From Assistance to Companionship
-
Designing Virtual Companions

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Timo Strohmann
geboren am 14.03.1992
in Hannover

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1. Referentin: Prof. Dr. Susanne Robra-Bissantz
2. Referent: Prof. Dr. Jan Muntermann

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Preface

I have had a passion for technology since my childhood. The world of the *Wirtschaftsinformatik* has shown me that there is much more to consider besides technology: the people who use it and the value it creates. A constant thirst for knowledge and the joy of passing it on are my daily drivers, and for this reason, I am passionate about research. Since Artificial Intelligence fascinates and inspires me, my research project should be located in this area. The idea of the Virtual Companion emerged during my research, and I strongly believe that in the future, it will be common for humans to collaborate with machines and build relationships with them.

This dissertation was carried out within the Ph.D. program „Design of Mobile Information Systems and Digital Transformation“ (GeMIDT) of Lower Saxony and conducted at the Chair of Information Management at the Technische Universität Braunschweig.

My research would not have been possible without the people who have accompanied me on this journey. First and foremost, I would like to thank my supervisor Susanne for her inspiring ideas, the valuable conversations concerning my research, and the creative freedom she gave me. I also want to thank my second supervisor Prof. Muntermann for supporting me and my dissertation, for leading the Ph.D. program and especially for his methodological input. Thanks also to my fellow students from the GeMIDT Ph.D. program for the discussions during our courses.

In particular, I would like to thank the best chair team one can imagine: the wi^2-team. Special thanks to Dominik for supporting me as a mentor during my research. Thanks to Rangina for the valuable talks and your linguistic elegance. Thanks to Felix for accompanying me in my first seminar as a teacher. Thanks to Michael for your energy and Paul for your calmness. Thanks to all the other colleagues - Thank you for an unforgettable time at the Technische Universität Braunschweig. And finally, I would like to thank all my friends and family who have accompanied and supported me on the path to my dissertation. Thank you, Alyssa, for always standing behind me, for your creativity and your mindfulness. Thanks to my parents for the way you shaped me.

Abstract

The technological progress in the field of Artificial Intelligence has already changed the way we humans interact with information technology. Chatbots take over conversations with people in customer service, and virtual assistants are available for small tasks on our smartphones. These technologies have one thing in common: they use human patterns and design features to interact with us, for example, by using natural language or a human appearance. It has already been proven that humans ascribe human attributes to these systems because of their humanization: Thus, humans are treating computers like other humans. For this reason, throughout the work on this research project, elements from interpersonal relationships and collaboration are applied to the human-machine interaction: The idea of the Virtual Companion was born. At the beginning of this research project, the focus was on investigating the use of such systems in creative contexts. By identifying a fundamental lack of design knowledge for such systems in the research domain, a more holistic approach was then taken. Through design-oriented research, design knowledge for different use cases is derived in this work, as well as specifically for the design of the proposed Virtual Companions. Later on, this dissertation will focus on a design theory for virtual companionship, as well as a design process tailored explicitly to the instantiation of Virtual Companions. For the design process itself, the use of different methods and design tools is suggested. Especially for the conceptual design phase, the Virtual Companion Canvas was created by the author of this dissertation in order to enable a creative, holistic, and user-centered design of Virtual Companions, detached from the technological implementation.

Zusammenfassung

Durch den technologischen Fortschritt im Bereich der Künstlichen Intelligenz hat sich schon heute die Art und Weise wie wir Menschen mit Informationstechnologie interagieren geändert. Chatbots übernehmen Gespräche mit Menschen im Kundenservice und virtuelle Assistenten stehen uns für kleine Aufgaben auf unseren Smartphones zur Seite. Eines haben diese Technologien gemeinsam: Sie verwenden menschliche Muster und Gestaltungsmerkmale, um mit uns zu interagieren, beispielsweise durch die Verwendung von natürlicher Sprache oder ein grundsätzliches menschliches Erscheinungsbild. Schon bewiesen ist, dass Menschen diesen Systemen durch ihre Vermenschlichung auch menschliche Attribute zuschreiben: Menschen behandeln Computer also wie Menschen. Aus diesem Grund wurden im Verlauf der Arbeit an diesem Forschungsvorhaben, Elemente aus der zwