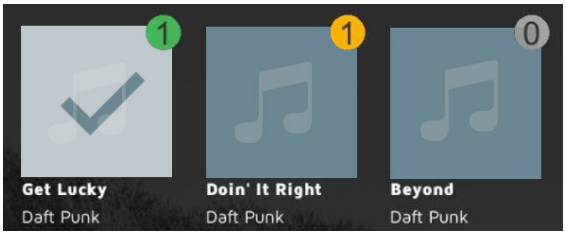


Figure 8.3: *Consensual control* UI: It shows the annotation of each action item depending on the selection. The right song is not selected, the left song shows one self's selection and the middle song shows a selection of another group member (icons by Icons8.com).

4 e.g., Apple: https://developer.apple.com/design/human-interface-guidelines/business-chat/visual-design/chat-bubble-content/, last accessed: 2022-01-21

The Token-Ring Control concept: The turn-taking gets simulated by a moving time slot where one passenger can perform a specific number of actions [168]. After the number of actions was performed or the time has passed, it is the next passenger's turn. While one passenger can perform actions, all other passengers can only observe and need to wait until receiving the token again. The UI consists of two different views (Figure 8.4): the token holder mode with access to all available functions, and the waiting mode with a read-only state (play/pause, next/prev not visible, while sliders and audio buttons are grayed out and not functional). To make the user aware of the current status, the lower bar changes its color and represents the remaining time for either having the token or until receiving the token (Figure 8.4). In the case of having the token, the background of the lower bar (where the playlist action buttons are displayed) turns dark green while the background turns orange in the non-token (read-only) mode.

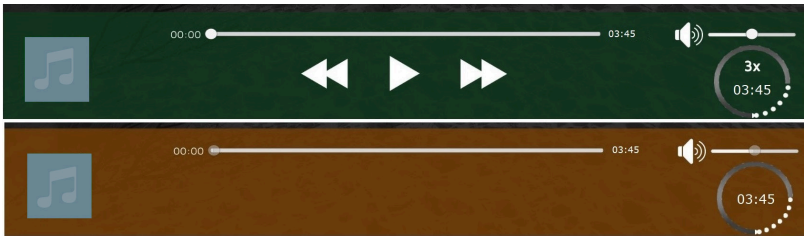


Figure 8.4: *Token-Ring control* UI which represents the changes on the UI's bottom. Top: represents the token holder UI with a dark-green background. The circle on the right shows the remaining time and numbers of control possibilities. Bottom: demonstrates the read-only UI with an orange background and the remaining time until receiving the token (again) (icons by Icons8.com).

The Hierarchical Control concept: Our *Hierarchical concept* is based on three different control levels, inspired by the access privileges from Jang et al. [125]. A user with level 3 has full control (front-seat passenger) while level 2 has limited control (left back-seat passenger) and level 1 (right back-seat passenger) can only perform one specific action. We defined the control possibilities per user level based on the maximum available functions of a playlist which are, adding, removing, adjusting song positions, next/prev, play/pause, as well as volume up/down and mute/unmute. A level 3 user has full access to these functions; a level 2 user can add a song and also adjust the position of a song within the playlist, while a level 1 user can only add a song to the playlist (see Figure 8.5).

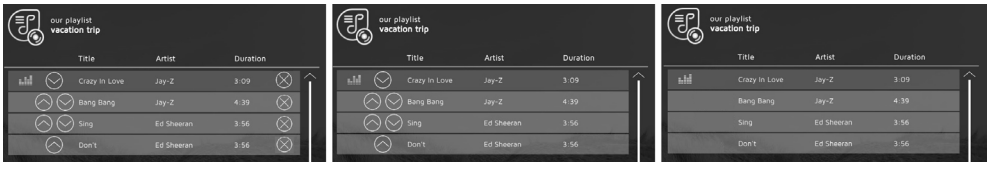


Figure 8.5: *Hierarchical control* UI: These images present the differences in control possibilities based on the playlist part of the UI. Left: level 3 where the user can remove songs and adjust their positions. Middle: level 2 where only adjusting the position is possible. Right: level 1 where no function is available. All users nevertheless can add songs to the playlist (not represented in these images) (icons by Icons8.com).

8.4 Research Question & Hypotheses

To investigate how the five modes of social control experience perform in the car, we focused on answering the following research question:

Which collaborative approach to NDRAs in fully automated vehicles supports perceived social connectedness, team performance, and fairness best?

First of all, we want to investigate whether there is a difference in perceived social connectedness (H1) depending on the mode of social control experience applied. In addition, prior research highlights that enabling every group member to contribute equally [136, 159] and supporting democratic content selection [192] constitutes a positive group collaboration and reduces conflicts [66, 133]. Thus, we speculate that *Consensual control* supports the group's social connectedness best (H1.a). Moreover, communication plays a major role when collaborating [75]. Therefore, we speculate that those modes which require communication (*Consensual control* & *Autocratic control*) result in a higher groups' social connectedness compared to *Anarchic control* where no communication is required since every user can control everything at any time (H1.b).

H1 The type of the collaborative NDRA approach has an effect on user's perceived social connectedness in terms of belongingness, affiliation, connectedness, and companionship.

H1.a The perceived social connectedness is highest when jointly making control decisions (*Consensual control*).

H1.b The perceived social connectedness is higher when active communication is required for control (*Consensual control & Autocratic control*) compared to no required communication for control (*Anarchic control*).

Secondly, we want to investigate whether there is an effect on the perceived team performance in terms of coordination effectiveness and team cohesion depending on the mode of social control experience applied (H2). As highlighted by prior research, the democratic selection of content or having a single key user minimizes interpersonal conflicts [2, 207]. Moreover, a high level of communication plays a major role when collaborating [75]. Thus, we speculate that both *Consensual control* & *Autocratic control* support team performance best (H2.a).

H2 The type of the collaborative NDRA approach has an effect on users' perceived team performance in terms of coordination effectiveness and team cohesion.

H2.a The perceived team performance is highest for *Consensual control* and *Autocratic control*.

Thirdly, we want to understand how the perceived fairness changes depending on the distribution of control possibilities among group members (H3). Since prior research highlights that every group member should be able to equally contribute towards the group goal to best support fairness [207], we speculate that such modes which provide equal control possibilities are perceived as fairer (H3.a).

H3 The perceived fairness is affected by different control possibilities among group members.

H3.a The perceived fairness is highest for *Consensual control, Anarchic control*, and *Token-Ring control*, since these offer equal control possibilities.

8.5 Comparative Study

We conducted a mixed-subject experiment in a parked, middle-class car (*Volkswagen Touran*, see Figure 8.6) with a group of three passengers (one front-seat passenger and two back-seat passengers). Even though a study in a parked car poses limitations concerning validity towards riding in a fully AV, we argue that the controlled environment in a realistic in-car setting is a valid approach to balance the need to study the set of NDRA modes concerning collaboration. Since Level 3 [195] automated cars are already on the market while still providing the standard interior (front-seat row and a back-seat row), we decided to maintain that interior for our study too.

Experimental Set-Up

Independent variables: We had the modes as the within-subject variable (*Consensual, Token-Ring, Hierarchical, Autocratic*, and *Anarchic control*) and the sitting position as the between-subject variable (front seat, left back seat, right back seat), which was connected to the different control possibilities. In the case a mode offered different control possibilities, we granted the front-seat passenger full control, while the back-seat passengers had limited (*Hierarchical control*) or restricted control (*Autocratic control*).

Dependent variables/measurements: As a dependent variable, we assessed users' perceived social connectedness in terms of belongingness, connectedness, companionship, and affiliation. Therefore, we used question 2 [companionship], question 3 [connectedness], and question 8 [affiliation] of the Social Connectedness Scale [148] to assess affiliation, connectedness, and companionship. Since the scale belongs to specific categories, which allow for individual assessment of each social connectedness factor, we only used the three questions of interest. Since this scale does not include the assessment of belongingness, we also applied the Inclusion of Community in Self-Scale [164] to measure belongingness towards the group. Furthermore, we evaluated users' perceived team performance in terms of coordination effectiveness and team cohesion using Paul et al.'s Team Performance Questionnaire [200] (three questions each). In addition to the subjective team performance,

Figure 8.6: The study set-up with three mounted screens (front-seat and back-seats) inside a parked car. Printed cards were placed below every screen to present the trip scenario from Salzburg to Vienna and to show the participant's favorite (left side, green) and non-favorite artist (right side, red).

we measured the time needed (seconds) until the group goal was achieved to evaluate each mode's time efficiency. In addition, we assessed the perceived fairness by self-defined questions (Q1: I had the feeling that others had more operating options than I had; Q2: I think the distribution of the operating options among the group members was fair) based on a 5-point Likert scale (fully agree to do not agree at all). We used participants' qualitative feedback to determine the positive and negative characteristics of the different modes under investigation (semi-structured interviews conducted after each mode's test round and all mode rounds). In addition, we used subjective ranking to investigate users' preferences among the five modes. As for possible influences due to the music playlists' user interface, we examined each mode's evoked usability by employing the System Usability Scale (SUS) [47], and assessed the individual, overall User Experience (UX) using the Short User Experience Questionnaire (UEQ-S) [234]. The questionnaires can be found in Appendix A, and the interview questions in Appendix B.

Participants

We used convenience sampling to recruit participants in groups of three. We explicitly recruited groups that know each other to avoid possible influences that might come from working with strangers [93, 152]. Overall, we recruited 27 participants (13 male, 14 female) from Austria. Their age ranged from 18 to 59 (*M = 39.5 years, SD = 13.35 years*). In each condition of the between-subject factor (sitting position = level of control possibilities) 9 participants were assigned. Concerning the team relationships, people had either a family relationship (3 teams) or a working relationship (6 teams). All participants reported using a touchscreen-based device at least several times a week. Concerning their passenger experience, 7 out of 27 mentioned being a passenger at least 5 out of 10 times, while the remaining 20 participants are less than 4 out of 10 times a passenger. Sitting in the back seat is generally less common for our participants. Only one participant mentioned sitting every time in the back, and 13 did so at least once in 10 times, while the majority (14 out of 27 participants) never sat in the back.

Technical Set-Up

We designed the music playlist application for a 12-inch tablet screen with a resolution of 2048 × 1536 using Unity 3D (Figure 8.2). The playlist library provided access to 60 different songs from only 12 artists. We kept the choice of songs static to best focus on assessing the five modes under a controlled situation. To provide all passengers access to the music application, we installed three tablet PCs inside the car. Since the performance of NDRAs can increase the occurrence of motion sickness by 6 up to 12% [241], the placement of displays' on passengers' eye-height [139] is a possible counteraction. Thus, we placed one screen on the front-seat passenger's dashboard and mounted another screen on the back side of each front seat's headrest (Figure 8.6). Each screen hosted the music application, and the front seat screen acted as the loudspeaker. The synchronization of the playlist among the tablets was achieved via WIFI through the Message Queuing Telemetry Transport (MQTT) protocol.

Procedure

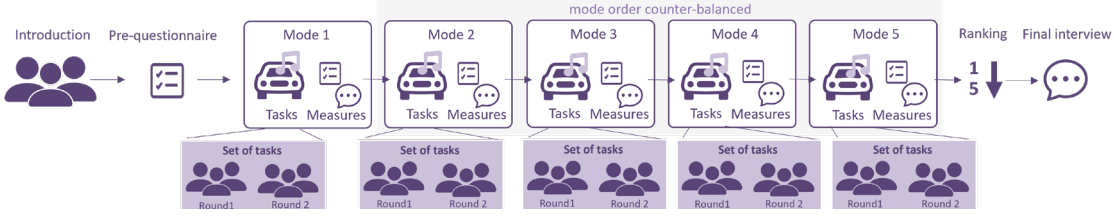


Figure 8.7: Study procedure of the mixed-subject experiment performed in a parked car (Bootstrap Icons).

We started by introducing the experimental goal, and study details, and informed the participants about the data to be collected (see Figure 8.7). After each participant gave their informed consent, we assigned them a passenger seat (the seat got randomly assigned by the researcher to avoid discussion among the participants, which could influence the overall study results). Once everyone was seated, they individually answered demographic questions and questions related to their passenger experience using their individual in-car tablet screens.

We aimed for a controlled social, collaborative situation in the car to draw an overall conclusion over the modes. Therefore, we introduced the participants to a scenario of driving together from Salzburg to Vienna. To maintain a social setting, the group had to create a shared music playlist together. Each participant got a favorite and non-favorite artist assigned on which the individual tasks were based (see Table 8.1). This was done to ensure that the group explores the mode to the fullest and is able to understand the underlying approach concerning collaboration. Thus, having fixed elements was necessary to control the experiment since an additional goal was also to investigate how authority and access to content influence team performance/fairness rather than exploring the evoked individual UX. To avoid mixing up the artists, we placed the representative album covers on a paper card below each participant's screen (see Figure 8.6). We used famous, international artists only (*Parov Stelar, Maroon 5, Jack Johnson*) to ensure that participants are familiar with the songs [258].

In addition, we asked participants to not include their liking of the song in the individual assessment of the modes. The experiment started with the *Anarchic control* to familiarize participants with the experiment, UI, and associated control possibilities. This was followed

	Set of tasks		
Mode	**Front-seat passenger**	**Left-back-seat passenger**	**Right-back-seat passenger**
Consensual control	1. Add one song from <your favorite artist> 2. Start the playlist 3. Remove all songs from the playlist		
Token-Ring control	Wait until your turn. Then perform the following tasks 1. Add two songs from <your favorite artist> 2. Start the playlist 3. Remove one song from <your favorite artist> 4. Stop the playlist		
Hierarchical control	1. Add two songs from <your favorite artist>. Start the playlist when the playlist contains six songs. 2. Delete two songs from <your non-favorite artist>	1. Add two songs from <your favorite artist> 2. Move the last song two positions up.	1. Add two songs from <your favorite artist> 2. Add another songs from <your favorite artist>
Autocratic control	1. Add one song from <your favorite artist> 2. Start the playlist 3. Stop the playlist	1. Add one song from <your favorite artist> 2. Skip the current song	1. Add one song from <your favorite artist> 2. Reduce the volume
Anarchic control	1. Add three songs from <your favorite artist> and wait until the playlist contains nine songs 2. Remove all songs from <your non-favorite artist> and wait until the playlist is empty		

Table 8.1: Experimental tasks performed by the three passengers per mode

by a counterbalanced set of the additional four modes. To avoid bias, we did not explain how the modes work in terms of collaboration and how they differ from each other. For every mode, the participants performed the set of tasks twice (Table 8.1). At the end of each trial, the experimenter asked the participants to fill out questionnaires related to usability, UX, perceived social connectedness, team performance, and fairness. In addition, the experimenter asked the participants about their positive and negative impressions. The experiment concluded with a subjective ranking of the modes and a short individual semi-structured interview regarding how participants perceived the modes and what they liked/disliked. The experiment lasted, on average, 1.5 hours, and the time spent on each mode was around 12 minutes. The participants did not receive any compensation.

8.6 Results & Findings

Data Analysis

We assessed the Likert scaled data of team performance [200], fairness (self-defined questions), social connectedness [148, 164] across the modes, and the subjective ranking data using Friedman tests. Since coordination effectiveness and team cohesion (measuring team performance) are composed of several questions, we calculated the average according to Paul et al. [200]. For the post-hoc pairwise comparisons, we performed Bonferroni-corrected Wilcoxon signed rank tests to reduce Type I errors. To understand whether different control possibilities (independent between-subject variable) have an impact on the perceived team performance and fairness, we performed Kruskal-Wallis H tests. In addition, we performed a repeated-measures ANOVA to investigate differences in time efficiency (collaboration completion time). Moreover, we used the qualitative data to conduct a thematic analysis based on inductive, free coding [128]. Since the number of diverse group relationships is limited, we did not look into differences between groups having a family relationship compared to groups having a working relationship.

Social Connectedness - H1

Belongingness

A Friedman test outlines that the effect of the modes on users' perceived belongingness is statistically significant ($\chi^2(4) = 29.964, p < .001;$ Figure 8.8). Post-hoc pairwise comparison shows that the *Consensual control* results in statistically higher belongingness than *Anarchic control* ($Z = -4.088, p < .001$), *Token-Ring control* ($Z = -4.088, p < .001$), and *Hierarchical control* ($Z = -3.271, p = .001$). Further, the average belongingness score is highest for *Consensual control* (*Mdn=g*) as well as *Autocratic control* (*Mdn=f*), while the *Hierarchical control* (*Mdn=e*), *Token-Ring control* (*Mdn=d*) and *Anarchic control* (*Mdn=b*) scored rather low (original scale ranges from a=no belongingness to g=max belongingness). These results indicate that *Consensual control* lets users belong significantly better towards the group while also *Autocratic control* improves belongingness positively. This holds in comparison to *Anarchic control*, *Token-Ring control* as well as *Hierarchical control*.

Companionship

The Friedman test reports an effect of the modes on companionship ($\chi^2(4) = 15.157, p = .004$; Figure 8.9). However, post-hoc pairwise comparisons do not show any significant differences which can be caused by the applied Bonferroni correction [19]. The *Consensual control* compared with the *Anarchic control*, nevertheless, shows a slightly higher companionship ($Z = -2.754, p = .059$). As shown in Figure 8.9, the *Consensual control* (*Mdn=6*) also received the highest average score, followed by *Autocratic control* (*Mdn=5*), *Hierarchical control* (*Mdn=5*), *Token-Ring control* (*Mdn=5*) and *Anarchic control* (*Mdn=4*). Thus, our results

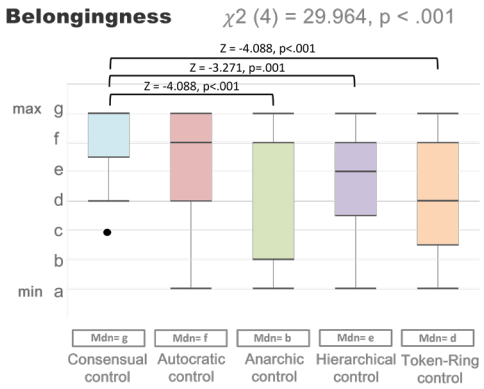


Figure 8.8: Distribution of the measured belongingness of each mode [164]. Scale ranges from a = min/low belongingness to g = max/high belongingness. Friedman test significant at $p < .05$, Wilcoxon signed-rank post-hoc test for multiple comparisons significant at $\alpha = .005$ (Bonferroni corrected).

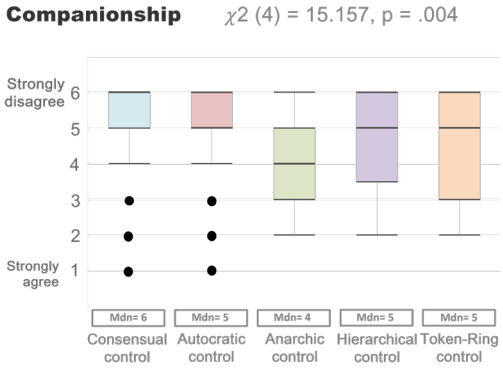


Figure 8.9: Distribution of the measured companionship of each mode [148]. Scale ranges from 1 = low companionship to 6 = high companionship. Friedman test significant at $p < .05$. *Q: Even around people I know, I don't feel that I really belong.*

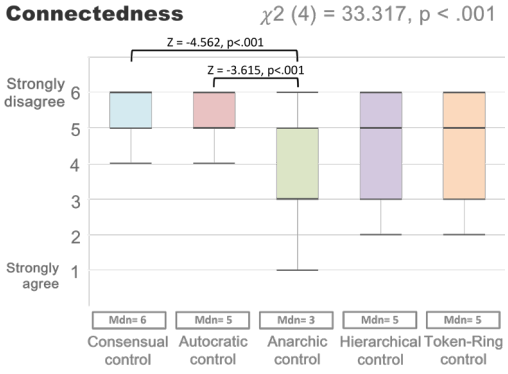


Figure 8.10: Distribution of the measured connectedness of each mode [148]. Scale ranges from 1 = low connectedness to 6 = high connectedness. Friedman test significant at $p < .05$, Wilcoxon signed-rank post-hoc test for multiple comparisons significant at $\alpha = .005$ (Bonferroni corrected). *Q: I feel so distant from the other people*

indicate a direction towards *Consensual control* for supporting companionship. However, there is no significant statistical evidence.

Connectedness

As unveiled by a Friedman test, the effect of the modes on connectedness is statistically significant ($\chi^2(4) = 33.317, p < .001$; Figure 8.10). Post-hoc pairwise comparison shows a significant difference between *Consensual control* and *Anarchic control* ($Z = -4.562, p < .001$) as well as between *Autocratic control* and *Anarchic control* ($Z = -3.615, p < .001$). Further, the data shows a high average connectedness evoked by *Consensual control* (*Mdn=6*), *Autocratic control* (*Mdn=5*), *Hierarchical control* (*Mdn=5*) and *Token-Ring control* (*Mdn=5*), while the *Anarchic control* (*Mdn=3*) scored in the middle. These results indicate that especially *Consensual control* and *Autocratic control* lead towards a significantly higher feeling of connectedness compared to *Anarchic control*.

Affiliation

As obtained from the statistical group comparisons by a Friedman test, there is a significant effect of the modes on affiliation ($\chi^2(4) = 35.847, p < .001$; Figure 8.11). The post-hoc analysis shows a significantly higher affiliation for *Consensual control* compared to *Anarchic control* ($Z = -4.346, p < .001$), *Token-Ring control* ($Z = -2.696, p = .003$), and *Hierarchical control* ($Z= -2.883, p = .004$). Besides that, it also shows a significant difference between *Autocratic control* and *Anarchic control* ($Z = -4.002, p = .001$). Further, participants report the highest average affiliation for *Consensual control* (*Mdn=6*) and *Autocratic control* (*Mdn=6*), followed by *Token-Ring control* (*Mdn=4*), *Hierarchical control* (*Mdn=4*), and *Anarchic control* (*Mdn=3*). Taken together, *Consensual control* enhances affiliation significantly positively compared to *Hierarchical control*, *Anarchic control* or *Token-Ring control*. In addition, *Autocratic control* still supports affiliation better than *Anarchic control*.

Team Performance - H2

Coordination Effectiveness

As visualized in Figure 8.12, the effect of the collaborative NDRA modes on users' perceived coordination effectiveness is statistically significant ($\chi^2(4) = 39.952, p < .001$). Post-hoc pairwise comparison shows statistically significant higher coordination effectiveness for *Consensual control* compared to *Anarchic control* ($Z = -4.088, p < .001$), *Token-Ring control* ($Z = -4.605, p < .001$), and *Hierarchical control* ($Z = -3.787, p < .001$). Moreover, *Autocratic control* evokes a higher coordination effectiveness compared to *Token-Ring control* ($Z = -3.529, p < .001$), and *Anarchic control* ($Z = -3.012, p = .003$). In summary, our results indicate that *Consensual control*, as well as *Autocratic control*, lead towards best coordination effectiveness. This holds especially in comparison to *Anarchic control* and *Token-Ring control*.

Team Cohesion

Figure 8.13 outlines a significant effect of the collaborative modes on team cohesion ($\chi^2(4) = 16.053, p = .003$). The post-hoc pairwise comparisons show a significantly higher team cohesion for *Consensual control* compared to *Token-Ring control* ($Z = 3.055, p = .002$). Overall, the *Consensual control* (*Mdn=7*) received the highest median score, followed by *Autocratic control* (*Mdn=6.33*), *Hierarchical control* (*Mdn=6.33*), *Anarchic control* (*Mdn=6.33*), and *Token-Ring control* (*Mdn=5.67*). Thus, our results indicate a direction towards *Consensual control* for supporting team cohesion best.

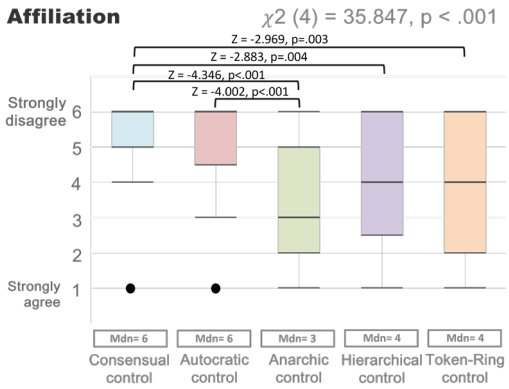


Figure 8.11: Distribution of the measured affiliation of each mode [148]. Scale ranges from 1 = low affiliation to 6 = high affiliation. Friedman test significant at p < .05, Wilcoxon signed-rank post-hoc test for multiple comparisons significant at α = .005 (Bonferroni corrected). *Q: I don't feel I participate with anyone or any group*

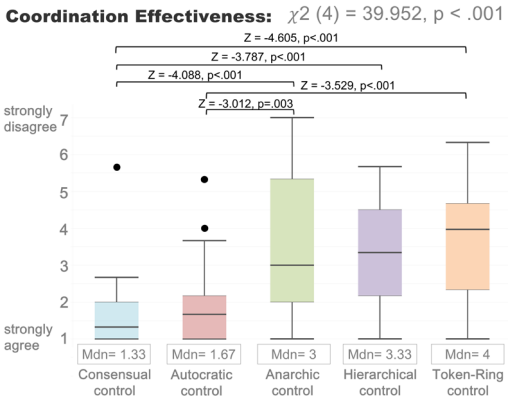


Figure 8.12: Distribution of the measured perceived average coordination effectiveness [200] of each mode. Friedman test significant at p < .05, Wilcoxon signed-rank post-hoc test for multiple comparisons significant at α = .005 (Bonferroni corrected). Scale ranges from 1 = high coordination effectiveness to 7 = low coordination effectiveness. *Q1: I am satisfied with my communication with the team members; Q2: There was a clear sense of direction during discussions with the team members; Q3: The interactions between the group members were well organized*

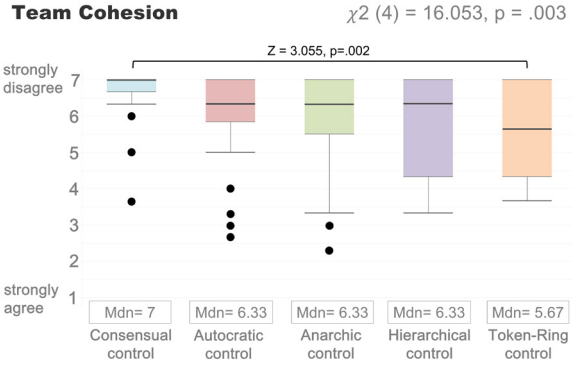


Figure 8.13: Distribution of the measured average team cohesion [200] of each mode. Scale ranges from 1 = low team cohesion to 7 = high team cohesion. Friedman test significant at p < .05, Wilcoxon signed-rank post-hoc test for multiple comparisons significant at α = .005 (Bonferroni corrected). *Q1: Dealing with the members of the team often left me feeling irritated and frustrated; Q2: I had unpleasant experiences with the team; Q3: Negative feelings between me and the team tended to pull us apart*

Fairness - H3

Perception of Fairness Support

There is a statistically significant effect of the modes on perceived fairness ($\chi^2(4) = 34.481$, $p < .001$), as shown in Figure 8.14. Bonferroni-corrected post-hoc tests show that *Anarchic control* ($Z = -4.648$, $p < .001$), *Consensual control* ($Z = -4.002$, $p = .001$), and *Token-Ring control* ($Z = -2.926$, $p = .034$) result in a statistically significantly higher fairness than *Autocratic control*. Thus, our results indicate a direction towards *Autocratic control* to be perceived as most unfair.

Perception of Different Control Possibilities

Figure 8.15 outlines a significant effect of the collaborative NDRA modes on the perception of different control possibilities among the passengers ($\chi^2(4) = 22.027$, $p < .001$). Post-hoc pairwise comparisons show that the passengers perceived *Hierarchical control* ($Z = 3.141$, $p= .017$) and *Autocratic control* ($Z = 3.141$, $p = .017$) as significantly more diverse in terms of control possibilities among passengers compared to *Anarchic control*.

Effect of Control Levels on Social Connectedness, Team Performance, and Fairness

To investigate whether the different control access levels (equal access, limited access, restricted access) have an effect on perceived social connectedness, team performance, and fairness, we conducted Kruskal-Wallis H tests for each mode and its factor measured. Results show, that different access for control does not influence the modes in any of the social connectedness factors. Thus, the perceived social connectedness is independent of users' control access level. The Kruskal-Wallis H test does also not report an effect on team performance or coordination effectiveness. Thus, different access levels for control do not influence the modes in any of the team performance factors.

A Kruskal-Wallis H test shows a statistically significant difference in perceived fairness between the levels of control possibilities for the *Autocratic mode* ($\chi^2(2) = 15.782$, $p < .001$). Subsequently, pairwise comparisons were performed with a Bonferroni correction for multiple comparisons. This post-hoc analysis revealed statistically significant differences between the key-user (full access, front-seat passenger) (*5.00*) and both restricted back-seat passengers (*left: 1.00, $p < .001$; right: 2.00, $p < .024$*). For all other modes (*Consensual, Anarchic, Hierarchical, Token-Ring control*), a Kruskal-Wallis H test did not show statistically significant differences in perceived fairness depending on the control possibilities. Taken together, the perceived coordination effectiveness and team cohesion are independent of users' control access levels. However, there is an effect on fairness particularly for the *Autocratic mode*.

Influences on Collaboration

Time Efficiency (Collaboration Completion Time)

A one-way repeated measures ANOVA (sphericity violated as assessed by Mauchly's test, ($\chi^2(9) = 26.268$, $p = .002$ – Greenhouse-Geisser correction applied, $\varepsilon = 0.528$) revealed a statistically significant interaction between the modes and the collaboration completion time ($F(1.7, 13.6) = 4.526$, $p = .036$, $\eta^2 = .361$, Figure 8.16). However, post-hoc pairwise comparisons did not show any significant differences, possibly caused by the Bonferroni correction [18]. Overall, the *Consensual control* ($M = 248.13$ s, $SD = 95.1$ s) takes the longest time on average to reach a group-based goal, followed by *Autocratic control* ($M = 210.73$ s, $SD = 21.5$ s), *Hierarchical control* ($M = 183.53$ s, $SD = 38.7$ s), *Anarchic control* ($M = 162.87$ s, $SD = 14.4$ s), and *Token-Ring control* ($M = 136.27$ s, $SD = 25.2$ s).

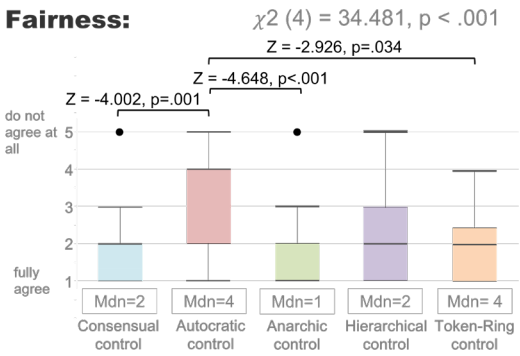


Figure 8.14: Distribution of the perceived fairness of each collaborative NDRA mode (1 = fully agree, 5 = do not agree at all). A Friedman test was significant at ($p < .05$). We used Bonferroni-corrected ($\alpha = .005$) Wilcoxon signed-rank post-hoc test for multiple comparisons. *Q: I think the distribution of the operating options among the group members was fair.*

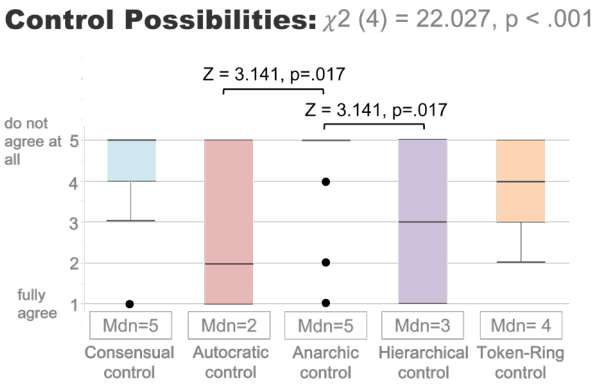


Figure 8.15: Distribution of the perceived control possibilities of each collaborative NDRA mode (1 = fully agree, 5 = do not agree at all) A Friedman test was significant at ($p < .05$). We used Bonferroni-corrected ($\alpha = .005$) Wilcoxon signed-rank post-hoc test for multiple comparisons. *Q: I had the feeling that others had more operating options than I had.*

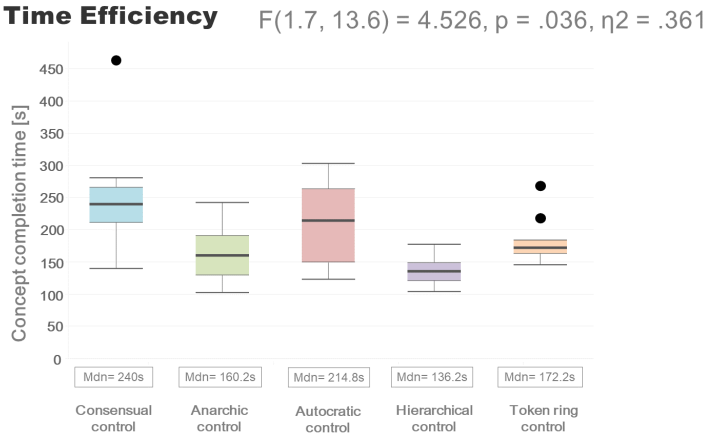


Figure 8.16: Distribution of the time needed [s] until a group-based goal was reached for each collaborative NDRA mode.

Usability & UX

We report the assessed playlists' usability (SUS score [47]) and evoked overall UX (UEQ-S [234]) as possible influencing factors on team performance, social connectedness, and fairness. The overall UX lies between below average ([0.68; 1.01]) and above average ([1.01; 1.37]) for all modes as outlined in Figure 8.17. A Friedman test shows in addition that the collaborative NDRA mode has no effect on the perceived UX ($\chi^2(4) = 3.764,\ p = 0.439$). Furthermore, usability (SUS) [47] is good ([70; 80]) up to excellent (> 80) for all modes as listed in Table 8.2.

Mode	Average SUS score (N=27)
Anarchic control	87.68
Autocratic control	78.14
Hierarchical control	77.03
Token-Ring control	75.74
Consensual control	75.74

Table 8.2: Results of the average SUS [47] scores, indicating a good ([70; 80]) up to excellent (> 80) usability of all the collaborative NDRA modes.

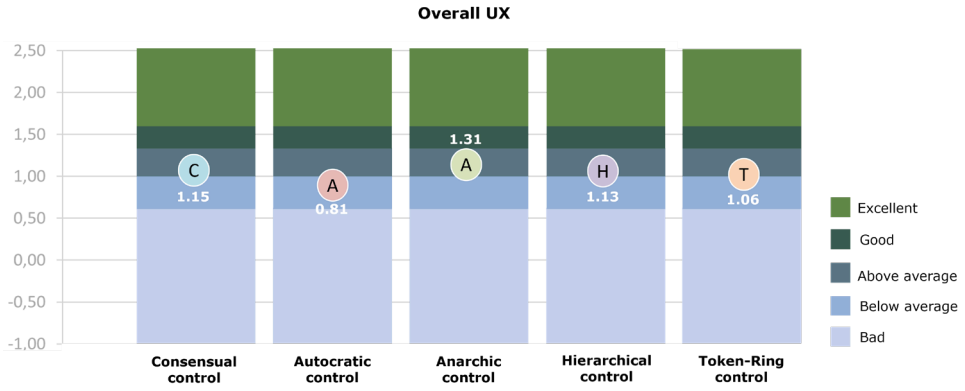


Figure 8.17: Results of the overall UX for each mode, derived from the User Experience Questionnaire [234]. The UX scale ranges from excellent (top) to bad (bottom).

Qualitative Insights

Subjective Ranking

A Friedman test outlines that there is no statistically significant order of preference for the different kinds of collaborative NDRA modes ($\chi^2(4) = 6.667,\ p = .155$). Figure 8.18 shows the ranking per mode, ranging from 1=most preferred to 5=least preferred with a median score of *Mdn=3* for *Autocratic*, *Consensual, Hierarchical,* and *Anarchic control* and a median score of *Mdn=4* for *Token-Ring control*.

Qualitative Feedback

We conducted a thematic analysis with the responses to the open-ended questions concerning each mode individually and the final interview. Individual sentences were iteratively assigned to themes that relate to aspects that support or hinder effective collaboration and team performance. The overview of the final themes of the thematic analysis, and how they relate to the different collaborative modes can be found in Table 8.3. In the following, we provide

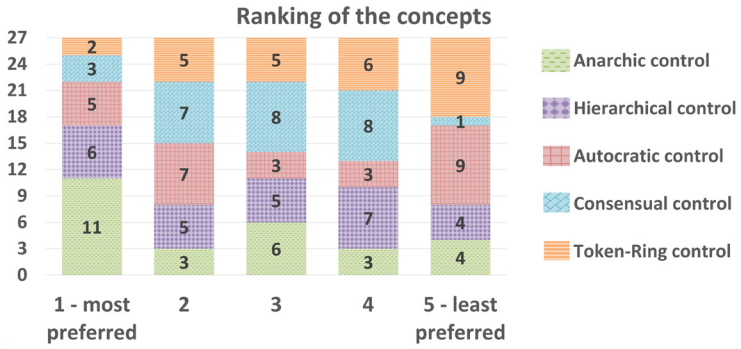


Figure 8.18: The subjective ranking of each collaborative NDRA mode.

Themes related to positive aspects	#Cnt	Mode	#Cnt	Themes related to negative aspects
encourage communication	14	Consensual	0	suppresses communication
	2	Token-Ring	8	
	7	Hierarchical	3	
	4	Anarchic	2	
	18	Autocratic	0	
perceived as fair	8	Consensual	0	perceived as unfair
	9	Token-Ring	2	
	2	Hierarchical	19	
	11	Anarchic	4	
	0	Autocratic	30	
supports collaboration	25	Consensual	0	obstructs collaboration
	2	Token-Ring	11	
	18	Hierarchical	1	
	2	Anarchic	1	
	11	Autocratic	6	
efficient	1	Consensual	8	not efficient
	3	Token-Ring	12	
	3	Hierarchical	1	
	0	Anarchic	0	
	2	Autocratic	2	
		Consensual	0	counteract others' decisions
		Token-Ring	8	
		Hierarchical	0	
		Anarchic	12	
		Autocratic	0	
inspired by others	5	Consensual		
	1	Token-Ring		
	0	Hierarchical		
	1	Anarchic		
	0	Autocratic		
		Consensual	15	dependency
		Token-Ring	0	
		Hierarchical	5	
		Anarchic	0	
		Autocratic	17	

Table 8.3: Overview of the qualitative feedback regarding positive aspects (left) and negative aspects (right) of the five modes, along with the number of statements (#C).

detailed insights into how each mode relates to the themes, supported by participant quotes.

The main aspect mentioned refers to the **encouragement of communication**, which gets mainly supported by *Consensual* & *Autocratic control* and to some extent also by *Hierarchical control*. Especially for *Consensual control*, participants attribute this to the discussions around the joint execution of functions which also supports comfort within the group (e.g., "*It induces a comfortable group dynamic*", P#8.3). For *Autocratic* & *Hierarchical control* the high amount of communication gets induced by expressing wishes to one another due to limited, individual access to functions (e.g., "*I need to ask for changes*", P#9.2). In contrast, **communication** gets rather **suppressed**, especially when collaborating by means of *Token-Ring control*. One mentioned reason for this is the time-restricted contribution a user can make (e.g., "*Everyone has a time frame and thus communication is low*", P#7.2). This lets participants feel overwhelmed, under pressure, and forced to interact with the application to achieve the goal together while not having enough time to think about how and what to contribute (e.g., "*I had to do something once it was my turn*", P#7.2; "*It was too much of a challenge to figure out what I want*", P#5.2). Therefore, participants report that they are highly focused on the UI, especially to check whether or not controlling is possible which in turn reduces the amount of group communication. However, waiting and observing until receiving the token again promotes structured collaboration and allows observing changes and being aware of who made what changes (e.g., "*You see what others do and like in case you did not know in advance*", P#8.3).

In addition, the perceived **fairness** has a major impact on the social experience and group satisfaction. Participants describe fairness as an equal opportunity to contribute and an adequate distribution of access to functions. Thus, participants attribute fairness mainly to *Anarchic control*, *Consensual* & *Token-Ring control*. Particularly *Autocratic* & *Hierarchical control* are described as **unfair** since some users have restricted access to functions, which is perceived as excluding (e.g., "*I did not feel included because I could not do a lot*", P#9.3). Even though *Autocratic control* in the car is associated with a familiar way of selecting music and allows delegating tasks, it induces **dependency** on one certain passenger, which is likely to cause frustration and can lead to a feeling of exclusion. On the contrary, *Consensual control* stresses inclusion but is also described as implying dependencies on others because of the induced voting and agreement process (e.g., "*Others always need to agree*", P#3.1). Some participants thus expressed their fear of not being able to reach the group goal (fast enough), since it is perceived as long until a first step towards the group goal can be reached and the first song gets played. One participant even proposed to rather "*express needs towards a more knowledgeable person*" to "*save time*", P#1.3, instead of contributing individually towards the group goal. Nevertheless, participants also see the agreement process as a possibility to get entertained, receive information, and be **inspired by others** due to the highlighting of other passengers' preferences (e.g., "*You immediately see the interests of others*", P#6.3; "*It was very funny*", P#1.1; "*You see what others want to listen to*", P#8.3). Apart from that, participants strive for the general **support of collaboration** rather than obstructions. Especially *Consensual control* is perceived as supporting collaboration due to reaching consensus and agreeing on one another, which ensures that only those functions get executed that everyone agrees on and feels comfortable with (e.g., "*I like that songs only get added if all agreed*", P#5.1). However, this comes with the price of being **less efficient** in terms of making group-based decisions (e.g., "*It is very slow*", P#6.2).

Even though *Hierarchical control* is perceived as unfair, it is still associated with collaborative support. Participants outlined that having dedicated functions assigned to dedicated users forces them to support each other. However, needing to rely on one user and verbally convincing a key-user to execute functions (*Autocratic control*) is to some extent perceived as collaboration, but only in the particular case of the key-user executing the requests that have been made. Due to this unpredictable role of the key-user, participants fear that power roles get induced which can lead to conflicts that further reduce communication and impact the

overall entertainment/in-car experience negatively.

While providing equal access to functions – at any time (*Anarchic control*), or temporarily (*Token-Ring control*) – constitutes forward fairness, on the one hand, it provides the opportunity to **counteract others' decisions** on the other hand. Retracting decisions that have been made by somebody else lets passengers feel frustrated, has the potential to induce conflicts, and generates chaos that influences the groups' progress negatively (e.g., "*I did not like that my songs were suddenly gone*", P#8.1; "*I was angry because things changed and I did not know why*", P#8.1; "*I was frustrated because somebody removed my songs*", P#8.2). Additionally, participants fear in a real-life scenario that they will never be able to start listening to music because everyone removes songs again. Even though they reflect that this might not be a major point of concern among friends and adults, they clearly see this as a challenge when collaborating with kids under *Token-Ring* or *Anarchic control*.

Findings

From this data, we can answer our hypotheses as follows:

H1 – The type of the collaborative NDRA approach has an effect on user's perceived social connectedness: Our results show a significant effect of the five modes on perceived social connectedness in terms of belongingness, affiliation, connectedness, and companionship (Figure 8.12), which leads us to accept *H1*. *Consensual control* performs best in terms of belongingness while resulting in an equally high connectedness and group affiliation compared to *Autocratic control*. Since there are no differences in evoked companionship among the modes, we only partially accept *H1.a – the Consensual control yields a better social connectedness in terms of belongingness.* In addition, *Consensual control* and *Autocratic control* do encourage communication according to qualitative insights and support connectedness as well as affiliation significantly better than *Autocratic control*. Therefore we also partially accept *H1.b – connectedness and affiliation are higher when active communication is required for control, compared to no required communication for control*.

H2 – The type of the collaborative NDRA approach has an effect on users' perceived team performance: Our results validate that the perceived team performance in terms of coordination effectiveness and team cohesion is influenced by the type of collaborative NDRA mode. Thus we accept *H2*. Concerning *Consensual control* and *Autocratic control*, both enable high coordination effectiveness due to the encouragement of communication and collaboration as outlined through qualitative insights. However, *Autocratic control's* team cohesion does not show significant differences compared to the remaining four modes which leads us to only partially accept *H1.a – The perceived team performance is highest for Consensual control and Autocratic control in terms of coordination effectiveness*.

H3 – The perceived fairness is affected by different control possibilities among group members: Furthermore, our study indicates that the modes have an effect on perceived fairness. Especially the modes with different control possibilities (*Autocratic control, Hierarchical control*) are described by users as most unfair and exclusive while being highly dependent on other users. Participants also noticed during operating these modes that others had more control possibilities. Notably, the *Autocratic control* induced a significant difference in perceived fairness among the passengers. Thus, we accept *H2 – The perceived fairness is affected by different control possibilities among group members.* Consequently, the modes which provide equal control possibilities (*Consensual, Anarchic, Token-Ring control*) are rated and perceived as most fair and do not tend to let users feel that others have more options to use, which leads us to also accept *H2.a – The perceived fairness is highest for Consensual control, Anarchic control, and Token-Ring control since these offer equal control possibilities.*

8.7 Discussion

In this chapter, we report how the five modes from the taxonomy enable the collaborative performance of Non-Driving-Related Activities (NDRA) in an Automated Vehicle (AV). Our results show that the nature of the mode plays a significant role in passengers' perceived social control experience in terms of social connectedness, team performance, and fairness. In this section, we discuss our findings and outline design recommendations for better collaboration in future AVs.

Implications of Collaborative NDRAs on Social Connectedness, Team Performance & Fairness

Our findings indicate that each mode evokes good companionship. In relation to previous work (e.g., [217]), we argue that all modes are socially satisfying and support well-being. However, the evoked connectedness, affiliation, and group belongingness differ majorly among the modes. Particularly, *Anarchic control* shows to limit users' social connectedness and suppress the feeling of belongingness and affiliation, which we related due to the qualitative feedback to counteract others' decisions. The *Consensual control*, instead, encourages communication and improves the feeling of belonging to the group, which according to qualitative feedback, can be related to the fact of exploring new content and getting inspired by others' input. Since it only allows the execution of control in case everyone agrees on it, it is seen as minimizing the chance of conflicts and establishing fairness. However, it is perceived as more inefficient, while it objectively does not require more time to reach a group-based goal.

Overall, our insights confirm that active communication [75] supports social exchange, prevents social conflicts (e.g., [66]), and is thus a key factor for high social connectedness. In addition, both *Consensual* and *Autocratic control* evoke a strong group affiliation and connectedness, which can be explained in connection to enhanced social bonds [148], built/established self-esteem [148], and providing a comfortable environment that allows for identification with the group [148]. However, we suspect that the set-up of *Autocratic control* is overall more familiar to users [264] because it is the most common available approach in today's cars. Thereby it fosters a sense of connectedness by providing a 'common ground'.

Furthermore, the *Token-Ring control* promotes structured group work due to asynchronous collaboration. However, the waiting time for participation limits active interventions in case a member overrules previously made decisions, which may justify negative impacts on belongingness and affiliation. Moreover, waiting until a contribution can be made can be tedious and increase temporal demand [168]. Finally, *Hierarchical control* scores average for all social connectedness dimensions, which can be explained in relation to the limited control of some members contributing to an unstructured and chaotic way of collaboration. Since our research shows no direct impact of limited or restricted control on perceived social connectedness, we conclude that the level of social connectedness among passengers reflects the overall social group interaction rather than individually possible group contribution. Thus, the perceived social connectedness influences the whole group and not only individual group members. Hence, designing for a higher level of social connectedness in AVs can improve collaboration, especially when it comes to the collaborative selection of media content and is in addition a crucial factor to co-experience [16, 39].

Moreover, both qualitative and quantitative data suggest that there is a nuanced relationship between the dimensions of fairness and team performance, which are highlighted in some modes. For instance, the *Autocratic mode* promoted high perceived team performance because it required a lot of intra-team communication which confirms the importance of communication in collaborative settings [75]. Since actions under *Autocratic control* were performed by a single passenger, individual agency was restricted, leading to a low feeling of fairness. In contrast, the *Token-Ring control* exemplified an interaction with low

perceived team performance but high efficiency and fairness. Everyone had an equal say in the decision-making process – contributing to a perception of fairness. Even though the turn-taking process supported high efficiency, users felt under pressure to contribute toward the group goal. Additionally, decisions taken by individuals could be deleted or overridden, which led to a sense of chaos and a lack of team performance and could also potentially be a source of conflicts as outlined by previous work [2, 66]. Also, *Hierarchical control* evokes a lower team performance compared to the other modes but is perceived as a mode that supports good collaboration. Even though it is on average rated as fair, qualitative feedback reveals that different access levels are unfair, which can instigate power games [207].

This interplay between the perception of fairness and team performance is perhaps explained by the fact that in a philosophical sense, fairness – defined by the dimensions of equality and social justice [189] – is a dimension of the inherent interpersonal dynamic of the team. Dissenting individuals within a team can participate equally in an activity. However, since decisions are not made in consensus, this results in a highly fair approach to individual rights (equality of opportunity) but a low team performance (e.g., *Anarchic control*, *Token-Ring control*). Despite that, a cohesive team can promote both fairness and team performance. An excellent example is the *Consensual control*, which scored high in both fairness and team performance, giving individual group members an equal agency in control without imposing time restrictions. Even though voting for changes can be tedious [207] and require more time, it was perceived as most fair because the executed interactions were the ones with which everyone in the group was in agreement. Additionally, *Consensual control* is an entertaining mode [207], enhances social connectedness, and enables the exploration of new content due to a high workspace awareness [97] which helps to get to know each other better and can even act as a conversation starter. Thus, there is evidence that a careful design of interfaces with certain modes of shared control can have an impact on fair and efficient collaboration while affecting social control experience when it comes to the performance of NDRA in AVs.

Recommendations for Collaborative NDRAs in AVs

Based on the insights gathered from the qualitative and quantitative data, we recognize certain markers that support good collaboration experience and performance, which we outline and discuss below:

Continuous contribution: Qualitative and quantitative insights clearly show that the modes which completely restrict some group members from contributing towards the team task (especially temporally) are perceived as unfair. This influences collaboration and social in-car experience negatively. Therefore, we recommend that future collaborative in-car systems support continuous contribution. This means that it allows individuals to interact with the system at all times and does not (fully) restrict their participation. While full access is not always needed, full restrictions are to be avoided. Evidence from the qualitative results shows that such restrictions tend to also lower communication, impact social connectedness and hinder collaboration. In contrast, allowing individuals to interact with the system to contribute towards the team task at all times [77] supports fairness and is perceived as socially pleasing.

Balancing of key users: It is possible that there are key users in the team who have access to more functionality and/or responsibility in interacting with the system. However, our qualitative insights suggest that a single key-user (e.g., *Autocratic control*) executing requests of other team members, while still perceived as a collaborative effort, can still lead to a perceived power dynamic and potential for conflicts. This may further reduce communication and negatively impact the in-car social experience. Therefore, it is important to have a balance in this role to avoid inducing power dynamics due to dependencies and perceived

unfairness. Hence, the system should support switching the role of key-user [2, 207] in order to promote fairness, provide an inclusive, collaborative environment, and ensure high co-ordination effectiveness.

Considering users' abilities/knowledge: Qualitative insights suggest that the modes where every team member has equal access to all functions regardless of their expertise or knowledge of the system can have an adverse effect. Participants commented that *Anarchic control* and *Token-Ring control* can have a negative influence on the group's progress since one can always retract decisions that have been made by somebody else, especially when this is made in error or out of a lack of understanding of the task. While there might be no problem among friends and adults, collaborating with children, for instance, might be more challenging and time-consuming within these modes. On the other hand, participants also remarked on the familiarity of this paradigm as this is typically the de-facto standard in cars today and observed the advantage of the ability to delegate tasks, for instance, to a more knowledgeable person, without obstructing the flow. This leads to the recommendation that the system should support offering a more straightforward and/or more limited version of the functionalities to novice users who are not familiar with and/or do not feel competent to interact with the system to collaborate effectively (e.g., kids [173]). To avoid the situation that an individual within a group hesitates or refrains from joining the collaborative process out of a fear of 'slowing the team down' because of their own perceived incompetence despite their willingness and motivation, the system should allow for an adaptive interface [48] to integrate every group member according to their abilities [77] without impacting the overall group goal.

Easy to pop-in & out to avoid pressure to contribute: Participant interviews highlighted that some collaborative approaches tend to force individuals into a pressure of "needing to do something" within the context of task execution (e.g., *Token-Ring*, even when they do not want to do anything or do not know what to do). Additionally, the *Consensual control* paradigm requires the interaction of others and forces an individual to wait for the input of others (dependency). Sometimes, passengers want the flexibility of partial engagement and not having to be forced into active contribution in each step of the decision-making process. This leads to the recommendation that the system should not force individual group members to collaborate. Instead, the system should allow for continuous contribution when they desire. This encourages interacting socially with one another [223] while avoiding forced participation, preventing negative emotions.

Prevent counteracting others' decisions: Even though our results show that users value having unlimited access to functions since it supports fairness and promotes belongingness, it runs a risk of increasing interpersonal dominance [168]. This prevents communication and impacts collaboration negatively [75]. According to qualitative insights, it can even result in the fear of not reaching the group goal at all. Therefore, it needs to be carefully decided who can overrule others by, e.g., balancing key-users and taking users' abilities into account. To best support collaboration in AVs, the system needs to ensure the handling of conflicting inputs to prevent erroneous overriding [168].

Create awareness of others: Participants explicitly mention that they aspire insights into changes other passengers will make and report even being inspired by it in their own choices. Highlighting someone's contribution or change(s) increases social connectedness, awareness [50, 97] and fosters communication [23, 75], collaboration [97], and a better in-car experience [30]. Besides, showing/highlighting changes (e.g., as done in *Consensual control*) also supports coordination effectiveness and high team cohesion. A high situational awareness towards other passengers' interactions can reduce conflicts [66, 250], enables structured group work, is entertaining, and offers the possibility to explore new content.

Furthermore, it exposes others' wishes which offers the opportunity to better address the needs and desires of other passengers in a collaborative setting which in turn can positively add to perceived belongingness and affiliation.

Provide initial state of collaboration & ensure progress towards group goal: One of the concerns observed by the participants in some modes (e.g., *Anarchic* or *Token-Ring control*) is that with an endless possibility to interfere with and override one another's input, there arises a potential of never getting started in the first place (i.e. a state where each user overrides another's contribution, leading to a perpetual deadlock). This adversely affects team performance and is detrimental to the efficiency of the task at hand. Therefore, it is critical that the system affords an environment where there is some progress toward the group goal. Since the first step towards group work causes users a lot of pressure and is perceived as mentally demanding as outlined by qualitative insights, we recommend that the system guides the collaboration by, e.g., providing an initial, collaborative state. This state should give users more time to think about how and what they want to contribute. An example can be a pre-filled playlist, so the music gets already played while passengers adjust the playlist together according to their preferences.

8

Limitations & Future Work

In this study, we modulated the possible influencing factors of individual perceived UX and the UI's usability to best ensure the internal validity of our findings. Nonetheless, our insights are limited to an initial usage as well as to the short period of time participants had to experience the modes with a limited choice of songs in combination with the pre-defined artists. Thus, future work is required to understand the effect on team performance and perceived fairness when a) having access to a bigger song library without restrictions on an artist and b) under longer usage and repetitive usages. Besides, our insights are limited to convenience-sampled Mid-Europeans collaborating in the car. Thus, future research is needed to verify whether and how our findings may transfer to other social and cultural contexts because different cultural backgrounds might have varying expectations when it comes to (in-car) collaboration. Even though we best ensured contextual validity by conducting the study inside a parked car adhering to the most important safety regulations (e.g., integrated in-car screen), future work needs to investigate how a moving environment or possible changes in the car interior may affect in-car collaboration.

8.8 Conclusion

In this chapter, we explored the role that social connectedness, fairness, and team performance have on passenger collaboration in future fully automated vehicles (AVs). We, therefore, applied the five modes of social control experience to design for collaborative NDRA. Through the results of an experimental assessment of the five collaborative NDRA approaches under the lens of passengers creating a shared music playlist, we found that the type of collaborative NDRA approaches influences perceived social connectedness, fairness as well as team performance. Especially *Consensual control* supports belongingness and affiliation best. In addition, *Consensual* and *Autocratic control* let users feel most comfortable within the group and help them to identify themselves as a part of the group. Moreover, providing equal control possibilities to each passenger impact fairness positively. However, it can decrease team performance and efficiency. Even though *Consensual control* leads towards a highly perceived team performance and supports fairness best, qualitative insights unveil key characteristics of each mode to best support collaboration in AVs. Based on these insights, we discussed the implications to support social control experience and collaboration in AVs. We contribute recommendations to support collaboration among passengers in future AVs by designing for a higher level of social connectedness, fairness, and team performance.

CHAPTER 9

Reflecting on this Domains' Investigation

A condensed, domain-specific summary about social control experience design for media in the automotive domain.

In this thesis part, we looked into social control experience design in the automotive domain. Therefore, we deployed the five modes from the taxonomy (*Consensual, Hierarchical, Token-Ring, Autocratic*, and *Anarchic*) from Chapter 5 to support driver-passenger collaboration in manually driven cars (Chapter 7) and to facilitate collaboration among passengers in a fully Automated Vehicle (AV) (Chapter 8). With these interventions, we investigated the extent to which the different modes affect occupants' perceived social connectedness, team performance, and fairness.

Investigation in Today's Cars

The first experimental assessment (Chapter 7) focused on how the modes can support collaboration among a driver and a front-seat passenger in manually driven cars. We provided the passenger with better access to Non-Driving-Related Activities (NDRA) to promote collaboration through shared control. Therefore, we outlined, in line with the modes, five collaborative approaches by means of an In-Vehicle Infotainment System (IVIS) – *Consensual concept, Token-Ring concept, Hierarchical concept, Autocratic concept*, and *Anarchic concept* (Section 7.3). We identified that the mode – the way how control over functions is shared between a driver and a passenger – significantly impacts perceived fairness, coordination effectiveness (aspect of team performance) as well as affiliation and connectedness (aspects of social connectedness) (Section 7.6). While all modes allow for social engagement, consequently establishing self-esteem, well-being, social satisfaction [217], and promoting connection with one another [261] (social connectedness in terms of affiliation, companionship, connectedness), none of the modes support a high feeling of social connectedness in terms of belongingness (Section 7.6). A possible reason, therefore, can relate to a lack of awareness of what the other user is doing on the screen [97] but also to the limited possibility of face-to-face communication [75]. Nonetheless, all concepts support collaboration as evident through a high level of team cohesion [200], even though the way of collaboration is not as effective for every concept. However, in a safety-critical environment, efficient and effective collaboration is key to ensuring safety and minimizing driver distraction [91, 134]. Thus, the evoked social control experience might be influenced by whether the system promotes safe task execution and collaboration. Moreover, the driver's role clearly impacts the perceived fairness concerning control distribution. This is evident through qualitative insights showing that the driver requires more access and should decide on the distribution of access to functions (Section 7.6).

Although all five modes revealed certain characteristics that promote social control experience when applied to an IVIS, our findings emphasize the general need to explicitly design for balanced power roles, situational awareness, active communication, and a balance between drivers' privacy and trust toward the passenger to enrich social control experience among occupants in current cars (Section 7.7).

Investigation in Future Cars

The second investigation (Chapter 8) concentrated on social control experience design among passengers in an Automated Vehicle (AV) based on the collaborative creation of a music playlist. Through individual in-car tablet screens, we provided passengers access to the playlist application. We applied the five modes from the taxonomy to balance access to playlist functions (e.g., adding songs, removing songs, controlling playlist action buttons) (Section 8.3). We identified that the five modes evoke a significantly different level of social control experience in all four factors of social connectedness – belongingness, companionship, connectedness, and affiliation, as well as in team performance (coordination effectiveness, team cohesion) and fairness (Section 8.6). Particularly counteracting others'

decisions (*Token-Ring* and *Anarchic control mode*) suppresses belongingness and affiliation. Equal control contribution and the encouragement of communication (*Consensual mode*) enrich overall social connectedness and minimize conflicts. Even though the *Consensual control* mode is more time-consuming, it still promotes high coordination effectiveness and team cohesion. Providing different access levels to functions (*Hierarchical mode*) induces power dynamics which lowers social connectedness and perceived fairness. Although having one user in charge of the system (*Autocratic mode*) establishes high team performance and induces communication which contributes to social connectedness, it is least inclusive, causes dependency, and limits the collaborative experience, consequently affecting social control experience. Moreover, our observations indicate that fairness contributes toward collaboration in AVs, while it does not naturally define a high team performance. This shows that time efficiency particularly in non-safety-critical scenarios does not necessarily evoke a high amount of social control experience. After analyzing the various collaboration modes in an AV, we discovered that each mode has its strengths and weaknesses.

To enhance the social control experience for media in AVs, we conclude that individuals must be able to contribute continuously while maintaining a balance of key users responsible for specific functions. The system should also avoid pressuring users to contribute and offer an effortless way to join or exit collaboration as desired. Additionally, high social control experience requires fostering awareness of others' actions, preventing contradictory decision-making, and establishing a collaborative basis while ensuring progress toward the group's objective is made (Section 8.7).

The insights from these two empirical assessments contribute to the overarching goal of this thesis part, which is to evaluate whether designing for shared control is indeed a valuable approach to promoting social control experience among people in the car. We found out that the five modes outlined in Chapter 5 overall do promote social control experience. However, perceived social connectedness, team performance, and fairness of a specific mode change depending on the use case and context. While we could observe significant differences among the modes in terms of affiliation, companionship (social connectedness), and team cohesion (team performance) when promoting passenger collaboration, this did not hold when supporting driver-passenger collaboration. Moreover, the intensity of social control experience evoked and also the qualities of certain modes vary among the experiments conducted.

Taken together, our findings demonstrate that designing for shared control can be a valuable approach to stimulating social engagement and enriching group experience among people in the car. Moreover, they emphasize the differences between the modes when it comes to the evoked social connectedness, team performance, and fairness. Overall, our investigations disclose detailed insights that contribute to the design of collaboration in cars toward social control experience. However, these findings are bound to the type of system, the use cases designed, and the contextual characteristics of the automotive domain. In the next step, we investigate social control experience in the smart home domain to deepen the insights.

Main Findings

- The findings from both experimental assessments of social control experience show that the five modes from the taxonomy (*Consensual, Hierarchical, Token-Ring, Autocratic*, and *Anarchic control mode*) significantly differ in the evoked social connectedness, team performance, and fairness. While all of these modes do have advantages and disadvantages, it highly depends on the in-car use case and context which mode evokes a higher social control experience and is preferred by users.

- Passenger Collaboration in an Automated Vehicle: When passengers collaborate on a task together, it is evident that equal control and influence on the final group outcome have a positive influence on social control experience, particularly on social connectedness in terms of belongingness, affiliation, connectedness, as well as on fairness. Moreover, letting everyone actively participate supports team performance (*Consensual mode*). Even though the delegation of tasks constitutes positive towards social connectedness due to the high level of communication, limiting individuals in contribution-making is unfair, not preferred, and prevents inclusion (*Autocratic mode*).

- Driver-Passenger Collaboration in a manually driven Car: Established roles and responsibilities in the car (e.g., the driver who controls the car and ensures safety, the passenger who is careful not to distract the driver), influence how the various modes elicit social control experience as detailed discussed in Section 7.7. These roles influence the perceived social connectedness in terms of affiliation and companionship as well as team performance in terms of coordination effectiveness and to what extent a mode is perceived as fair or not (Section 7.6). To ensure safety, users tend to prefer the current established *Autocratic mode*. However, this perception changes when collaborating in a fully automated vehicle among passengers (Section 8.6) where active, continuous participation (e.g., through *Consensual, Anarchic mode*) promotes social control experience best.

- The context and situation in which collaboration gets performed in the car define the importance of time efficiency over fairness and social connectedness. Overall, high efficiency and team performance do not naturally cause social connectedness and a perception of fairness. This is particularly evident when collaborating under safety-critical circumstances such as driving. There, the execution of a task needs to be fast with a low error rate. In contrast, collaboration in a non-safety-critical situation focuses on considering others' interests and being more inclusive. Nevertheless, a focus on shared control and the design for social control experience has a positive impact on driving safety and promotes individuals' empowerment in a group setting.

V

Social Control Experience in the Smart Home Domain

Part V, **Social Control Experience in the Smart Home Domain**, presents four chapters that scope, investigate, and reflect on social control experience design in the smart home domain. The research question for this part is RQ4 – H*ow do the various modes of shared control (Anarchic, Hierarchical, Autocratic control) affect the social control experience in the smart home domain?* More precisely, we want to understand RQ4.b – *To what extent do various modes (Anarchic, Hierarchical, Autocratic control) affect social control experience in terms of social connectedness, team performance, and co-experience in the living room?* The goal is to investigate whether and how the diverse modes from the taxonomy promote social control experience in shared living spaces.

Chapter 10 – Introducing & Scoping this Domains' Investigation, introduces and outlines the scope of the investigations in the smart home domain.

Chapter 11 – Investigation on Movie Selection, illustrates how the various modes can promote three users to select a movie together while simultaneously interacting with a TV. Through a controlled lab setting, we report on their effect on individuals' perceived social connectedness, team performance, and co-experience.

Chapter 12 – Investigation on Genre Selection, demonstrates how the modes can support a group of three in picking a movie through collaborative genre selection facilitated by tangible genre tokens. In a controlled lab environment, we assessed the individuals' perceived social connectedness, team performance, and co-experience.

Chapter 13 – Reflecting on this Domains' Investigation, summarizes the insights gained through the experimental investigations in Chapter 11 and 12 and outlines main findings.

CHAPTER 10

Introducing & Scoping this Domains` Investigation

Abstract

This part of the thesis investigates how the taxonomy promotes social control experience among co-located users in the smart home domain. We provide an introduction to the smart home and outline the essence of media in shared living spaces. In relation to these insights, we design, implement, and investigate social control experience design under collaborative movie selection (Chapter 11) and genre selection (Chapter 12).

The home is a prominent recreational space that provides a safe and welcoming environment [37, 243]. Particularly the (shared) living areas are a hub for media consumption [85] and the central gathering place for social activities among friends or family members [55, 129]. Over the past decade, advances in technology have transformed traditional living spaces into multi-functional environments [5]. Thus, many households nowadays are equipped with a variety of connected devices, including smart TVs, voice-activated assistance, or mobile devices (e.g., tablets and smartphones) [8, 96, 179] to enhance the media experience [243]. This shift towards a highly technology-oriented environment has expanded the role of the living room beyond just being a place for relaxation [5, 8]. It transformed into a space where individuals can access information, communicate, navigate, and engage with various media-oriented content [55, 243]. However, a multitude of these devices is not yet designed for collaborative usage, which can limit shared experiences [78]. Particularly the interaction with a TV is restricted to the use of a single remote control which limits others from actively participating in movie selection [22]. Yet, watching movies in shared living spaces is the most common recreational activity [85, 176], while decision-making is confined to verbal agreements. Therefore, we investigate social control experience in the smart home domain with a focus on movie selection.

With exploring social control experience in shared living spaces, the decision-making strategy compared to the automotive domain changes due to contextual circumstances as outlined in Section 5.4. While the performance of tasks in the car was guided by ensuring safety [134] and thus its efficient and effective performance was crucial [91], this aspect is expected to change when controlling media systems in the home. Therefore, making decisions on, e.g., a movie is not as time critical as executing tasks in the car. This means that the empirical assessment of all modes from the taxonomy concerning their evoked social control experience might exceed the attention span of participants when assessed and compared in a single study and, thus, not ethically defensible. The insights from the automotive investigations (Chapter 7 & 8) report that active participation and avoiding overruling others' decisions are key to the promotion of social control experience. This means timely limited interventions (*Token-Ring mode*) or simultaneous access to all functions (*Anarchic mode*) are less likely to promote excellent social control experience. To comply with ethical standards while still exploring social control experience in shared living spaces, we build upon the insights gained from the automotive domain and thus focus on studying the *Hierarchical, Consensual,* and *Autocratic modes* in more detail. To assess the evoked social control experience in the home, we focus first on social connectedness [148, 164] in terms of belongingness, affiliation, connectedness, and companionship. Since the performance of a task is not critical, we limit the assessment of team performance to measuring the perceived team cohesion only. Moreover, we gained a comprehensive understanding of the modes' evoked fairness through investigations in the automotive domain. Since the examination of movie selection reflects a single decision-making process that impacts the experience for an average duration of 130.9 min[1], we focus deeper on assessing individuals' perceived

1 https://www.statista.com/statistics/1292523/lenght-top-movies-us/, last accessed 2023-05-03

co-experience [17] in terms of user experience and social experience. Thus, we place more emphasis on the generated experience through collaborative interactions with the system and among users in shared spaces. Taken together, we explore the evoked social control experience in the smart home domain with an emphasis on social connectedness in terms of belongingness, affiliation, connectedness, and companionship, team performance in terms of team cohesion, and co-experience in terms of UX and social experience.

Particularly watching movies together with others is a common activity in the living room [82, 147] that fosters family bonding and generates a shared experience [132]. Moreover, socializing with friends by organizing film nights can be a great way to bond and create lasting memories. However, diverse movie preferences can make it challenging to reach a consensus about what movie to watch together. Even though streaming services offer a variety of content, it takes, on average, 18 minutes to make a final decision [181]. Particularly in a group setting, this lengthy decision-making process can cause frustration and lead to the selection of a movie not everyone is up for watching. This, in the end, can impact the overall viewing experience because people engage in other activities such as playing with the smartphone [152] or even leaving the room, which can reduce social engagement and group experiences [152]. Thus, we see the opportunity to research whether and how the diverse modes from the taxonomy can promote collaborative movie selection and enrich social control experience.

Investigation on Movie Selection

Therefore, we first concentrate on enhancing the current situation of a TV controlled by a single remote control in the living room toward social control experience (Chapter 11). We focus on extending the TV interaction through multiple remote controls to promote simultaneous interaction with a TV and to encourage every user to participate in the decision-making process. The modes of *Consensual*, *Hierarchical*, and *Autocratic control* were used to guide the execution of functions and the selection of a final movie. In Section 11.2, we report on the design decision made. Further, we outline in Section 11.5 the effect on social connectedness, team performance, and co-experience, assessed in a lab study in groups of three.

Investigation on Genre Selection

Furthermore, recent research outlines that media consumption behavior, particularly the preference for movie genres, depends on users' personality [119]. Thus, there is a high chance that deciding on a movie genre can already lead to huge discussions and disagreements among people. Since genres are the classifiers of movies [44] and are also used by popular streaming services to guide users through their libraries [59, 210], we see the chance to promote social control experience through collaborative genre selection. Thus, as a second intervention, we focused on whether and how the taxonomy of social control experience applied to genres can guide and support genre decision-making (Chapter 12). We, therefore, made use of tangible interfaces; more precisely, we designed physicalized genre tokes to stimulate discussion and selection of genres (Section 12.3). Based on the genre decisions made, the system guides the user group to a follow-up collaborative movie selection based on *Consensual*, or *Autocratic control*. Through a lab experiment in groups of three, we studied the evoked social control experience in terms of social connectedness, team performance, and co-experience. We report on the insights gained in Section 12.6 and discuss their implications in Section 12.7.

Part V concludes with a summary of designing for social control experience in shared living spaces and outlines important findings.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CHAPTER 11

Investigation on Movie Selection

This chapter is based on the following publication:

Melanie Berger*, Rutger Verstegen, Bahareh Barati, Harm van Essen, and Regina Bernhaupt. 2023. Collaborative TV Control: Towards Co-Experience and Social Connectedness. In *Petrie H. et al. (eds) Human-Computer Interaction – INTERACT 2023. INTERACT 2023. Lecture Notes in Computer Science.* Springer, Cham. (accepted, in press)

* primary, responsible researcher

Abstract

Consuming media together is enjoyable and lets people connect. However, controlling the TV, for instance, is still restricted to one user. This limits individual participation in group decision-making, particularly in the home context, which can cause frustration and negatively impact social exchange and engagement. In this chapter, we explore how we can support users in the living room to collaboratively interact with the TV to stimulate social engagement and support the selection of a movie everyone is up for watching. Therefore, we investigate three collaborative approaches to movie selection: Consensual, Hierarchical, and Autocratic. We empirically validated the approaches' effect on co-experience, social connectedness, and team performance as indicators for social control experience. Consequently, we conducted a mixed-subject experiment (N=30) inside a living room in groups of three choosing a movie together. Results show that the collaborative approach to movie selection influences collaboration and social control experience. Promoting consensual decision-making or enabling users to provide movie recommendations under the hierarchical approach entrusts individuals, supports involvement, and is perceived as more inclusive while also enabling a higher chance of picking a movie everyone enjoys watching. Letting only one user interact with the TV stimulates communication, yet, it enhances the chance of excluding group members.

11.1 Introduction

The living room is one of the central gathering places for social activities at home [129]. Particularly watching movies together generates a shared experience which can enhance social engagement and enrich the overall viewing experience [132]. While streaming services have made it easy to access a wide variety of content, users spend almost an hour a day deciding on what content to watch [70]. In addition to the challenging and daunting task of making a choice, a traditional TV allows for single user input only [22]. Yet, neglecting individual participation in group decision-making can cause a feeling of exclusion [66] due to limiting expression of needs [51] and lack of intervention in control if necessary [66]. Even though 76% of household members are open to sharing devices with one another in the home [138] and using them simultaneously, the majority of devices do not support collaboration or simultaneous interactions. This, in turn, impacts social interaction and belongingness negatively [78], which can reduce family bonding [85] and cause interpersonal conflicts and frustration [133].

To overcome this, previous work investigated the promotion of collaboration in shared living spaces by sharing control among multiple users. McGill et al. [168], therefore, investigated a voting system for movie selection in the home using smartphones to encourage collaboration [168]. Their results concerning collaboration show that using personal devices to vote induces a high level of frustration and a high mental workload while resulting in a low perceived usability [168]. Promoting a democratic selection of music content in public spaces in turn increases social value, is entertaining, and supports fairness, even though it is time-consuming to initiate changes [192]. A recent study by Berger et al. outline that a democratic creation of a music playlist in the car among passengers enhances social connectedness, especially perceived belongingness, and affiliation, while it also encourages communication [23]. In turn, providing users with different levels of control strengthens power games, induces dependency on others, and is perceived as unfair [23]. Nonetheless, it supports structured collaboration due to dedicated responsibilities [207]. Having a single key user who controls on behalf of others shows high usability and low frustration [168]. It is described as not ambiguous, encouraging storytelling and ensuring conversations [2]. Even though this notion is the easiest to implement from a technological perspective [207], it generates

high dependency on a single user and is perceived as unfair because it limits interventions which increase conflicts in case the key user does not want to perform changes requested by others [23]. Overall, the most common approach refers to providing different access levels to users [180, 207] or switching key users from time to time (e.g., by means of a rotating access token [2, 168]). While especially hierarchical levels sound promising in involving all users actively, they can provoke unbalanced power dynamics and has the potential to increase interpersonal conflicts [207]. While prior work reports on technical feasibility and outline qualitative aspects concerning collaboration support, little is known about how to design for social control experience in the living room. We, thus, see the need to investigate how the modes concerning social control experience as outlined in Section 5.3 can promote the collaborative selection of a movie in the living room. Therefore, in this chapter, we focus on answering the research question (RQ):

How does collaborative movie content selection among co-located users in the living room affect social control experience in terms of social connectedness, team performance, and co-experience?

We investigate three different types of social control modes (*Consensual, Hierarchical, Autocratic*; details see Section 11.2) to support co-located users in the living room with the selection of a movie using several remote controls to interact with a single TV. To evaluate their effect on co-experience, team performance, and social connectedness, we conducted a mixed-design lab experiment in groups of three (*N=30, 10 groups*).

The contribution is three-fold: First, we contribute to the exploration of implementing social control experience in the living room, particularly under the lens of shared TV control using several remote controls. Secondly, with the experimental assessment of the three collaborative movie-selection modes, we provide evidence-based insights on users' perceptions of co-experience, team performance, and social connectedness. Third, based on these insights, we discuss proposals to conquer social connectedness, team performance, and co-experience when designing interactive media systems for co-located users in the living room.

11.2 Social Control Experience: Designing for Collaborative Movie Selection

With the design of collaborative movie selection, we aim to support co-located users in the home to interact with one another and to stimulate social engagement. Our spotlight lies in investigating how the distribution of control among co-located users affects social connectedness, team performance, and co-experience. Since the average European household compromises 2.2 people [71], we focused on the exemplary use case of three users selecting a movie together in the living room. To investigate movie selection under a familiar setting, we focused on the shared interaction with a single TV screen using multiple remote controls.

Modes to Collaborative Movie Selection

To best support collaborative movie selection among three co-located users, we considered several key factors. First, we aimed to provide every user with a remote to lower the barrier to participating in the decision-making process and enable the continuous contribution of any user. Prior research indicates that enabling to vote for changes or providing different levels of control supports continuous contribution best while also promoting social engagement [23, 192]. Further, having a key user (for certain functions) can facilitate structured decision-making and avoid chaos [23, 168]. Thus, we considered the two modes of social control experience concerning *Consensual control*, providing equal control possibilities and *Hierarchical control* related to limited/different control possibilities to define two initial types

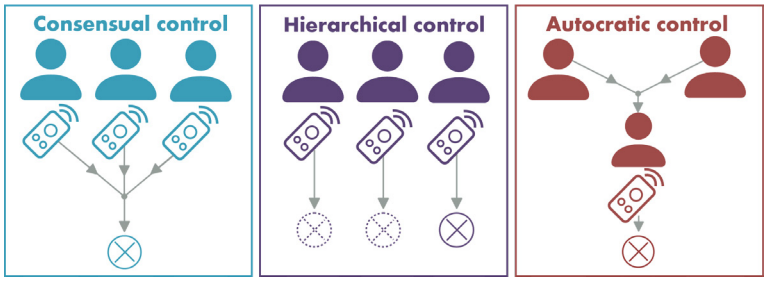


Figure 11.1: Adaptation of the visual representation of the modes from the taxonomy of social control experience design. It shows a group of three selecting a movie on a TV using (a) remote control(s). (Bootstrap Icons)

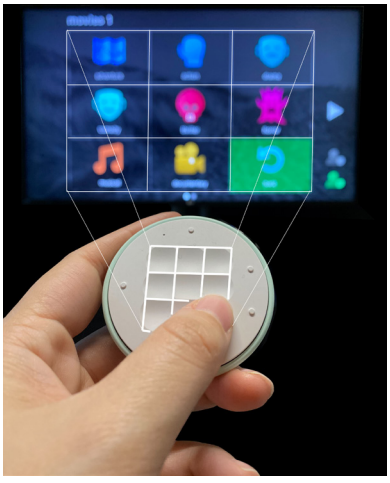
of collaborative movie selection. We combined them with the *Autocratic mode* which is the current standard of TV interaction where one user selects a movie on behalf of the group (baseline) for comparison reasons. These three modes of movie selection are visualized in Figure 11.1 and their implementation is described in detail below.

Choice of Interaction Concept & Interface Design

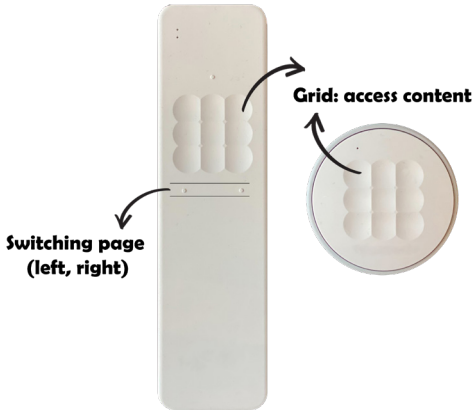
To enable controlling the TV by multiple remotes at once, we decided to explore this with absolute indirect touch-based (AIT) remote controls to ensure high usability [34] and workspace awareness [97]. These design choices are made independent of the modes with regard to social control experience described above.

Absolute Indirect Touch-Based Remote Controls

A TV gets controlled over a distance (indirect interaction), usually via a single remote that provides a navigation grid (up, down, left, right, ok) to browse/navigate through content. However, promoting users to interact with the TV using absolutely indirect touch (AIT) with haptic marks for landmark-based target selection (for the demonstration of AIT see Figure



(a) Illustration of the mapping between the 3x3 remote grid and the TV UI. The user touches the right lower grid element, which gets highlighted on the UI - represented in green.



(b) Key-user (left) and non-key-user remote (right). Both have the 3x3 AIT grid to access the content. The key-user remote, in addition, has two interactive dots below the grid to switch pages.

Figure 11.2: Demonstration of the remotes which enable an active, indirect touch interaction (AIT) with the TV user interface.

11.2a) improves eyes-free tapping and accuracy [53]. It also improves usability and UX [34], compared to standard, navigation-based remote controls [34]. Thus, we decided on AIT with a 3x3 landmark-based grid for the TV interaction (see Figure 11.2b). A grid position can be touched and the corresponding UI element gets highlighted to ensure workspace awareness [97]. Pressing a grid position executes the underlying function/enters a menu.

User Interface for AIT Interaction

To map the 3x3 AIT grid of the remote control with the TV user interface (UI), we designed an app-based TV UI with the same dimensions. We took existing TV UIs (*Apple TV, Android TV*) as inspiration to make the UI visually appealing and engaging. The UI provides access to TV channels, TV guides, an online movie library, games, an offline library, radio, favorites, the weather, and settings (see Figure 11.3). Since the focus lies on collaborative movie selection, we provided the users with access to the 13 most prominent genres [183] via the movie menu. Every genre had a variety of the 16 most prominent movies, derived from *IMDB*[1], demonstrated on two pages. Once one movie got selected, the UI played the trailer and provided options to watch the full movie in full-screen mode or to go back to the movie overview page (for the UI layers, see Figure 11.3).

Implementation of Social Control Experience

We demonstrate how we implemented the modes of social control experience using AIT-based remotes in combination with the dedicated TV UI. To provide every user with a remote and to ensure that individual TV interactions can be distinguished from one another, the backside of the remotes had different colors (white, gray, green). Additionally, we decided on two differently shaped AIT-based remotes (Figure 11.2b) – a rectangular key-user remote and two circular non-key-user remotes. The reasons, therefore, are high-level TV functions (e.g., volume, on/off, paging/scrolling) which will induce chaos and confusion if performed by several users while having only one screen. Thus, to support a structured decision-making process [23], the key-user remote permits switching pages while the non-key-user remotes do not. To make the group aware of who is currently selecting/focusing on what element [50, 97], user icons in the corresponding color of the remote are presented in the right lower corner of the UI. Additionally, all interactions are highlighted on the TV in the same color (Figure 11.4a).

The Consensual Movie Selection

The *Consensual* movie selection mode provides every user with a remote to vote for genres and movies. While all can vote, only the key-user-remote allows switching pages and selecting the initial menu on the main UI page (Figure 11.3). To establish workspace awareness in the UI, every button/element gets highlighted with the current number of votes „x/3“ including the colored user icon corresponding to the remote color (see Figure 11.4b). A vote is made

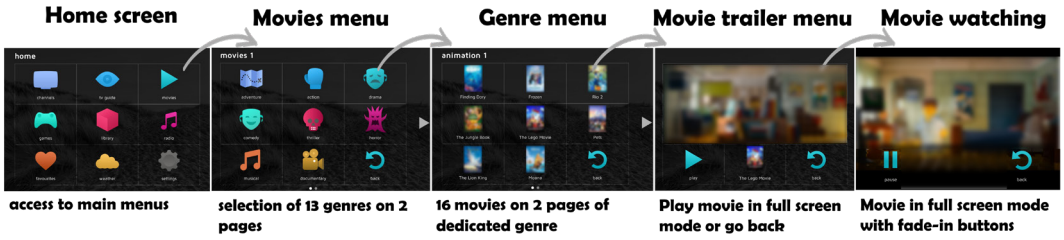


Figure 11.3: Representation of the different menus and underlying layers of the movie library user interface (icons partly by Icons8.com).

1 https://www.imdb.com/, last accessed 2023-05-22

or retracted by pressing a grid element of the remote. The UI allows voting for an indefinite amount of elements. Once everyone votes for the same element (3/3), the underlying function gets executed automatically, and the voting of this particular element resets.

The Hierarchical Movie Selection

The *Hierarchical* movie selection mode demonstrates two different control levels: The key user, owning the key-user remote that can execute all functions directly (incl. paging), and the non-key-users having the non-key-user remotes that can indicate suggestions for movies. While the key user can directly select any movie, independent of the suggestions provided, non-key-users are not able to start a movie. However, the suggestions enable users to express their interests more direct. Suggestions can be positioned/retracted by pressing a grid element on the remote. On the UI, the suggestions are visualized at the corresponding element by the user icon in the corresponding remote color (Figure 11.4b).

The Autocratic Movie Selection

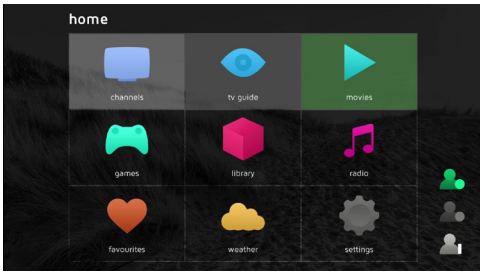
The *Autocratic* movie selection mode provides only one user – the key-user with the key-user remote. The other two users do not have a remote available. The user interface stays in the standard mode without additional adjustments.

11.3 Research Question & Hypotheses

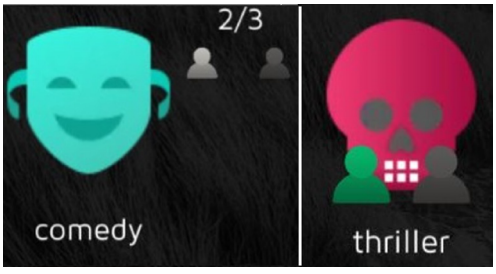
To investigate the impact of the modes on social control experience, we focused initially on answering the research question:

What type of collaborative approach to movie selection supports social connectedness, team performance, and co-experience best?

Since this is to our knowledge the first investigation of these modes supporting collaborative movie selection using multiple remotes, we focus on users' impressions and experiences by gathering qualitative insights. We are particularly interested in how users perceive the modes concerning the decision-making process of selecting a movie jointly. In addition, we want to investigate if there is a measurable effect on perceived social control experience. According to literature, enabling every user to interact with the system supports social connectedness and enhances the feeling of belongingness towards the group [23]. Thus, we speculate that both, the *Consensual* and the *Hierarchical mode* support social connectedness best.



(a) Color highlighting of the touched element. Every user touches a different element. The color corresponds to the color of the remotes' backside & user icon on the right lower corner (white, gray, green).



(b) Left: *Consensual control* - votes are displayed as text in combination with colored user icons. Right: *Hierarchical control* - colored user icon gets visible when suggestions are placed. (icons partly by Icons8. com)

Figure 11.4: The developed user interface that can be controlled by three remotes simultaneously.

H1 The perceived social connectedness in terms of belongingness, connectedness, affiliation, and companionship is higher for *Consensual* and *Hierarchical* movie selection compared to *Autocratic* movie selection (baseline).

Secondly, promoting interaction with media content for all users at once improves individuals' experience and enables exploring others' preferences and needs [23]. Thus, we speculate that the *Consensual* & *Hierarchical mode* generate a higher co-experience as well as team performance.

H2 The perceived co-experience in terms of UX and social experience is higher for *Consensual* and *Hierarchical* movie selection compared to *Autocratic* movie selection (baseline).

H3 The perceived team performance in terms of team cohesion is higher for *Consensual* and *Hierarchical* movie selection compared to *Autocratic* movie selection (baseline).

11.4 Comparative Study

We conducted a mixed-subject experiment in a living room lab with groups of three to answer our research question and investigate the hypothesis.

Experimental Set-Up

Independent variables: The modes (*Consensual, Hierarchical, Autocratic*) were the within-subject variable and the type of control (key-user, non-key-user) was the between-subject variable. The between-subject variable was mapped to the users' sitting position: the key-remote user had the middle position, and the non-key-users were sitting at the key-users left and right sides to ensure verbal communication.

Dependent variables/measurements: To gather qualitative feedback, we conducted semi-structured group interviews after each mode's round and at the end of the experiment. We particularly focused on how users experienced the decision-making process and what they liked/disliked (the interview questions are listed in Appendix B). We assessed each user's perceived social connectedness in terms of connectedness, companionship, and affiliation by using the Social Connectedness Scale [148] and belongingness by applying the Inclusion of Community in Self-Scale [164]. We measured the perceived team performance in terms of team cohesion using the Team Performance questionnaire [200]. To assess the evoked co-experience in terms of social experience and UX we used the questions related to social experience from the GAMEFULQUEST [111] and we applied the short user experience questionnaire (UEQ-short) to assess the overall UX as well as the hedonic and pragmatic qualities of the modes [234]. Besides, we measured the decision-making time (in seconds) and used subjective ranking to investigate users' preferences among the modes. After each mode round, we also asked about their interest in the movie they selected. To control possible influences due to the TV UI and remote controls, we examined the evoked usability by employing the System Usability Scale (SUS) [47] after the trial round. An overview of the questionnaires can be found in Appendix A.

Participants

We recruited participants by convenience sampling in groups of three. Since watching a movie jointly is a typical family/friendship activity, we explicitly recruited groups of friends to reduce bias that might come from collaborating with strangers [152]. Overall, we recruited *N=30* participants (10 groups), 12 males and 18 females, living in the Netherlands. Their age

Figure 11.5: Experimental set-up in the living room lab.

ranged from 22 to 42 (*M = 27.4 years, SD = 4.6 years*). All participants own a laptop and a smartphone while 20 out of 30 also own a TV. Besides, 20 out of 30 reported owning at least one subscription to an over-the-top media service (e.g., Netflix, Amazon Prime). When it comes to movie watching, 24 participants (*80%*) mentioned watching a movie at least several times a month, 2 (*6.7%*) do so only once a month, and 4 (*13.3%*) less than once a month. Additionally, 18 out of 30 watch movies together with others at least 5 out of 10 times. None of the participants had prior experience using AIT-based remotes.

Technical Set-Up

We implemented the TV UI as an Android TV app (Figure 11.8) in Full HD (1920 × 1080) using *Unity 3D*. The remote controls have been produced by the industry partner, *ruwido austria GmbH*. To enable the control of the TV UI simultaneously by three remotes, we used the *NVidia SHIELD TV*-Streaming Mediaplayer as a gateway to handle the Bluetooth input signals of all remotes. To generate a convenient TV-watching experience, we set up a living room in an empty lab with a couch, a small living room table, and a 49-inch smart TV (Figure 11.5).

Procedure

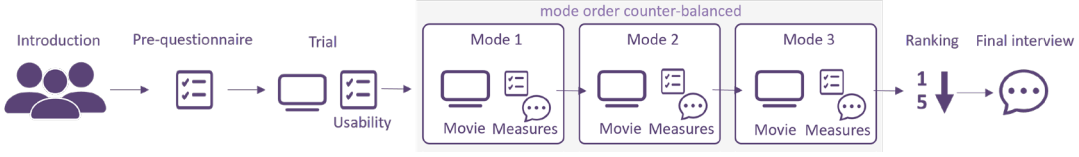


Figure 11.6: Visual representation of the study procedure (Bootstrap Icons).

After the introduction and receiving informed consent (Figure 11.6), we asked the participants to select a sitting position according to their convenience and let them fill out a demographic survey. To evaluate the effects of the modes on social control experience, we aimed for a controlled social situation in our living room lab. Since we were interested in how the modes evoke social engagement, we did not introduce the purpose of them. We only presented a social scenario of having a movie night together with the goal of collaboratively selecting a

movie everyone feels comfortable watching. We clarified that discussions are allowed and that as many movie trailers as desired can be watched before making a final decision. Overall, the group had a maximum of 15 minutes per mode to decide on a movie. To avoid bias of the time constraints on the decision-making process, we did not share the time limit with participants. The experimenter reminded the group to find a movie in the next 5 minutes in case 10 minutes passed already. The groups had to select a different movie per mode to ensure ongoing decision-making. The experiment started with a trial round to familiarize each participant individually with the remotes and the TV UI (Table 11.1). After the trial task, we assessed the usability of the setup by means of the SUS questionnaire [47]. This was followed by a fully counterbalanced set of the three modes. For each mode, the group had to decide on a movie together (see Table 11.1). Exchanging or handing over remotes to others was forbidden. At the end of each mode condition, the participants filled out questionnaires related to social connectedness, team performance, and co-experience. In addition, the experimenter asked about their collaborative experiences and positive/negative impressions after each mode. The experiment concluded with a subjective ranking of the modes and a semi-structured group interview about decision-making experiences and what they liked/disliked. The study was approved by the ethics committee of the researcher's institution and lasted, on average, one hour. Participants were not compensated for their participation.

	Trial tasks	Mode test round scenario
Task key-remote user	Please start the movie „Finding Nemo" from your favorites list in full-screen mode. And then go back to the home screen.	Make yourself comfortable. Try to feel at home and imagine it is Friday and you are having a cozy evening together. You want to chill, relax and therefore you want to watch a movie together. Your goal is to watch a movie everyone will enjoy watching. Therefore, you collaborate with the selection of the movie.
Task circular remote user (green)	Please start the movie „King Kong" from your favorites list in full-screen mode. And then go back to home screen.	
Task circular remote user (gray)	Please start the Movie „Wonder Woman" from your favorites list in full-screen mode. And then go back to home screen.	

Table 11.1: Experimental tasks of the trial round and the scenario description of the mode test rounds.

11.5 Results & Findings

Data Analysis

We report on the modes' effect on social connectedness belongingness, affiliation, connectedness, companionship, team performance (team cohesion), and co-experience (social experience, UX). Due to technical problems, we had to omit the responses of one group resulting in a total of 27 data sets per mode. With the qualitative data, we conduct a thematic analysis based on inductive, free coding [128]. The quantitative data from the Inclusion of Community in Self Scale [164], the Social Connectedness Scale [148], team performance questionnaire [200], and social experience data [111] use Likert scales. Due to the ordinal data, we applied non-parametric Friedman tests to assess mode differences with Bonferroni-corrected Wilcoxon signed-rank tests for post-hoc comparisons to reduce Type I errors. To investigate differences in time efficiency (normally distributed data assessed by Kolmogorov-Smirnov tests), we conducted a one-way repeated-measures ANOVA.

Social Connectedness - H1

Belongingness

A Friedman test outlines no significant effect of the modes on users' perceived belongingness ($\chi^2(2) = 0.026$, $p = .987$, Figure 11.7). The median belongingness score is highest for *Consensual*

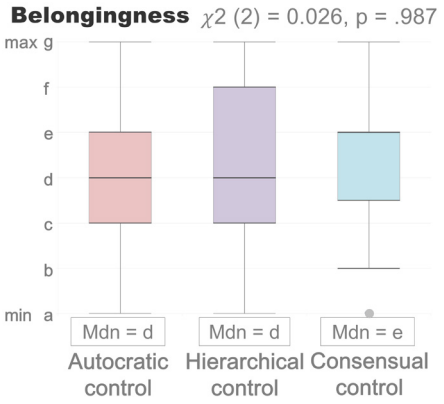


Figure 11.7: Distribution of the measured belongingness of each mode [164]. The scale ranges from a = min/low belongingness to g = max/high belongingness. Friedman tests for pairwise comparison significant at $p < .05$.

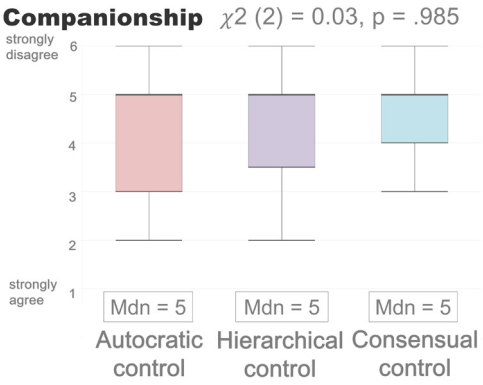


Figure 11.8: Distribution of the measured companionship of each mode [148]. The scale ranges from 1 = low companionship to 6 = high companionship. Friedman tests for pairwise comparison significant at $p < .05$.

Q: Even around people I know, I don't feel that I really belong.

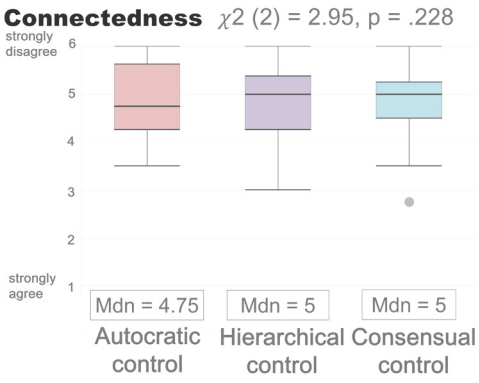


Figure 11.9: Distribution of the average measured connectedness of each mode [148]. The scale ranges from 1 = low connectedness to 6 = high connectedness. Friedman tests for pairwise comparison significant at $p < .05$. *Q1: I feel so distant from the other people; Q2: I feel disconnected from the world around me; Q3: I don't feel related to anyone; Q4: I catch myself losing all sense of connectedness.*

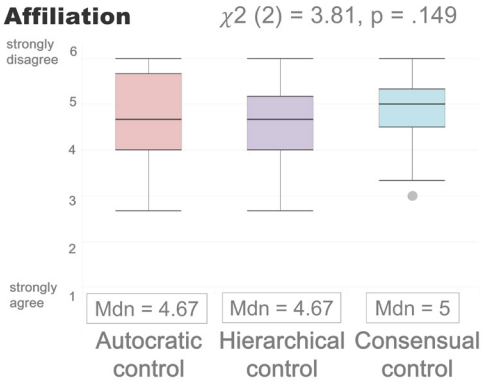


Figure 11.10: Distribution of the average measured affiliation of each mode [148]. The scale ranges from 1 = low affiliation to 6 = high affiliation. Friedman tests for pairwise comparison significant at $p < .05$. *Q1: I don't feel I participate with anyone or any group; Q2: I have no sense of togetherness with my peers.; Q3: Even among my peers, there is no sense of brother/sisterhood.*

control (*Mdn=e*) followed by *Hierarchical* & *Autocratic control* (*Mdn=d*) which indicates that all modes let users belong to one another positively (original scale ranges from a=no belongingness to g=max belongingness).

Companionship

The companionship is not significantly different among the modes, as outlined by a Friedman test ($\chi^2(2) = 0.03$, $p = .985$, Figure 11.8). The median companionship lies above average (*Mdn=5*) for *Consensual*, *Hierarchical* as well as *Autocratic control*.

Connectedness

According to a Friedman test (Figure 11.9), the modes do not evoke a significantly different perception of connectedness ($\chi^2(2) = 2.95, p = .228$). The media perceived connectedness lies above average for all three modes, *Consensual control* (*Mdn=5*), *Autocratic control* (*Mdn=4.75*), and *Hierarchical control* (*Mdn=5*).

Affiliation

A Friedman test shows no significant effect on affiliation ($\chi^2(2) = 3.81, p = .149$; Figure 11.10). Median scores show an above average evoked affiliation for all modes, *Consensual control* (*Mdn=5*), *Autocratic control* (*Mdn=4.67*), *Hierarchical control* (*Mdn=4.67*).

Taken together, all modes evoke a high social connectedness, indicated by an above-average belongingness, companionship, affiliation, and connectedness rating. Since they did not evoke significant differences in any of the social connectedness factors, we reject *H1.*

Co-Experience - H2

Social Experience

The evoked social experience is highest for *Consensual control* (*Mdn=2.5*), followed by *Autocratic control* (*Mdn=2.88*), and *Hierarchical control* (*Mdn=3*) (Figure 11.12). However, there is no significant difference between the modes as outlined by a Friedman test ($\chi^2(2) = 2.3, p = .317$).

User Experience

The overall UX (Figure 11.11) is highest for *Consensual* (good), followed by *Hierarchical* (above average) and *Autocratic control* (below average). Our results indicate that all modes are equally practical, simple, and pleasant - indicated by an above-average score of pragmatic quality. Concerning hedonic quality (satisfactory, creative, original), *Consensual control* scored best (excellent), followed by *Hierarchical control* (good), and *Autocratic control* (bad). A Friedman test shows a significant effect of the three modes on perceived hedonic quality ($\chi^2(2) = 16.42, p < .001$). Post-hoc comparisons show a significantly lower hedonic quality for *Autocratic* compared to *Consensual control* ($Z = -3.81, p < .001$) and *Hierarchical control* ($Z = -2.93, p = .01$). An effect of the modes on pragmatic quality ($\chi^2(2) = 0.74, p = .964$) and overall UX ($\chi^2(2) = 5.15, p = .076$) was not observed.

Summed up, the *Hierarchical* & *Consensual mode* evoke a significantly higher hedonic quality which indicates high originality, creativity, and satisfaction. However, the pragmatic quality and overall UX did not result in differences among the modes. Further, all modes evoke an equally high social experience. Taken together, we could not observe differences among the modes in evoked UX and social experience which leads us to reject *H2*.

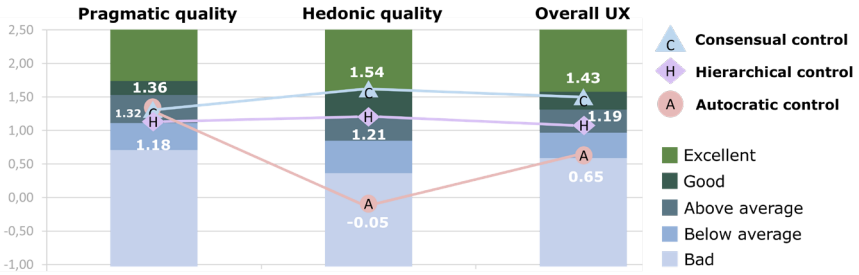


Figure 11.11: The mean values of the measured pragmatic (left) & hedonic quality (middle), as well as the overall UX (right) score per mode *The colors of the bars represent the UX scale, ranging from excellent (light green) to bad (light blue). The scale in general ranges from -3 (horribly bad UX) to +3 (extremely good UX), while values above 0.8 represent a positive evaluation [234].*

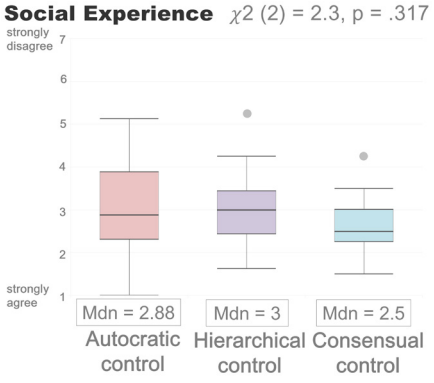


Figure 11.12: Distribution of the measured social experience [111] - average score of eight questions. The scale ranges from 1 = high social experience to 7 = low social experience. Pairwise comparison, Friedman tests are significant at p < .05.

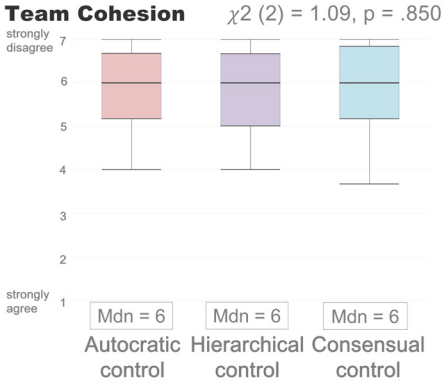


Figure 11.13: Distribution of the average measured Team Cohesion [200] per mode. The scale ranges from 1 = low team cohesion to 7 = high team cohesion. Pairwise comparison, Friedman tests are significant at p < .05.

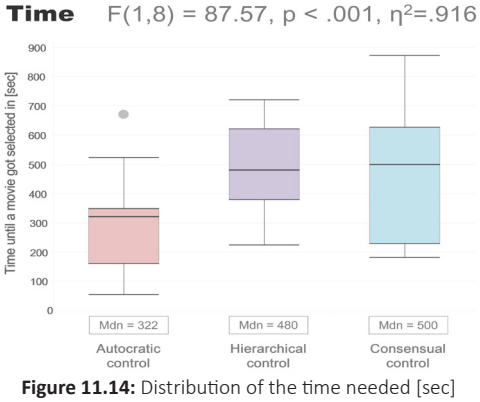


Figure 11.14: Distribution of the time needed [sec] until a group-based decision over a movie was made for each mode. Pairwise comparison, Friedman tests are significant at p < .05.

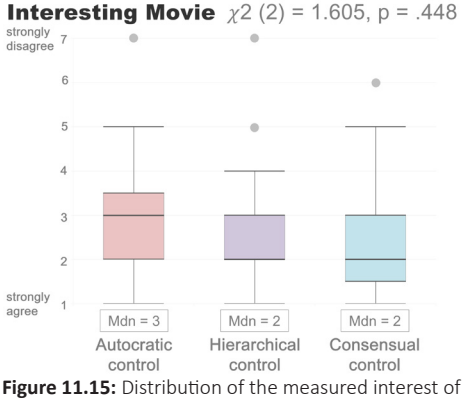


Figure 11.15: Distribution of the measured interest of the selected movie per mode. Pairwise comparison, Friedman tests are significant at p < .05. *Q: The movie we selected together is interesting to me.*

Team Performance - H3

Our insights do not show a significant effect on perceived team performance in terms of team cohesion ($\chi^2(2) = 1.09, p = .850$). Nonetheless, all three modes evoke a high team cohesion with a median score of *Mdn=6* (Figure 11.13). All modes are promoting high perceived team performance with no observed differences. Thus, we also reject *H3.*

Influences on Collaboration

Time Efficiency (Movie Selection Time)

All groups could make a decision within the time limit of 15 min. An ANOVA revealed (sphericity not violated. Mauchly's test - $\chi^2(2) = 3.35, p = .187$) that there is a significant effect of the modes on movie selection time ($F(1,8) = 87.57, p < .001, \eta^2 = .916$), while Bonferroni-corrected post-hoc tests did not show significant differences (see Figure 11.14).

Movie of Interest

The modes equally allowed participants to select a movie of interest ($\chi^2(2) = 1.605, p = .448$), indicated by a median score of *Mdn=2* for *Consensual* & *Hierarchical control* and *Mdn=3* for *Autocratic control* (most interesting=1; least interesting=7; see Figure 11.15).

Usability

The usability score, as assessed after the trial task, resulting in an average score of *M=68.5*, which indicates OK usability [47] of the overall TV system (UI in combination with the remote controls).

Qualitative Insights

Subjective Ranking

A Friedman test outlines a statistically significant order of preference for the modes ($\chi^2(2) = 8.3, p = .016$). Post-hoc comparisons show significantly higher preferences for *Consensual* compared to *Hierarchical control* ($Z = 2.722, p = .019$). There is also a significantly higher preference for *Consensual* compared to *Autocratic control* ($Z = 2.177, p = .029$). Figure 11.16 outlines the ranking per mode with a median score of *Mdn=1* for *Consensual*, and a media score of *Mdn=2* for both *Hierarchical* & *Autocratic control*.

Qualitative Feedback from Interviews

We conducted a thematic analysis with the responses to the open-ended questions concerning each mode individually and the final interview. Sentences were iteratively assigned to themes, and themes were clustered in overarching groups. The overview of the final themes of the thematic analysis and how they relate to one another, particularly to the three modes, can be found in Figure 11.17.

The Autocratic movie selection provides the traditional, most familiar way of decision-making. Users perceive it as efficient and particularly suitable for smaller groups. However, it can happen that the key-user performs actions without prior group discussion or actions that are not in line with the discussion, which is perceived as exclusion (e.g., "*[Key user] was just doing whatever he wanted*", P#4.2; "*It was not clear to me if the [Key user] just want to check it or if it was of interest*", P#3.1). It introduces unique social dynamics, particularly power roles and dependency - primarily due to one remote only, which prevents interventions and impact on the final decision by others. Besides, those users not in charge over the remote mentioned

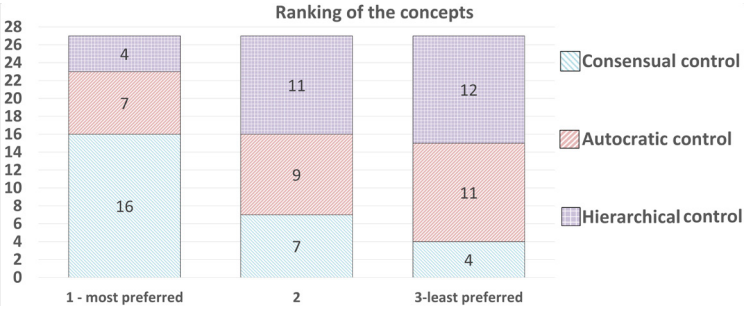


Figure 11.16: The subjective ranking of the modes toward social control experience.

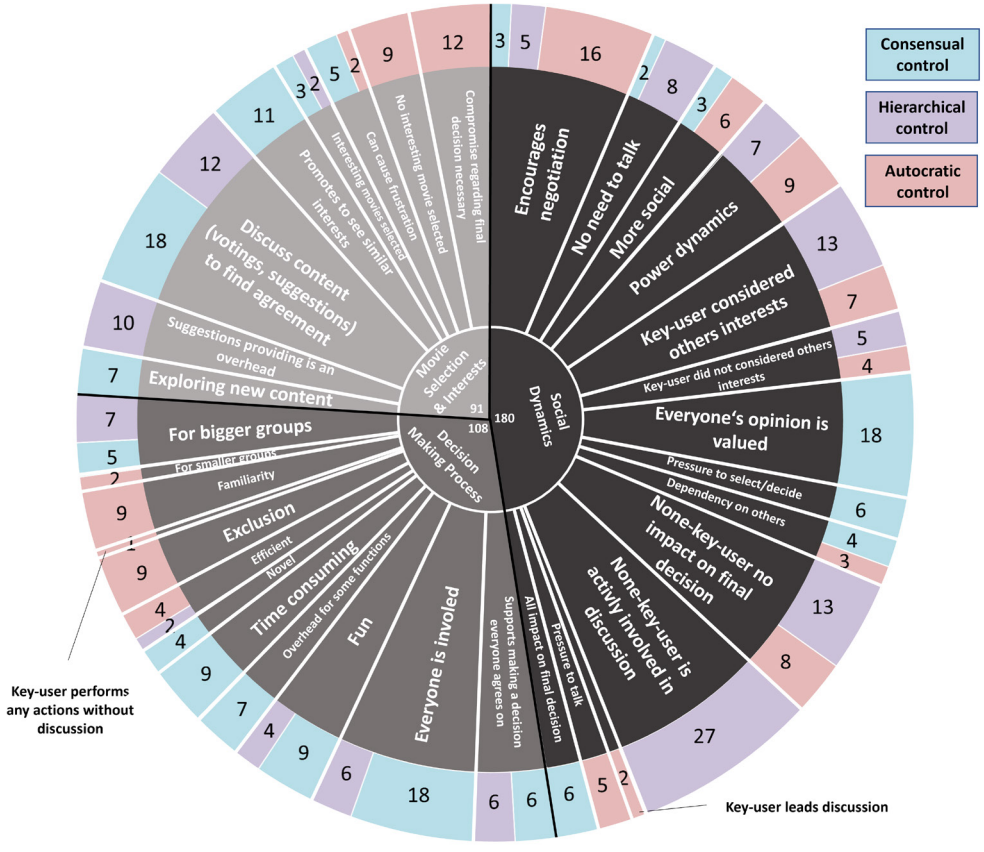


Figure 11.17: Representation of the qualitative analysis. The inner circle shows the overarching groups. The middle circle presents the sub-groups of the overarching groups while the outer circle shows to which mode(s) the sub-groups are connected. The numbers refer to the total amount of mentions.

that the autocratic way of selecting a movie encourages them to talk with one another in order to express their wishes and interests, which feels very social. However, particularly for introverts, it provides pressure to talk (e.g., "*It gives me more pressure because you got to talk with each other*", P#9.2). Nevertheless, a few participants report that the key user takes on the lead of discussions and tries as best as possible to consider others' interests (e.g., "*[Key user] was more attentive to us*", P#9.3). However, in some groups, the key-user did not consider others' interests at all (e.g., "*It did not feel [the Key user] was selecting the movie for and with us*", P#4.3). Concerning the movie selection and interests, mainly those not in control reported that they had to make a compromise regarding the movie choice (e.g., "*Someone will give up their interests*", P#10.3). This, according to user feedback, guides to a final movie selection that is most likely not in line with everyone's interest which can cause frustration (e.g., "*We felt OK watching it but no one had a strong feeling for that movie*", P#3.2; "*It's a movie I least preferred to watch*", P#10.3).

The Hierarchical movie selection is a fun (e.g., "*That is fun for me*", P#9.3) and efficient way to make decisions together. Besides, users point out the fact that everyone is involved and can express themselves, which is perceived as active participation in the discussions (e.g., "*I am allowed to have some opinions*", P#2.1). Participants highlight that providing suggestions helps in making decisions together, and supports the discussion around the final selection (e.g., "*It helps because you can see what other people do and want to see*", P#8.2) with a higher chance of selecting a movie that everyone is interested in. Particularly for the key-user, it is easy to check others' interests (e.g., "*I saw everyone's opinions*", P#9.1). However, a few participants mentioned that the key-user nevertheless prioritized their own interests or ignored the suggestions provided (e.g., "*It is more like [the key user] makes the choice*", P#6.2). Thus, some perceived the process of providing suggestions as an overhead to verbal communication and also stopped providing suggestions (e.g., "*I forgot about the remote because I could just talk and look*", P#1.2). Others outline that they rather do not want a remote, especially when the remote does not have a direct impact on the final decision (since it's only a suggestion) (e.g., "*They are useless to me since I don't have direct control*", P#1.3). However, others like the possibility to position movie suggestions because they can express themselves without the need to actively talk/interrupt ongoing conversations or make a final decision (e.g., "*I can show my opinion but I don't need to make the final decision*", P#9.2; "*I can give my opinion even if I don't have the courage to talk*", P#4.3). The *Hierarchical mode* is seen particularly suitable for bigger groups where not everyone can be involved in verbal discussions.

The Consensual movie selection is a fun and novel way to decide on a movie together, even though it is more time-consuming until a decision is made. Due to consensual voting, users describe it as a fair decision-making process where everyone is involved, their opinion is valued equally and votes have an equal impact on the final decision (e.g., "*My opinions are actually being taken into consideration*", P#2.3; "*Everyone's opinion is equally important*", P#10.3). Besides, participants outline that the *Consensual mode* supports outlining similar interests and particularly promotes the discussion of diverse interests (e.g., "*We talk a lot more about the movies*", P#8.2; "*It is nice to see who selected what*", P#2.1). The voting also enables users to explore new content together which in turn provides a higher chance to select a movie that everyone enjoys watching (e.g., "*All three having to choose so we choose on a movie we really want to watch*", P#8.2). Even though it was not experienced during the study, participants fear that too diverse interests can lead to frustration while too dominant personalities involved can impose pressure to vote for particular movies in order to proceed (e.g., "*If people are divided then it is difficult*", P#2.1; "*It will somehow force me if there is an option and the others already select it*", P#2.2). Both aspects thus can introduce a dependency on other users.

11.6 Discussion

In this chapter, we present how to design for social control experience when selecting a movie together in a living room. Therefore, we provided each user with a remote control in order to enable shared control of the TV. We evaluated the multi-remote modes of *Hierarchical control* and *Consensual control* in a controlled lab experiment against the baseline of the traditional *Autocratic* single-remote concept. Results show high social connectedness, team performance, and co-experience for all modes. Qualitative insights outline that users prefer owning a dedicated remote because it promotes participation and thus creates a novel collaborative decision-making experience. In this section, we discuss the implications of our design decisions and results toward promoting social control experience among co-located users in the living room.

Implications of Collaborative Movie Selection on Social Connectedness, Team Performance & Co-Experience

Despite being unable to validate our initial speculations, our findings indicate that various forms of collaborative movie selection promote social engagement, well-being [217], and a sense of belonging among users [148]. Previous research has outlined the importance of social connectedness and co-experience in group decision-making processes [23, 152, 192]. In our study, we found that all modes of collaborative movie selection evoked a high level of social connectedness and co-experience, which ultimately supports well-being [217], satisfaction, and establishes a social bond among group members [148, 261]. Moreover, all modes supported the establishment of a shared goal [200], reflected by the high team cohesion.

In particular, our study found that *Autocratic control* had a high level of social connectedness and co-experience, which can be attributed to the familiarity [264] of the mode and the amount of required verbal communication [23, 75]. Despite the *Autocratic control* supporting a more efficient selection process [168], qualitative insights outline that it may not always result in a satisfying decision for all group members. Furthermore, it induces power dynamics and is also the user's least preferred choice. Promoting consensual decision-making or enabling users to provide movie recommendations under the hierarchical approach were found to promote the exploration of movie offerings because they provided the opportunity for group members to see the interests of others. This particularly stimulated richer, goal-related discussions. Additionally, both modes support involvement, are perceived as fair, and thus provide a higher chance of picking a movie that everyone enjoys watching. The downside of *Consensual control*, however, relates to the fear of causing frustration [207] due to diverse interests that can hinder final decision-making. Yet, our research highlights that promoting direct involvement of every group member supports user experience and is a preferred solution when it comes to movie selection in the home.

Therefore, it is crucial for the design of future collaborative, interactive media systems to consider how users can feel included in the decision-making process, even if their input may not always directly influence the final decision. For example, providing opportunities for users to recommend movies or express their preferences can make them feel heard and valued, which can in turn enhance their overall experience. Additionally, providing clear guidance on how the collaborative decision-making process works and what role each user plays can promote a sense of fairness and inclusion among group members. Hence, the choice of the interaction mechanism and the design of the user interface [50], particularly the level of workspace awareness [97] have a crucial impact on the collaborative experience and outcome of the decision-making process. In conclusion, our study highlights the importance of understanding the role of user participation and authorization in the design of collaborative media systems. While the specific approaches to control may vary, it is crucial

to consider how users can feel included – beyond initiating conversations – and valued in the decision-making process to ultimately enhance social control experience.

In our study, we introduced the concept of active-indirect-touch (AIT) TV interaction (details in Section 11.2) as an approach to enable joint movie selection. Our results showed that it is possible to apply this interaction concept to establish high social connectedness and co-experience in collaborative settings. Furthermore, users experienced the modes for the first time and also for a limited period of time. Thus, there is the possibility of novelty effect inducing e.g., high(er) UX ratings [3, 229]. Hence, a longitudinal study is needed to research long-term effects on social control experience. Since our study was limited to Mid-European friends collaborating, it would be interesting to study diverse, social group settings, such as different types of relationships and different cultural backgrounds. Also, the personality of individuals may influence social control experience [224]. Therefore, future research is needed to understand how different personality types affect social connectedness, team performance, and co-experience when selecting a movie together. Prevailing, our study provides valuable insights into the design of collaborative, interactive media systems. Nonetheless, further research needs to be conducted to understand long-term effects on social control experience.

11.7 Conclusion

In this chapter, we explored opportunities to design for a higher level of social control experience among co-located users when selecting a movie together on the TV. We, therefore, designed three collaborative approaches to movie selection (*Autocratic, Hierarchical, Consensual*) based on the distribution of control among users by providing several remote controls. Through an experimental assessment of these modes in a living room lab environment, we found that the type of collaborative mode has no objective influence on perceived social connectedness, team performance, and co-experience. However, qualitative results show that users prefer owning a dedicated remote and being able to interact actively with the TV. The main reasons, therefore, refer to the support of inclusion and having the opportunity to contribute towards the final movie selection. Further, users perceive particularly *Consensual* movie selection as the possibility to find a movie everyone really enjoys watching. With this work, we contribute design opportunities on how to distribute control over a TV among co-located people, how they impact collaboration and individuals' experience, and discuss aspects to support collaborative movie selection in future homes.


Horror
Comedy
Action
Drama
OK
OK
OK

CHAPTER 12

Investigation on Genre Selection

This chapter is based on the following publication:

Melanie Berger*, Rutger Verstegen*, Harm van Essen, and Regina Bernhaupt. 2023. Introducing Sharemote: A Tangible Interface for Collaborative TV Control. In *Petrie H. et al. (eds) Human-Computer Interaction – INTERACT 2023. INTERACT 2023. Lecture Notes in Computer Science.* Springer, Cham. (accepted, in press)

* both authors contributed equally

Abstract

The TV is among the most favored devices to consume media together with others in shared living spaces. Yet, the interaction with a TV is still limited to one user. This likely causes frustration or leads to long decision-making processes which in turn can reduce belongingness and affiliation with one another and impact the overall TV-watching experience negatively. To overcome this, we investigate opportunities in designing tangible interfaces to support collaborative movie selection among co-located users. Therefore, we present Sharemote – a concept that provides physical genre-based tokens to explore group interests and to narrow down possible movies to select. We evaluated the effect of Sharemote on social control experience in terms of perceived social connectedness, co-experience, and team performance through a controlled mixed-subject lab experiment in groups of three (N=30). Results show that providing genre-based tokens combined with Consensual movie selection significantly promotes the overall user experience of jointly selecting a movie and is the users' preferred choice. Although Sharemote doesn't lead to a measurable increase in social connectedness compared to the current standard in homes using a single remote, it supports the investigation of shared interests and thus helps to select a movie everyone enjoys watching. With this work, we contribute toward the design of a novel entertainment experience and discuss the value of tangibles to promote social control experience when selecting a movie together.

Figure 12.1: We introduce Sharemote: a tangible interface to support co-located users in selecting a movie everyone feels satisfied watching.

12.1 Introduction

The living room is a recreational area and the central place for social activities at home [37]. Statistics show that two-thirds of prime-time television is watched together [147]. Prevailing, watching movies jointly generates a shared experience that can enhance social engagement [168]. While the act of watching TV with others is considered a social activity, the selection of content, particularly the control of the TV, is often limited to one person at a time [22]. This can lead to conflicts and power struggles over movie selection [168], resulting in a choice that not everyone is satisfied with. Furthermore, limiting individuals from participating in the decision-making process can also cause conflicts and frustration [66], potentially harming the social bond among users [223]. To overcome this, we see the need to investigate how the modes of social control experience can promote collaborative movie selection while enriching social engagement.

Therefore, in this chapter, we study collaborative movie selection strategies through tangible interfaces – "*physical objects to represent and manipulate digital data*" [239] since tangible interfaces have the potential to encourage discussion and foster collaboration in a subtle way [239]. More precisely, we study how tangible interfaces can enhance the TV-watching experience and enrich social control experience among co-located users. To research

this, we focus on movie genres as a tool for decision-making. Genres act as a classification system of movies [44] and are commonly used by online streaming services such as Netflix and Amazon Prime (e.g., [59, 210]) to guide users through offerings [44]. Additionally, genres support finding a movie that fits certain moods or situations [44, 119]. By utilizing genres as an initial decision-making process, we aim to guide a group toward a movie selection that everyone will likely enjoy more while also promoting high levels of user experience and social engagement. In this chapter, we focus on answering the following research question (RQ):

How can tangible interfaces related to genres support a group of users to collaboratively select a movie in the living room?

To this end, we explore how physical, genre-based tokens help co-located users in selecting a movie together. Therefore, we designed the research artifact Sharemote. It incorporates tangibility while facilitating collaborative movie selection based on either *Consensual* or *Autocratic* movie selection (final design in Section 12.3). For the initial exploration of Sharemote with regard to movie decision-making support and the enrichment of social control experience, we conducted a controlled mixed-design lab experiment in groups of three (*N=30, 10 groups*).

Contribution statement: With this work, we contribute to the design of collaborative TV interfaces and provide empirical insights into how physicalized genres, in combination with the modes of shared control promote social control experience in terms of social connectedness, team performance, and co-experience.

12.2 Background & Related Work

Watching movies together in the living room is among the most prominent social activities in the home [129]. However, not all devices or systems in the home support collaborative interactions and decision-making [78]. In the following, we provide an overview of the qualities of tangible interfaces to support collaboration among co-located users.

Designing & Qualities of Tangible Interfaces

Tangible interfaces are specified as "*physical objects to represent or manipulate digital data*" [239], in other words, it is the design of "*physical metaphors which bridge physical and digital worlds*" [121]. Therefore, the meaning of the tangible artifact and its use needs to be easily understood by users [108] to ensure high usability and user experience [239]. Additionally, a tangible artifact should consider desired qualities such as being ergonomically pleasant to use, accessible, and practical [239]. The advantage of tangible interfaces in collaborative settings lies in the possibility of observing ongoing interactions from the outside, supporting group awareness and coordination of tasks [114]. Moreover, tangible objects can be handed over more transparently to start discussions or engage deeply with one another [73, 74]. Similarly, tangibles have the potential to provoke shared activities which in turn can impact and promote social engagement among users, particularly belongingness and affiliation with one another [11].

Thus, we see the potential to explore social control experience through tangible interfaces to enable collaborative movie selection, consequently enhancing social connectedness, team performance, and co-experience of co-located users in the living room.

12.3 Social Control Experience: Designing for Collaborative Genre Selection

With a design for collaborative movie selection supported by tangibles, we intend to enhance the decision-making process among co-located users toward social control experience. More precisely, we want to assist users in the selection of a movie everyone is satisfied with

while promoting perceived co-experience, team performance, and social connectedness. To explore this, we focused on the use case of a group of three watching a movie together on TV in a living room. In the following, we present first the design decisions we made and then how they led to Sharemote: a concept that enables collaborative movie selection supported by tangible genre tokens.

Design Decisions Considered

To promote collaborative movie selection through tangibles, we focused on movie genres because they represent thematic movie categories and guide users through the available content [44]. To support a group of three in collaboratively selecting a movie, we split up the design for the decision-making process into two phases: First, the decision on genre(s), and second the selection of a movie from the specific genre(s).

Genre Selection - Tangible Tokens

To support the first decision-making phase of selecting genre(s), we designed physical tokens (Figure 12.1) that represent the genres. The tokens come in a size of 75mm X 12mm X 12mm (l x w x h), to take into account easy and ergonomic handling as well as visibility to other users even when held in hands [112]. The color of the tokens represents a dedicated genre. In our initial investigation, we concentrated on the five most prominent genres from 2022 [183], which are *Horror = red, Comedy = light blue, Action = yellow, Drama = blue, Adventure = cyan*. The colored genre tokens can then be grabbed and attached to a dedicated remote (on one of four sides, see Figure 12.3) in order to decide/vote on a specific genre(s). The remote, with its four sides, allows to select and attach up to four genre tokens (same genres or different genres), making use of its embodied constraints [114] to enable all users to attach an equal amount of tokens to their remote. Supporting movie selection through tangible tokens has the advantage that groups' interests and choices made are continuously visible via the selected tokens attached to a remote, which promotes workspace awareness [97]. Additionally, the attached genres can also be visualized, e.g., digitally on the TV.

Movie Selection - Modes of Social Control Experience

After the selection of genre(s), the group needs to interact with the TV to actively select

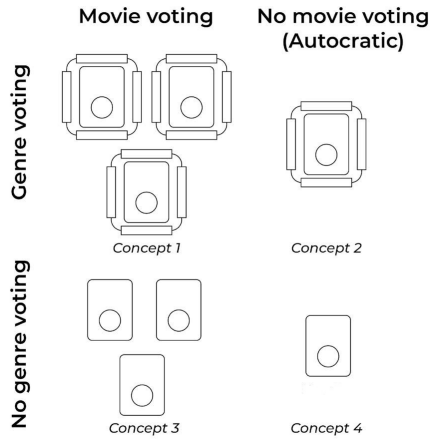


Figure 12.2: Overview of the variations of Sharemote to support collaborative movie selection among three co-located users.

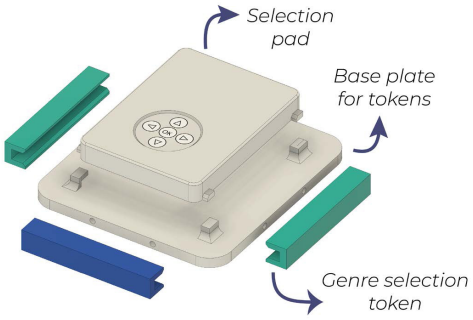


Figure 12.3: Sharemote: the navigation-based remote where tokens can be attached to each side.

a final movie. For the interaction with the TV (movie selection only), we decided on a standard smart TV remote that provides a navigation pad (up, down, left, right, ok). For the collaborative selection of the movie, prior work highlights that users strive for active participation [23]. Providing every user with equal control without having the possibility to overrule others promotes fairness and social connectedness [23]. However, having a key-user is the most established way of selecting a movie in current living rooms [23, 168], and thus users are most familiar with it. Further, research shows that such an autocratic approach enforces communication which in turn enhances social engagement [23, 168]. Thus, we applied the *Consensual mode* to promote the movie selection by providing everyone with a remote. Additionally, we consider the traditional, *Autocratic mode*, where only one user has a remote as the baseline mode.

Variations of Sharemote

With the idea of Sharemote we enable co-located users to collaboratively select a movie supported by tangible genre tokens. Sharemote presents a two-piece modular concept (Figure 12.3) that includes (1) tangible genre tokes, which can be attached to (2) a navigation-based remote control. Therefore, the decision-making process is split up into two parts – first the decision on genre, and second, the decision on a movie. For the decision on the genre(s), a maximum of four tokens out of five genres (Horror, Comedy, Action, Drama, Adventure) can be attached to the remote and confirmed by pressing ok (for the process of Sharemote see Figure 12.5). To enable collaborative movie selection on the offerings that result from the (group) genre selection (more details on this in Section 12.3), we combined the collaborative modes of consensual and autocratic (baseline) decision-making with the tangible genre-tokes. This resulted in a set of four different variations of Sharemote (Figure 12.2 and 12.4), which we describe in detail below.

(1) The Genre-Consensual variation combines the genre selection process with the *Consensual mode* of selecting the movie afterward (see also Section 5.3). Therefore, every user has their own Sharemote and can first select up to four genres by attaching the physical genre tokens to the individual base plate. During the movie selection, users can then vote for a movie using their own remote control. To support workspace awareness [97], every user/every remote has a dedicated colored cursor dot presented on the TV UI (see Figure 12.6a). However, the decision of what movie to watch can only be made jointly [159, 180]. Thus, a movie can only be picked when every group member agrees and actively selects the movie to be watched. This means users can posit as many votes as they want. The movie that all voted on (3 out of 3 users) starts automatically.

(2) The Genre-Autocratic variation combines tthe genre selection process with the *Autocratic mode* of selecting a movie. In this variation, only one Sharemote is available for the group. The group can nevertheless jointly decide on up to four genre tokens. The active control of the TV to select a movie afterward, however, can only be performed by one single key-user [180].

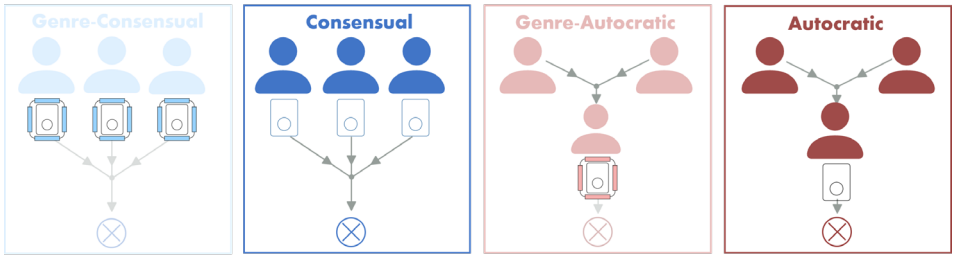


Figure 12.4: Adaptation of the visual representation of the modes from the taxonomy of social control experience design. It demonstrates the modes without and with the combined tangible genre selection. (Bootstrap Icons)

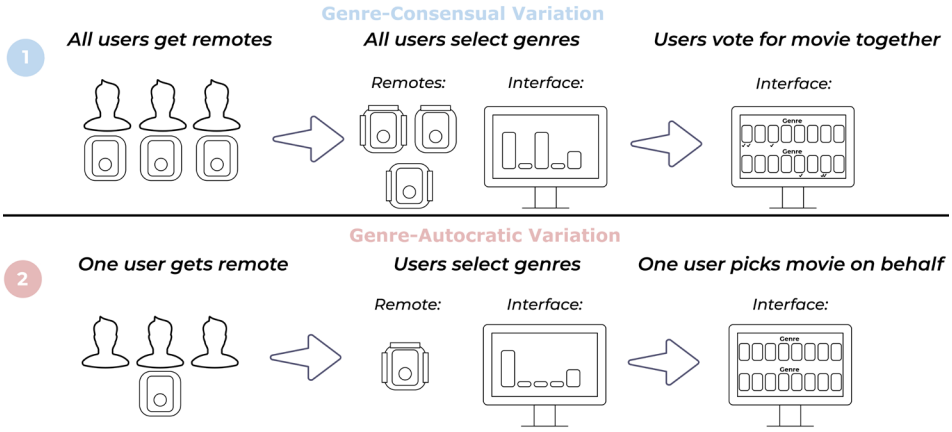
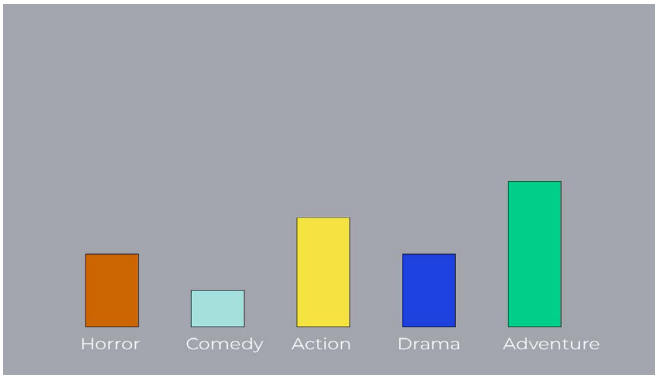


Figure 12.5: Visual representation of Sharemotes' process of picking a movie together. Top: the process of the *Genre-Consensual* variation. Bottom: the process of the *Genre-Autocratic* variation.

(a) Eight movies per genre with movie voting active. Positioned votes and focused movies framed in red.



(b) Visualization of the selected genre tokens. Bar colors match token colors.

Figure 12.6: Developed user interface for the collaborative selection of a movie. Left: the movie library. Right: the real-time visualization of the selected genre tokens.

The following two variations are without the genre selection process, which is to investigate whether or not social control experience can be enhanced by tangible genre tokens.

(3) The Consensual variation is also about the *Consensual mode* of selecting a movie. Therefore, all users have the Sharemote remote part available without the tokens. Thus, everyone can vote for movies by means of the remote control. A movie gets only selected once every user votes for the same movie (3 out of 3 users).

(4) The Autocratic variation is about one key-user who decides on behalf of the group and represents the *Autocratic mode*. Therefore, only one user has the Sharemote remote part without tokens. The other users can only participate through verbal communication. This variation is the standard in current homes and thus represents the baseline.

TV User Interface and Movie Library

To support the decision-making process, we provide two user interfaces (UI): First, a real-time overview of the number of tokens attached to the remote(s) (Figure 12.6b) to support workspace awareness [97]. Secondly, a movie library UI. Therefore, we created a database of the 16 most prominent movies per genre, derived from *IMDB*[1]. In the case of a Sharemote variation with genre tokens involved, the UI provides the users, after acknowledging their genre selection, with a total set of 16 movies. These movies derive from up to two most frequently selected genres (8 randomly selected movies per genre out of the database created). We are aware that there exist other concepts of providing movies. Since our focus lies on exploring the tangible aspect rather than the possibilities of group movie recommendations and UI variations, we argue that this is a viable approach for our investigation. In case no genre selection is involved, the UI provides the user with randomly picked 16 movies from the whole database (genre independent). To support workspace awareness [97] during the movie voting procedure, we highlight which user is focusing on which movie by displaying colored cursor dots (white, orange, green) at the bottom of the focused movie. Once a user votes for a movie, it shows a check icon in the corresponding cursor color (see Figure 12.6a). Votes are made or retracted by pressing ok. For the autocratic procedure, only one cursor for the single remote is demonstrated.

12.4 Research Question & Hypotheses

To explore how Sharemote supports social control experience of users when selecting a movie together, we focus on the following research question: *How does collaborative movie selection, supported by tangible interfaces influence social connectedness, team performance, and co-experience?* One of our goals lies in the qualitative exploration of how users perceive Sharemote, and how they perceive the overall decision-making process. Since tangible interactions tend to promote social engagement, we speculate that those variations with tangible aspects integrated (*Genre-Consensual* & *Genre-Autocratic*) enhance social connectedness (H1), co-experience (H2), and team performance (H3) compared to those variations without tangible interaction (*Consensual* & *Autocratic*).

H1 The perceived social connectedness in terms of belongingness, connectedness, affiliation, and companionship is higher for tangible genre selection compared to no tangible genre selection.

H2 The perceived co-experience in terms of UX and social experience is higher for tangible genre selection compared to no tangible genre selection.

H3 The perceived team performance in terms of team cohesion is higher for tangible genre selection compared to no tangible genre selection.

1 https://www.imdb.com/, last accessed 2023-05-22

12.5 Comparative Study

We performed a mixed-subject study in a living room lab setting (Figure 12.7), with groups of three participants to examine the Sharemote variations' effect on social connectedness, team performance, and co-experience.

Experimental Set-Up

Independent variables: We had the variations (*Genre-Consensual, Consensual, Genre-Autocratic, Autocratic*) as independent within-subject variable and the owning of a remote (no-remote-owner, key-remote-owner – applicable for the *Autocratic* variations) as independent between-subject variable. We mapped the between-subject variable to the users' sitting position. Therefore, we assigned the key remote owner to the middle position and the left and right positions as no-remote-owner to ensure verbal communication.

Dependent variables & measurements: As dependent variables, we assessed the user's individually perceived social connectedness in terms of connectedness, companionship, and group affiliation using the Social Connectedness Scale [148] and group belongingness by means of the Inclusion of Community in Self-Scale [164]. We evaluated their perceived team performance in terms of team cohesion using the Team Performance questionnaire [200]. To assess the co-experience in terms of social experience, we used the questions related to social experience from the GAMEFULQUEST [111]. Furthermore, we measured the User Experience (UX) (as a part of co-experience) in terms of hedonic, pragmatic, and overall UX with the UEQ-short [234] and asked about their individual interest in the movie they selected. We then used participants' qualitative feedback to explore each variation's unique characteristics by conducting semi-structured group interviews after each variation and at the end of the experiment. Additionally, we assessed how long the decision-making process lasted (in seconds) and used subjective ranking to investigate users' preferences among the four variations. To control for possible influences due to the TV user interface and Sharemote in general, we examined the evoked usability by employing the System Usability Scale (SUS) [47] after the trial round. An overview of the questionnaires can be found in Appendix A. The interview questions are listed in Appendix B.

Participants

We used convenience sampling to recruit participants in groups of three. To limit bias that may be introduced by collaborating with strangers [152], we specifically aimed for groups of friends. Overall, we recruited *N=30* participants (10 groups), 9 male, 20 female, and 1

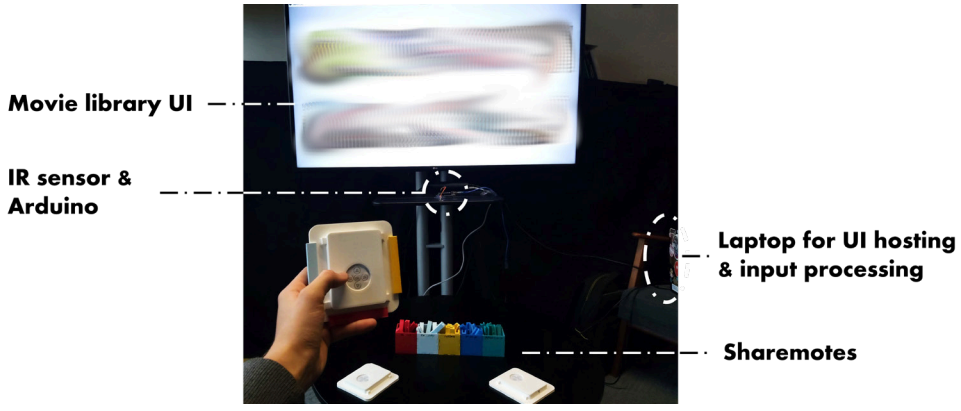


Figure 12.7: Experimental set-up in the living room lab.

non-binary, living in the Netherlands. Their age ranged from 22 to 32 (*M = 23.93 years, SD = 2.36 years*). Their movie-watching frequency refers to '*Less than once a month*' (1 out of 30), '*Once a month*' (1) '*Several times a month*' (12), '*Once a week*' (6), '*Several times a week*' (4), '*Once a day*' (2), and '*Several times a day*' (4). Participants, on average, watch a movie together with someone else 4.3 times out of 10 (*lowest = 0, highest = 9, SD = 3.443*).

Technical Set-Up

We implemented the TV UI (Figure 12.7) with a resolution of Full HD (1920 × 1080) using *Processing3* and hosted it on a Laptop that streamed to the TV. To enable the control of the UI by several remotes at once, we used infrared (IR) communication. For the remotes themselves, we re-modified existing IR-based remote controls to ensure diverse IR frequencies. The IR signals were received by an *HX1838* IR sensor which was placed right under the TV and connected to an Arduino. The received signals were passed on to the laptop using serial communication. All incoming serial data was handled in the Processing UI application. The colored genre tokens were 3D printed and provided to the users in dedicated laser-cutted storage boxes as presented in Figure 12.1. Overall, seven tokens per genre were available to ensure everyone could select the genre at least twice. The visualization of the selected tokens is based on a Wizard-of-Oz method [54], handled by an independent research assistant (the Wizard-of-Oz functioning was not introduced to users). To create a comfortable TV viewing environment, we set up a cozy living room in an empty lab with a couch, a small living room table, and a 49-inch smart TV. To ensure easy access to Sharemote we place the remotes and tokens on the table in front of their seating position.

Procedure

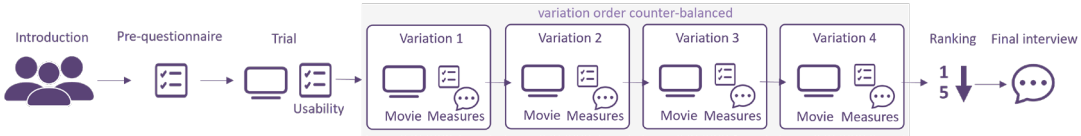


Figure 12.8: Visual representation of the study procedure (Bootstrap Icons).

We introduced the goal of the study, collected informed consent, and handed out a demographic questionnaire. Afterward, we asked the participants to select a sitting position on the couch according to their convenience. To evaluate the effects of the variations on social control experience, we aimed for a controlled social situation in a living room lab. To evaluate how individual variations affect group experience, we did not introduce the functioning beforehand. We only introduced the participants orally to a social scenario of having a movie night with the goal of selecting a movie everyone enjoys watching (Table 12.1). Discussions with one another were allowed and appreciated. We also pointed out that there is no possibility to revoke the movie's decision made. Thus per variation round, the first movie selection was the final decision and the end of the test round. The group had a maximum of 15 minutes per variation to select a movie together. We did not communicate this time constraint to the participants in order to avoid influencing the decision-making. In case 10 minutes had passed already, the experimenter reminded the group to make a decision in the upcoming 5 minutes. The group had to select a different movie per variation's test round to ensure (new) decision-making. The experiment started with a trial round to familiarize the group with the remotes, genre tokens, and TV UI (for tasks, see Table 12.1).

After the trial, we assessed the usability of the set-up by means of the SUS questionnaire [47]. This was followed by a fully counterbalanced set of the four variations. For each variation, the group had to decide on a (new) movie. Exchanging or handing over remotes to others was forbidden. At the end of each variation, participants filled out questionnaires related

to social connectedness, co-experience, and team performance. In addition, the experimenter asked about their collaborative experiences and positive/negative impressions after each variation. The experiment concluded with a subjective ranking of the four variations and a semi-structured group interview about their decision-making experience and what they liked/disliked. The experiment lasted on average 1.5 hours. Participants did not receive compensation.

Trial tasks	Variation test round scenario
Select one Horror token and attach it to your remote. Then navigate to the right lower movie on the TV UI and press OK.	Make yourself comfortable. Try to feel at home and imagine it is Friday and you are having a cozy evening together. You want to chill, relax and therefore you want to watch a movie together. Your goal is to watch a movie everyone will enjoy watching. Therefore, you collaborate with the selection of the movie.

Table 12.1: Trial round task and scenario description.

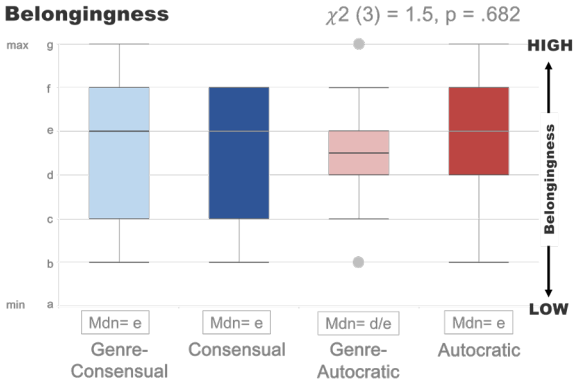


Figure 12.9: Distribution of the measured belongingness [164] of each Sharemote variation. The scale ranges from a = min/low belongingness to g = max/high belongingness. Pairwise comparison, Friedman test significant at p < .05.

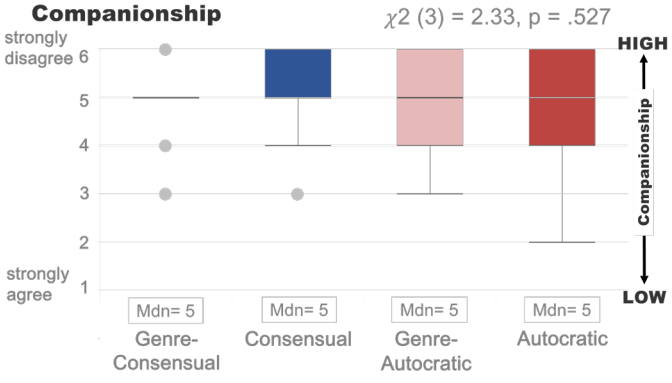


Figure 12.10: Distribution of the measured companionship of each Sharemote variation [148]. The scale ranges from 1 = low companionship to 6 = high companionship. Pairwise comparison, Friedman test significant at p < .05.

Q: Even around people I know, I don't feel that I really belong.

12.6 Results & Findings

We report on how each variation affects users' perceived social control experience in terms of social connectedness, team performance, and co-experience. With the gathered qualitative data, we conducted a content analysis. For all the ordinal-scaled data collected via validated questionnaires, we used non-parametric Friedman tests to assess group differences. For post-hoc comparisons, we executed Bonferroni-corrected (to reduce Type I errors) Wilcoxon signed-rank tests. In addition, we performed a repeated-measures ANOVA to investigate differences in time efficiency (data normally distributed according to Kolmogorov-Smirnov test).

Social Connectedness - H1

Belongingness

There is no significant difference between the four variations in their perceived belongingness, as outlined by a Friedman test ($\chi^2(3) = 1.5$, $p = .682$, Figure 12.9). The median belongingness score is equally high for *Genre-Consensual*, *Consensual*, and *Autocratic* (*Mdn=e*), followed by *Genre-Autocratic* (*Mdn=d*) (original scale ranges from a=no belongingness to g=max belongingness).

Companionship

The evoked companionship is not significantly different among the four variations, as outlined by a Friedman test ($\chi^2(3) = 2.23$, $p = .527$). Overall, the median companionship lies above average (*Mdn=5*) for all four variations (Figure 12.10).

Connectedness

A Friedman test shows, that the variations have no effect on Connectedness ($\chi^2(3) = 2.6$, $p = .458$, Figure 12.11). The average connectedness is highest for *Genre-Consensual* and *Autocratic* (*Mdn=5.5*) followed by *Consensual* and *Genre-Autocratic* (*Mdn=5.25*).

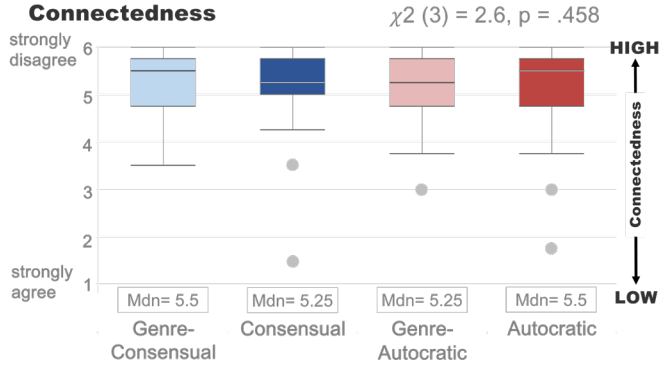


Figure 12.11: Distribution of the average measured connectedness of each Sharemote variation [148]. The scale ranges from 1 = low connectedness to 6 = high connectedness. Pairwise comparison, Friedman test significant at $p < .05$. *Q1: I feel so distant from the other people; Q2: I feel disconnected from the world around me; Q3: I don't feel related to anyone; Q4: I catch myself losing all sense of connectedness.*

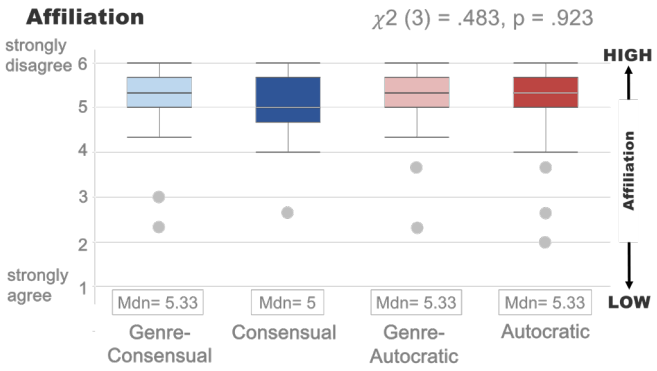


Figure 12.12: Distribution of the average measured affiliation of each Sharemote variation [148]. The scale ranges from 1 = low affiliation to 6 = high affiliation. Pairwise comparison, Friedman test significant at $p < .05$. *Q1: I don't feel I participate with anyone or any group; Q2: I have no sense of togetherness with my peers.; Q3: Even among my peers, there is no sense of brother/sisterhood.*

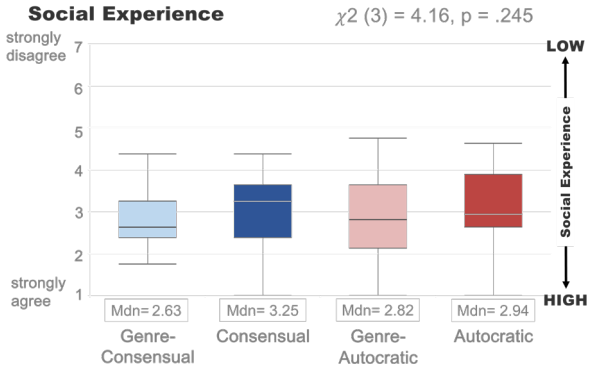


Figure 12.13: Distribution of the measured social experience [111] per variation- average score of eight questions. The scale ranges from 1 = high social experience to 7 = low social experience. Pairwise comparison, Friedman tests are significant at $p < .05$.

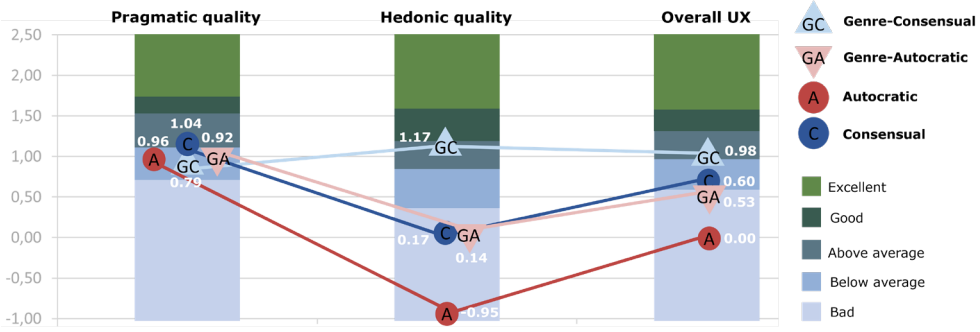


Figure 12.14: Results from UEQ-short [234]. It shows the mean values of the measured pragmatic quality (left), hedonic quality (middle), as well as the overall UX (right) score per variation. *The colors of the bars represent the UX scale, ranging from excellent (light green) to bad (light blue). The scale in general ranges from -3 (horribly bad UX) to +3 (extremely good UX), while values above 0.8 represent a positive evaluation [234].*

Affiliation

The variations do not have a significant effect on the perceived Affiliation as reported by a Friedman test ($\chi^2(3) = .483, p = .923$, Figure 12.12). *Genre-Consensual, Genre-Autocratic*, and *Autocratic* evoked a slightly higher average affiliation (*Mdn=5.33*) than *Consensual* (*Mdn=5*).

Taken together, all variations evoke a high social connectedness, indicated by an above-average belongingness, companionship, affiliation, and connectedness rating. Since the variations did not evoke significant differences in any of the social connectedness factors, we reject *H1*.

Co-Experience - H2

Social Experience

The evoked social experience is best for *Genre-Consensual* (*Mdn=2.63*), followed by *Genre-Autocratic* (*Mdn=2.81*), *Autocratic* (*Mdn=2.94*), and *Consensual* (*Mdn=3.25*) (Figure 12.13). Overall, all variations promote a highly social experience. However, there is no significant difference between the variations in terms of social experience as outlined by a Friedman test ($\chi^2(3) = 4.16, p = .245$).

User Experience

The overall UX (see Figure 12.14) is highest for *Genre-Consensual* (above average), followed by *Consensual* (below average), *Genre-Autocratic* (bad), and *Autocratic* (bad). A Friedman test outlines a significant effect of the four variations on overall UX ($\chi^2(3) = 12.71, p = .005$). Post-hoc tests report a higher UX for *Genre-Consensual* compared to *Autocratic* ($Z = 3.45, p = .003$). Looking into the UX in more detail, our results indicate, that all variations are equally practical, simple, and pleasant – indicated by an equal pragmatic quality ($\chi^2(3) = 1.98$, $p = .576$). Concerning hedonic quality (satisfactory, creative, original), *Genre-Consensual* scored best (good), followed by the other three variations (bad). A Friedman test outlines a significant effect of the three variations on perceived hedonic quality ($\chi^2(3) = 40.98$, $p < .001$). Post-hoc pairwise comparison shows a significant higher hedonic quality for *Genre-Consensual* compared to *Consensual* ($Z = 3.2$, $p < .008$), *Genre-Autocratic* ($Z = 3.15, p = .01$), and *Autocratic* ($Z = 6.25, p < .001$). Besides, *Autocratic* has a significant lower hedonic quality than *Consensual* ($Z = 3.05, p = .014$), and *Genre-Autocratic* ($Z = 3.1, p = .023$).

Summed up, there is no significant difference in terms of social experience. However, the UX shows a significant difference among the variations. Yet, group comparisons only outline a difference between *Genre-Consensual* and *Autocratic* which leads us to only partially accept *H2 - The perceived co-experience in terms of UX is higher for the tangible genre selection variation of Genre-Consensual compared to no tangible genre selection of Autocratic.*

Team Performance - H3

A Friedman test outlines no significant effect of the variations on perceived team performance in terms of team cohesion ($\chi^2(3) = 3.18, p = .365$, Figure 12.15). Overall, *Consensual* (*Mdn=6.33*) resulted in a slightly higher average team cohesion than *Genre-Consensual*, *Genre-Autocratic* & *Autocratic* (*Mdn=6*). Even though the variations evoked a high team cohesion, there is no evidence for differences among the variations. Thus, we need to reject *H3*.

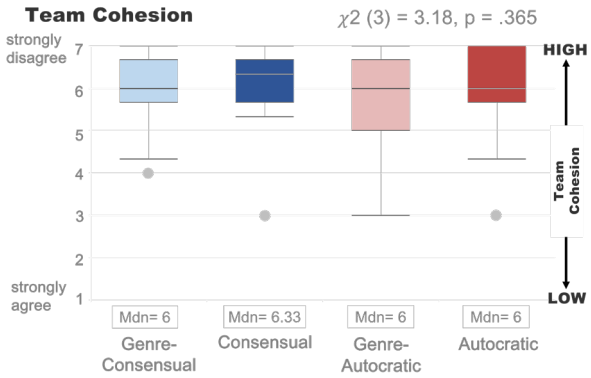


Figure 12.15: Distribution of the average measured team cohesion [200] per variation. The scale ranges from 1 = low team cohesion to 7 = high team cohesion. Pairwise comparison, Friedman tests are significant at $p < .05$.

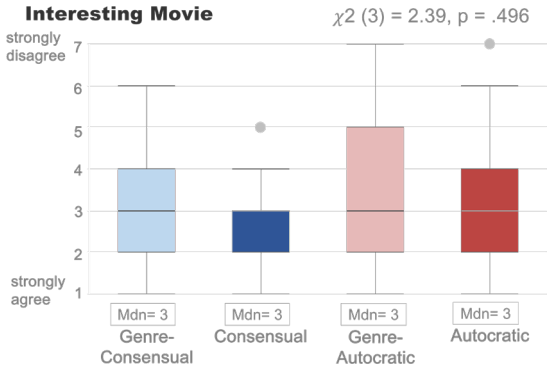


Figure 12.16: Distribution of the measured interest of the selected movie per concept. *Q: The movie we selected together is interesting to me.*

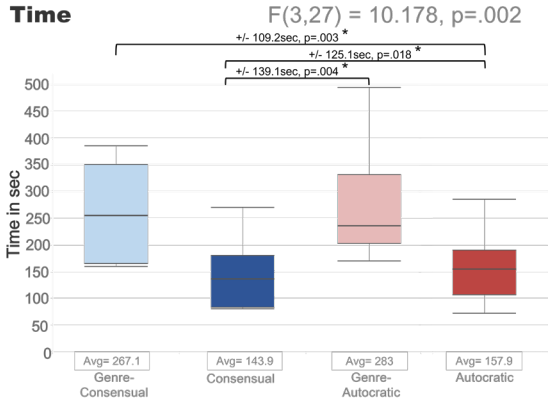


Figure 12.17: Distribution of the time needed [sec] until a group-based decision over a movie was made for each concept. ANOVA significant at $p < .05$.

Influences on Collaboration

Time Efficiency (Movie Selection Time)

Additionally, all groups decided on a movie within the time limit of 15 min. The ANOVA revealed (sphericity violated as assessed by Mauchly's test, $\chi^2(5) = 11.7$, $p = .041$ – Greenhouse-Geisser correction applied, $\varepsilon = 0.673$) a statistically significant effect of the Sharemote variations on time needed to select a movie, $F(3,27) = 10.178$, $p = .002$, $\eta^2 = .531$ (see Figure 12.17). Post-hoc tests show a significantly longer decision time for *Genre-Consensual* compared to *Autocratic* (+/− 109.2sec, $p = .003$). Furthermore, it took significantly longer to agree on a movie using *Genre-Autocratic* compared to *Consensual* (+/− 139.1sec, $p = .004$) and *Autocratic* (+/− 125.1sec, $p = .018$).

Movie of Interest

All variations enabled the selection of a movie all group members were interested in ($\chi^2(3) = 2.39$, $p = .496$). The level of interest lies above average for every variation, with an equal median score of ($Mdn=3$) (most interesting=1; least interesting=7; see Figure 12.16).

Usability

The usability score, as assessed after the trial task (initial usage of the UI and remotes), resulted in an average score of $M=64.8$, which indicates OK usability according to [47].

Qualitative Insights

Subjective Ranking

There is a statistically significant order of preferences among the four variations, as indicated by a Friedman test ($\chi^2(3) = 11.92$, $p = .008$). Post-hoc pairwise comparison shows a significantly higher preference for *Genre-Consensual* compared to *Autocratic* ($Z = -3.4$, $p = .004$). Figure 12.18 outlines the ranking per variation, ranging from 1 = most preferred to 4 = least preferred with a median score of $Mdn=1.5$ for *Genre-Consensual*, a median score of $Mdn=2.5$ for *Genre-Autocratic*, and a score of $Mdn=3$ for both *Consensual & Autocratic*.

Qualitative Feedback

We conducted a qualitative content analysis with the responses to the open-ended questions concerning each variation individually and the final interview. Sentences were iteratively assigned to themes and themes were clustered in overarching groups by two researchers under a common agreement basis [89] (for an overview see Figure 12.19).

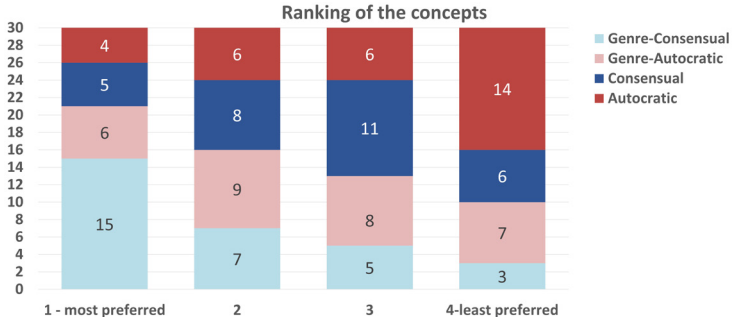


Figure 12.18: The subjective ranking of the Sharemote variations.

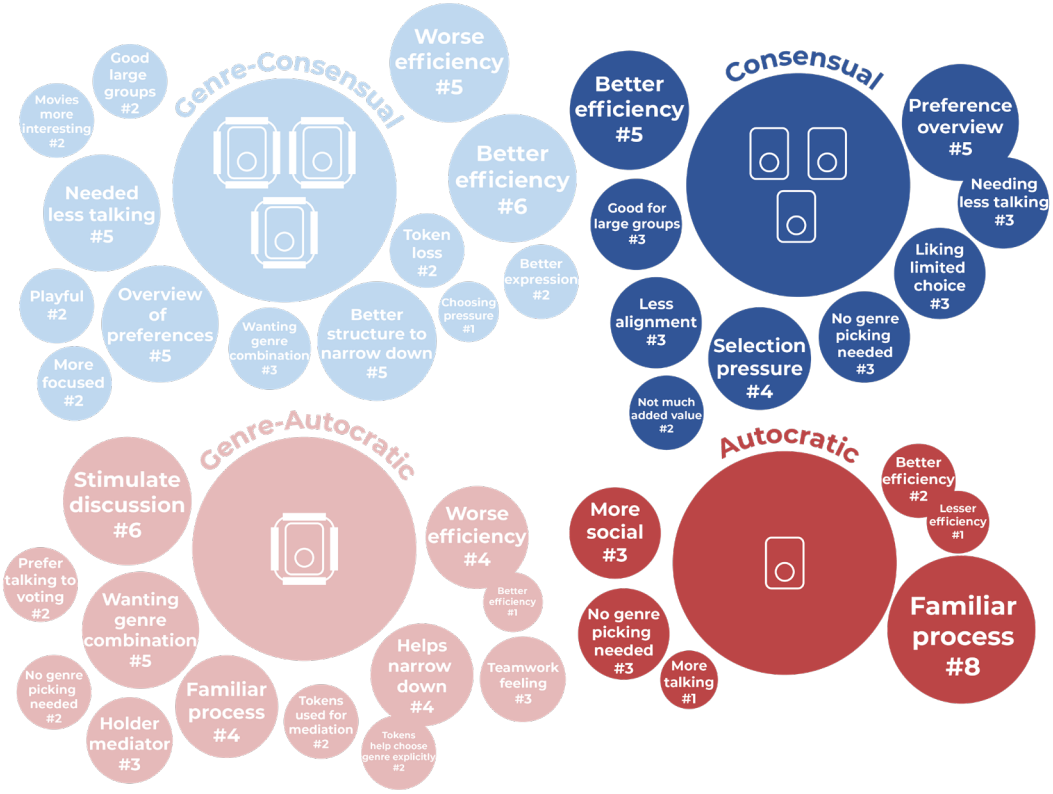


Figure 12.19: Overview of the themes arrived from the qualitative analysis. Colors represent the Sharemote variations. The number refers to the times mentioned.

The (1) Genre-Consensual variation is described by participants as playful, particularly because of the tokens involved (e.g., "*At the moment that is the fun part. Yeah, it's like playing some children's games*", P#8.3). Further, this variation supports a more focused selection of movies in line with the group's preferences which also helps in initiating movie-related discussions (e.g., "*What I liked is that you have a good overview to start a discussion*", P#5.1). Additionally, this variation allowed participants to be better involved, particularly through the possibility to express personal preferences through the genre tokens (e.g., "*I think it allows to pretty express like what you like*", P#2.3). Participants also mention that it supported them in having an overview of individuals' preferences which required less talking in the early stage of decision-making (e.g., "*Like there's no discussion on the first part, which did 'cause we did not get the double discussion. It's just put in what you like*", P#4.3). Overall, the tokens enabled to narrow down options and to have a preference-oriented discussion which is perceived as being able to come up with a movie everyone is more interested in (e.g., "*Yeah but I like the feature of eliminating the choices to make it more focused*", P#10.1). The feedback concerning efficiency was split up among the participants. Some perceived this variation as faster compared to the other variations (e.g., "*It went very quickly. It's nice, it's the first step for suggestions that works faster*", P#4.3) while some mentioned that it takes notably more time (e.g., "*I think adding this wouldn't make this selection of movies more efficient than just talking*", P#9.3). Mentioned downsides of this variation refer to the possibility of easily losing the tokens (e.g., "*I would actually lose all of the tokens*", P#1.3). A few commented on the movie recommendations after the token selection since they expected movies related to the genre combination instead of receiving offers from two separate genres (e.g., "*The options weren't overlapping or something. I assumed, we select action and comedy and that we would get action-comedy choices*", P#5.3). Even though this variation might be particularly

interesting for bigger groups, one participant had the feeling of being under pressure when it comes to the selection of genres/movies.

The (2) Genre-Autocratic variation stimulates richer discussion around both the genres and the movie (e.g., "*for me this one is better to share opinions with others*", P#6.1). The key-user likely took on the mediator role and stimulated discussions around the genre selection as well as the movie selection (e.g., "*The one who gets the remote is still the most active one and authoritative about what we're going to watch*", P#7.1). Particularly for two groups, the key-user encouraged others to grab tokens and discuss together which ones to attach to the remote (e.g., "*I think it's good to have the token here first, so you can - So it's very, very clear to see. The kind of genre the other people choose. And then we can start the conversation, based on the tokens*", P#10.1). Users describe the token selection in this variation, particularly as supportive in terms of deciding on a genre in advance (e.g., "I *actually think that like having the genres physically in front of you makes it easier to choose, which one you want to take or something*", P#2.1) to narrow down final movie decisions (e.g., "*Yeah, it takes away that ... you open Netflix you have like this ocean of choice. And it does help that it narrows it down*", P#1.2). However, some participants also mentioned that they perceived this variation as time-consuming and that they rather prefer to talk to the key user without additional actions (prefer talking to voting; no genre picking needed) (e.g., "*I didn't really need to specify the genre", P#1.1; "Because we have to wait and talk and wait and talk*", P#8.3). Some even had the impression that it is already similar to the current situation in the living room (e.g., "*It's basically already what we do*", P#10.1) while a few also mentioned here expecting movies related to genre combinations (e.g., "*It would be nice if there was a combination between two genres*", P#4.2). Nevertheless, this variation was perceived as more social and as fostering teamwork (e.g., "*I kind of like the part of the whole team together*", P#9.3).

The (3) Consensual variation is perceived as efficient (e.g., "*It's super fast we don't even talk to each other because it's so obvious [what others want]*", P#8.3) and described as requiring less communication (e.g., "*I like the voting for it. Like that you know people, what people like*", P#4.2). Overall, the voting variation provides an overview of other preferences which supports the overall decision-making process (e.g., "*Yeah, but I like the idea that you vote and that you see what the other people vote like, oh P3.3, you wanted to see that one, OK? Well, why don't we see that one?*", P#3.1). Moreover, a few participants remarked positively on the fact that no genres had to be picked beforehand, since they usually do not know which genre they are up for. Thus this variation provides them the possibility to more focus on the individual movie offerings (e.g., "*Yeah, I focus more on the individual movie that I want to watch and not the overall genre, because normally I don't really feel like a specific genre necessarily*", P#1.1). Yet, three participants highlighted the downside of not having the tokens because it was hard to find alignment on what to watch (e.g., "*Without choosing the genre is kind of a bit harder to reach a consensus*", P#6.2). Overall, this variation is perceived as particularly suitable for large groups (e.g., "*In a bigger group it might be helpful to keep track of what everyone wants*", P#1.2). While a few participants commented on the fact of having limited choices helped the overall selection of a movie, others felt under pressure to select movies (e.g., "*I still got a feeling that we were pushing P7.3 to select a movie that he didn't have that much interest in*", P#7.1).

The (4) Autocratic variation is described as the most familiar way of selecting a movie together (e.g., "*I don't know it was a bit conventional. I think it always goes like this. Same feelings as when choosing a movie normally at home*", P#2.1). Thus some participants refer to an efficient movie selection process which is mainly connected to more conversations but for some participants also to the fact that no tokens were involved (e.g., "*I think it provides a chance for us to discuss a lot. [...] I think it's really good to elicit conversations and discussions*", P#9.3).

12.7 Discussion

In this chapter, we explored variations of Sharemote. More precisely, we investigated how tangible genre-based tokens in combination with modes of shared control impact social control experience. In the following, we will delve deeper into the results of our controlled mixed-design lab experiment and explore the implications of our findings on evoked social connectedness, team performance, and co-experience.

Implications on Social Connectedness, Team Performance & Co-Experience

Our results indicate that collaborative movie selection is a general social activity that evokes high social connectedness, team performance, and co-experience, independent of the decision-making strategy provided. The insights show that all Sharemote variations evoke a high level of social connectedness and co-experience, which ultimately supports well-being [217] and establishes a social bond among group members [148, 261]. Even though we could not validate all of our speculations, we found out that the Sharemote variations involving the tangible genre tokens stimulate a higher UX, particularly when combined with consensual movie selection. Overall, the genre tokens are associated with being original, creative, and satisfying, as indicated by high hedonic quality.

Moreover, the pre-voting via tangible genre tokens leads to narrowing down choices and provides a more inviting atmosphere for exploring individual preferences and daring to outline current moods. This, in turn, directs to more satisfying and creative decisions compared to the traditional, *Autocratic* movie selection method. Additionally, the tokens as well as a consensual way of movie selection encourage conversations about potential movies before browsing a list of options, which can be seen as a stimulating social activity [23]. Furthermore, the physicality of the genres enables users the possibility to actively participate in the decision-making process even though they do not own a remote to interact with the TV. Moreover, the general possibility to select a movie under consensus encourages participation and lets users engage more in the decision-making process. This provided self-determination of participation can contribute positively toward social connectedness [23]. Despite the longer decision-making process when genre selection is involved or consensus needs to be reached, users did not necessarily perceive it as more time-consuming. A reason therefore can be the engagement and flow mode [249] that the active participation induces, which was found to aid in preventing conflicts, increasing belongingness and loyalty [116]. Even though participants expressed their preferences towards those Sharemote variations that incorporate tokens, it is important to note that the use of physical objects also has potential downsides. The tokens may induce overhead, particularly when the preferences of users are similar and a movie can be easily decided on. In such cases, autocratic decision-making, delegating a single user to select the verbally agreed-upon movie will be most convenient and efficient. Another downside is the physicality itself, which requires storage space and parts can be easily lost [239]. Moreover, the more users are involved, the more tokens and remotes are necessary which will certainly have an influence on whether or not users see the value in purchasing such or similar concepts. While this on the one hand is a downside, it can also be seen as an opportunity to easily welcome more users into the decision-making process of movie selection. However, decision-making strategies and the perception of social interaction can significantly change the bigger the group gets [120].

Overall, the insights show that physical genre tokens incorporated into the movie selection process are a novel and engaging method that evokes high UX, promotes group satisfaction, and sustains social engagement. Our research emphasizes the value of introducing tangible interfaces to the collaborative process of movie selection to easily identify overarching interests and helps users to narrow down the list of possible movie choices. This prevents the

tedious scrolling through a long list of none matching movie offerings. Combining the tokens with consensual movie selection let users actively participate in the whole decision-making process, which stimulates more thorough conversations around the movies. This on the one hand promotes group bonding while it also supports making decisions all users are more likely satisfied with. While Sharemote creates a novel UX, it also provides the opportunity to enhance group movie recommendations through genre tokens. Since genre preferences often correlate with users' moods and situations [119], it can be difficult for traditional recommender systems to accurately recommend movies that fit the diverse preferences and needs of several users at once [263]. Thus, we see the incorporation of genre preferences has a potential for future group-based movie recommendations.

We acknowledge the limitations of our study, such as the rather small movie library, as well as the choice of five genres only. Furthermore, users used Sharemote for the first time and also only once for a short period of time. This can influence the evoked UX due to a novelty effect [3, 219] but also the perceived social connectedness since differences in feelings might not be recognizable after an initial and short testing period. Thus, a longitudinal study is required to understand long-term effects on social control experience. While we ensured internal validity by recruiting groups of friends, diverse social group settings might evoke different experiences. Thus, investigations of whether and how our insights are transferable to other societies and cultural contexts are needed. Overall, our research work provides valuable insights into the interaction with tangible genre-based tokens in the process of collaborative movie selection. However, additional investigation is needed to understand its potential when used in everyday home scenarios for a longer period.

12.8 Conclusion

In this chapter, we presented the concept of Sharemote, a tangible interface that promotes social control experience among co-located users in the process of collaboratively selecting a movie. By using tangible genre-based tokens in combination with the *Autocratic* or *Consensual mode* of movie selection, users are able to first vote for their genre preferences in order to narrow down movie choices. Results from our mixed-subject experiment in a living room lab setting outlined that genre tokens enhance the overall user experience compared to traditional decision-making methods. Particularly combined with *Consensual* movie selection, it entrusts individuals and stimulates discussions. Overall, the tokens were found to initiate conversations about personal choices and to stimulate discussions about overarching intentions. While the selection process may take longer, users prefer the pre-voting on genres in order to explore group interests and preferences to enhance the chance of finding a movie that everyone can enjoy.

CHAPTER 13

Reflecting on this Domains' Investigation

A condensed, domain-specific summary about social control experience design for media in the smart-home.

In this thesis part, we looked into the social control experience design for media in the smart home domain. Therefore, we deployed the *Consensual, Autocratic*, and *Hierarchical modes* as proposed in Section 5.3 to promote collaboration on media content among co-located users in the living room. We particularly looked into collaborative movie selection (Chapter 11) and genre selection (Chapter 12). With these interventions, we explored to what extent various modes from the taxonomy affect social control experience in terms of social connectedness, team performance, and co-experience in everyday shared living spaces.

Investigation on Movie Selection

The first investigation explored how the three modes promote social control experience among a group of three when deciding on a movie together. Therefore, we provided everyone with a remote control to enable simultaneous interaction with the TV under the *Consensual* and *Hierarchical mode* and compared it with the current standard in the living room, the *Autocratic mode*. The comparative study in a living room lab environment revealed that all three modes foster strong social connectedness, team performance, and co-experience, ultimately leading to enhanced well-being and a sense of belongingness [217, 261]. Even though the *Autocratic mode* elicited a high social control experience, it resulted more likely in an unsatisfying decision for some group members due to reliance on one user and the daunting task of convincing others. Moreover, it perpetuates power dynamics and is therefore also users' least preferred option. In contrast, *Hierarchical* approaches or the promotion of *Consensual* control facilitate the exploration of the groups' interests, encouraging engagement and more goal-oriented discussions. Furthermore, there is an indication that novel approaches to movie selection (*Consensual* and *Hierarchical mode*) promote higher UX, particularly concerning hedonic qualities.

Ultimately, our research highlights that promoting active involvement and direct interaction with a TV enriches individuals' UX and is the preferred solution for collaborative movie selection in the home.

Investigation on Genre Selection

The second experiment focused on movie selection via *Consensual* and *Autocratic mode* supported by pre-collaborative genre selection with tangible genre tokens (Chapter 12). The empirical comparison outlines high perceived social connectedness, team performance, and social experience for all variations of decision-making regardless of whether the modes are supported by tangible genre decision-making. Moreover, all variations promote a high level of team cohesion, which means that all users work toward a shared goal. However, there is evidence that particularly the *Consensual mode*, combined with the genre selection, stimulates higher UX. Moreover, voting on movies but also genres (*Consensual*) provides an overview of individual preferences, thus encouraging discussions around possible choices which support the selection of a movie everyone is more likely up for watching. Even though reaching a consensus is time-consuming, it still is users' preferred choice, particularly when combined with prior genre selection.

Due to no differences in evoked social connectedness, team cohesion, and social experience, we conclude that selecting a movie among friends is a general social activity with an already established social engagement and experience, regardless of the structure of the decision-making process. Yet, there is evidence that promoting richer discussions about what movie to select and enabling active interactions, e.g., with the TV or with genre tokens increases individual experiences.

With these two empirical assessments, we contribute to the overall objective of this thesis, which is to evaluate whether the design of shared control in living spaces promotes social control experience among co-located people. The research shows that the three modes of *Hierarchical, Consensual*, and *Autocratic control* create high levels of social connectedness , team performance, and social experience (part of co-experience). Yet, there is no evidence that one of these modes promote a higher social control experience than others. However, we could observe significant differences between the modes regarding UX (part of co-experience).

In particular, novel approaches (*Hierarchical, Consensual*) to movie selection provide a unique experience, entrust users, are more inclusive, and encourage individuals to express their needs and expectations. Thus, users tend to prefer these unexplored modes to the conventional mode of *Autocratic control*, even if the decision-making process takes more time. In conclusion, our findings show that collaboration in shared living spaces is a well-established social activity that naturally leads to a high social control experience. While the current conventional way of collaborating relies on high levels of communication and convincing the user in charge of a system, our findings demonstrate the qualities of being more inclusive and authorizing individuals by giving them access to control options. This has the potential to deliver outstanding media consumption experiences in shared living spaces while encouraging content selection that is more likely to satisfy everyone. However, we must acknowledge that these findings are linked to the type of system and the use cases designed within the contextual dimensions of shared living spaces. The next step is to discuss and reflect on these aspects in more detail.

Main Findings

- The findings from the two experimental investigations reflect that collaboration in shared living spaces is a general social activity that naturally evokes a high social control experience. This is evident through the highly evoked social connectedness, team performance, and social experience, independent of the mode of shared control.

- Enabling every user to contribute actively toward the group goal by means of interactions with the system enhances experiences and promotes richer goal-oriented discussions. Moreover, authorizing users is perceived as more inclusive, helps explore media content, thus supporting decision-making that more likely fulfills everyone's needs and expectations. Thus, we see the need to include and entrust users when designing interactive media systems in shared living spaces towards an enriched social control experience.

- The results show that thoroughly exploring the content and making selections everyone is comfortable with is more relevant than the time it takes to make a final decision together when collaborating in shared living spaces. This is evident from users preferring modes such as *Hierarchical* and *Consensual control*, which promote outlining individual needs and preferences, even though it requires significantly more time to make a decision.

VI

Insights, Discussion & Recommendations

Part VI, **Insights, Discussion & Recommendations**, presents two chapters that summarize the overall findings, discuss the insights gained and outline the lessons learned from the investigations of social control experience design for media. Moreover, this part outlines design recommendations for future designs toward an enriched social control experience. Therefore, the research questions for this part refer to RQ5 – *How do the insights across the two domains compare and what are key differences and emerging patterns regarding the design for social control experience?*

Chapter 14 – Insights & Discussion, summarizes the findings and discusses important insights gained.

Chapter 15 – Design Recommendations towards Social Control Experience, posits design recommendations based on the insights gained.

CHAPTER 14

Insights & Discussion

Abstract

The main aim of this thesis is to understand how to design for social control experience for media. We conceptualized the design for social control experience in Part III and designed, implemented, and evaluated its experience in Part IV & V. In this chapter, we reflect on the collected insights gained. We first provide a summary of the important findings across the investigations in the automotive and smart home domains and outline the lessons learned for the design of social control experience. Thus, we will focus on How do the insights across the two domains compare? and What are the key differences and emerging patterns regarding the design for social control experience? Even though we could not identify a single mode from the taxonomy to enrich the social control experience best, there is evidence that active interaction with a system and individual control possibilities increase the social control experience. Hence, we will report on the essence of control and the opportunity to actively participate in decision-making. Furthermore, we will discuss how social control experience for media gets affected by the context.

14.1 Condensed Summary of Domain-Specific Findings

To investigate how to design for social control experience for media, we defined social control experience design as the design of collaborative, interactive media systems with shared control to enrich individuals' experience in a group setting (Chapter 5). In Part III we outlined a taxonomy consisting of five modes (*Consensual, Hierarchical, Token-Ring, Anarchic, Autocratic*) to systematically share control among users to promote social control experience in terms of social connectedness (belongingness, affiliation, connectedness, companionship), team performance (coordination effectiveness, team cohesion), fairness, and co-experience (social experience, UX). We applied the modes to two media use cases in the automotive and smart home domains to design, implement, and evaluate the evoked social control experience in everyday shared spaces.

The Automotive Investigations

Chapter 7 demonstrated that each mode applied to an In-Vehicle Infotainment System (IVIS) provokes a different intensity of social control experience in terms of social connectedness, team performance, and fairness. The *Token-Ring mode* and the *Anarchic mode* lack awareness of what others are doing, which induces frustration and limits the perception of belongingness. Nevertheless, the *Anarchic mode* as well as the *Autocratic mode* are considered rather fair. The *Consensual mode* is the least effective mode when it comes to driver-passenger collaboration and also induces a high mental workload for the driver. In comparison, the *Autocratic* and *Hierarchical modes* promote the highest coordination effectiveness. Moreover, the traditional way of *Autocratic control* is the users' preferred choice, even though it distracts the driver whenever the passenger performs tasks. Despite these differences, all modes allow for collaboration, as evidenced by the measured and reported high team cohesion. Further, every mode establishes a social bond as well as self-esteem, as noticeable from overall high ratings of affiliation and companionship. Taken together, all modes enable collaboration and provoke social control experience. Yet, not every mode is as effective when it comes to task performance in the safety-critical event of driving, and thus affects safety and driving performance.

Insights retrieved through the investigation of the creation of a music playlist among passengers in a fully automated vehicle (Chapter 8) also show a different intensity of social control experience among the modes. Overall, the *Anarchic mode* suppresses a feeling of

belongingness and affiliation, due to counteracting others' decisions. Nevertheless, users tend to favor this mode because it is fair and provides access to all functions. The *Consensual mode* is also attributed as fair, entertaining, fun, and in addition evokes a strong affiliation and connectedness between users, providing a space of inclusion. Collaborating under the *Token-Ring mode* is described as very structured and creating awareness of others' needs. However, it limits communication and puts users under pressure when it comes to contribution-making. Thus, it is the least preferred option for the creation of a music playlist. The *Hierarchical* and *Autocratic modes* are rated unfair due to unequal distributions of control. Particularly the *Hierarchical mode* limits the establishment of social connectedness. The *Autocratic mode* introduces a dependency on others, which requires communication, consequently leading to high social connectedness. However, due to the power dynamics, this mode is not envisioned in a fully Automated Vehicle (AV).

The Smart-Home Investigations

In Part V, we built on these insights and investigated particularly those modes that prevent overruling others, enable continuous, active contribution-making, are perceived as fair, and provoke a high feeling of social connectedness (*Hierarchical, Consensual mode*) to design for social control experience in shared, living spaces. The two modes applied to collaborative movie selection (Chapter 11) evoked a similarly high social connectedness, and co-experience in terms of social experience and team cohesion compared to the current standard in homes, the *Autocratic mode*. Yet, there is evidence of the more novel modes of movie selection to stimulate a more unique UX. Furthermore, they also support making a decision on a movie everyone is satisfied with. Insights from the promotion of collaborative genre selection (Chapter 12) outlined similar findings. While social connectedness, social experience, and team cohesion were not perceived differently between the *Consensual* and *Autocratic mode*, there is confirmation of a higher UX when selecting genres and a movie dedicated to a prior selected genre under consensus. Thus, we concluded Part V that collaboration in shared living spaces is a general social activity that naturally evokes a high social control experience. Yet designing for social control experience, particularly with a focus on individual interaction and contribution-making lead to an enhanced UX, contributing to richer engagements and goal-oriented discussions.

14.2 The Enrichment of Social Control Experience

The study findings revealed that the individual modes from the taxonomy evoke a different intensity of social control experience in private, shared spaces. In this thesis, we centralized social control experience design around the design of collaborative, interactive media systems with shared control to enrich individuals' experience in terms of social connectedness (belongingness, connectedness, companionship, affiliation), team performance (coordination effectiveness, team cohesion), fairness, and co-experience (UX, social experience) (Section 5.1). In this section, we outline the main findings of what promotes and what hinders social control experience. Therefore, we start by discussing each mode's evoked experience. A condensed overview of the overall positive and negative qualities of each mode can be found in Table 14.1.

Autocratic Control Mode

The *Autocratic control* mode is the current established form of control in everyday shared spaces, particularly in the car and in the living room. Hence, users are most familiar with this mode, which in general can bias the evoked experience [264]. Through our investigations, it is evident that the *Autocratic control mode* stimulates a high level of social control experience. This includes an enriched social connectedness, team performance, and social experience.

However, it lacks high UX. This means that users feel to belong to one another, are affiliated, connected [148, 217, 261], and work together towards a shared goal [200], which we attribute to the **necessity of communication**. Prior research outlines that communication evokes a high social engagement and is the most common way to interact socially with one another [75]. Moreover, having one user executing certain functions is highly effective and also requires less time to make a decision. However, qualitative feedback shows that the final decision made does not always satisfy everyone's needs and expectations, particularly noticeable from the home domains' investigations (Section 11.6 & 12.7). Even though our experimental studies are limited to pre-defined tasks, there is an increased chance that collaborating under Autocratic mode induces dependency and power dynamics [207], which leads to perceived exclusion. Moreover, users reported that asking for changes can be overwhelming and frustrating, particularly when the user in charge does not consider them. These characteristics are also reflected by low perceived fairness when it comes to decision-making, notably on non-safety critical tasks. Even though the perception changes in safety-critical environments and the *Autocratic mode* is attributed as fair there and constituting low mental workload when performing tasks while driving, it distracts the driver. Hence, we argue that *Autocratic control* does not ensure social control experience. The experience generated highly depends

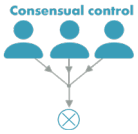
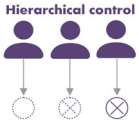
Mode	Qualities	
	promoting social control experience	obstructing social control experience
	• attributed as fair • includes everyone equall • encourages participation • fun & entertaining • promotes exploration of content • making decisions that satisfy everyone • engaging • entrusts individuals	• can induce pressure to select content • time-consuming • can be mentally demanding • overhead for frequently performed tasks • distracting in safety-critical environments
	• parallel task performance possible • reduces distraction in safety-critical environments • perceived as fair • encourages participation	• suppresses communication • override others' decisions possible • increased frustration • lacks efficiency due to low action awareness • fear of not reaching the group goal
	• fair due to equal control possibilities	• frustrating to wait for control • suppressing communication • induces high mental workload • reduces efficiency • lowers users' satisfaction • override others' decisions • fear of not reaching the group goal
	• enforces conversation • parallel task performance possible • interesting & fun • entrusts individuals • active interaction with the system • ensuring safety and efficiency in safety-critical environments • good for initiating collaboration	• unfair • inducing dependency on others • chaotic (lack of overview)
	• encourages communication • effective task execution	• lacks high UX • unfair / excludes users • decisions do not satisfy everyone's needs • induces power dynamics and frustration • asking for changes is overwhelming

Table 14.1: Condensed overview of the qualities per mode that promote or obstruct social control experience

on whether or not the task needs to be performed efficiently, whether or not the user in charge considers others' interests, **acts as a mediator**, and whether or not individuals are able or willing to participate. In summary, in a situation where users have time to discuss and reflect on the choice of media content, *Autocratic control* is not expected to produce a good social control experience. It prevents the selection of content that satisfies everyone and, at the same time, limits UX.

Consensual Control Mode

The *Consensual control mode* lets the group identify themselves as a single entity, supporting them to pursue a shared goal [200], as evident from high team cohesion independent of the use cases and domains. Executing functions and selecting media content under consensus is attributed as fair and includes everyone equally. This is in line with prior investigations on voting systems [207]. Furthermore, voting on content is perceived as **fun, and entertaining**, and also encourages conversations, consequently contributing to social engagement and individuals' experiences [75]. As evident from our insights, it also sustains high belongingness and affiliation toward the group, particularly when the task performance is not safety critical (Section 8.7). However, the *Consensual mode* can induce pressure to select and interact with an application which was reported by a few participants during the automotive investigations. Thus users can feel forced to comply with certain values and group norms [157], which is expected to suppress social control experience even though it was not observed through our investigations. Nevertheless, the *Consensual mode* evokes high co-experience because it allows the exploration of individuals' preferences and needs through voting. This contributes in general positively to the social control experience because it **supports making decisions that satisfy everyone.** However, reaching a consensus takes significantly more time than the other modes, which is consistent with previous work [207]. Due to the extensive decision-making time, the *Consensual control mode* poses the risk of distraction in safety-critical scenarios. Further, it induces a higher mental workload compared to other modes, as evident from the investigations in passenger cards (Section 7.6). Even though it takes longer for groups to make a decision, it is among users' preferred choices when it comes to collaborative media control in non-safety-critical scenarios. Taken together, the *Consensual mode* is a good choice to entertain and stimulate sharing of needs, expectations, and preferences. It can be used to initiate conversations around available media content. Further, it **promotes the exploration of the content** and possibilities in more detail. Our insights show that these characteristics contribute positively to the social control experience. Yet, the downsides refer to a longer decision-making process which can cause danger in safety-critical environments or induce an overhead to frequently performed tasks [207]. Even though we did not observe any tensions during our investigations, some users reported fear of being pushed toward making a decision or feeling restricted due to another user not confirming when using *Consensual control* in everyday life. However, we see this only as problematic for functions or tasks that need to be performed efficiently or frequently. An example can be pausing a movie or adjusting the volume. Overall, we argue that the *Consensual mode* is a practical solution to stimulate content exploration and for promoting to make a final decision that satisfies everyone. Yet, it might not be beneficial to be applied to every function, particularly not to such that need to be performed frequently or fast.

Hierarchical Control Mode

The *Hierarchical control mode* stimulates moderate social control experience, attributed to a neutral evoked social connectedness, team performance, and social experience, as observed across the two domains. Users describe it in general as unfair and inducing dependency on other users that have more control authority. We see this as a cause of the limited intensity of evoked social control experience since not every user can express themselves freely

[75]. However, due to the distribution of access to functions, the group requires more task coordination which enforces conversations and thus promotes collaboration [136] while also fostering belonging [148]. Nevertheless, the *Hierarchical mode* allows for **executing functions in parallel,** which users describe as making collaboration faster, more **interesting, and fun**. However, it can cause chaos and a lack of overview of who controls what. Even though it limits some users in terms of influence on the final decision, the *Hierarchical control* mode **entrusts individuals** and generates unique experiences as evident from the smart home investigations (Chapter 13), because everyone can **actively interact with the system**. Particularly for introverted users, it opens the possibility to easily contribute to the decision while not necessarily needing to talk. Therefore, the encouragement of participation through the *Hierarchical mode* provides an inclusive space for every user. Moreover, this mode allows one to collaborate while minimizing cognitive effort [168] and reducing distractions, making it a useful strategy for ensuring safety and efficiency in a safety-critical environment. Although it may not be the most socially interactive mode, it can be an effective means of achieving active participation and promoting collaboration while ensuring important tasks are completed. An example can be related to enabling *Hierarchical control* when introducing collaboration to a use case the first time or when allowing less-novice users to contribute as well. Further, *Hierarchical control* can be beneficial to particularly seek support for dedicated functions, for instance, the driver requesting assistance for setting up the navigation system. Yet, the design of a collaborative UI implementing the *Hierarchical mode* requires high workspace awareness [97] to maximize transparency of others' interactions in order to avoid chaotic execution of tasks.

Anarchic Control Mode

The *Anarchic control mode* enables **parallel task performance**, which, particularly in the safety-critical event of driving, brings the advantage of reducing driver distraction and minimizing cognitive workload as evident from our results (Section 7.6). However, users are highly focused on the system and on performing their tasks while forgetting to communicate with others. This can lower task coordination and thus prevents highly efficient collaboration [136]. Further, due to equal control authority, users tend to **override others' decisions without asking for permission**. This impacts goal achievement, increases frustration [168], and is another obstruction toward collaboration [136]. We see this as a major cause of neutral social connectedness, particularly perceived affiliation and belongingness. Moreover, allowing users to execute many tasks in parallel lacks awareness of actions [97] and thus negatively affects efficiency. Even though the *Anarchic controls*' evoked social connectedness was rated low in the event of passenger collaboration in AVs, it achieved above neutral for driver-passenger collaboration. This highlights that the use case is a possible influence on social control experience, particularly when collaborating under the *Anarchic control mode*. Despite rather low evoked team performance and social connectedness, the *Anarchic mode* is perceived as fair because all users have the same control authority. It encourages participation through unlimited access to functions which is also the major reason why users prefer this choice. However, frustrations may more easily arise due to others' interactions counteracting prior decisions made. As reported by users, *Anarchic control* causes the **fear of not reaching the overall group goal**. Taken together, the *Anarchic control* entrusts individuals even though it does not support efficient and effective task performance, consequently preventing excellent social control experience.

Token-Ring Control Mode

The *Token-Ring control mode* elicits moderate social control experience due to a neutral evoked social connectedness and team performance. Turn-taking is perceived by users as fair. However, **waiting to receive control (again) is frustrating** and also described as sup-

pressing communication, consequently lowering collaboration [69, 83], social exchange, and engagement with one another [75, 110]. Further, participants reported that the moving token demands a high mental workload because users need to stay focused to not miss when it is their turn to contribute to the group goal. Moreover, the **asynchronous collaboration** and the thereby induced waiting time **reduces efficiency and lowers users' satisfaction**, as evident from low perceived coordination effectiveness. Yet, turn-taking provides users an overview of who prefers what type of media and what control functions individuals execute. However, it allows **counteracting others' decisions** while there is no option to intervene. This introduces power games, lowers engagement with one another, and **causes the fear of not being able to reach the group goal** or make a decision together. Also, it poses the risk that the group does not follow the same goal or lose track of the goal, as indicated by neutral team cohesion [200]. Overall, asynchronous collaboration, as provided through the *Token-Ring control mode* limits engagement with one another due to suppressed communication and an induced focus on the system/UI, consequently limiting social control experience. Even though it enables every user to actively contribute and allows for collaboration, it is neither an efficient way of collaboration nor establishes a high social control experience.

Taken together, these insights reveal that each mode has characteristics that, on the one hand, constitute social control experience for media while, on the other hand, can also obstruct social control experience (see Table 14.1). This means there is no single mode that best enriches social control experience in various use cases and domains. Yet, it is evident that communication plays a crucial role in establishing social control experience. However, only communication as a means of shared control (*Autocratic control*) is neither preferred nor does it ensure high evoked social control experience. As evident through the discussion above, continuous promotion of interaction with the system and providing everyone the possibility to contribute toward the group goal constitutes UX and affects particularly social connectedness positively. Further, users prefer active involvement and the possibility to interact with the dedicated system when deciding on media content together. This holds even when individual interactions and choices might not result (directly) in the final group decision (e.g., providing recommendations via *Hierarchical* or *Consensual mode*) because enabling access to the UI promotes engagement and supports the exchange of preferences, thoughts, and needs, consequently contributing towards social control experience. As a next step, we discuss in more detail the impact of the type of shared control authority on the social control experience. Additionally, we look into the role of the context and whether and how contextual factors influence the experience generated.

14.3 The Role of Control and Active Participation

As observed across the two domains, providing individuals access to (certain) functions allows users to engage more in decision-making and is also favored by users. Distributing control authority equally among passengers is attributed as fair and positively constitutes group bonding (*Consensual, Autocratic, Token-Ring*). Moreover, active interaction with a system, in general, is inclusive and stimulates better goal-oriented discussions, also reflected in high UX, particularly evident from the home investigations. This even holds when control decisions made by one user do not directly lead to the final decision (e.g., providing suggestions via *Hierarchical control*). Moreover, assigning control authority allows users to express opinions, needs, and expectations more effortlessly in a group setting. This brings us to the conclusion that active control over media functions constitutes social control experience among co-located users in private, shared spaces.

Yet, the way how control authority is distributed among co-located users influences the intensity of evoked social control experience. Continuous equal control, provided by, e.g., the *Anarchic* and *Consensual mode*, promotes fairness and allows everyone to have the same influence on the outcome. However, these two modes differ in the impact individuals' control

decisions have on the group goal, consequently affecting the intensity of the social control experience. Meaning that reaching a consensus before executing a function promotes higher social connectedness in terms of belongingness, affiliation, and connectedness, particularly in non-safety-critical contexts. Through qualitative feedback, we attribute this to the fact that everyone needs to agree on executing an underlying function. This induces inclusion [207], stimulates conversations [75], and generates more awareness of others, which according to literature, contributes to collaboration and social engagement [97, 185]. In contrast, overruling or counteracting others' decisions as possible through *Anarchic control* induces frustration [168] and causes fear of not reaching the intended group goal, consequently lowering social control experience. Taken together, stimulating discussions among decisions before executing functions, as enforced through *Consensual control* enriches the social control experience.

Furthermore, there is evidence that static, continuous control positively affects the social control experience because it encourages conversations and does not limit participation compared to asynchronous control distribution (*Token-Ring control*). As clarified by users, the turn-taking causes too much focus on the system itself, consequently lowering communication and social engagement. Providing different control levels balances responsibilities, allows also to consider users' abilities [77], and thus offers more inexperienced users to contribute easily. However, it is perceived as unfair, induces power dynamics, and can be perceived as excluding, particularly when users feel they have the necessary ability and knowledge to contribute.

What is evident from our insights is that **continuous control constitutes a positive social control experience** and is overall preferred by users. However, it needs to be carefully evaluated how much control authority a user can get assigned with respect to the abilities [77] and the tasks that are performed within a certain environment. This brings us to the discussion about the domains influencing social control experience.

14.4 The Role of the Domain and Tasks

There is evidence that contextual factors influence the evoked social control experience. Even though each mode has characteristics that constitute social control experience, the intensity evoked changes with the use case and domains. We observed a consistently high level of social connectedness, team performance, and team cohesion across the *Consensual*, *Hierarchical*, and *Autocratic mode* in the home environment. Yet, notable discrepancies were obtained in the automotive domain, with some modes (*Anarchic, Token-Ring, Hierarchical*) scoring average or even below average on certain measurements taken. Further, the results from the automotive domain show significant differences in evoked social control experience among various modes. However, this was not observed in the smart home domain. These findings imply that the social control experience is rather effortlessly stimulated in the living room, which does not inherently emerge in the car.

The particular task performed defines whether and how a mode evokes a high social control experience. Group belongingness among all modes in the study of driver-passenger collaboration (Section 7.6) resulted in a lower intensity than in the music playlist investigation (Section 8.6). Further, the perceived coordination effectiveness per mode varies between the automotive use cases, detrimental for *Consensual control*, being perceived as highly effective in automated vehicles (Section 8.6), but none effective for driver-passenger collaboration while driving manually (Section 7.6). Furthermore, participants rated the *Autocratic mode* as least fair when collaborating in fully AVs because it excludes individuals, but it was rated highly fair when it comes to the distribution of control between a driver and a passenger. Qualitative feedback shows that users feel the need to ensure that the driver has continuous access to functions to feel safe while riding a car, consequently affecting the perception of fairness in terms of control distribution. This implies that collaboration in a safety-critical

environment affects the social control experience. On the one hand, this can be attributed to the time-critical task performance, but also to shared cognitive recourse of the driver who needs to stay situational aware while performing media tasks [127, 221]. Findings consensus takes more time and thus is less efficient and distracts the driver, consequently, lowering driving safety [127]. Whereas *Autocratic mode* is familiar to users. Thus, we argue it induces a safer feeling, even though it distracts the driver, as evident from our insights (Section 7.7). Yet, in a fully AV or inside the car, every user can fully engage in collaboration and media control which positively constitute social control experience. Taken together, our insights show that **safety-critical task performance and perceived safety affect the social control experience**.

14.5 Conclusion & Outlook

Technology can be a mediator to promote the exchange of thoughts, visions, and needs to generate shared experiences and stimulate collaborative decision-making. In this chapter, we looked into the overarching insights gained concerning social control experience design for media through four investigations across two domains. We discussed the individual attributes of the *Consensual, Hierarchical, Autocratic, Anarchic*, and *Token-Ring mode*, and how they contribute to or limit social control experience. Further, we examined the role of control and how the level of control authority influences the experience generated. Also, we discussed the differences observed between the two domains and debated the influence of safety-critical task performance on social control experience. We concluded, that every mode has certain characteristics that positively constitute social control experience for media. However, there is no overarching mode that evoked excellent social control experience among use cases and domains.

Through the reflection on the findings, we demonstrated important aspects that are crucial for social control experience design. Particularly **verbal communication** plays an important role in social engagement. Additionally, allowing for **continuous, active interaction with the system** enhances UX, entrusts individuals, and is perceived as fun and entertaining. Further, there is the need to **ensure that progress toward the group goal is made**, which means **counteracting decisions should be avoided**. Yet, considering all these aspects at the same time can be challenging, particularly concerning contextual factors that further influence the design of the social control experience as evident from our insights. In general, designing collaborative systems is complex because it demands designing for a diverse group of users under consideration of contextual characteristics such as the environment, tasks, and technology available. To support designers and practitioners toward promoting social control experience design particularly for media, we discuss and posit design recommendations in the follow-up Chapter 15. Overall, our insights contribute to the emerging work on collaborative, multi-user media systems. More precisely, they add to the design of shared control to promote active participation, togetherness, and stimulating shared experiences, consequently enriching individuals' experiences in a group.

CHAPTER 15

Design Recommendations towards Social Control Experience

Abstract

Through experimental investigations on collaborative media systems in the car and in the living room, we gained a comprehensive understanding of what constitutes and limits social control experience. Hence, in this chapter, we reflect on the overarching patterns and formulate design recommendations to generalize and transfer our insights. Through these recommendations, we aim to support future researchers and inspire the design of collaborative, interactive media systems with shared control among co-located users to enrich individuals' group experience. The first consideration refers to the promotion of communication as a key driver for social control experience design. Other recommendations tackle control authority, the generation of shared experiences, and the prevention of conflicts.

15.1 Introduction

We systematically explored how different ways of shared control over media among co-located users in everyday, private, shared spaces affect individuals' experience in terms of social connectedness, team performance, fairness, and co-experience. We discussed the implications of our findings in Chapter 14 and outlined overarching patterns that constitute social control experience. Based on these overarching insights gained, we posit recommendations for social control experience design. The recommendations build upon the scope of this thesis which reflects social control experience design under the lens of media in private, shared spaces such as in the car and the living room. Thus, the recommendations should be taken cautiously when transferred to non-media-oriented tasks or to collaboration in public spaces. Overall, the recommendations are formed according to the generated knowledge in this thesis. Therefore, they are intended to inform and inspire the generation of collaborative multi-user media systems toward enriched social control experience. Hence, they are broad aspects to be taken into account when designing, rather than detailed procedures and guidelines that need to be followed. Founded in our work we discuss the following recommendations toward enhance social control experience design:

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- Encouragement of active communication through technology while not replacing communication with technology
- Balancing control to entrust individuals while allowing for self-determination
- Generating shared experiences through content exploration and awareness building
- Minimizing power dynamics and avoiding the counteracting of others' decisions
- Entitling mediator roles and providing an initial state of collaboration

15.2 Communication as a Key Element

Communication constitutes social exchange [75, 110] and is further crucial to coordinate the execution of tasks when collaborating on a joint goal [69, 83]. Through the course of the four investigations, it has become clear that **communication plays an essential role** in the design of social control experience. It is the most natural, and easiest way to enable the exchange of needs, expectations, and thoughts [246].

Encouragement of Active Communication

Active communication, whether verbal or non-verbal, fosters effective collaboration, enhances group bonding, and promotes knowledge sharing [83, 246]. This further allows for more goal-oriented discussions and better decision-making aligned with group expectations as obtained through our investigations. Without clear and effective communication, groups may face misunderstanding, confusion, and frustration toward the overarching goal [69, 83], or experience unstructured, and unsatisfying collaboration [69, 83] due to a lack of awareness of others' preferences and needs. **Prioritizing active communication** in the design of interactive media systems promotes creativity, social connectedness, and inclusivity as evidenced by our findings. Subsequently, we recommend designing systems that mediate communication among co-located users. Therefore, **technology should not replace communication**, instead, **technology should act as a mediator to foster** and **encourage communication.** As explored in this thesis, examples can be designed to position recommendations for content to be selected (see Section 11.2), vote for content (see Section 8.3 & 11.2) or to send content for approval (see Section 7.3). This also provides those users the possibility to engage in discussions that are more hesitant in speaking up for themselves. Further, it also supports individuals with different needs to communicate their needs and participate in decision-making. Consequently, encouraging communication promotes inclusion and enhances social control experience.

15.3 Balancing Control & Participation

The ability to actively participate in decision-making processes is perceived as inclusive [207], and fair while promoting group bonding. Enabling **users to interact with the application**, even without offering the option to execute dedicated functions, enhances their experiences, as evident from our findings (Chapter 13). Yet, forcing participation can introduce frustration while also disconnecting users. Therefore, we see the need to balance **entrusting individuals** and **allowing for self-determination** to enrich social control experience.

Entrust Individuals

Providing every user with the possibility to interact with the system and allow them to execute certain functions, entrusts individuals as evident from our findings. Thus, we see entrusting users as a key element for social control experience design. Enabling **active interaction with the application** or system gives users the **opportunity to express themselves** easily (e.g., through posting recommendations or voting for content possible to implement via *Hierarchical* or *Consensual mode*). Further, it offers the chance to posit preferences and thoughts more effortlessly, without the necessity of prior discussion or requesting permissions. This promotes inclusion [207] and fosters affiliation as well as belonging, consequently leading to a higher social control experience (Section 11.5 and 12.6). Thus, we recommend entrusting individuals by granting them access to the application when designing for social control experience. While the direct impact on the final group decision is preferred (e.g., as possible through *Consensual* or *Anarchic mode*), it is not necessarily required to stimulate social control experience. Even interactions with the system itself or the execution

of functions that do not lead to the final decision already provoke discussions among the group members. An example can be the positioning of own preferences, or just highlighting a single element on the screen (see Section 11.2). Hence, **authorizing individuals** by enabling interaction with the system **promotes collaboration, social exchange, and enriches experiences,** while even facilitating **making decisions that everyone is more satisfied with.**

Allow for Self-Determination

Besides supporting entrustment, a user should be able to independently decide whether or not to collaborate with others in the room, consequently contributing to the decision-making. Thus, we recommend supporting self-determination. This means users should not be forced to participate while groups should in turn also not need to wait for a user in the event of a lack of encouragement to contribute. Thus, users should have the possibility to **easily join or leave without any disadvantage** for themselves or the group (Section 8.7). Therefore, a system should provide users the freedom to decide whether and when they want to participate in the decision-making process to enrich social control experience. To facilitate this, it is generally advisable to avoid limiting contribution-making based on time and rather allow for continuous, synchronous collaboration, letting users participate whenever they desire. By entitling self-determination in this way, users are entrusted to take control based on their values and needs, ensuring their full engagement and commitment to the collaboration. This can help to promote more meaningful contributions, stimulate higher levels of social control experience, and lead to better outcomes for the group as a whole.

15.4 The Art of Building Shared Experiences

Performing leisure activities together such as controlling media in everyday shared spaces supports bonding [132], and promotes the generated of shared experience [132, 192]. To enhance engagement with one another, consequently enriching co-experience, we recommend **inspiring the exploration of content through designing for awareness.**

Inspire Exploration of Content through Awareness Building

Promoting awareness of others' interaction is a key design element for any collaborative system [97, 185] because it provides transparency and thus promotes efficiency and effectiveness [50]. As evident from our findings, a high level of workspace awareness supports team cohesion and most importantly stimulates conversations (Section 8.6 and 11.5). The group is more engaged in goal-oriented discussions, exploring individuals' preferences while also thoroughly checking the available content and functions of a system. Examples demonstrated in this thesis are about voting for music (Section 8.3) or movies (Section 11.2) in a library, or by highlighting movies of interest (Section 11.2). While exploring content together is perceived as fun as well as entertaining, it also encourages the sharing of experiences and needs which ultimately supports belongingness and affiliation. Moreover, being aware of what others like and prefer, allows one to take care of others' needs [146] which supports making (final) decisions that satisfy everyone. Consequently, we recommend aiming for **awareness building** to promote the **exploration of content** to generate higher levels of co-experience.

15.5 Navigating Conflicts: Insights & Strategies

Collaboration refers to the act of working together to achieve a shared objective [161]. Consequently, it is crucial to support the headway toward goal achievement [136]. This also incorporates **ensuring** that **progress** is made while **offering individual contribution-making.**

Avoid to Counteract Decisions

Collaborative systems toward social control experience need to avoid counteracting the decisions made by others, particularly those decisions that have been either negotiated or contributed positively toward the group goal (Section 8.7). Although providing users with unlimited access to functions promotes inclusiveness and a sense of belonging, it invites users to run a risk of increasing interpersonal dominance [168]. This, in turn, can result in losing the narrative of the joint goal [200]. Consequently, it hinders effective collaboration due to negative implications on the group dynamics, diminishes progress, and causes fear of not achieving the group's objective at all. Hence, it leads to increased frustration [168] and limits the exchange of thoughts and needs [75, 110]. As a consequence, users may become disengaged, and dissatisfied, which counteracts social control experience. Therefore, it is crucial to promote respect for the decisions of others and foster a sense of shared accountability toward the common goal. Moreover, the system needs to ensure the handling of conflicting inputs to particularly prevent erroneous overriding [179]. Taken together, it needs to be **carefully decided who can overrule others' decisions** by also taking users' abilities into account [77]. This refers, on the one hand, to define who has more control authority or dedicated control authority for specific functions, and on the other hand to which functions can only be performed jointly by e.g., voting, instead of one user deciding alone. An example related to creating a music playlist might be that any user can add songs while removing a song requires everyone's approval.

Establish a Mediator Role

Establishing shared accountability might not always be possible or beneficial, given the diversity of collaborative tasks that exist. Further, there can be situations where an agreement cannot be reached concerning the path to be taken toward the goal which may obstruct progress. For such situations, we recommend **assigning a group representative** (e.g., a key user for certain functions) who can **mediate decisions** with respect to the group's interest. This prevents the event of never getting started in the first place, while also reducing the likelihood of losing track of the progress.

Provide an initial State of Collaboration

Our research has indicated that designing for social control experience can also create significant pressure for participants, leading to an increase in mental demand [168]. One potential solution could involve incorporating guidance and support in the system itself, for instance, **recommending which contributions can be made** or might be most beneficial. Moreover, depending on the task and situation, we suggest that the system provides an **initial, collaborative state.** This gives users more time to consider and plan their contributions to the group effort. An example is a pre-filled playlist, so the music gets already played while the group adjusts the playlist according to their needs.

Minimize Power Dynamics

While there might be situations where certain users can access more functions or are entitled to more responsibilities [77], it is crucial to **reduce explicit power dynamics** [168, 207]. This means it should be avoided to have a single key user in charge of a system. Even though this may foster communication and generate a high sense of social connectedness, particularly belongingness, it also induces dependency on a single group member, consequently suppressing social control experience. Further, it is sensed as unfair and reduces motivation to engage in the decision-making process. While switching key users (*Token-Ring*) might be one option to consider, we want to stress that this limits the continuous contribution of every

user involved. Particularly in situations where the execution of tasks may significantly impact the experience in everyday shared spaces (e.g., media, lights), we recommend avoiding the key user approach. Instead, focus on the self-determination and entrustment of users to promote higher levels of social control experience.

15.6 Conclusion

Grounded in our insights, we presented in this chapter five recommendations for social control experience design for media. Their main focus refers to the **encouragement of communication, balancing control & participation, generating shared experience, and preventing conflicts.** While the recommendations report on the main, overarching patterns observed that positively constitute social control experience and capture crucial discoveries, they can be incompatible with one another. This implies the necessity to accurately define the aim of the system to be designed in relation to its user group, the technology involved, and the tasks performed in which environmental setting. Even if this is achieved, it can be a non-trivial challenge for researchers, designers, and practitioners to navigate through the recommendations to design a media product or system towards social control experience. As a next step, we provide in Part VII tools that help to reflect on the recommendations and support designing more effortlessly towards social control experience for media.

VII

Design Support Tools

Part VII, **Design Support Tools**, consists of two chapters that provide researchers, designers, and practitioners support toward social control experience design. It provides instruments to design for a diverse group of users in terms of values. Furthermore, it demonstrates a card-based design toolkit that makes the design recommendations more accessible to enrich social control experiences for media in other domains or use cases. Thus, the main research question of this part refers to RQ6 – *How do the modes for social control experience transfer to other application domains and how to support the design for social control experience in the future?*

Chapter 16 – Social Control Experience for Everyone: Considering Users' Values, looks into how personal human values can support the design of social control experience for user groups representing various media behavior, independent of the culture.

Chapter 17 – Social Control Experience Design: A Toolkit, reports on a card-based design tool to support generation, ideation, and reflection of ideas toward enriched social control experience.

Transferring Recommendations into Design Tools

The investigations of social control experience in the automotive and smart home domains showed overarching patterns that constitute social control experience for media. To generalize and transfer our insights, we outlined recommendations for social control experience design in Chapter 15. However, promoting collaboration is generally complex because it demands designing for a diverse group of users under consideration of contextual characteristics such as the environment, tasks, and technology available. Designing for social control experience in future scenarios requires additional reflection on the recommendations proposed. Yet, the recommendations can be conflicting with one another and their importance will depend on the use case and context.

Thus, we see the need to provide design tools to support and guide researchers, designers, and practitioners from the industry to effortlessly design for social control experience. Therefore, we focus on two aspects: First, on the challenge of designing collaborative media systems for a diverse, dynamic user group. The dynamics of a group can vary due to individuals' abilities, know-how, experiences, and needs [199, 227], as well as personality traits (e.g., personal values) [4, 236]. Thus. we see the necessity to understand how we can assist the user-centered design process to consider users' long-term values, which are culturally independent [236]. Hence, we provide eight value-based personas (Chapter 16). Due to their values focus, instead of needs focus, they are generally practical and independent of the context. When combined, they reflect a diverse user group that can support the design of collaborative media systems toward enhanced group experience. Furthermore, focusing on values during the design process allows reflecting on personas' long-term motivational factors, which can provide the possibility to design products or systems toward long-term usage and group experience. This is expected to positively affect users' satisfaction which in turn can increase customer loyalty and the business value of a product, system, or design. Secondly, we provide a card-based design toolkit to bridge the gap between the theory and practice of social control experience design (Chapter 17). With this toolkit, we support ideating, designing, and reflecting on collaborative media systems toward social control experience in various domains and use cases. Through the cards, we provide easy access to the taxonomy and the design recommendations. Together with the value-based personas and self-defined design challenges, it enables reflection on generated shared experiences and consequences of the design choices.


Simone
Age 54 years
Relationship Married
Home town Zurich
Profession CTO IT company

CHAPTER 16

Social Control Experience for Everyone: Considering Users` Values

This chapter is based on the following publications:

Melanie Berger*, Guillaume Pottier, Bastian Pfleging, and Regina Bernhaupt. 2022. Considering Users' Personal Values in User-Centered Design Processes for Media and Entertainment Services. In: *Bernhaupt, R., Ardito, C., Sauer, S. (eds) Human-Centered Software Engineering. HCSE 2022. Lecture Notes in Computer Science*, vol 13482. Springer, Cham. https://doi.org/10.1007/978-3-031-14785-2_8

Melanie Berger*, Regina Bernhaupt, and Guillaume Pottier. 2022. Global News or Romantic Movies: How Customer Values are Key for the Entertainment Experience. In: *International Broadcasting Convention (IBC 2022)*, London, GB, Link: https://www.ibc.org/download?ac=21859

* primary, responsible researcher

Abstract

Creating technology that facilitates social control experience is a multifaceted process that demands a deep awareness of users, tasks, surroundings, and technical abilities. As obtained through our insights, the context influences the evoked social control experience on media. While we can carefully define and design the technological aspect under consideration of environmental variables, dealing with a diverse set of users in the design process of a collaborative system is not trivial. Yet, the dynamics of a group can vary due to individuals' abilities, know-how, experiences, and needs, as well as distinct norms or personality types. Moreover, the preferences of media can also differ among users. To better support the future design of social control experience, we look in this chapter into whether and how individuals' characteristics, particularly their overall life-guiding principles, such as values, influence the way of media consumption. Therefore, this chapter presents the outcome of an online web survey study that investigates the relationship between users' values and media behavior. Results show that the way users consume media is defined and influenced by users' values. To address diverse media behaviors in the future design of social control experience, we propose a set of value-based personas. These personas, on the one hand, can guide the design through a human-centered design approach, while they also form the base of the toolkit in Chapter 17. Overall, this chapter adds to the research question of How to support the design for social control experience in the future?

16.1 Introduction

For the design of interactive media systems, currently, the key to success is a design that focuses on flexibility and personalized content to provide a similar experience to what a smartphone provides [35, 50]. Content on media libraries is provided in an app-oriented portal. Especially latest developments in media applications (e.g., *Spotify, Amazon Prime, Netflix*) show that supporting long-term User Experience (UX) through personalized recommendations [58, 124, 170] is at the center of the development of the next generation of media services [36, 219]. Furthermore, additional features are accessible by using secondary devices like smartphones or tablets, which allow users to enjoy content on different platforms [41, 50] or enable them to share experiences via social media [115], or directly with others. However, the main practice in the media industry still lies in the promotion of individual UX. Further, recent design and development trends neglect more user-centered approaches and rather establish plan-driven (waterfall) development processes [21, 203].

Hence, the design of media applications lacks the ability to understand the long-term usage of entertainment systems and services as well as the focus on the generation of shared experiences. Thus, it limits shared control among co-located users in everyday private, shared spaces. Consequently, restricting the generation of social control experience. The design to enhance media experience has primarily focused on users' short-term needs – the need to be entertained, informed, distracted, or relaxed [50, 153]. This neglects a focus on users' long-term life goals [36], which can have an impact on long-term experience when using a service or product. Key aspects of how peoples' behavior changes over time and what they strive for in their lives are guided by their life goals, defined as values [236, 237]. Values guide beliefs, convictions, and daily activities [237]. In comparison to needs, they are long-term oriented, culturally independent, explain the motivational bases of attitudes [236], are motivating, and direct decision-making processes [236, 237]. Consequently, values implicitly define overarching goals that reflect the interest of individuals across cultures. Further, values also guide the decision on which products to buy [7], consequently affecting the business value of a product on the market.

In this work, we explore if values can be a useful psychological concept to reflect diverse

users across cultures and thus support the design of social control experience. Therefore, we look into whether values define users' preferences and experiences when consuming media or using certain media products (e.g., smart TVs, smart speakers, remote controls). Based on insight into the relationship between users' values and media consumption, we aim to tailor the User-Centered Design (UCD) approach toward more value orientation by proposing a set of value-based personas to better support the design of collaborative media products.

The dynamics of a group can vary due to individuals' abilities, know-how, experiences, and needs [199, 227], as well as personal characteristics (e.g., personal values) [4, 236]. Thus, we see the necessity to understand how we can assist the UCD process to consider users' long-term values, which are culturally independent [236]. Hence, we provide eight value-based personas (Chapter 16). Due to their values focus, instead of needs focus, they are long-term valid, independent of the context, and reflect diverse motivational factors that can form a user group. Thus, we expect to support the design of collaborative media systems toward long-term group experience and support the design of products toward customer loyalty.

16.2 Background & Related Work

The Theory of Basic Human Values

Basic human values are defined as "*concepts or beliefs about desirable end states or behaviors, that transcend specific situations, guide selection or evaluation of behavior and events*" [237] and are used to "*explain the motivational bases of attitudes and behavior*" [236]. Thus, human values are goals that arise from different desires and situations and are guiding principles in a person's life. Values define different goals that reflect the interests of an individual. They are motivating and provide directions, as well as emotional intensity. Values also act as judgments and justifications for actions and are acquired through both social groups and unique learning experiences [235]. Overall, values are critical motivators of behaviors, actions, and attitudes [236]. The theory of basic human values from Schwartz et al. [236] reports four main value groups with between two and up to five values per group (see Figure 16.1):

- **Openness to Change:** People who are highly into openness to change strive for the independence of thought and actions and are ready for changes [236]. Values: self-direction, stimulation, hedonism.
- **Self-Enhancement:** People highly into self-enhancement emphasize the pursuit of one's interests and strive for success and dominance over others [236]. Values: hedonism, achievement, power, face.
- **Conservation:** People highly into conservation emphasize order, self-restriction, preservation of the past, and resistance to change [236]. Values: face, security, tradition, conformity, humanity.
- **Self-Transcendence:** People highly into self-transcendence emphasize concern for the welfare and interests of others [236]. Values: humanity, benevolence, universalism.

Overall, there are 12 values (for value group alignment, see Figure 16.1) that are unique to one another as they underlie different motivational factors and therefore represent different overall life goals. The more apart values are presented in Figure 16.1, the more different the underlying motivational factors are (e.g., values opposite to each other like Achievement vs. Benevolence). Overall, these values and their representative groups apply to all humans, independent of their religion or culture [236].

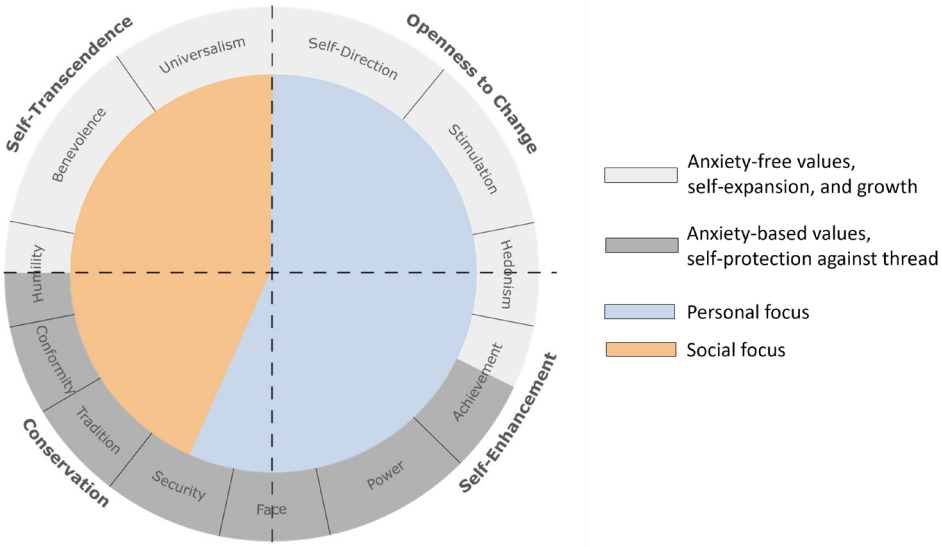

Figure 16.1: The four different value groups (quadrants) and their underlying values (gray cycle) - visualization adapted from [236].

16.3 Problem Description

While Allen et al. report that users' values can impact buying decisions [7], little is known about how those values affect media consumption and how users' values can be integrated into UCD approaches for supporting the design of social control experience. We believe that if designers consider users' values, and tailor their products to support one or several values better, their products can enhance the group experience on a long-term basis. However, as of now, little is known about how values (1) are connected to users' media behavior, (2) shift over time, and (3) how this can be considered in the design of future interactive, collaborative media systems. Thus, we answer the following research questions:

How do values impact users' media behavior and consumption? How can we design future products that take the value changes and their effect on media behavior into consideration?

16.4 Method: Survey Study

We conducted a web survey in December 2021 on SurveyMonkey[1] and focused on the assessment of the user's value shifts over the past five years and the accompanying changes in their media behavior and media consumption. We used the Short Schwartz Values Survey (SSVS) [43, 151] to assess participants' values with ten validated questions, one question per value (power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity, and security) (the SSVS can be found in Appendix B). Participants were asked for each value to decide on a 9-point Likert scale if the value is of supreme importance for them (= 8) or opposed to their principle (= 0) [43, 151]. To determine a person's main value group, the average scores of the individual values questions per value group were processed according to Lindeman et al. [151]. For entertainment-oriented features, we asked three questions based on a 7-point Likert scale (extremely important to not important at all) referring to five important media categories [244]: audio (e.g., music streaming, radio, and podcast), video (traditional TV, video on demand, and video sharing platforms), news, social

1 https://www.surveymonkey.com/, last accessed: 2023-03-23

media (e.g., Facebook, Instagram), and digital communities (e.g., Reddit). The survey was performed with a German-speaking audience. An overview of the translated questions can be found in Table 16.1. To assess the values shift over the past five years each participant answered the SSVS and entertainment-oriented questions twice. Besides that, the survey also included demographic questions (age, gender, home country) and questions related to technological equipment owned and entertainment services used.

16.5 Results: Media Consumption and User's Values

The recruitment of participants was outsourced to a professional agency[2]. Overall, 144 people from German-speaking households (Germany = 93, Austria = 39, Switzerland = 11, Other = 1) participated in the survey study. Participants' average age was *M=38.15* years (*SD=7.42years*), ranging from 23 to 61. 65 participants identified as women and 79 as men. Filling out the survey took an average of 17 minutes. Overall, 103 out of 144 participants use free or cable TV, 94 video-on-demand services, and 106 indicated using social media.

Value Shift

Comparing the changes in media behavior and the related value changes – based on the four value groups, between now and five years ago, we performed non-parametric Wilcoxon tests due to the ordinal nature of the data. Investigating the value shift, our data outlines that participants are today significantly more into universalism ($Z = 2.79$, $p = .005$) and benevolence ($Z = -2.64$, $p = .008$) than 5 years ago. Overall, we found that participants are nowadays significantly more into the value group of Self-Transcendence ($Z = -3.25$, $p = .001$) compared to five years ago. Even though participants value security today more ($Z = -2.99$, $p = .003$), a value shift towards the group of Conservation could not be observed ($Z = -1.56$, $p = .119$). In addition, there is a slight increase in the importance of self-direction ($Z = -2.99$, $p = .052$). However, the overall value group of Openness to Change does not show any difference between now and then ($Z = -.188$, $p = .851$). Besides that, there was also no difference observed for any values connected to the group of Self-Enhancement or the group itself ($Z = -.311$, $p = .756$).

Media Consumption Change

Regarding media consumption and usage, our data outlines that having a big screen for watching media content ($Z = -2.108$, $p = .035$), having access to content at any time ($Z = -3.145$, $p = .002$), and watching videos without interruption (e.g., advertisements) ($Z = -3.159$, $p = .002$) is nowadays more important than it was five years ago.

Survey questions	
Viewing online movies that match my interests (e.g., via Netflix, Prime)	Having access to local news
Watching TV shows at the time of broadcasting	Having access to news from all over the world
Watching TV programs/videos in media libraries	Listening to music whenever possible
Record TV content to (re)watch later	Using digital community platforms (e.g., Reddit, Twitch)
Watching movies on a large screen	Using social media platforms to stay in contact with friends
Choose from a variety of content (e.g., movies, genres)	Using social media to be informed about other people
Access to media when I want and where I want	Consumption of media because I want to inform myself
Watching a movie without interruption (e.g. by others or by advertising)	Consumption of media because I enjoy it
Movie Marathon (e.g., movie night, binge-watching)	Usage of devices made from sustainable raw materials
Watching short videos (duration 15 sec to 3 min)	Usage of sustainably produced devices
Consumption of media because I can relax	Consumption of media to get inspired

Table 16.1: Overview of the questions asked (translated from German to English) to assess the media behavior in relation to users' values

2 we thank ruwido austria GmbH for the additional financial support conducting this study.

In addition, users strive significantly stronger for the content of their interests ($Z = -5.445$, $p < .001$), access to both local ($Z = -4.284$, $p < .001$) and global news ($Z = -2.865$, $p = .004$), and the possibility to listen to music at any time ($Z = -2.161$, $p = .031$). However, watching shows or content directly from live TV broadcasts is nowadays less important than it was in the past ($Z = 2.980$, $p = .003$). Apart from these changes, users report that accessing online libraries and being able to select from a variety of different content is still as important as it was in the past. This also holds for having access to social media to stay informed about other people and to connect with friends. In addition, it is important that media is relaxing, inspiring, fun, and entertaining and enables one to gain knowledge. Besides that, we observed dependencies of features and functions (correlation). For instance, when users use an online video library, they want to be able to select from a variety of different content ($r(142) = .710$, $p < .001$). Users also prefer a big screen in combination with different content ($r(142) = .717$, $p < .001$). In addition, when having access to a variety of content, users seek access at any time at any place ($r(142) = .718$, $p < .001$). When it comes to making a buying decision, a product that provides additional features (e.g., voice control, 3D, or virtual reality) should be compatible with different devices (e.g., smart home) ($r(142) = .748$, $p < .001$). In addition, a product out of renewable resources should also be produced sustainably ($r(142) = .905$, $p < .001$).

Media Consumption based on Users' Values

To understand the media consumption based on users' values, we looked detailed into those answers from $n=99$ participants that could be attributed unambiguously to one of the value groups as their most important one. We excluded cases that reported having two or more value groups of similar importance. We investigated how important the assessed media characteristics are for certain value groups. In Figure 16.2, we outline the main characteristics for each value group ranging from highly important (+++) to not important at all (---) (also a 7-point Likert scale as used in the survey). We report in the following only statistically significant differences between value groups. Survey participants reported Self-Transcendence as their most important value group (*42.4%*), showed a higher interest in sustainability-oriented offers and products, and would

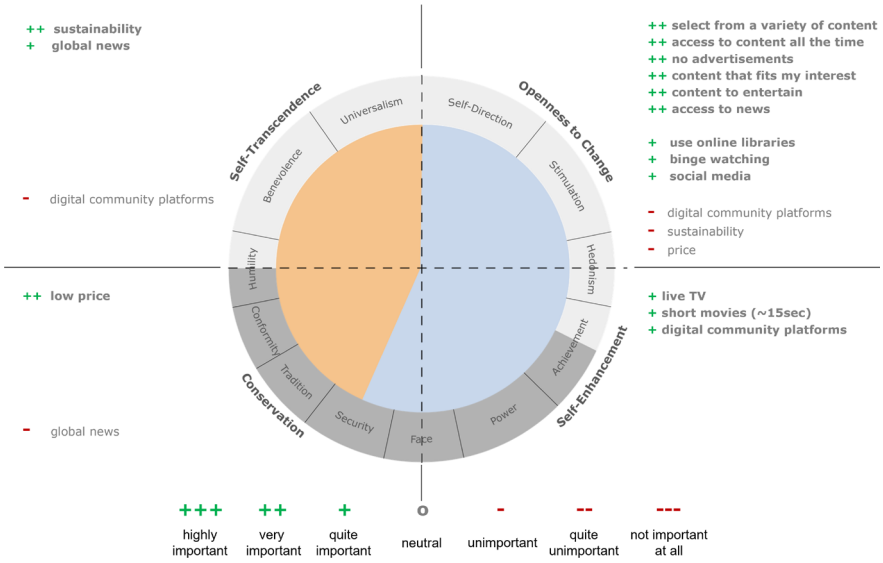

Figure 16.2: Importance of media characteristics depending on users' main value group. Importance ranges from highly important (+++) to not important at all (---).

be interested in entertainment services supporting their behaviors and choices to support sustainable lifestyles. Their main interest lies in global news, while they perceive digital community platforms (e.g., Facebook) as one of the services they would not value long-term. Openness to change is a key value for *18.2%* of the participants. They are eager to have access to content at all times, want to select from a broad variety of content, value services where content fits their interest (to be entertained, to receive news as key categories), and in general, prefer advertisement-free services. They are the group that is into binge-watching the most and value social media as an information source. Global news is least important to participants who self-reported Conservation as their central value (*32.3%*). This group has only one key indicator when it comes to media entertainment: price. They are the least likely to spend money to accept ideas on how to support a more sustainable lifestyle, and their local environment and surroundings are key for media entertainment-related choices. With only *7.1%* of participants who identify with Self-Enhancement as a key value for life, this is the smallest group in terms of representation in the overall survey sample. This group values live-TV and short movies and, not surprisingly, wants to use community platforms the most.

16.6 Value-Based Persona

To support the design of social control experience, we defined eight typical, differential persona types depending on key values, associated with media behavior as well as media service affinities. Figure 16.3 shows how the eight personas are distributed over the different values, based on the original description of the Schwartz values theory [236]. Overall, a persona should be bold and represent unique characteristics [52]. Since every value group consists of two or more values with a unique motivational background [236, 237], we created only two personas per value group. This allowed us to cover every value group as best as possible with bold personas while not involving too many personas, which might make design decisions impossible [52]. These total eight personas are defined by a unique, underlying value in combination with the associated media behavior investigated through our media survey. Since values are long-term oriented guiding principles, these specific types of persona

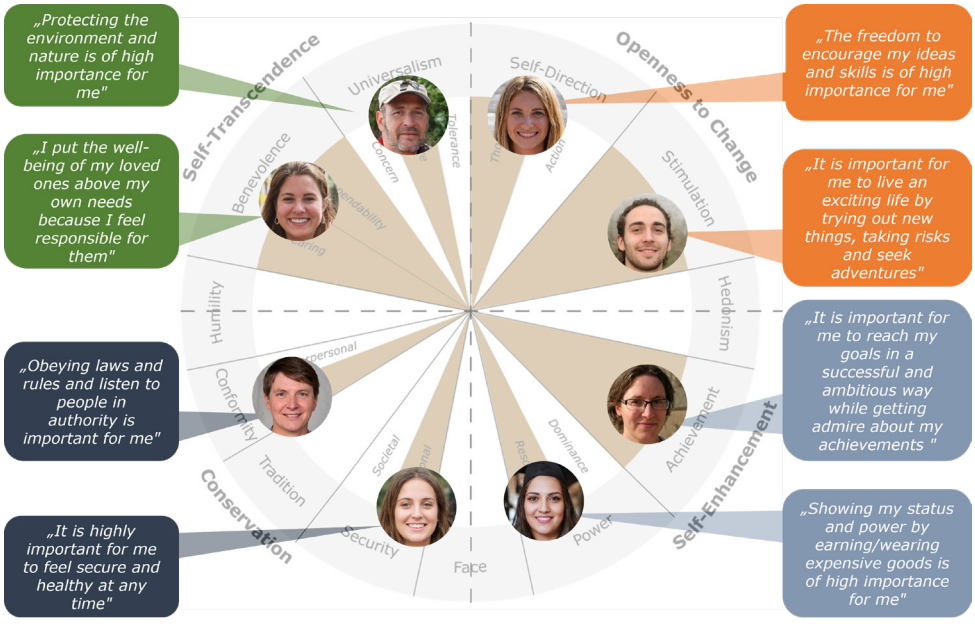

Figure 16.3: The defined eight personas, aligned with their underlying main value of the Schwartz value theory [233] (fictional people, images generated using this-person-does-not-exist.com)

Persona		Value	Quote	Media Behavior
Openess to Change				
	**Marie**	Self-Direction	"The freedom to encourage my ideas and skills is of high importance for me"	Access to media all the time; Knowledge gain through media
	**Luke**	Stimulation	„It is important for me to live an exciting life by trying out new things, taking risks, and seeking adventures"	Variety of content; Binge-watching
Self-Enhancement				
	**Simone**	Achievement	„It is important for me to reach my goals in a successful and ambitious way while getting admired for my achievements „	Quick information via short movies and clips
	**Sylvia**	Power	„Showing my status and power by earning/wearing expensive goods is of high importance for me"	Connection with others via digital community platforms
Conservation				
	**Anna**	Security	„It is highly important for me to feel secureand healthy at any time"	No changes
	**Mark**	Conformity	„Obeying laws and rules and listening to people in authority is important for me"	Low price
Self-Transcendence				
	**Diana**	Benevolence	„I put the well-being of my loved ones above my own needs because I feel responsible for them"	Access to global and local news
	**Anton**	Universalism	„Protecting the environment and nature is of high importance for me"	Sustainable media consumption; Sustainable media products

Table 16.2: Detailed overview of the name, underlying value, quote, and media behavior of the eight defined personas. (fictional people, images generated using this-person-does-not-exist.com[3])

support designers in making decisions beyond what normal need-oriented personas would enable. Thus, they enable implicitly to design for long-term values instead of short-term needs which helps the design for a broader user group, and more diverse users by focusing on overarching values in addition to instant gratification. Table 16.2[3] provides an overview of all personas and their main characteristics derived from their values and media behavior.

Usage of a Value-Based Persona

In Figure 16.4 & 16.5 we demonstrate the usage of the value-based persona Marie for the idea generation of an in-car media user interface for passengers through brainstorming sessions. Since the focus of this chapter lies in the creation of the persona rather than on the exploration of ideas through the usage of persona, we limit the information provided to the persona preparation. For the brainstorming session, the persona Marie got extended with domain-specific behavior. In this case with behavior related to being a car passenger (see 16.4). Furthermore, we extended the value-based persona with a scenario related to traveling as a passenger (see Figure 16.5). For the brainstorming session, we handed out to every participant these two cards in printed form.

16.7 Discussion

The personas in this work represent the values and media behavior of users from middle Europe, with a focus on German-speaking audiences. These types of personas describe users differently, allowing them to segment users into value groups and enabling media product design to be focusing on long-term oriented users' values [236, 237] when it comes to understanding key moments for collaborative decision-making as well as long-term UX. To maximize products toward social control experience, designers, producers, and marketers must take into account as many of these life-defining values as possible when conceiving products, content, and marketing pieces for collaborative usage. To do so, they have to identify how users' values interfere with their product or service. As an example, a new streaming platform offering social network features will please the "benevolence" (sharing experiences with others, staying in touch) and "power" (displaying wealth, themselves) value

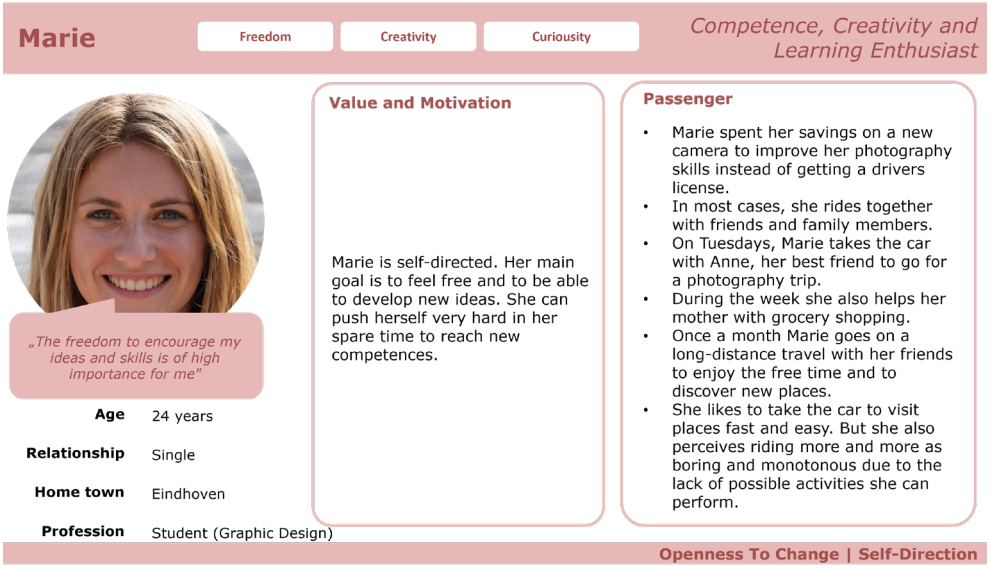

Figure 16.4: Value-based persona Marie which includes a behavioral description of being a passenger.

3 https://this-person-does-not-exist.com/en, last accessed: 2023-05-22

groups the most while displeasing the "security" group who might have concerns about the use of their personal data when using the system. The personas can help identify every group's apprehensions about a feature, positive or negative, thus also promoting the design of collaborative, interactive systems toward enhanced social interaction. This methodological approach is also valuable when looking into communication between stakeholders. They can serve as means to discuss different features that might be contradicting social control experiences. Moreover, they can help to align requirements like the business handling aspects (e.g., payment processes), security requirements, technical requirements (bandwidth when it comes to streaming, infrastructure like set-top-boxes, etc.), and user-oriented properties. For instance, when designing for collaborative, interactive media systems it is difficult to discuss which key features should be most important for which user types in terms of values. Even though values are independent of cultures [235], the relationship between values and media behavior might not be transferable to other cultures and regions. The value-based personas linked to their media behavior require cautious usage when employed for designing products beyond the Mid-European, German-speaking culture.

16.8 Conclusion

Is there a relationship between which values people self-identify and the media that they consume? Is it beyond the simple fact that it would affect the buying decision of a product [7]? And if there is a relation, how could we benefit from this knowledge when it comes to the design of social control experience? Motivated by these questions, we have been demonstrating in this work how human values, in general, define the way users consume media and how they influence users' media behavior. We further used these insights to enhance UCD processes to support the design of interactive, collaborative systems for groups of users with different personality traits. Therefore, we developed a set of eight value-based personas to guide future designers toward the generation of shared experiences and social control experiences. Thus, the contribution of this chapter is two-fold: first, we investigated the relation between users' values and media behavior and outline that human values affect not only users' buying decisions [7], instead, they also influence what and which type of media users consume. Second, we made a methodological contribution by developing long-term-oriented value-based personas that can help in a UCD process of entertainment services to better design for social control experience due to the ability to focus on values, ultimately considering diverse users in a group setting. As a next step, we will make use of these personas in the design of collaborative media systems for social control experience.

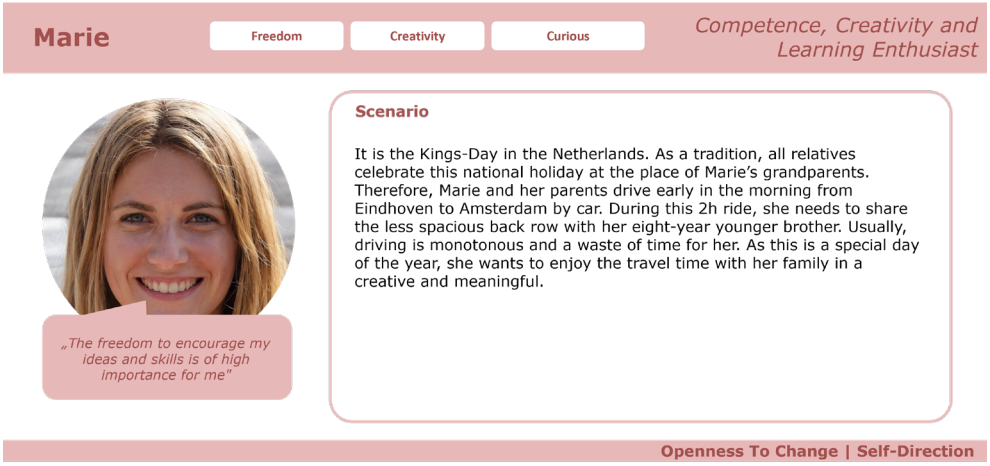

Figure 16.5: Value-based persona Marie including a scenario description related to passenger experience.


No dependency
Collaborative Characteristics
Not needing something or someone's support to continue
Collaborative Characteristics
Collaborative Characteristics
Suppresses communic
Reduces the communic
talks less
Collaborative Characteristics
No particip
Not taki
Collaborative Characteristics
TOKEN-RING CONTROL
ANARCHIC CONTROL
ERARCHICAL CONTROL
TIC

CHAPTER 17

The Social Control Experience Ideation Toolkit

Abstract

Verbal as well as non-verbal communication enables us to express our needs and exchange thoughts. However, when deciding on media content together with others, there are reports of increasing exclusion and limited social exchange since verbal communication is often not enough to participate in the decision-making process. The technologies that enable the selection of media content in everyday private, shared spaces are not necessarily designed to support the collaborative selection of content among co-located users. Yet, limiting active participation in decision-making among co-located users can increase frustration, detach users despite being physically close and thus impact social engagement negatively. Furthermore, there is a lack of design tools to support the focus of designing media systems toward collaborative control and enhanced social control experience. Therefore, in this chapter, we focus on the research question "How do the modes from the taxonomy for social control experience design transfer to other application domains, and how to support the design for social control experience in the future?" We thus created the Social Control Experience Ideation Toolkit, a card-based design toolkit to support designers and practitioners to create interactive, collaborative media systems toward social control experience. The toolkit was developed using an interactive design process involving designers and researchers across two workshops with a total of 12 participants. In this chapter, we first report on the initial toolkit version and its evaluation and outline important insights gained toward improvement. We conclude with a demonstration of the final Social Control Experience Ideation Toolkit.

17.1 Introduction

Through advances in technology, media content is nowadays accessible at any time on nearly every digital device, independent of the user's location (e.g., TV, smartphone, laptop). Established innovations, especially in the living room or inside the car, are digital movie libraries or (shared) music playlists (e.g., [100, 117, 245]). Even though media gets most commonly consumed in private, shared spaces [85, 176], deciding on media content is limited to verbal negotiation. Current, established interactive systems for entertainment purposes leave the control of media content still to a single person. Hence, people often sit nearby at home or in the car not being able to participate in the control of entertainment services.

Research reports that limiting people in the participation in decision-making processes causes social conflicts and frustration [133] and impacts togetherness as well as group experience negatively [23, 28]. As evident from this thesis' investigations, (Chapters 7 to 12), users aim to be actively involved in decision-making. Designing interactive media systems with shared control among co-located users enhances the overall group experience while also promoting togetherness, belongingness, and the creation of a social bond. Further, collaboratively choosing media content supported by technology leads more likely to a decision every user is satisfied with, consequently promoting co-experience (Chapter 13).

Prior work provides a deep understanding of mediating efficient and effective collaboration by means of technology [69, 95, 136]. Even though shared control is an important topic, particularly when designing safety-critical control systems (e.g., [77]), there is little support for designers to enable collaborative control among co-located users. Although researchers have investigated design frameworks for general collaborative system design [77] and implemented toolkits to promote the design of communication systems to connect people over distance [149], there is a lack of tools dedicated to designing everyday media technology used in private, shared spaces toward shared control.

This chapter bridges the gap between theory and practice by introducing the Social Control Experience Ideation Toolkit. Thus, this card-based design tool supports designers and

practitioners in ideating and designing shared control of media systems in everyday, private, shared spaces to enrich social control experience. We report on the creation of the toolkit and its evaluation by means of a workshop involving 12 participants. The workshop was designed to understand the following research question:

What is the value of the toolkit when designing for social control experience - designing collaborative, interactive media systems for co-located users in private, shared spaces?

The contribution is twofold: First, to help both designers and practitioners leverage social control experiences in everyday shared media systems, we contribute the Social Control Experience Ideation Toolkit as a novel card-based design tool. Second, to enable the design of collaborative systems for diverse users to improve group experience, we contribute implications for considering value-based personas in the design process.

17.2 Background & Related Work

Research in Human-Computer Interaction (HCI) outlines a variety of methods to bridge the gap between theory and practice. Mainly focused on the early design stages, common methods include personas, scenarios [52], probing studies [42], focus groups [218], and a variety of toolkits. In particular, card-based toolkits are used to provide structure to the design process [260] and thus are often employed in early design stages to support ideation, reflection, and communication.

Characteristics of Card-Based Design Tools

Through physical cards, design or domain knowledge can be easily made accessible in a concise way [1]. Due to cards' tangibility, they are often seen as a playful research method, stimulating creativity and evoking discussions among designers [6]. In general, cards are a great way to provide a common understanding of a specific topic within a group, providing important information while facilitating idea generation [220]. Thus, card-based tools are valuable provocations for providing designers with inspiration [158]. According to Roy & Warren, there exist six main categories of card decks which are creative thinking and problem solving, domain-specific design, human-centered design, systematic design methods and procedures, team building and collaborative working, and futures thinking [220]. The first three form the core types of design tools, concentrating on helping designers to work systematically from problem to solution, supporting designers to focus on users and their needs throughout the whole design process, or providing additional domain-specific knowledge [220].

While card decks may facilitate creative thinking, and are an easy way to provide knowledge and understanding related to a specific topic [220, 260], there is also the risk of overloading users with too much information [220]. Especially in this case, it can take too long until designers get used to the cards, which reduces engagement and efficiency of the toolkit itself [6]. Therefore Alkhuzia & Denisova outline design heuristics for card-based toolkits [6]. The most important aspect refers to the content of the cards, which needs to be effortlessly understandable [6]. Recommendations refer to plain and simple language when outlining theory insights while not overloading the cards with content [6]. Furthermore, cards representing different categories should be easily distinguishable, e.g., by color or general design [6]. Moreover, the text should be readily readable. Therefore, attention needs to be paid to the contrast between the colors used [6]. Depending on the purpose of the cards, visuals or images can be a useful addition to stimulate engagement and creativity (e.g., PLEX Cards [154], UX Needs Cards [143]). However, attention needs to be paid when selecting images to not induce biased behavior due to eye-catching images that attract designers more than other cards [6]. Overall, card-based design tools "provide inspiration and challenge designers to take another point of view" [260]. Moreover, cards can provide examples and explanations for novice users and can make ideation processes faster, more efficient, and fun [6].

17.3 Introducing the Toolkit

To address the challenge of designing for social control experience among co-located users through collaborative, interactive systems with shared control, we developed the Social Control Experience Ideation Toolkit. This toolkit aims to make social control experience design more accessible to designers and practitioners and enable the design of concepts with shared control from the beginning of the design process. Since diverse stakeholders might be involved in designing and developing collaborative media systems for co-located users, the card-based toolkit primarily focuses on designers and practitioners developing interactive (collaborative) media systems. The materials used to support this aim were reviewed and developed by the researchers through a 1-month iterative design process. The first version of the Social Control Experience Ideation Toolkit consists of five primary components: 51 *ideation cards* (divided into 4 categories), 6 *personas*, 2 *scenarios*, and a *physical think-space*. In the following, we report on the information considered that led to the definition and content of the cards.

Designing the Social Control Experience Cards

For the design of the cards, we carefully reviewed key factors of social control experience. This involved what makes and defines social control experience (Section 5.1) as well as the findings of the investigations reported in this thesis (Chapter 14). Further, we looked into the aspect of media, more precisely into users' media usage and behavior.

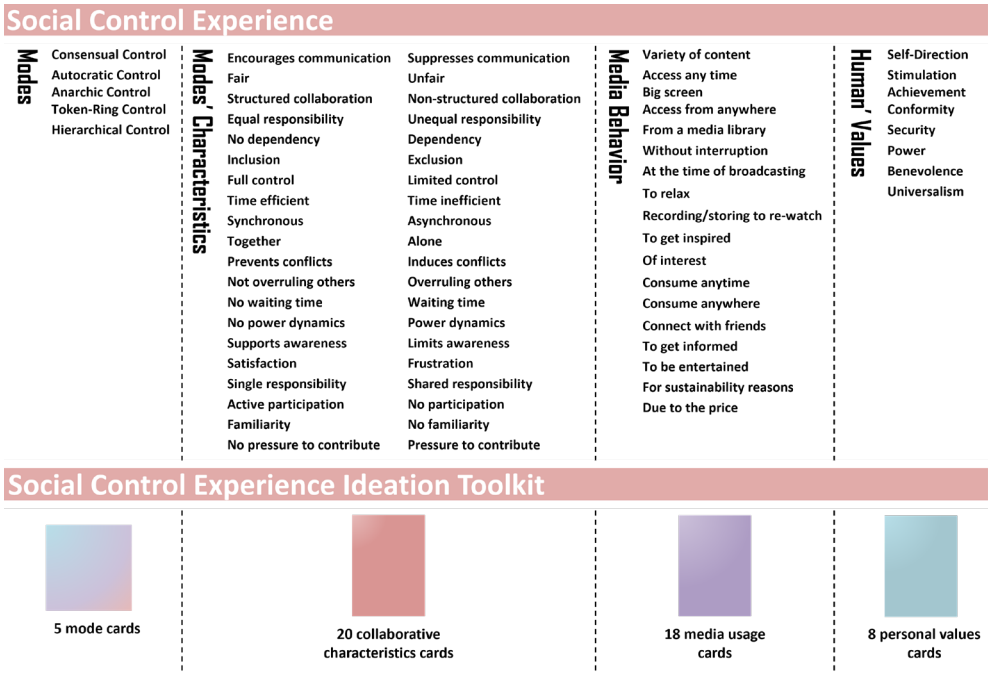

Figure 17.1: Overview of how the insights concerning social control experience, media behavior [31], and human values [31] have been transformed into the toolkit. The modes derived from Chapter 5, the modes Characteristics from Chapter 14, the Media Behavior from Chapter 16 along with Schwartz et al. Human Values [236].

Defining the Focus of the Cards

Drawing on the notation of social control experience, we selected the modes of shared control from the taxonomy (Section 5.3) as the theoretical basis for the Social Control Experience Ideation Toolkit. Thus, we created a single card for the five modes (*Consensual, Hierarchical, Autocratic, Token-Ring*, and *Anarchic mode*). This mode set forms the basis of the toolkit and stimulates how control among co-located users can be shared.

Identifying the Key Concepts of Social Control Experience

In order to ground discussion among designers in terms of what experience, limitations, and consequences the individual modes may evoke when applied to an interactive, collaborative system, we chose to define the collaborative characteristics card deck. We, therefore, combined the attributes of the modes (decision-makers, time-based collaboration, (un) restricted control, active contribution making; Section 5.3) with the insights gained through the investigations on the modes' characteristics and generated experiences. We outline in Figure 17.1 an overview of the 40 *characteristics* included in the toolkit. These characteristics can be combined into 20 direct antonyms due to their opposite meaning. Therefore, we outline them as word pairs to report on the semantic relation.

Capturing the diverse User Groups

Designing for social control experience can be challenging due to the diverse set of users that collaborate together. Various personalities involved can make it difficult to achieve the desired experience for everyone. Values – users' life-guiding principles that motivate actions and desires [235, 236], can direct the media behavior (as outlined in Chapter 16) and guide product preferences [7]. Therefore, we decided to involve values in the design process to facilitate the design of collaborative systems. Thus, we created a *Human Values card deck* that consists of 8 cards, reflecting the eight values defined by Schwartz et al. [236]. Every value card is only available once to meditate on the diversity of groups and challenge the design.

Identifying the Key Concepts of Media Behavior

Through prior exploration (Chapter 16), we identified key aspects of media behavior that are guided by users' personal values. Therefore, we incorporated a set of *media usage cards* evolving around the media behavior aspects discussed in Chapter 16. This resulted in a total of 18 cards. Details on the content are reported in Figure 17.1.

Developing the Cards' Textual and Visual Content

Every card deck represents one important category to design for social control experience. To differentiate the decks from one another, we followed the recommendation by Alkhuzia & Denisova [6] to color-code the cards. Since the mode card deck is the basis of the toolkit, we decided on coloring it gradually based on the colors of the other three card decks. For ensuring easy handling of the cards and the readability of the content, we printed them in the size of standard trading cards (8.9cm x 6.4cm).

Mode card deck: To easily identify the modes, we incorporated a visual representation on the front (from Section 5.3) along with the descriptive names. Additionally, a single-sentence description of the decision-making process was put on the back.

Collaborative Characteristics card deck: This card deck comes in red and is printed double-sided due to the semantic relation of the collaborative characteristics. One side, therefore, comes with a light red background, and the other side with a dark red background. The header of the card defines the main topic. The center of the card provides an easily

understandable and short definition of the topic, derived from either scientific literature or the Cambridge Dictionary[1].

Media Usage card deck: The media usage cards come in purple and are single-sided. The concept for each media usage card is illustrated with a single graphic and a short text similar to the UX Needs Cards [143] or Tiles Cards [177]. The corresponding graphic per card was downloaded from Unsplash[2].

Human values card deck: The value cards come in blue and are single-sided. On top is the name of the value for easy access, and at the center of the card is the short single-sentence description of the value [236].

Crafting the Context

We created the Social Control Experience Toolkit with the vision to support the early design process through an exploratory design method. Therefore, we included personas and crafted design challenges to support the reflection on possible application areas of social control experience when controlling media content. Therefore, the toolkit includes personas, design challenges, and a physical think-space.

Persona

While defining these personas, we aimed to ensure that they are diverse in age, gender, and underlying personal values. We only focused on demographic-oriented personas since our main goal was to assess the usefulness of the toolkit rather than designing for a real use case. Future toolkit users may bring in design-oriented personas that include needs, expectations, and motivations [52]. Thus, we made use of the value-based personas from Chapter 16. These included Marie, a young student; Simone, a 54-year-old and CTO of an IT company in Switzerland; Mark, a middle-aged tax officer based in Zurich; Luke, a 32-year old Bricklayer from Berlin; Sylvia, 38 years old and an architect based in Paris; Anton, an elderly already retired and living in Linz, Austria. Assigning one value to each persona might limit the stimulation of ideas because it does not offer variability in the combination of demographics and values. That's the reason we decided to detach the values from the persona and create

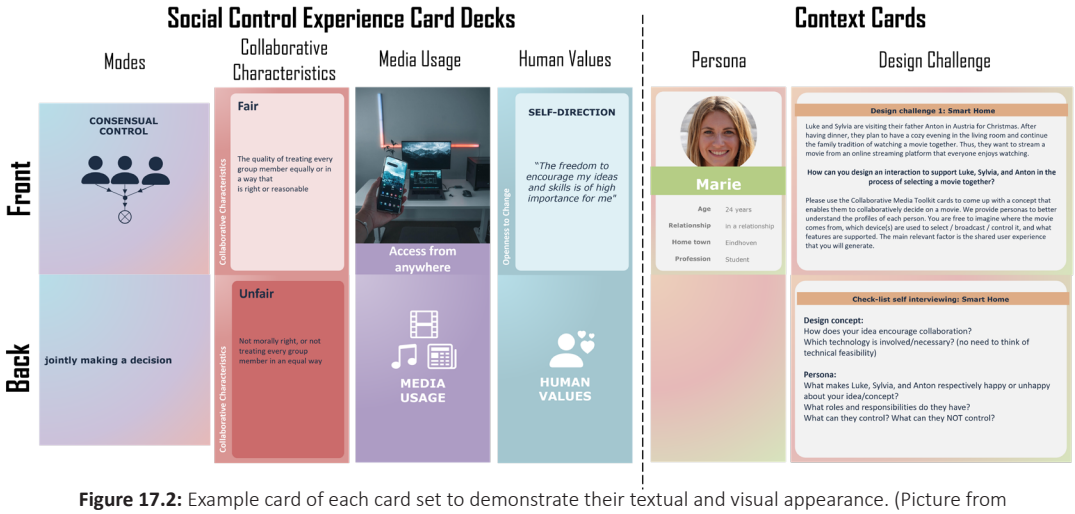

Figure 17.2: Example card of each card set to demonstrate their textual and visual appearance. (Picture from Unsplash.com, Bootstrap Icons)

1 https://dictionary.cambridge.org/, last accessed: 2023-03-21

2 https://unsplash.com/, last accessed: 2023-03-21

dedicated value cards. The persona can then be linked by the designers at the beginning of the design process with a single value card to specify the most outstanding personality trait.

Visual representation of the cards: The persona cards contain the important demographic information (i.e., age, relationship status, occupation, hometown) in table form along with a photo. To clearly distinguish the persona cards from the main social control experience cards, we made them bigger (11cm x 8cm) and decided on a gray background with a colored border.

Design Challenges

To inspire engagement with the persona and to design to enrich their social control experience, we developed 2 design challenges to evaluate the toolkit – one for the collaboration on media content in the smart home domain and one for the automotive domain in line with the thesis' objectives. These design challenges contain two elements: First, they demonstrate a scenario based on three personas and a particular problem the personas face with regard to media control. Secondly, it provides five reflective questions that should help the toolkit users to debate the role of every individual persona in the collaborative setting. The questions focus on the developed concept (how does it encourage collaboration; which technology is necessary) and on the personas (are they satisfied; do they have responsibility and options to control). A visual representation can be found in Figure 17.2, and the details of the design challenges are in Appendix C.

Visual representation of the cards: To stress the link between the persona cards and the design challenges, the cards match the visual appearance (colored border). To provide easy readability of the content and to ensure the toolkit users engage thoroughly with the design challenge, we decided to print them in the size of 12cm x 18cm (bigger than the other cards).

Preparing the Process: The physical Think-Space

Inspired by Nadal et al.'s virtual think-space [182], we developed a physical think-space. This think-space guides the designers and practitioners in using our toolkit and provides space for interacting with the Social Control Experience cards, personas, and scenarios (Figure 17.3). Our space contains two parts: First, the design context in which each persona gets linked

Figure 17.3: The think-space of Group 4 after smart home challenge session 2. It shows (left) the design context where values and media usage cards are assigned to the personas. At the right side, the mode card that describes the underlying design concept developed in combination with the collaborative characteristic cards.

with a value card and additionally with at least one media usage card (mandatory, more are possible). Secondly, the design part with space for the mode cards in combination with up to six collaborative characteristics cards. The think-space comes in A3 format and the card placeholders provided match the corresponding card decks' size and color.

17.4 Evaluating the Toolkit

We conducted a study to gather insights into researchers' experiences of using the toolkit and to understand its value for designing interactive, collaborative systems toward enhanced social control experience.

Participants

We recruited 12 researchers with a focus on HCI or (interaction) design through personal and professional networks. Participants' ages ranged from 20 to 41 with an average age of *M=31.25 years* (*SD=6.58 years*), living in either Luxembourg (8), France (3), or Germany (1). Ten identified as female, and two as male. All of them are working as researchers in either academia (6), industry (1), or both and between (5) with an average experience of *M=5.1years* (*SD=4.96 years*). This participant sample spanned multiple degrees of expertise: 5 PhD students, 3 post-doctoral researchers, 2 research assistants, 1 research associate, and 1 senior researcher. We aimed to recruit individuals with diverse backgrounds to reflect the interdisciplinary work of designing collaborative, interactive systems, resulting in a diverse range of participants specialized in social science (5), design (3), HCI (2), information science (1), and media (1). Half of the participants reported on prior experiences using a card-based design toolkit. Another five participants had previously encountered design challenges related to collaborative system design.

Figure 17.4: The lab in which the workshop was set up.

Figure 17.5: Visual representation of the workshop procedure, incl. the time spent per workshop part.

We conducted two identical workshop sessions with six participants each. Per session, we divided the participants into groups of three (a total of 4 groups). The workshop took place in person in a research lab (see Figure 17.4) supported by two facilitators. In the beginning, we collected written consent and handed out a demographic survey (Figure 17.5). This was followed by a presentation that introduced the purpose of the workshop, outlined the diverse types of cards, and reported on the agenda. The facilitator described that the groups would get two design challenges that consist of a specific use case either related to the automotive domain or the smart home domain. This use case includes three pre-defined persona cards. And that the goal of each group will be to design or re-design a media-oriented system to enable collaboration among the persona. This is done in two rounds per design challenge, which will last a total of 15 minutes (20 minutes for the very first round to get familiar with the cards) – 10 minutes for brainstorming the design solution, followed by a 5-minute self-recorded pitch of the design.

Therefore, each group received the toolkit, consisting of the modes cards, collaborative characteristics cards, media usage cards, and personal values cards. For the collaborative characteristics cards and the media usage cards, we also provided blank cards so the participants could extend the card decks in case important information was missing. For each design challenge, the groups received three persona cards and a card with the design challenge description. Moreover, each desk was equipped with sticky notes, pens, and a smartphone for the pitches. The workshop started with the automotive design challenge. In round 1, each persona card got assigned a value card and a dedicated media usage card (see Table 17.1). For round two, both value and media cards per persona got randomly selected by the participants. This procedure was repeated for the smart home design challenge. Following the workshop, each participant filled out a post-workshop feedback form that collected data about the user experience of the toolkit, personal opinions, and perceived usefulness. After that, the facilitators conducted a semi-structured group interview with all participants together about experiences, perceptions, difficulties, and opportunities for improvement. Each workshop session lasted a total of 120 minutes. Participants did not receive compensation. The study was approved by the Ethical Review Board of the Eindhoven University of Technology.

		Design Challenge					
Sessions		Automotive			Smart Home		
Session 1	Persona	**Marie**	**Simone**	**Mark**	**Luke**	**Sylvia**	**Anton**
	Value card	Self-Direction	Achievement	Conformity	Stimulation	Power	Universalism
	Media card	Withouth interruption	At the time of broadcasting	Due to the price	Withouth interruption	At the time of broadcasting	For sustainability reasons
Session 2	Persona	**Marie**	**Simone**	**Mark**	**Luke**	**Sylvia**	**Anton**
	Value card	random	random	random	random	random	random
	Media card	random	random	random	random	random	random

Table 17.1: Overview of the persona, value, and media cards used per session.

Data Collection & Analysis

We audio-recorded each workshop and interview, resulting in a total amount of 4h of audio from the workshops and 40min from the group interviews. Moreover, we collected the cards the groups used to describe their design idea per round (two per design challenge), including their self-recorded video pitch of the idea developed per session (4 pitches per group, 8 diverse designs per design challenge). Further, we conducted an open observation of the groups while working on the design challenge. The observation was conducted without the knowledge of the participants. Each was responsible for observing one group while the responsibility rotated through the workshop to reduce confounding factors. With the observations, we focused primarily on difficulties using the cards involving misinterpreting the content or not being able to understand the aim of (specific) cards. At the end of the workshop, we handed out a feedback form to every participant. We assessed the toolkit's UX through the short user experience questionnaire (UEQ-short) [234]. Further, we asked 5 questions on a 7-point marked semantic differential scale to understand how participants perceived the toolkit. We also employed six open-ended questions that users had to complete related to what they think, like, encounter, wish for improvement, and how they used the cards. Lastly, we asked them about the perceived usefulness of the toolkit for practitioners or researchers and application areas related to the design of collaboration systems or systems for users with different life-guiding values. The questions were based on a 7-point Likert scale ranging from unlikely to likely. The semi-structured final interview was guided by questions related to their opinions, perceptions, encountered problems, and areas for improvement. The survey and the interview guideline can be found in Appendix C.

For this part of the thesis, the focus lies on the evaluation of the cards themselves. Thus, the emphasis of the analysis was set on the individual feedback from the participants (group interview, feedback form). For the analysis, we first transcribed and anonymized the audio recordings. The transcripts were analyzed through an inductive thematic analysis, following the approach described by Braun & Clarke [45]. This process included getting familiar with the data first and then generating initial codes, collating codes to potential themes, reviewing the themes and defining them, and reporting on the findings. Further, we looked into the quantitative data collected through the feedback form. For the sentence completion data, we also performed an inductive, thematic analysis per question asked [45]. For the remaining ordinal scaled data collected through self-defined questions, we report the median scores and visualize the data with box-plot diagrams to show the central tendency, spread, and skewness of the answers.

17.5 Results & Findings

Every group was able to come up with a concept at the end of every session. In the following, we report on the insights gained through the feedback survey and the interview.

Usefulness of the Toolkit

Data from the questionnaires suggest that the toolkit is overall perceived as useful for both researchers and practitioners. Moreover, the toolkit is most likely useful for the design of a system for users with different life-guiding values but also for designing collaborative systems as outlined in Figure 17.7.

Qualitative data outlines that particularly the mode card deck helped to explore possibilities of supporting collaboration among the personas (e.g., "*they [mode cards] were very structuring. They were basic but they pumped the idea*", Group2#3). Notably, the persona cards, in combination with the value and media usage cards, enabled participants to specify the design idea toward the whole group, making the concept accessible and usable for everyone (e.g., "*I especially found the personas helpful to frame for whom are we*

designing?", Group3#2; "*they [values cards] are really engaging. They told you more about the persona*", Group3#1). Further, one participant pointed out the benefit for researchers to look at their own research from a different angle which also supports idea generation. Also, for practitioners, the toolkit might support thinking beyond technical limitations or business interests. Yet, two participants found the five available mode cards as rather restrictive and too conventional in designing collaborative systems (e.g., "*The control cards, these five felt like already well-explored ways of controlling something. I think this limited my creativity to some extent*", Group1#3). They also expressed their wish for a blank card to self-specify a mode (e.g., an AI mode for full automation).

Experiences generated through the Toolkit

While using the toolkit to tackle the design challenges, participants reported that they rather felt obliged to use the cards. Yet, the cards stimulated idea generation, and users were also interested in the cards. Moreover, the participants, on average, had enough time to use the cards and also felt knowledgeable enough to interact with them (Figure 17.6). Even though the toolkits' pragmatic qualities (perspicuity, efficiency, dependability) are assessed as bad, the hedonic qualities (stimulation, novelty) are good. The overall User Experience (UX) lies between below and above average (see Figure 17.8).

Through the workshop, the groups were encouraged to use the toolkit. Groups 2 and 4 expressed that the toolkit stimulated them to come up with more crazy ideas, particularly evoked through the diverse and even contradictory persona personalities (e.g., "*You have constraints. Because of this, it pushes you to think differently*", Group2#2; "*It was a really difficult combination [of cards]. But without this, we would not have come up with the trees & subscription idea*", Group4#3). While on average, the participants reported that they had enough time, some participants mentioned that they would have wished to prior explore the cards without the pressure of the design challenge (e.g., "*Just discovering the cards before you will really use them [...] because then they [the cards] encourage you more*", Group2#1). Further, Group 1 had trouble navigating through the card sets due to the enormous amount of cards which made it difficult for them to keep an overview and understand their dedicated

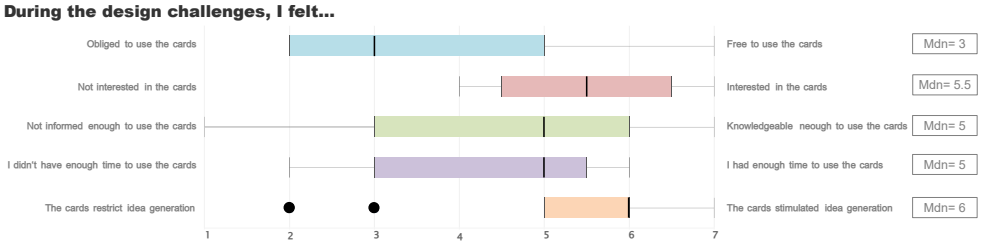

Figure 17.6: Ratings of the feelings generated while using the toolkit.

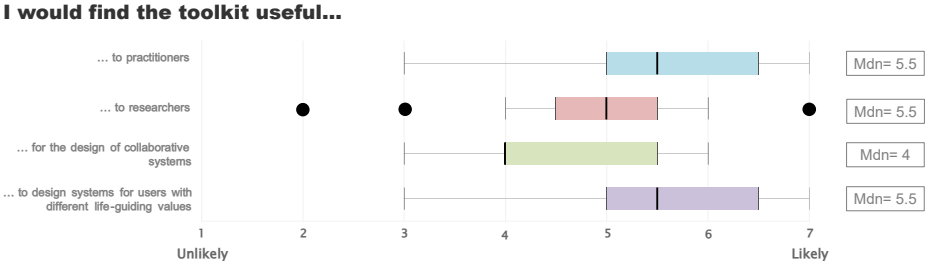

Figure 17.7: Perceived usefulness of the toolkit.

purpose (e.g., "*I had difficulty fully understanding the whole card sets because of so many items*", Group1#1). The latter can be a reason for the widespread answers of perceived knowledge to use the cards. Group 1 but also Group 3 missed a more thorough introduction on where to start and when to use the media usage or the collaborative characteristics cards. One participant expressed hesitance to use the collaborative characteristics cards due to their inclusion of negative aspects of collaboration highlighted by the use of dark-red colors (e.g., "*It was kind of unconscious that when you look at the card, there's like a side that is almost negative like you don't want to use this*", Group3#3). This caused a sense of unease or discomfort. Overall, the participants find the toolkit suitable for ideation and brainstorming (5x), *designing for a diverse group of users* (2x), *discover more ideas that have been missed by designers* (1x), and *identifying pros and cons of a design* (1x). However, there are too many cards (3x), *some of them are overlapping* (2x) or *require a clearer description* (3x), and *not all cards are compatible with one another* (3x). Even though four participants found the toolkit *overwhelming, confusing, and complex*, or *too numerous*, the majority reported that the toolkit is *playful, supportive, inventive, beautiful, clear, well-developed* and *informative* while being *helpful to think about the context of use*.

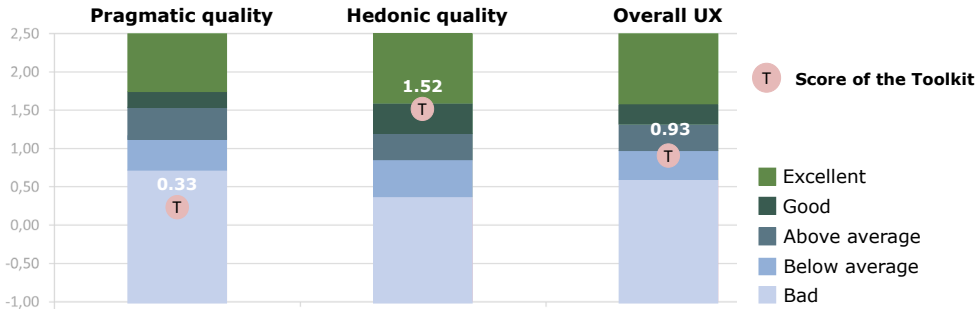

Figure 17.8: Perceived user experience assessed with the UEQ-short [234].

Insights (inductive thematic analysis)

Inductive thematic analysis of the 4 workshops (2 final interviews) provided insight into how the toolkit supports the design for social control experience, particularly its value for bridging theory and practice, stimulating designers and practitioners with idea generation.

Bridging Theory and Practice

The primary goal of this toolkit was to make the design of social control experience more accessible to designers and practitioners, ultimately supporting the design of collaborative systems with shared control. Findings from both workshop interviews highlighted the value of the toolkit in (i) challenging the designers in promoting collaboration, (ii) designing for users with varying needs and values, and (iii) grounding the idea in theory.

Challenging Designers in promoting Collaboration: Participants commented on the role of the toolkit in challenging the design of collaborative systems for co-located users. It stimulated them in developing more diverse ideas and enabled them to think outside of the box. One participant mentioned that the toolkit encourages thinking beyond individual expectations (e.g., "*You have these constraints because this pushes you to think differently than if you ideate on your own*", Group2#1). This is seen as extremely valuable for researchers working in the field of collaborative system design because it supports generating more crazy concepts than the obvious. Also, the toolkit is perceived as provoking thoughts that are more

innovative and exploratory, allowing particularly practitioners to think beyond particular business values (e.g., "*I feel these cards are super to push them [industry stakeholders] to think differently*", Group2#1). Specifically, the mode card deck, in combination with the persona cards, was found practical in structuring the design and ideation process. It guided the participants to think about various aspects of the collaborative system, including control and the role of the users in relation to their needs and values.

Designing for Users with varying Needs and Values: The toolkit also expanded designers' perception of considering the needs and values of multiple users at once during the ideation phase. Through the combination of the media and value card decks, participants were able to challenge their ideas against diverse users. This supported optimizing the concept for collaboration support and making the idea more accessible to everyone (e.g., "*I could add the different needs to make it personal [...] and accessible. Try to design product for this person*", Group2#2). Further, the value cards were described as engaging, allowing them to personalize a specific concept or design idea, consequently enhancing satisfaction and end-user engagement. Moreover, through the varying needs and value cards, designers can add and adjust the complexity of the design challenge, making the toolkit more dynamic to adjust according to designers' and researchers' main purposes (e.g., "*It is nice to flip things around and see if it [the idea] still works, or if you need to change things*", Group2#3).

Grounding Idea in Theory: The collaborative characteristics cards were mainly used in reflecting on the advances of the idea generated or to justify the collaboration mode selected in relation to the personas (e.g., "*It was more the way to evaluate our solution which we came up with*", Group2#3). Although the collaborative characteristics cards were not used for active ideation, they did promote clarifying functions or limitations and estimating the evoked experience of the concept invented (e.g.,"*It was to justify our choice and conclude about what we said but they weren't really inspiring*", Group1#3). Overall, the cards were found to be a useful tool for grounding the design in theory and ensuring that it was aligned with the collaborative characteristics that were desired for the particular design challenge. Even though some cards were too ambiguous and thus ignored (e.g., "*This one doesn't work, so let's put it aside*", Group1#1), the qualitative insights suggest that the use of the collaborative characteristics card deck can support designers in creating more theoretically grounded and conceptually coherent designs that are well-suited to the needs and values of their users.

17.6 Reflection & Discussion

Overall, the workshop showed that the Social Control Experience Ideation Toolkit is a supportive tool to design collaborative, interactive systems for co-located users. In a very limited amount of time, the participants were able to design a collaborative media system and point out the provided control authority to the individual personas. In this section, we reflect on the strength and limitations of the current toolkit version.

Strength of the Toolkit

Participants reported that the toolkit is a fun and playful way to design collaborative media systems, consequently sparking idea generation. The design process was guided by the personas, and their values, which defined the mode card best fitting to promote collaboration. The initial choice of the mode card drove the idea generation. Other cards, particularly the collaborative characteristics cards, were then excluded if they were not relevant to this particular scenario. Despite the focus on collaboration, participants refer back to the initial design challenge and the personas involved. Consequently, the most converging elements were the personas and their values in combination with the design challenge and the mode card deck. Particularly the diverse and contradictory combinations of personas, values, and

their media needs sparked creativity and made the toolkit engaging. Moreover, the dynamics and individual adjustments of the personas allowed for dynamic requirements, which enable checking whether or not a concept supports diverse user groups. This makes the toolkit a valuable addition to existing design tools which are static in user needs and motivations (e.g., standard personas [52]). Further, the collaborative characteristics cards provided information to reflect on the idea generated. This was reported to be valuable in understanding the possible advantages and disadvantages of the current idea and justifying certain functionalities with respect to the personas and their values. Even though this card deck was rich in cards and information, it was barely used for active ideation and idea generation. Reasons can relate to the content itself, which was rather reflective and not stimulating enough, the two-sided content limiting the ability to see everything at once, and the number of cards [6].

Given the originality of the toolkit and the domain-specific research area, it was critical to support the user in exploring new content. While some participants enjoyed the freedom and exploration of the novel cards, some users tended to revert to what they already knew and stuck to a few cards throughout the design challenge. While this may be attributed to the users' lack of experience with card-based toolkits, it could also be because the content of the cards was not easy to follow [6]. Nevertheless, the Social Control Experience Ideation Toolkit was successful in supporting idea generation with respect to different groups of users in terms of their values. Overall, the cards stimulated in-depth discussions among participants, which contributed to creativity and even led to extraordinary, collaborative media concepts.

Areas for Improvement

Provide Guidance for the Start: Several suggestions were made to provide a more thorough introduction to the toolkit. Some users struggled to understand where to start and where to place the cards at the physical think-space. A more effective think space design, along with a step-by-step introduction card, could have allowed for better guidance.

Visual Appearance and Content Clarity: While the decks themselves could be easily distinguished from one another, particularly the Collaborative Characteristics cards were hard to interpret. Moreover, the red color, in combination with a „negative" content side, restricted some users from thoroughly engaging with this card deck. Further, some media usage cards were vague which caused misinterpretation or non-alignment of the meaning among participants. Thus, iterating on the description and content provided is necessary to clarify the meaning of some cards. Further, changing the main color of the Collaborative Characteristics cards would prevent hesitation in usage.

Number of Cards: Although we did not exceed the recommended number of 60 cards [6], participants were overwhelmed and tended to either ignore certain cards or use the same familiar cards in all four sessions. Therefore, reducing the number of cards is recommended to ensure that all cards are considered for the design challenges.

Limitations of the Toolkit

Due to the short usage periods per design challenge, not every participant or every group had the time to explore and use all cards. Thus, the insights are limited to first-time usage of the toolkit. Further, our insights are limited to the workshops run by us. Thus, we cannot conclude on possible adaptations and usages of the toolkit by other researchers or practitioners in diverse scenarios. Additionally, we did not attempt to evaluate or rank the ideas generated. Thus, we cannot conclude about the quality and novelty of the design ideas generated. Moreover, comparing the results from the workshop was limited by the participants having diverse prior experiences with using card-based design toolkits while also being trained in understanding design methods and procedures. To focus the evaluation process on the design outcomes generated, further workshops and hands-on studies are required.

17.7 The Social Control Experience Ideation Toolkit

Through the workshop, we gained important insights into how the toolkit promotes idea generation toward enhanced social control experience and the individual card decks' usefulness. The feedback we gained outlined areas for improvement to enhance engagement with the cards and to better facilitate ideation. In this section, we report on the next iteration of the Social Control Experience Ideation Toolkit, where we incorporated feedback gained from the workshop participants. We provide a condensed summary of the new iteration's card decks and report on the feedback we've taken into account.

Integrated Feedback

We iterated on the card decks individually with regard to the number of cards, visual appearance (color, images), and their textual description provided. First, to connect the value cards better with the persona cards, we changed their color to orange, in line with the persona and scenario cards. Second, we iterated on the Collaborative Characteristics card deck. Therefore, we divide this deck into two decks – the Design Recommendations card deck and the Effects of the Collaboration card deck to encourage ideation while still enabling users to reflect on the concept and ground their idea in theory. We colored them blue and green and avoided red. Also, we added a non-collaborative mode card to the mode card deck and consolidated characteristics and media usage cards that had similar meanings. Moreover, we adjusted the physical think-space to provide a more structured ideation process and included a step-by-step instruction card.

The Social Control Experience Card Decks

The final iteration consists of a total number of 45 cards organized in five card decks. An overview of the cards' content can be found in Figure 17.9 and an example of the visual representation in Figure 17.10. First, the *Mode Card deck* has six cards, the five modes of social control experience in combination with an additional card representing the non-collaboration mode. Second, the *Design Recommendations Card deck* with 11 dedicated

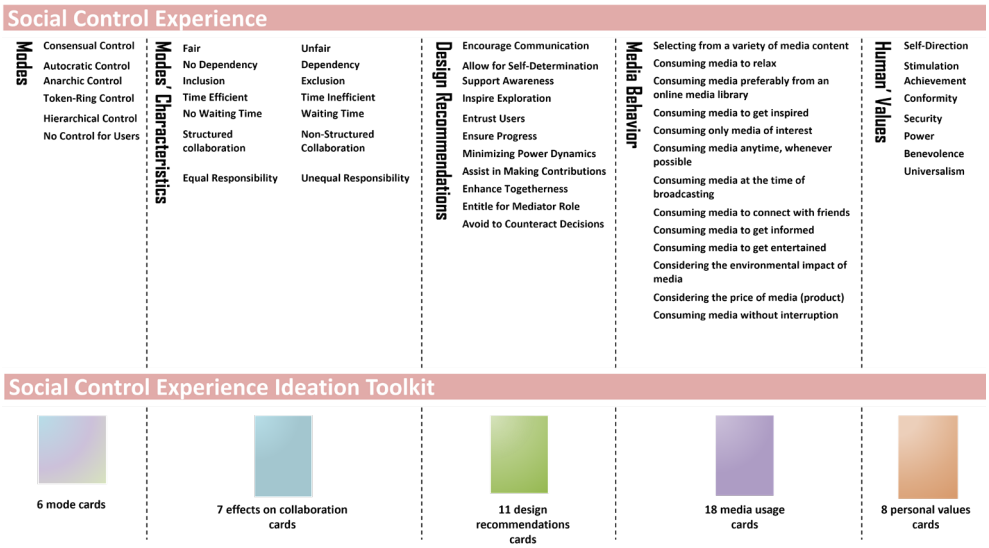

Figure 17.9: Overview of the card decks, their content, and color. The modes derived from Chapter 5, the modes Characteristics from Chapter 14, the design recommendations from Chapter 15, the Media Behaviour from Chapter 16 along with Schwartz et al. Human Values [236].

Figure 17.10: Visual representation of each card set. From left to right: the Modes card deck containing the modes from the Taxonomy (Section 5.3), the Effects on Collaboration card deck which contains consequences to support reflection on the ideas' generated experience, the Design Recommendations Card deck based on Chapter 15 to stimulate ideation, the Media Usage card deck presenting important media behavior of persona/users derived from Chapter 16, and the Human values card deck according to Schwartz et al. [236]. (Picture from Unsplash.com, Bootstrap Icons)

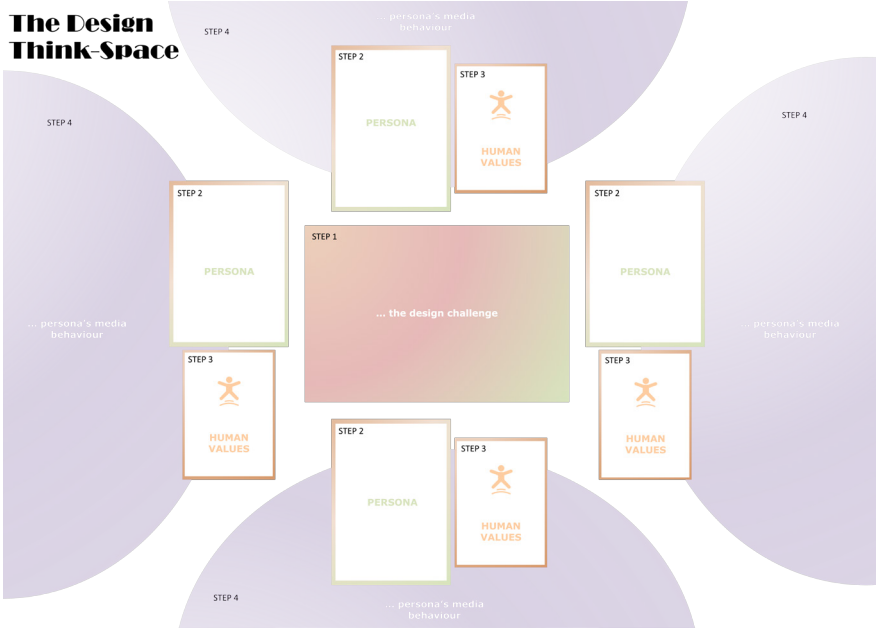

Figure 17.11: The Design Think-Space with place for the design challenge (middle) and up to four personas. Each persona can be mapped with one value card and a self-defined amount of media usage cards.

recommendations to stimulate ideation around social control experience. Thirdly, the *Effects of Collaboration Card deck*, comprising 7 double-sided cards to support reflection on the ideas' generated experience. Then, the *Media Usage Card deck* with 13 cards presenting important media behavior. Lastly, 8 value cards representing the *Human Values Card deck*.

The Context & Think-Space

The personas, and the design challenges, in combination with the think-space, allowed participants to thoroughly engage in the ideation process. While the design challenges and personas depend on the context of use, we only iterated further on the think-space. Since we observed that some participants lacked a more detailed introduction on how to use the card in combination with the think-space, we re-structured the think-space and also created a step-by-step instruction.

Physical Think-Space

We expanded the think-space with step-by-step instructions on how to use this toolkit (see Figure 17.13). This instruction first guides the set-up and familiarization phase with the design challenge, along with the personas (not a part of the toolkit), value cards, and media behavior cards. To best support this process, we created a dedicated Design Think-Space (Figure 17.11). This think-space links the instruction steps to the card placeholders highlighted through labels. Moreover, the placeholders match the size and color of the dedicated cards. We decided to limit the number of personas to 4 since the dynamics of co-located collaboration change considerably with 5 or more people [10, 222] and the toolkit is based on insights related to collaboration among 2 up to 3 users. Furthermore, the Ideation Think-Space provides room for ideating by using the modes, design recommendations, and effect on collaboration cards. To not limit ideation, this think space does not have pre-defined card placeholders.

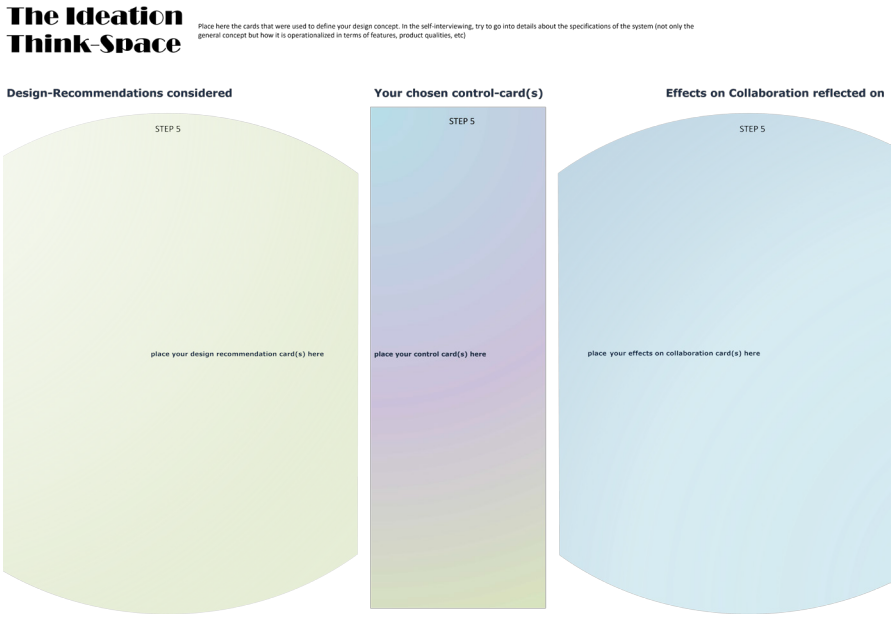

Figure 17.12: The Ideation Think-Space with place for the mode cards and design recommendations considered, including effects of collaboration cards.

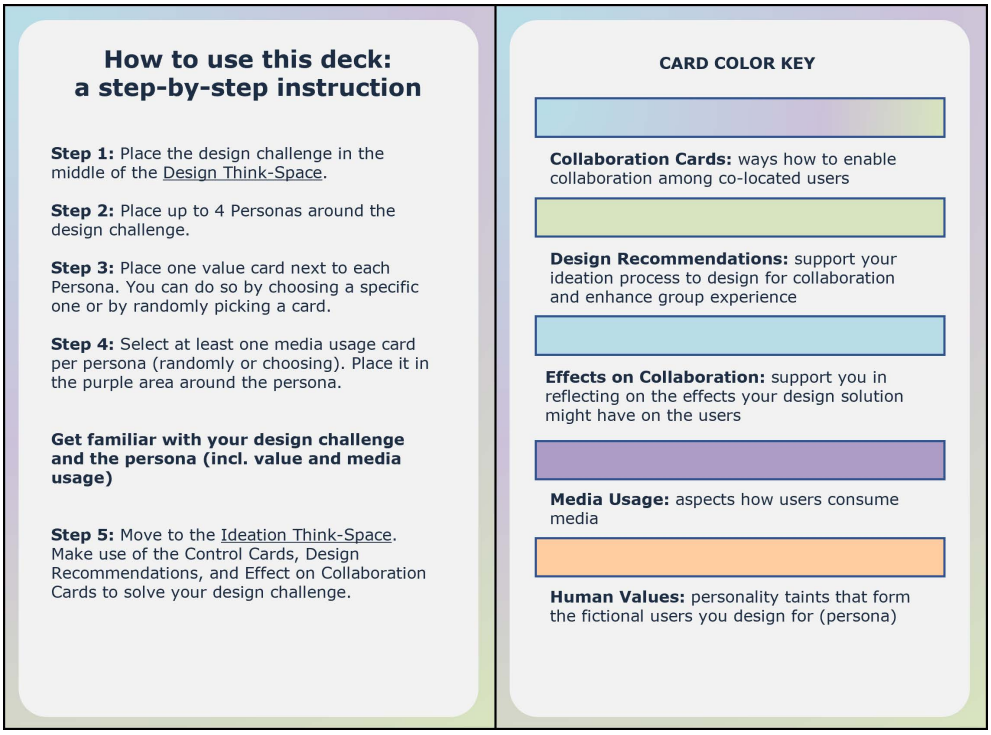

Figure 17.13: The step-by-step instruction card.

Figure 17.14: An overview of all persona cards, included in the final version of the toolkit

The Persona & Design Challenges

The personas and design challenges were created to be able to assess the card decks. This means personas and design challenges are meant to be defined by the users of the toolkit and should preferably match real cases and scenarios. Nevertheless, we decided to provide a total set of the value-based personas from Chapter 16 and also add the two design challenges created. These cards can be used for training and education purposes while they can also act as an example of how to create and formulate future design challenges. Thus, for completeness, this iteration of the toolkit contains eight value-based personas along with two design challenges related to the automotive and smart home domains. An overview of all persona cards can be found in Figure 17.14 .

17.8 Conclusion

In this chapter, we reported on the creation of a toolkit to support designers and practitioners in designing collaborative, interactive media systems for an enriched social control experience. We developed an initial set of 51 cards, grouped into 4 categories, which we evaluated in a workshop via design challenges supported by value-based personas. The insights showed that the toolkit enabled the creation of concepts that allow a diverse group of users in terms of values and media behavior to collaborate. While the cards were found to be fun, engaging, and inspiring and helped to ground the concept being developed in theory, they lacked structured and thorough support in the ideation process. We integrated the feedback by iterating on the visual and textual representation of the cards. This resulted in the Social Control Experience Toolkit: a toolkit consisting of 45 cards grouped into 5 categories, supported by 8 personas and a physical think space. Designers and practitioners can apply those cards to self-defined design challenges in combination with self-defined personas or by means of the toolkit personas. Overall, with this toolkit, we bridge the gap between theory and practice by facilitating the design of interactive media systems toward social control experience for various domains and use cases.

VIII

Conclusion

Part VIII, **Conclusion**, presents two chapters that discuss the overall implications of social control experience, answer the research questions, provide an overview of the contributions, and outline future work.

Chapter 18 – Overall Discussion & Reflection, discusses the insights according to contextual dynamics and reflects on the implications made through the cross-domain investigations as well as the design support.

Chapter 19 – Conclusion, answers the research questions, provides a detailed summary of the research contributions, and points out potential areas of future work.

CHAPTER 18

Overall Discussion & Reflection

Abstract

In this thesis, we have investigated the design for social control experience – the design of collaborative, interactive media systems with shared control to enrich individuals' experience in a group setting. In this chapter, we review the cross-domain approach to media and discuss the insights from multiple perspectives. First, we look at the benefits of shared control. Further, we discuss the considerations of social control experience for media, the role of the context, and the generalizability of our findings. Further, we reflect on the research approach, methodology, design artifacts created, and use cases designed. The chapter concludes with a statement of the general thesis limitations.

18.1 Introduction

We adopted a user-centered design approach to investigate the design for social control experience. Our work was guided by a cross-domain investigation of collaborative media systems in the automotive and smart home domains as scoped in Chapter 5. We designed and implemented fully functional collaborative media systems for the car and the living room. To evaluate the evoked social control experience we conducted controlled lab experiments in groups of two up to three people (Chapters 7, 8, 11, 12). Through the assessment of social control experience in terms of social connectedness, team performance, fairness, and co-experience in combination with qualitative insights, we obtained a comprehensive understanding of what constitutes social control experience design for media (Chapter 14). We generalized our findings by outlining design recommendations for designing social control experience (Chapter 15). To make the insights easily accessible and to support researchers, designers, and practitioners in the design of social control experience for future media use cases, we developed several design tools. First, value-based personas which promote the design of collaborative media applications for a diverse group of users in terms of media behavior (Chapter 16). Second, a card-based toolkit to guide the ideation and reflection toward social control experience design for media under the design recommendations presented (Chapter 17).

In the following Section 18.2, we will discuss the scope of social control experience as presented in Chapter 5. We discuss control and active participation, the assessment of social control experience, and the influences of the context. In Section 18.3, we reflect on the decisions made concerning approach, methodology, and research scope and their influences on our insights gained. We end the chapter with a statement of the overall thesis limitations (Section 18.4).

18.2 Discussing Social Control Experience Design

Through social control experience design, we aimed to share control among co-located users to promote active participation in media decision-making. Therefore, we outlined in Section 5.3 a taxonomy consisting of five modes *Consensual, Hierarchical, Anarchic, Autocratic*, and *Token-Ring control* to share control among users systematically. To evaluate social control experience within a group, we assessed the individuals' perceived social connectedness, team performance, fairness, and co-experience. In the following, we discuss the role of control in social control experience, the experience generated, and the domain- as well as use-case specific characteristics as influencing factors.

Shared Control and Active Participation

Interactive systems and technologies in shared spaces often restrict input to one user at a certain time. This particularly relates to media systems such as TV or sound systems. Yet, interactions or tasks performed can change the experience of others in the room [17] while active participation in control is limited [22, 185]. Through social control experience design, we explored sharing control among co-located users to enable active participation in control. Consequently, we defined control as "*to influence the situation so that it develops or keeps in a way preferred by the controlling entity*" [77].

While control can be different for individuals depending on the mode (e.g., *Hierarchical mode*), our findings show that the provided level of control does not necessarily need to lead to a change in the system's status toward the final decision. This means control in social control experience refers to the interaction with a system and the visual representation of information. Control does not require making changes that affect the experience of everyone (e.g., starting a new song or selecting a movie). Even though users appreciate having control that directly contributes toward the goal (e.g., *Anarchic, Consensual mode*), there can be situations in which users do not want to engage in decision-making [168]. Additionally, depending on the decision to be made, shared control can induce overhead [168, 207]. An example is the *Consensual mode* applied when the movie decision was already made throughout the day. Hence it means that having one user in charge of the system (*Autocratic mode*) can, in certain situations and constellations, also relate to a high social control experience. However, in everyday practice, such forms induce power dynamics [22, 168] that affect perceived inclusion and belongingness negatively. Even though users are most familiar with the *Autocratic mode*, the decision-making process depends on the openness of the user in charge to consider others' interests [146] and to also take care of everyone involved in the decision-making process. Yet, in reality, the dynamics might change, or in certain situations, agreements cannot be found easily, which demands collaborative control and thus designing for social control experience.

Our findings show that active participation beyond verbal communication (*Autocratic mode*) constitutes social control experience. Consequently, there is a need to design for shared control of media applications to enrich individuals' experience in a group setting. This is especially important when decisions could not be made before interacting with a system/application or when the decisions affect everyone's experience (e.g., music, movie selection) in a shared space. Shared control promotes social engagement, inclusion, and stimulates richer goal-oriented discussions, which enable the selection of media content every user is satisfied with, evident from the discussion in Chapter 14. However, there is no single mode from the taxonomy to achieve an excellent social control experience when designing for a specific use case or domain. Nonetheless, each mode has certain characteristics that constitute social control experience. In this thesis, we have explored the modes individually by designing collaborative media systems fully guided by a single mode from the taxonomy. Yet, we see the possibility of combining the modes in an application to enrich the social control experience in future scenarios.

The Assessment of Social Control Experience

To get a comprehensive understanding of whether and how the modes from the taxonomy concerning shared control stimulate individuals' experience in a co-located group setting, we assessed the evoked social connectedness, co-experience, fairness, and team performance. Limited participation in decision-making in shared spaces can emerge frustration [66] and thus negatively affect group bonding and social engagement. However, socially interacting with one another is fundamental for humans [223] and contributes to well-being [148, 217], defining whether someone feels comfortable expressing their needs and expectations. Furthermore, making decisions together demands communication and collaboration towards

a shared goal [83, 98]. Thus, we assessed the stimulated social connectedness, co-experience, fairness, and team performance. Through social connectedness, we could identify whether and how the modes from the taxonomy let users feel to belong to the group, support well-being, and enhance social satisfaction [217] while sustaining social exchange and helping to maintain a social bond [261]. Through team performance, we gathered insights if the group sees themselves as a single entity, pursuing a shared goal [200]. The co-experience helped to understand how others' interactions and the system involved change the experience of individuals in a group setting [17] while fairness enabled us to comprehend which role the level of control authority has. The automotive studies outlined that high efficiency and team performance do not naturally cause social connectedness and a perception of fairness (Chapter 9). Further, efficient and effective task performance, as evident from the smart home investigations do not naturally cause high co-experience and supports the selection of media content everyone is satisfied with (Chapter 13). This indicates an interplay between the individual measurements, depending on the domain and use cases.

Overall, the measures covered central aspects of the social control experience. They enabled us to get a detailed overview of whether and how shared control for media let users feel comfortable in participating and promotes the expression of needs. Since our insights also reflect varying intensities measured across the modes and domains, we argue that perceived social connectedness, team performance, fairness, and co-experience are essential factors in evaluating social control experience in the first place.

However, our findings demonstrate that there is the potential that social control experience for media gets affected by other dimensions. Noticeably from the automotive domain investigation (Chapter 7), the evoked social control experience is influenced by the perceived safety when collaborating in a safety-critical environment. Further, there is an indication that privacy and trust toward other group members affect the evoked experience, also evident from the automotive study on manual driving. Meaning that the relationship between occupants [93], but also the physical and mental ability to assist [93] influences whether and how collaboration is valued, consequently affecting the social control experience. Similarly, Marky et al. reported that perceived privacy also plays a role if visitors and homeowners feel confident sharing data in the smart home ecosystem [160]. Yet, it is currently difficult for individuals to estimate the amount of personal data collected in a particular room [160]. Nevertheless, we see the possibility that privacy perceptions influence participation in decision-making. Even if it is unclear to what extent users perceive sharing their media preferences and needs as a privacy issue, it needs to be investigated whether and how it affects the social control experience among co-located users in everyday shared spaces. Another indication directs toward task engagement to reduce the perceived amount of communication which in turn can impact social control experience. Through qualitative insights related to the *Token-Ring* and *Anarchic mode*, participants mentioned being too focused on the screen and exploring the functions available rather than coordinating and exchanging information with others (Section 7.6 & 8.6). Furthermore, participants attributed the *Consensual* and *Hierarchical mode* as fun and entertaining (e.g., Section 8.6, 11.5) because they promote content exploration and stimulate goal-oriented conversations, as discussed in Chapter 14. Thus, there is the possibility of perceived playfulness which Lucero et al. define as "*spontaneous enjoyment arising from an action*" [155], affecting social control experience, particularly for media.

Yet, active interactions with a system, being in control, and having the ability to contribute to the group goal in various forms, as discussed in Section 18.2, constitute social control experience. It is evident from the smart home investigations that interacting with the system (Chapter 11 & 12), enriches UX, individuals' satisfaction, and evokes a high level of social experience. This touches the notion of users feeling empowered through technology, meaning they can do things they would otherwise not be capable of doing [233]. Schneider et al. define empowerment in HCI as "*users given action opportunities they would not have*

without technology, thus fostering productivity, efficiency, independence, and engagement." [233]. While we introduced shared control, particularly through the *Hierarchical, Consensual, Anarchic*, and *Token-Ring control mode*, users might have ultimately experienced more power than usual when collaborating under *Autocratic mode*. This means the psychological component of feeling empowered through shared control can induce bias in perceived social control experience.

In this thesis, social connectedness, fairness, co-experience, and team performance have been thoroughly investigated in relation to social control experience. However, further research is needed to understand these measures' interconnections and possible correlations. In addition, our findings indicate that other factors may influence or constitute the generated experience through shared control. Thus, more in-depth research is required to understand the role of perceived empowerment, task engagement, playfulness, trust, privacy, and safety (in a safety-critical environment) on social control experiences.

The Role of the Domain

We conducted a cross-domain investigation to comprehensively understand social control experience for media. Various literature outline that collaboration, in general, is a complex interplay between users, environment, task, and technology (e.g., [113, 169, 231]). Our findings across the automotive and smart home domains provided overarching patterns that constitute social control experience which involves the encouragement of communication, entrusting individuals, allowing for self-determination, generating shared experiences through content exploration, minimizing power dynamics, and entitling mediator roles (see Chapter 15). However, domain-specific characteristics affect the level of evoked social control experience, consequently influencing the design of social control experience (Chapter 14). As a next step, we discuss the contextual characteristics in more detail by reflecting on the differences between the automotive and smart home domains.

The environment provides infrastructure and also induces physical characteristics [231], which are constraints when it comes to collaboration. As evident from our findings, and in line with prior work [75], verbal communication is a crucial factor to establish social control experience (Section 15.2). We found that an environment that effortlessly allows verbal communication while keeping eye contact, such as a shared living space, contributes positively toward social control experience. In contrast, replacing verbal communication by introducing technology, as evident from the automotive investigations, significantly lowers social control experience. Although the automotive and smart home domains differ in terms of motion, available space, and seating, our findings are inconclusive concerning the impact of these environmental differences on social control experience.

However, there is evidence that task performance in a safety-critical environment affects social control experience, particularly in perceived belongingness, fairness, and team performance. We attribute this to the time-critical aspect of task performance, e.g., in a manually driven car. Performing non-driving related tasks while maneuvering a car requires distributing cognitive resources while ensuring safety [127]. However, the main goal of driving is to reach a certain destination [20], so conducting NDRA as a driver is less urgent. This can cause an impact on social control experience because it generates a slight dis-alignment of the overarching goals between users, in this case, between the driver and the passengers due to the driver needing to ensure safety. Yet, in automated vehicles or the living room, every user can fully engage in collaboration since there is no need to stay situational aware. Consequently, sharing cognitive resources and needing to stay situational aware while collaborating on another task will likely negatively impact social control experience.

Supporting Social Control Experience Design

The findings discussed in Chapter 14 and in the sections above show that designing for social control experience is a complex interplay between technology, users, task, and the environment. Through the cross-domain research approach, we obtained a comprehensive overview of how the individual modes from the taxonomy contribute to social control experience in specific environments. To generalize the patterns, we framed design recommendations to support researchers, designers, and practitioners to ideate and reflect on social control experience when designing collaborative media products in everyday shared spaces.

Yet, the primary purpose of recommendations is to inform and inspire rather than provide clear guidelines. Due to the recommendations tackling diverse aspects such as communication, control, and experience generation, they can contradict one another. Further, depending on the context applied, it can be that they are not applicable or not allowed to be implemented due to restrictions or standards. Thus, it can be challenging for researchers, designers, and practitioners in the industry context to reflect on and use those recommendations.

To bridge this gap between theory and practice, we provided design tools. First, we focused on the challenge of designing collaborative media products for a diverse and dynamic group of users. Therefore, we looked into correlations between media behavior and human values and proposed value-based personas. Even though values motivate actions [236, 237], are long-term oriented [236, 237], and are also culturally independent [235], it is not yet evident whether and how those personas are beneficial when used in the user-centered design process for the design of collaborative media systems. Further, we developed a card-based design toolkit because its strength is to make design guidelines more accessible to a broader audience [1]. It provides access to the most important information required when designing for social control experience. Such comprehensive representation of details, in combination with the guidance of the toolkit itself, provides an easy entry point for researchers, designers, as well as practitioners from the industry to familiarize themselves with social control experience design. Moreover, cards are flexible in usage. They can act as inspiration and generation of initial ideas, but they can also guide a whole design process and support the reflection on decisions made [220].

Hence, such a toolkit enables the design of social control experience for media, independent of the application domain. This is a general advantage of such design tools compared to framed design recommendations [220]. Furthermore, cards can be easily expanded with further insights, or card decks can be exchanged. This opens the possibility for instance to change the focus of social control experience design by replacing the media cards. Through workshops, we evaluated and improved the initial card decks and created the Social Control Experience Ideation Toolkit. Evident from our insights, the toolkit stimulates discussion around the modes of social control experience combined with personas with diverse values and media needs. Yet, the evaluation also outlined aspects for improvement. Even though we carefully integrated the feedback, it is not evident if the current toolkit version promotes efficient and effective idea generation. In addition, there is a lack of knowledge about the quality of the ideas the toolkit can stimulate.

18

Social Control Experience Design for Media and Beyond

In this thesis, we explored social control experience for media based on the most prominent media use cases in the automotive and smart home domains, reflecting audio, information, and video content selection. This resulted in the exploration of social control experience under diverse types of media use cases. Yet, the use cases of collaborating on music selection (automotive) and movie selection (home) differ in their commitment which can be another cause for the diverse intensity of evoked social control experiences between the car and

home investigations. While a song on average takes 3.5 min[1], a decision on a movie lasts on average for 130.9 min[2]. Therefore, the generated social control experience can be affected by the commitment to the decision. Thus, research is required to understand the consequence of commitment and the type of media on social control experience.

Nevertheless, our insights demonstrated similarities that constitute social control experience for media. However, we still need to acknowledge that the limited exploration of media types does not allow us to draw an overall conclusion about the taxonomy's effectiveness in enriching social control experience for any media type. Furthermore, we scoped the investigation for media through the cross-domain approach involving the car and the living room environments. This leaves an open question of whether and how our insights concerning enriched social control experience related to media applications are transferable to other domains. To overcome this limitation, we contribute the card-based design toolkit. This toolkit supports the ideation and reflection on social control experience design for any media applications and products in various self-defined domains and contexts (see Chapter 17). Furthermore, our insights show that every mode from the taxonomy has certain qualities that constitute social control experience. Hence, we argue that the taxonomy (Section 5.3), can act as a starting point to explore social control experience design beyond media applications. Due to the systematic outline through related work, the modes can guide the general design of interactive, collaborative systems to enable shared control among co-located users.

18.3 Reflecting on Design and Research Approach

The findings of this thesis indicate that designing for shared control of media is a promising approach to enriching individuals' experience in a group setting, as obtained from our investigations in the car and a living room. Nonetheless, there are additional factors to consider regarding the design of social control experience, which we will reflect on in this section.

Domain and Use Cases

From a design perspective, the support of collaboration through shared control is relevant for various domains and use cases. In this thesis, we focused on media in the automotive and smart home domains. Therefore, we investigated social control experience based on the most prominent media use case in the respective domain. Even though we were able to outline certain influences of the domain on social control experience, finding an overlapping use case that is prominent in both domains would have allowed drawing overall conclusions on the impact of domain-specific characteristics on social control experience. Further, not all tasks performed in any shared space might be made for collaboration [179]. Moreover, specific characteristics or policies within a domain can hinder the appliance of various modes from the taxonomy due to safety regulations, limited knowledge of users, or special training required prior to the task performance, to name a few examples. Thus, research in other domains might generate further design challenges regarding the design of social control experience for media or beyond.

Measurements

In this thesis, we defined the social control experience as perceived social connectedness, co-experience, fairness, and team performance. We assessed the individuals' perception of these factors by employing validated questionnaires and self-defined questions (fairness). Through validated questionnaires, we ensured the reliability and face validity of our insights [242]. Moreover, it enabled a standardized measurement that allows for better comparability

1 https://www.musicianwave.com/whats-the-average-length-of-a-song-year/, last accessed 2023-05-22

2 https://www.statista.com/statistics/1292523/lenght-top-movies-us/, last accessed 2023-05-22

across the modes to ensure consistency of results [242]. However, self-reported data can be influenced by social desirability bias [94] – the pressure to conform to social norms and expectations, which may affect data accuracy, especially in group investigations [94]. Although our experimental evaluations ensured individual, independent responses, verbal as well as non-verbal communication is a crucial aspect of collaboration too [69, 83]. Any form of communication, as evident from the literature [75] and our insights, can constitute social control experience especially for media. However, communication cannot be fully captured through validated questionnaires. Therefore, investigating the aspect of communication, particularly looking at gestures performed, eye contact maintained, or the amount of verbal communication, can further enhance our understanding of the social control experience.

Methodology

Our insights provide evidence of enriched social control experience for media through various modes of shared control after first-time usage under highly controlled settings. Extending this research by investigating long-term usage can reveal whether specific modes can establish higher levels of social control experience, potentially leading to behavior change in groups. Therefore, studying the long-term effects of applications that enable shared control (e.g., groups of friends and families) through field studies can provide deeper, ecologically valid insights for interventions that promote behavior change when it comes to social control experience design for media or beyond.

The Variety of the Social Control Experience Modes

Through the taxonomy of social control experience, we defined five modes of how control over media functions can be shared among multiple users. Therefore, we combined the theory of decision-makers [10, 159], with the introduction of coordination policies [180], and time-based collaboration [95]. For the initial investigation of social control experience, we explored all the modes individually in this thesis. First in the automotive domain. We made use of those findings to look deeper into social control experiences for media in shared living spaces. While we evaluated all five modes inside the car, we narrowed down the modes for the investigations in the smart home based on prior findings and to comply with ethical standards as scoped in Chapter 10. Even though we only investigated three different modes in the smart home domain, it does not mean the other two modes are not worth considering when designing for social control experience in the home or beyond. While we focused on individual exploration, we only applied one dedicated mode to a certain media device or system. However, there might be situations where a combination of several modes can be more beneficial toward promoting social control experience. Since we showed evidence that every mode has certain characteristics that promote social control experience for media, they lay the groundwork for exploring further their combinations for various media use cases beyond the car and the living room.

Design Support

To make our findings easily accessible and transferable to other domains and media use cases, we designed and evaluated a card-based design toolkit. While toolkits are common practices in HCI to bridge the gap between theory and practice [220, 260], practitioners from other disciplines might have limited experiences with such tools for inspiration or ideation. Even though we incorporated step-by-step instructions to guide users through the toolkit, it can be the case that descriptions or terms on cards have slightly different meanings in various research or industry domains.

18.4 Overall Limitations

In this thesis, we researched the design of social control experience through media in the automotive and smart home domains. Correspondingly, we designed experiments with a focus on the variables we intended to study. Therefore, we limited confounding factors to ensure high internal validity. Consequently, we conducted studies in a lab environment, which allowed us to imitate real-life situations best while maintaining control over the experimental conditions. Moreover, we recruited user groups (size, relationship) corresponding to the use case to increase ecological validity. Despite the rigor of our experimental design, we need to acknowledge certain overall limitations.

Even though the scope of this thesis referred to collaboration in small groups of two up to three users that know each other, we need to acknowledge the dynamics in users' behavior, particularly the dynamics in group settings. While users' behavior is broadly studied within several research areas, e.g., HCI, and social psychology, there is no average definition of a group. Humans are complex and have diverse backgrounds, personality traits, and expectations that form their group behavior (e.g., [7, 199]). Cultural norms define yet another attribute. Even though a group might reflect a diverse set of personalities, values, and norms, the constellation and combination can introduce power dynamics or cultural norms that affect the collaborative performance of tasks and the perception of social control experience. Additionally, prior work outlines that the group size influences whether and how individuals feel to belong to the group and see the possibility to actively contribute [144, 188]. Consequently, our findings are limited by the user sample representing the socio-cultural background of Mid-Europeans only. This may limit the generalizability of our results to other populations with different social norms and cultural backgrounds.

Moreover, the insights gained in this thesis are limited to users that know or like each other. Collaboration on media in co-located spaces among strangers might evoke different experiences, which needs to be investigated in future work. Another consideration concerns that dynamics and roles assigned to users throughout the experiments were static. In real-life situations, group structures are more dynamic, with users joining and leaving, and roles might change during collaboration. Field studies in users' natural environments are necessary to understand whether and how the modes perform in more dynamic group settings under highly ecologically valid conditions. We extended existing media technologies toward collaborative usage. Even though our insights indicate a direction toward the context influencing the social control experience, we need to acknowledge the diversity in interaction modalities used (touchscreen vs. remote controls). Also, our applications only provided a static and limited amount of media content which makes it uncertain whether and how, for instance, (group) recommender systems [212] can promote social control experience. All our studies are limited to a single usage period. This makes it uncertain whether the measured experience of a mode refers to the first-time experience generated (e.g., due to novelty effects) or is induced by the mode itself. Prior work demonstrates that the perception of UX changes over time [219] and gets affected by the system/product novelty [3, 229]. Therefore, it is necessary to conduct follow-up investigations to examine whether the modes evoke social control experience over time or whether a novelty effect fades with prolonged usage.

Overall, our studies relied heavily on collecting self-reported data to gain a comprehensive understanding of users' perceived social control experience, which limits the insights concerning evoked physical interactions among users. While we performed the statistical analysis under reducing Type I errors, we acknowledge the potential of Type II errors, induced particularly due to rather limited sample sizes. Finally, while we provided a comprehensive and deep understanding of social control experience on media through the automotive and smart home domains, the modes might evoke a diverse intensity of social control experience when applied to other domains or non-media-oriented use cases. Therefore, our results should be taken cautiously when transferred to other domains or use cases.

CHAPTER 19

Conclusion

Abstract

In this final chapter, we present our main conclusion and provide an overview of the insights from this thesis. We answer the research questions we formulated at the beginning of this thesis and summarize the contributions made. Further, we set the direction for future work based on the limitations of our research and the new opportunities it opened up. This thesis investigates how to design for social control experience - the design of collaborative, interactive media systems with shared control to enrich individuals' experience in a co-located group setting. It presents findings on several aspects of collaborative media systems toward social control experience. These findings are based on insights from both qualitative and quantitative data gathered through experimental assessments of collaborative media systems with shared control in the automotive and smart home domains.

19.1 Answers to Research Questions

To thoroughly explore the topic of social control experience design for media, we raised six interconnected research questions in Chapter 2. In this section, we answer these research questions based on the findings of our research investigations.

RQ1 – What is and what constitutes social control experience? Interactive systems in everyday shared spaces limit usage often to one user at a specific time. However, changing the status of a system within shared spaces (e.g., switching radio channels, selecting a movie, adjusting lights) can affect the experience of others in the room too, not necessarily positively. Frustrations can emerge, which negatively influence group bonding, social engagement, and group experience [66]. However, interacting with one another is fundamental [223], contributes to well-being, and defines whether someone feels comfortable expressing their needs and expectations [148, 217]. Hence, social control experience design focuses on the design of collaborative, interactive systems with shared control to enrich individuals' experience in a co-located group setting. Consequently, the experience generated was characterized as the individuals' perceived social connectedness (how much someone feels to belong to a group [148]), team performance (whether the group perceives themselves as a single entity working toward an overarching goal [200]), fairness (the perceived justice and promotion of rights [189]), and co-experience (shared experience through others' interactions [17]) evoked through collaborative, interactive systems with shared control in everyday private, shared spaces (Chapter 5). Experimental insights obtained in this thesis provide evidence that social connectedness, team performance, fairness, and co-experience constitute social control experience (Chapter 18). However, these four measurements may not provide a conclusive definition of social control experience. Through the investigations of social control experience for media in the smart home and automotive domains, we identified privacy, trust, playfulness, task engagement, empowerment, and safety (in a safety-critical environment) as potential contributors or influencers of social control experience which require further research to specify their role (Section 18.2).

RQ2 – What impacts social control experience? Through literature research (Part II), we identified that co-located collaboration and social control experience is a dynamic process that gets influenced by the users involved, the tasks performed, in which environment (Section 5.2). Moreover, the technical system provided plays a crucial role in support of collaborative task performance. Thus, we concluded that the technology involved defines whether and how social control experience gets promoted. From a technology and design perspective, we identified characteristics to consider in the design of shared control to enrich the social

control experience. First, the consideration of decision-makers – those user(s) that tend to decide on behalf of the groups. Introducing coordination policies can structurally support decision-making. Hence, it requires assigning control authority to (certain) users, depending on their abilities, resulting in different access to control (everyone has access, one has access, restricted access). Thirdly, the time-based collaboration, which refers to the performance of tasks synchronously together or asynchronously one after the other. These factors guide the way of contribution making (together, alone) of individuals towards the group goal.

RQ3 – What are the different modes of shared control to design for a social control experience? To systematically explore how control over functions can be shared in order to design for social control experience, we made use of the characteristics identified through RQ2. We systematically combined the way of access to control (everyone has access, one has access, restricted access), time-based collaboration (synchronous, asynchronous), and the way of providing contribution-making for individuals (together, alone). This resulted in 12 variations, where six needed to be excluded due to contradicting characteristics, and one represented a combination of two other variations and was thus excluded as well. The remaining five variations represented five diverse modes of balancing decision-makers involved through the implementation of coordination policies. These five modes form the taxonomy for the design of social control experience that we outlined in Chapter 5, Section 5.3. Taken together, the taxonomy constitutes five diverse modes of how control over functions can be shared among co-located users: *Consensual control, Token-Ring control, Hierarchical control, Autocratic control*, and *Anarchic control*. The *Consensual control mode* allows a group to only jointly make a decision, e.g., by voting on content/functions. The *Token-Ring control mode* reflects turn-taking and thus allows only one user at a specific time to control and make decisions. The *Hierarchical control mode* assigns different levels of control authority to users while allowing them to make decisions in parallel. The *Autocratic control mode* limits control to only one user without turn-taking. The *Anarchic control mode* allows every user to control everything all the time.

RQ4 – How do the various modes affect the social control experience in the automotive and smart home domains? Our empirical findings, as discussed in Chapter 14, indicate that each mode from the taxonomy constitutes social control experience. However, the way how control gets shared among users affects the evoked intensity of social control experience in terms of social connectedness, fairness, team performance, and co-experience. Further, there is evidence of the media use case and contextual dimensions impacting social control experience. In the automotive domain, we identified significant differences among the modes concerning evoked social connectedness, team performance, and fairness. Particularly in an Automated Vehicle (AV) users prefer a fair distribution of access to functions and a continuous contribution toward the group goal, facilitated by the *Consensual* and *Autocratic control modes*. Yet, in safety-critical situations, we uncovered that efficient and effective task performance and a high feeling of safety is key and thus more important than social control experience. Consequently, users prefer the established traditional mode of *Autocratic control*. In the smart home domain, the various modes investigated resulted in a generally high social control experience with only a significant difference in evoked user experience. There was no observed difference in terms of social connectedness, social experience, and team cohesion, which let us conclude that collaboration in the living room is a general social activity that evokes a high social control experience. Yet, the preferences of the modes in the smart home domain relate to active participation and involvement in decision-making (*Consensual, Hierarchical*). Taken together, the empirical assessments provided evidence of all modes to promote social control experience. However, the way how control gets shared among users affects the intensity of evoked social control experience for media in a particular domain.

RQ5 – How do the insights across the two domains/use cases compare, and what are key differences and emerging patterns regarding the design for social control experience? Results from our studies showed differences in the evoked social control experience among the modes, use cases, and domains as discussed in Chapter 14. Even though we could not conclude on a single mode as being the best in stimulating social control experience for media, we identified overall patterns that constitute social control experience in everyday shared spaces. These patterns refer to encouraging communication, allowing for active interaction with the system, ensuring progress toward the group goal, and avoiding counteracting others' decisions. These aspects, derived from the cross-domain investigation in the smart home and automotive domains, positively affect social control experience.

RQ6 – How do the modes for social control experience transfer to other application domains, and how to support the design for social control experience in the future? In Chapter 15, we posited five design recommendations for social control experience design for media, based on the emerging patterns from the cross-domain investigation derived from RQ5. These recommendations refer to (1) the encouragement of active communication through technology while not replacing communication with technology, (2) balancing control to entrust individuals while allowing for self-determination, (3) generating shared experiences through content exploration and awareness building, (4) minimizing power dynamics and avoiding the counteracting of others' decisions, (5) entitling mediator roles and providing an initial state of collaboration. Through these recommendations, we inform and inspire the generation of future collaborative (media) systems toward the design of social control experience for various domains. Yet, it can be a non-trivial challenge for researchers, designers, and practitioners to navigate through these design recommendations while also considering possible contextual influences identified through *RQ2*. Hence, we developed two design tools to enable designing more effortlessly for social control experience. First, value-based personas (Chapter 16) which reflect a diverse user group that can support the design of collaborative media systems toward enhanced long-term group experience. Secondly, we developed a card-based design toolkit to bridge theory and practice (Chapter 17). With this toolkit, we support ideating, designing, and reflecting on collaborative media systems toward social control experience.

19.2 Research Contributions

Through the cross-domain investigation of social control experience design for media, this thesis makes the following contributions:

Main Contributions

A Taxonomy for Social Control Experience Design

The primary contribution of this thesis is the taxonomy for social control experience design, outlined in Section 5.3. This taxonomy acts as a guide for designing interactive, collaborative, multi-user media systems with shared control. Derived from interdisciplinary research fields including Human-Computer Interaction (HCI) and Computer-Supported Cooperative Work (CSCW), the taxonomy presents a set of five modes that systematically share control among co-located users. These modes differ from each other in the type of decision-makers involved, implemented coordination policy, and supported time-based collaboration. The combination of these three factors guides whether a user has (un)restricted control and can contribute actively toward the group goal. Evaluated through a cross-domain investigation of two media use cases in the automotive domain (Chapter 7 & 8) and two use cases in the smart home domain (Chapter 11 & 12), this thesis provides evidence-based insights into how each mode enriches social control experience for media among co-located users. Prevailing,

this taxonomy delivers an overview of how collaborative media systems can be designed to share control authority among multiple users to promote fairness, social connectedness, co-experience, and team performance.

Design Case Studies in the Automotive Domain

This thesis presents two comprehensive controlled lab experiments that address the social control experience for media in today's cars (Chapter 7) and future fully automated vehicles (Chapter 8). These case studies are significant contributions to the automotive research community. On the one hand, they present detailed examples of how the taxonomy can be applied to design and implement social control experience, and how this shapes individuals' experience in the car. The case studies contribute dedicated guidelines to promote social control experience and collaboration in manually driven cars (Section 7.7) and fully automated cars (Section 8.7). While the automotive research conducted, as part of this thesis, presents the value of social control experience, it also provides details for the design and implementation of future in-car applications toward collaboration support. The importance of this work is evident from the best paper award received [28].

Design Case Studies in the Smart Home Domain

Moreover, this thesis contributes two in-depth controlled lab experiments investigating the social control experience for media in shared living spaces. These case studies are noteworthy on their own since they showcase how the taxonomy can guide the collaborative selection of a movie (Chapter 11) or a genre (Chapter 12). Through the design and implementation of these use cases in the living room, we show how it shapes social control experience among people. Additionally, the experiments contribute to the respective research field of smart home system design. They demonstrate the importance of social control experience and offer insights as well as recommendations for future home applications toward the design of social control experience (Section 11.6 & 12.7).

A Toolkit for the Design of Social Control Experience

To guide researchers, designers, and practitioners in the design, setup, and implementation of social control experience, we contribute a card-based design toolkit. This toolkit bridges the gap between social control experiences' theory and practice. It facilitates the design of interactive media systems toward shared control in various domains and use cases for a diverse group of users. Therefore, it consists of five card decks that represent the taxonomy, design recommendations, effects of collaboration, media usage, and human values. Through a physical think-space, the toolkit provides an easy, engaging, and inspiring way to design for social control experience in everyday shared spaces.

Contribution to Industry

This thesis contributes to the industry through technical implementations of various ways of shared control inside the car and the living room. Further, the research insights are made transferable through design tools that can be used by practitioners from the industry to design, iterate, and reflect on new products to provide social control experience. The industry relevance of this thesis research is evident from the peer-reviewed industry publications [25, 33]. Furthermore, ruwido austria GmbH actively uses the findings as well as the design support tools (value-based personas, card-based design toolkit) to shape future TV control towards social control experience. Due to a non-disclosure agreement, more details about the activities and usages in projects cannot be reported.

Additional Contributions

In addition to the main contributions related to social control experience design, this thesis makes the following additional contributions:

Collaboration Support in Cars

We contribute insights into how driver-passenger collaboration mediated through single or multiple In-Vehicle Infotainment System (IVIS) screens affect driving performance. We also contribute to the design and implementation of a collaborative music UI for AVs (Section 8.3), and a collaborative IVIS in manually driven cars (Section 7.3).

Collaboration Support in the Living Room

We further contribute by showing different ways how to design and implement a TV UI toward collaborative interaction by multiple remote controls (Section 11.2 & 12.3). Also, we contribute that tangible interfaces have the potential to enhance movie selection and watching experience in a group setting (Chapter 12).

Design Support Toward Social Control Experience

Through the cross-domain research approach, we identified overarching patterns that constitute social control experience for media (Chapter 14). Based on these patterns, we contribute five design recommendations for the design of social control experience, which we outlined in Chapter 15. The discussion of our insights (Chapter 18) reflects the complex interplay between users, technology, environment, and task when designing for social control experience. However, designing under the user-centered design approach for a diverse and dynamic group of users that collaborate on media content together can be challenging. To support this process, we contribute with Chapter 16 value-based personas. Due to the personas' values focus, instead of needs focus, they are generally practical and independent of the context and culture. When combined, they reflect a diverse user group that can support the design of collaborative media systems toward enhanced group experience.

19.3 Research Gaps & Directions for Future Work

The findings of this thesis provided valuable insights into designing for social control experience for media. Yet, several directions for future research can expand our understanding of this topic. Therefore, in this section, we report on opportunities we see for future work. We divided these opportunities into four aspects: future work (i) that improves the research presented and addresses the limitations of this thesis, (ii) that investigates influences on social control experience, (iii) that examines the implications of the design tools, and (iv) extends the research scope.

Improving this Research

The insights presented in this thesis have a high internal validity because they are derived from controlled experiments. Moreover, the experiments were conducted with Mid-Europeans that are familiar with one another collaborating on media. Further research can investigate whether and how the design for social control experience in the car or in the living room is similar or different in other socio-cultural contexts and how they promote collaboration among strangers. Further, future work can explore the design of social control experience under more ecologically valid conditions. This includes investigations in more dynamic group situations where group sizes but also users' roles within a group change. Also, conducting longitudinal investigations, preferably in the field, are beneficial to understand the long-term effects on perceived social control experience, group experiences, and behavior.

Extending Insights into Evoked Social Control Experience

In Section 18.2, we discussed the assessment of social control experience in terms of social connectedness, team performance, fairness, and co-experience. First, our insights indicate an interplay between these individual measurements. Further, our insights suggest that perceived privacy, trust, playfulness, and the level of task engagement are possible factors that might influence or constitute social control experience. Moreover, the provided control authority can induce a perception of the empowerment of individuals. Thus, social control experience design will benefit from future work looking more detail into interconnections and correlations between social connectedness, team performance, fairness, and co-experience. Additionally, there is a need to research whether and how perceived privacy, trust, safety, empowerment, playfulness, and task engagement affect social control experience. In this thesis, we focused on assessing social control experience through self-reported data. Thus, another possible step can be to extend those insights and look deeper into whether and how designing for shared control affects verbal and non-verbal communication.

Examining Implications of Design Recommendations & Design Tools

In this thesis, we lay the groundwork for social control experience design for media. Based on empirical insights, we posit design recommendations (Chapter 15) and developed design support tools (Chapter 16 & 17). A research area of potential interest is to examine the effectiveness of the recommendations and tools concerning social control experience design. A possible first step can be to evaluate the quality of ideas stimulated by both, the recommendations and the toolkit related to design challenges similar to the use cases and domains presented in this thesis. Concepts and ideas can further be assessed through expert sessions, focus groups, or by conducting user studies. Another effort involves the appliance of the design tools to other use cases and domains. This will allow an understanding of the potential limitations or consequences of the recommendations and design tools.

Expanding the Scope: Social Control Experience in Everyday Shared Spaces

Studies in this thesis have looked at how social control experience for media can be introduced into private, shared spaces. The scope referred to collaborative media systems in the living room or a passenger car. Therefore, we concentrated on the extension of existing, established technology toward shared control (e.g., in-car screens, TV). Future work can explore the design of new systems or devices to promote social control experience or research how social control experience changes by introducing different or multiple interaction modalities. Furthermore, more use cases beyond media and other shared environments might benefit from the design of social control experience too. Related to private spaces, Niemansverdriet et al. looked into the design of shared lighting systems in office spaces [186]. A potential next step could be to understand how the taxonomy can be of use when controlling lights, temperature, or shutters in the office and how this affects the experience among working colleagues. Further, more activities get performed in various private, shared spaces that can promote the generation of shared experiences such as cooking or planning of activities to just name a few. Moreover, prior research reports on music control in public spaces such as in a restaurant to encourage communication among strangers [192]. Therefore, we see the potential for future research to investigate how to design for social control experience among strangers in diverse settings such as public transportation, museums, and public buildings. Any investigation in various use cases and application domains can expand insights on what constitutes, affects, or limits social control experience. This allows a more thorough, generalized understanding of how to design for shared control in everyday shared spaces.

Expanding the Scope: Technical Implementation

Every mode from the taxonomy has certain characteristics that constitute social control experience while there is no single mode that evokes an excellent social control experience across domains or media use cases. Thus we see that social control experience design can benefit from context-awareness because designing for context-awareness supports the adaptation of services or systems to different environments and situations [87]. In the implementation of social control experience presented in this thesis, the modes of sharing control were applied on a system level. This means that every function a system offered was guided by the same control mode. Context awareness can guide the decision of combining modes (e.g., adjusting volume under *Autocratic mode*, adding songs under *Anarchic mode*, removing songs under *Consensual mode*) or changing modes over time depending on the situation. Furthermore, the media systems developed had only a static media library available since we provided access to the most prominent music/movies only. Yet, recommending content that reflects the overall groups' interests could influence the decision-making process. Recommender systems suggest interesting content and, in addition, remove those that do not reflect the end-users interests [212]. Research shows that recommender systems can enhance UX [135], and in the situation when several people participate in a single activity, group recommendations can increase individuals' satisfaction [191]. Thus, it would be interesting to research the effect of context-awareness and recommender systems on social control experience.

In this thesis, we transferred the insights from the investigations into design recommendations and design support tools. However, another possibility would have been to focus more in detail on the technical implementation, providing technicians and software developers support in implementing interactive systems with shared control. An example, therefore, could be the creation of a task model per mode from the taxonomy. Task models describe how an interactive system is used [38]. This is particularly helpful in the early phase of the User-Centered Design cycle to understand and analyze users' behavior [38] when using an application with shared control. While a task model can be a simple textual description [38], there are also specific notations that visualize users' activities in a hierarchical way (e.g., Concurrent Task Tree Environment (CTTE) [178], Human-centered Assessment and Modeling to Support Task Engineering for Resilient Systems (HAMSTERS) [163]). Thus, generic task models of the modes can be beneficial for the implementation of collaborative, interactive systems to identify users' goals, tasks, errors, and their effect on collaboration [198], while also supporting the heuristic evaluation of the systems' usability [162] prior to launching products or systems on the market.

19.4 Concluding Remarks

The research in this thesis demonstrated social control experience design for media. Through a user-centered design approach, this thesis has investigated the design of interctive, collaborative media systems in everyday shared spaces with shared control. Based on consuming media in private shared spaces where control is limited to one user, it reports on the benefits of sharing control among multiple users. By designing and evaluating collaborative media systems in the automotive and smart home domains, this thesis contributes important insights into how shared control evokes social control experience in terms of individuals' perceived social connectedness, team performance, fairness, and co-experience. Furthermore, it posits design recommendations and provides design tools to explore the social control experience in everyday shared spaces. In conclusion, this thesis contributes to the design of interactive, collaborative multi-user media systems by demonstrating how shared control enriches individuals' experiences in a co-located group setting.

Appendix A

Social Control Experience Questionnaires

In the following, we provide the used questionnaires and surveys for the assessment of the perceived social control experience in terms of social connectedness (belongingness, affiliation, connectedness, companionship), team performance (coordination effectiveness, team cohesion), fairness, and co-experience (social experience, UX).

Team Performance Questionnaire

Table 1 shows the questions from Paul et al.'s [200] team performance questionnaire used to assess users' perceived team performance in terms of coordination effectiveness and team cohesion. The complete set of questions was used for the investigation in today's cars (Chapter 7) and the investigation in future cars (Chapter 8). The three questions concerning team cohesion were used for the investigation on movie selection (Chapter 11) and genre selection (Chapter 12). The questions got handed out in printed form, without the Item column but with the instruction: „*Please answer the following questions in relation how you were feeling while using the system you have just tested together with others.*"

Item	Question	1 (strongly agree)	2	3	4	5	6	7 (strongly disagree)
Coordination Effectiveness	I am satisfied with my communication with the team members							
	There was a clear sense of direction during discussions with the team members							
	The interactions between the group members were well organized							
Team Cohesion	Dealing with the members of the team often left me feeling irritated and frustrated							
	I had unpleasant experiences with the team							
	Negative feelings between me and the team tended to pull us apart							

Table 1: Overview of the questions from the team performance questionnaire [200], asked to assess team performance in terms of coordination effectiveness and team cohesion.

Social Connectedness Scale

Table 2 provides the Social Connectedness Scale from Lee et al. [148] which was used in this thesis's investigations, presented in Chapter 7,8, 11, and 12 to assess social connectedness in terms of companionship, connectedness, and affiliation. The questions got handed out in printed form as presented in Table 2, without the Item column including the instruction: „*Please answer the following questions in relation to how you were feeling while using the system you have just tested together with others.*"

Item	Question	1 (strongly agree)	2	3	4	5	6 (strongly disagree)
Companionship	Even around people I know, I don't feel that I really belong						
Connectedness	I feel so distant from the other people						
	I feel disconnected from the world around me						
	I don't feel related to anyone						
	I catch myself losing all sense of connectedness with society						
Affiliation	I don't feel I participate with anyone or any group						
	I have no sense of togetherness with my peers						
	Even among my friends, there is no sense of brother/sisterhood						

Table 2: Overview of the questions from the Social Connectedness Scale [148], asked to assess social connectedness in terms of companionship, connectedness, and affiliation.

Inclusion of Community in Self Scale

Table 3 presents the Inclusion of Community in Self-Scale [164] including the instructions provided which got used in the thesis Chapters 7,8, 11, and 12 to assess social connectedness in terms of belongingness.

How do you feel about the relationship between you and the other participant(s) after using the system you just tested? Please select the image below that best describes your perception of belonging. The first image - the two separate circles (a) - demonstrates no belongingness between you and other participant(s). The last image - two nearly fully overlapping circles (g) - symbolizes a maximum positive belongingness between you and the other participant (maximum group membership).

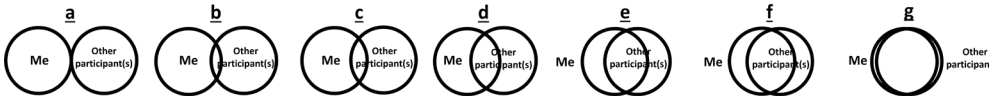

Table 3: The applied Community in Self Scale [164], to assess social connectedness in terms of belongingness.

Social Experience Questionnaire

Table 4 shows the questions used for the assessment of social experiences as a part of co-experience. These questions are derived from the GAMEFULQUEST [111]. The questions were handed out in printed form and used for the investigations on movie (Chapter 11) and genre (Chapter 12) selection. The instruction was as follows: *„Please indicate how much you agree with the following statements regarding your feelings while you were the just tested concept."*

Item	Question	1 (strongly agree)	2	3	4	5	6	7 (strongly disagree)
Social Experience	Gives me a feeling that I am not on my own							
	Gives me a sense of social support							
	Makes me feel like I am socially involved							
	Gives me a feeling of being connected to others							
	Feels like a social experience							
	Gives me a sense of having someone to share my endeavours (activities) with							
	Influences me through its social aspects							
	Gives me a sense of being noticed for what I have achieved							

Table 4: Overview of the questions used from the GAMEFULQUEST [111] to assess perceived social experience as a part of co-experience.

Fairness Questions

Table 5 shows the self-defined questions that have been used in the automotive investigations (Chapter 7, and 8) to assess users' perceived fairness in relation to the modes from the taxonomy of social control experience. The questions have been handed out in printed form (with the column related to) with the instruction: *„Please answer the following questions in relation to the system you have just tested. OPERATION OPTIONS means, in this case, the possibility to select, navigate, the UI, and so on."*

Related to	Question	1 (fully agree)	2	3	4	5 (do not agree at all)
Perception of fairness support	I think the distribution of the operating options among the group members was fair					
Perception of different control possibilities	I had the feeling that others had more operating options than I had					

Table 5: Self-defined questions asked to assess the perceived fairness of each mode of social control experience.

System Usability Scale

In the investigation in future cars (Chapter 7), as well as in the smart home investigations (Chapter 11, 12) we assessed the usability of the UI/interaction modality by means of the System Usability Scale (SUS) [47] which can be found in Figure 1.

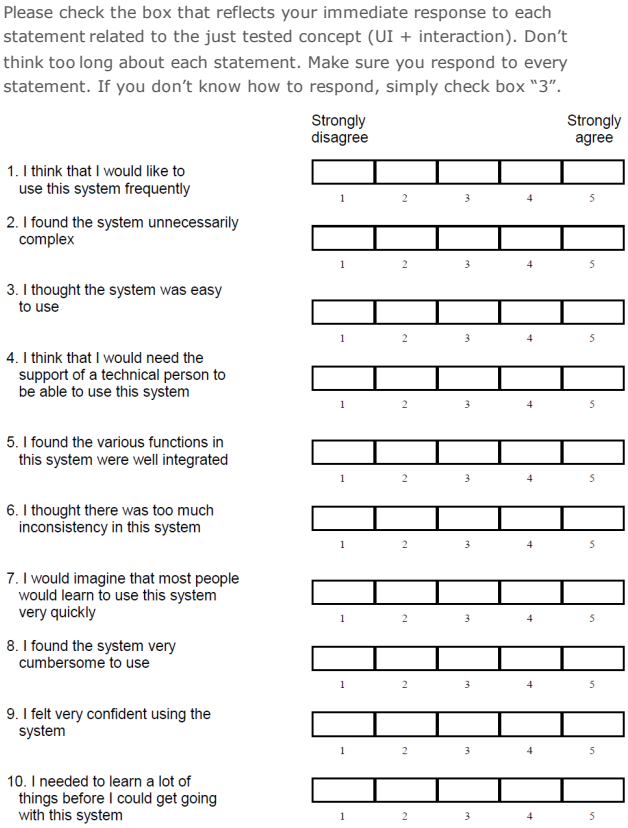

Figure 1: The System Usability Scale [47].

User Experience

In the individual investigations, we assessed the user experience by means of the UEQ-Short [234] which can be found in Figure 2. The UEQ-Short was used in all investigations, presented in Chapter 7,8, 11, and 12. We handed the questionnaire out in printed form, in combination with the following instruction: *„For the assessment of the just tested product/system, please fill out the following questionnaire. The questionnaire consists of pairs of contrasting attributes that may apply to the product. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression."*

obstructive	o o o o o o o	supportive
complicated	o o o o o o o	easy
inefficient	o o o o o o o	efficient
confusing	o o o o o o o	clear
boring	o o o o o o o	exciting
not interesting	o o o o o o o	interesting
conventional	o o o o o o o	inventive
usual	o o o o o o o	leading edge

Figure 2: The UEQ-Short [234] for the assessment of UX.

Workload

In the investigation in today's cars (Chapter 7), we assessed the perceived workload of the driver and the passenger as an influencing factor on social control experience. Therefore, we used the NASA-TLX [102] which can be found in Figure 3.

NASA Task Load Index

Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

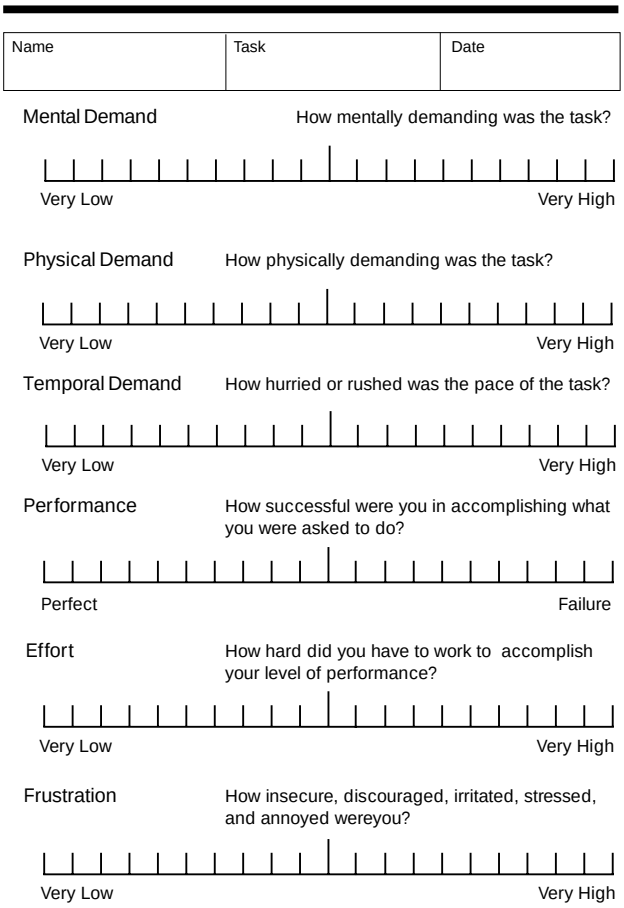

Figure 3: NASA-TLX questionnaire [102].

Appendix B

Study Materials

In this part of the thesis, we provide access to additional study materials from the individual investigations presented in Chapter 7, 8, 11, & 12.

Material Chapter 7: Investigation in Today's Cars

This section provides additional material from the investigation of social control experience in today's cars, presented in Chapter 7.

Example of Task Cards

In Figure 1, we demonstrate an example of the task card handed out prior to the test round.

Concept – E

You are driving together from Eindhoven to Amsterdam. Since this is a beautiful city with lots of sights, you want to visit some sights together. Besides that, you want to enjoy the drive, thus you want to listen to music together.

DRIVER	PASSENGER
Task 1 Scenario: You want to visit Amsterdam together. Task: Start the route to Amsterdam city. *And press the HOME button when you are finished.*	**Task 1** Scenario: Since you are into museums, you also want to visit the Rijksmuseum. Task: add the point of interest Rijksmuseum to the route. *And press the HOME button when you are finished.*
Task 2 Scenario: While driving to the museum you want to get entertained. Therefore, you want to listen to the radio. Task: start listening to radio channel SUBLIME. *And press the HOME button when you are finished.*	**Task 2** Scenario: You like to listen to music while riding. However, you are not satisfied with the current radio channel. Task: change the radio channel to QMusic. *And press the HOME button when you are finished.*
Task 3 Scenario: You are also not satisfied with the music. So you decide to select a song from your own music library. Task: Go to my Music and select the song Bang Bang by Jay-Z. *And press the HOME button when you are finished.* 	**Task 3** Scenario: You also want to listen to one of your favourite songs. Task: go to my music and add the song Beyond by Daft Punk. *And press the HOME button when you are finished.* 
Task 4 Scenario: You decided to change your plans because you want to go for lunch first. This is why you want to cancel the current route. Task: cancel the current route. *And press the HOME button when you are finished.*	**Task 3** Scenario: You are in charge of selecting the restaurant. Task: start the route to the restaurant "Dutch". *And press the HOME button when you are finished.*

Figure 1: Handed out task card prior to the concept test round. This image presents the task card of the *Anarchic* IVIS concept.

Overview of the Route from the Simulator Study

Figure 2 demonstrates the route from the simulator study that the driver had to follow for every test round of the collaborative IVIS concepts presented in Section 7.3.

Figure 2: Bird-eye view of the route that participants had to follow per tested collaborative IVIS concept.

Survey & Interview Guideline

Semi-Structured Interview Questions

Asked for each mode of social control experience:

1) How did you perceive this concept in terms of distraction? (driver)
2) How did you perceive this concept in terms of driver support? (passenger)
3) How would you describe the collaborative experience? (driver and passenger)
4) What is your impression of this concept in terms of collaboration in a car?

Asked at the end of the study:

1) Which concept was most distracting for you and why? Which concept was least distracting and why? Do you have some suggestions for improvement? (driver)
2) Which concept was best in terms of driver support? Which concept was the worst? Do you have suggestions for improvement? (passenger)
3) What was your general experience? Which concept did you like most? Which concept has the best potential in future cars- and why? (driver and passenger)

Material Chapter 8: Investigation in Future Cars

This section provides additional material from the investigation of social control experience in future cars, presented in Chapter 8.

Survey & Interview Guideline

Semi-Structured Interview Questions

Asked for each mode of social control experience:

1) What was your impression and what did you observe?
2) How did you perceive collaboration?
3) Could you imagine using this system in the future? if so - why? if not - why not?

Asked at the end of the study:

1) Which concept did you like the most? and why?
2) Which concept did you like the least? and why?

Material Chapter 11, 12: Investigations in the Home

This section provides additional material from the investigation of social control experience in the smart home domain related to movies (Chapter 11) and genre selection (Chapter 12).

Survey & Interview Guideline

Semi-Structured Interview Questions

Asked for each mode/test round of social control experience:

1) How did you perceive the decision-making process?
2) What did you like about the way you selected a movie together?
3) What did you not like about the way how you selected a movie together?
4) What was your general impression of the concept?

Asked at the end of the study:

1) Which concept did you like the most and why?
2) Which concept did you not like at all?
3) What was your overall impression in terms of collaborative movie selection?

Material Chapter 16: Social Control Experience for Everyone

This section provides additional material from Chapter 16 related to the design support tool of value-based personas.

Short-Schwartz Values Survey

In Chapter 16, we assessed participants' personal values using the Short-Schwartz Value Survey (SSVS) [151]. The survey that we put into the online survey-tool Survey-Monkey, including the instruction can be found in Figure 3.

Instructions:

Please, rate the importance of the following values as a life-guiding principle for you. Use the 8-point scale in which 0 indicates that the value is opposed to your principles, 1 indicates that the values is not important for you, 4 indicates that the values is important, and 8 indicates that the value is of supreme importance for you.

The scale:

	Opposed to my principles	Not important		Important				Of supreme importance	
POWER (social power, authority, wealth)	0	1	2	3	4	5	6	7	8
ACHIEVEMENT (success, capability, ambition, influence on people and events)	0	1	2	3	4	5	6	7	8
HEDONISM (gratification of desires, enjoyment in life, self-indulgence)	0	1	2	3	4	5	6	7	8
STIMULATION (daring, a varied and challenging life, an exciting life)	0	1	2	3	4	5	6	7	8
SELF-DIRECTION (creativity, freedom, curiosity, independence, choosing one's own goals)	0	1	2	3	4	5	6	7	8
UNIVERSALISM (broad-mindedness, beauty of nature and arts, social justice, a world at peace, equality, wisdom, unity with nature, environmental protection)	0	1	2	3	4	5	6	7	8
BENEVOLENCE (helpfulness, honesty, forgiveness, loyalty, responsibility)	0	1	2	3	4	5	6	7	8
TRADITION (respect for tradition, humbleness, accepting one's portion in life, devotion, modesty)	0	1	2	3	4	5	6	7	8
CONFORMITY (obedience, honoring parents and elders, self-discipline, politeness)	0	1	2	3	4	5	6	7	8
SECURITY (national security, family security, social order, cleanliness, reciprocation of favors)	0	1	2	3	4	5	6	7	8

Figure 3: The English version of the Short-Schwartz Value Survey (SSVS) [151].

Appendix C
Toolkit Materials

The appendix presented in this chapter provide additional material related to the Social Control Experience Ideation toolkit from Chapter 17.

The Toolkit Card Sets

Design Challenges

Figure 1 shows the two design challenges related to the smart home and automotive domains which have been used for the evaluation of the toolkit and are provided for educational purposes in the final toolkit version.

Figure 1: An overview of the design challenges.

Materials of the Study

Group Interview Questions

An overview of the questions asked in the group interview after the workshop:

What is your overall feeling about the cards?
In which aspects did the toolkit support you best? Which group of cards was most supportive?
In which aspects did the toolkit hinder you? Which group of cards did hinder you the most?
Did you use the cards often when and how?
Did the cards have an impact on the collaboration or organization or your teamwork? If yes, in what way? if not why not?
Did the cards impact in your opinion the quality of the concept/output?
What is the one thing you would change for the next version? and why and how? What is the one thing you would like to keep?

Post-Workshop Feedback Form

Feedback Questionnaire

I found the cards...

obstructive	○	○	○	○	○	○	○	**supportive**
complicated	○	○	○	○	○	○	○	**easy**
inefficient	○	○	○	○	○	○	○	**efficient**
confusing	○	○	○	○	○	○	○	**clear**
boring	○	○	○	○	○	○	○	**exciting**
not interesting	○	○	○	○	○	○	○	**interesting**
conventional	○	○	○	○	○	○	○	**inventive**
usual	○	○	○	○	○	○	○	**leading edge**

During the design challenges, I felt:

Obliged to use the cards	○	○	○	○	○	○	○	**Free to use the cards**
Not interested in the cards	○	○	○	○	○	○	○	**Interested in the cards**
Not informed enough to use the cards	○	○	○	○	○	○	○	**Knowledgeable enough to use the cards**
I didn't have enough time to use the cards	○	○	○	○	○	○	○	**I had enough time to use the cards**
The cards restrict idea generation	○	○	○	○	○	○	○	**The cards stimulate idea generation**

Complete the following sentences:

I find the cards _____
What I like about the cards is _____
The cards are suitable for _____
The problem with the cards is _____
To improve the cards, I suggest _____
We have mainly used the card for _____

I would find the toolkit useful...

...to practitioners	**Unlikely**	○	○	○	○	○	○	○	**Likely**
...to researchers	**Unlikely**	○	○	○	○	○	○	○	**Likely**
... for the design of collaborative systems	**Unlikely**	○	○	○	○	○	○	○	**Likely**
... to design systems for users with different life-guiding values	**Unlikely**	○	○	○	○	○	○	○	**Likely**

Figure 2: The post-workshop feedback form which was handd out to every participant at the end of the workshop.

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Zusammenfassung

Die Entwicklung verschiedener technischer Geräte und deren Integration in das tägliche Leben erhöhen Komfort sowie Gemütlichkeit und ermöglichen es, Aufgaben schneller und einfacher zu erledigen. Während Technologien das Leben für den Einzelnen komfortabler machen, können sie auch die Erfahrungen anderer in einem gemeinsam genutzten Raum beeinflussen. Dies gilt insbesondere für den Medienkonsum in privaten gemeinsam genutzten Räumen wie dem Büro, dem Auto oder dem Wohnzimmer. Jedoch ist die Auswahl von Musik, Filmen oder Radiosendern meist auf eine Person beschränkt und kann daher zu Machtdemonstrationen oder zu Abhängigkeiten von einzelnen Nutzern führen. Der Medienkonsum in gemeinsam genutzten Räumen beeinflusst hingegen die Erfahrungen und Erlebnisse aller. Durch die Einschränkung der Medienauswahl eines Einzelnen kann dies je nach Situation zu zwischenmenschlichen Konflikten führen, die sich negativ auf das Gemeinschaftsgefühl und das Gruppenerlebnis auswirken.

Diese Dissertation befasst sich mit der Frage, ob und wie interaktive Mediensysteme die Zusammenarbeit mehrerer Benutzer fördern können, um Gruppenerlebnisse und Gemeinschaft zu unterstützen. Unter dem Begriff „Social Control Experience Design“ konzentriert sich diese Forschungsarbeit auf die Gestaltung interaktiver, kollaborativer Systeme, die die Steuerung von Funktionen in gemeinsam genutzten Alltagsumgebungen auf Benutzern verteilen. Die Benutzer werden dadurch ermutigt, sich aktiv an der Medienauswahl zu beteiligen. Dies fördert Fairness, Zusammenarbeit, und Teamleistung was zur Bereicherung gemeinsamen Erlebens und sozialen Engagements beiträgt. Mit Hilfe eines interdisziplinären Konzepts von kollaborativen Mediensystemen im Automobil- und Smart-Home Bereich diskutiert diese Dissertation das Zusammenspiel zwischen Mensch-Computer-Interaktion und interaktivem Systemdesign. Basierend auf der Analyse der Forschung und dem aktuellen Stand der Technik werden theoretische Anforderungen an die Gestaltung kollaborativer Mediensysteme aufgezeigt. Auf Basis des nutzerzentrierten Designansatzes werden kollaborative Mediensysteme entworfen, entwickelt und experimentell im Auto und im Wohnzimmer getestet. Die Ergebnisse und Einsichten münden in Gestaltungsempfehlungen und Hilfestellungen für die nächste Generation an interaktiven, kollaborativen Mediensysteme in gemeinsam genutzten Alltagsräumen für ein verbessertes Gemeinschaftsgefühl und Gruppenerlebnis.

Included in this thesis, peer-reviewed & published

Won the best paper award

Peer-reviewed & published insights from the exploration phase, referenced in this thesis

List of Publications

2023

1. **Empowering Driver-Passenger Collaboration: Designing In-Car Systems with a focus on Social Connectedness, Fairness, and Team Performance** Melanie Berger, Debargha Dey, Aditya Dandekar, Bahareh Barati, Bastian Pfleging, and Regina Bernhaupt. International Journal of Human–Computer Interaction. https://doi.org/10.1080/10447318.2023.2205769

2. **Introducing Sharemote: A Tangible Interface for Collaborative TV Control** Melanie Berger, Rutger Verstegen, Harm van Essen and Regina Bernhaupt. In: Petrie H. et al. (eds) Human-Computer Interaction – INTERACT 2023. INTERACT 2023. Lecture Notes in Computer Science. Springer, Cham. (accepted, in press)

3. **Collaborative TV Control: Towards Co-Experience and Social Connectedness** Melanie Berger, Rutger Verstegen, Bahareh Barati, Harm van Essen, and Regina Bernhaupt. In: Petrie H. et al. (eds) Human-Computer Interaction – INTERACT 2023. INTERACT 2023. Lecture Notes in Computer Science. Springer, Cham. (accepted, in press)

4. **Designing for Collaborative Non-Driving-Related Activities in Future Cars: Fairness and Team Performance** Melanie Berger, Debargha Dey, Bahareh Barati, Bastian Pfleging, and Regina Bernhaupt. In: Proceedings of the ACM on Human-Computer Interaction, MobileHCI (MHCI), (accepted, in press)

5. **Multi-User Control of Media in Everyday Shared Spaces** Melanie Berger, Regina Bernhaupt. Position paper for the workshop 'CUI@CHI: Inclusive Design of CUIs Across Modalities and Mobilities' at the 2023 ACM CHI Conference on Human Factors in Computing Systems (CHI'23)

6. **Voices of the Past: The Promise and Perils of VUIs for Home-Based Memory Recall** Fatemeh Alizadeh, Melanie Berger, Gunnar Stevens. Position paper for the workshop 'CUI@CHI: Inclusive Design of CUIs Across Modalities and Mobilities' at the 2023 ACM CHI Conference on Human Factors in Computing Systems (CHI'23)

2022

7. **Together in the Car: A Comparison of Five Concepts to Support Driver-Passenger Collaboration** Melanie Berger, Debargha Dey, Aditya Dandekar, Bahareh Barati, Regina Bernhaupt, and Bastian Pfleging. In: 14th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI '22), September 17–20, 2022, Seoul, Republic of Korea. DOI: https://doi.org/10.1145/3543174.3544940

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Workshop Organization

25. **Authority vs. Responsibility: Workshop on Revisiting Socio-Technical System Approaches to Design for Convenient Forms of Smart Mobility** Regina Bernhaupt, Bastian Pfleging, Alexander Meschtscherjakov, Debargha Dey, and Melanie Berger. In: 14th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI '22 Adjunct), September 17–20, 2022, Seoul, Republic of Korea. DOI: https://doi.org/10.1145/3544999.3551346

Curriculum Vitæ

Melanie Berger was born on November 18, 1994 in Braunau am Inn, Austria. After obtaining a bachelor's degree in Information Technology & System Management in 2017 from the Salzburg University of Applied Sciences, Austria, she continued with a master's degree in Human-Centered Computing at the University of Applied Sciences Upper Austria, Austria. Melanie worked as a robotics & electrical engineer, project manager, software architect, and group leader for several years before and during her academic career.

In October 2019, Melanie started her PhD research within the Department of Industrial Design at the Eindhoven University of Technology, the Netherlands. Her PhD work, described in this thesis, involves developing interactive, collaborative media systems for everyday shared spaces to enrich group experience. This research project has been guided by Dr. Bahareh Barati, Dr. Harm van Essen, Prof. Dr. Bastian Pfleging, and Prof. Dr. Regina Bernhaupt and was carried out in collaboration with the industry partner, ruwido austria GmbH. Over the course of her PhD, she published and presented her work at international peer-reviewed conferences such as CHI, Interact, NordiCHI, and AutoUI, and has also received a Best Paper Award (AutoUI' 22).

Next to her research, Melanie was an active member of the departmental PhD Council and has been involved in education as a teaching assistant and coached various students at both Bachelor and Master's levels within the Future Mobility and New Futures squad. She has peer-reviewed for CHI, Interact, AutoUI, DIS, IMX, MobileHCI, and NordiCHI and was also local organization chair of the 9th International Working Conference on Human-Centered Software Engineering (HCSE' 22), hosted in Eindhoven. Melanie is also an active member of the AutoUI community, where she is currently serving as the student-volunteer chair for the AutoUI '23 conference in Ingolstadt, Germany.

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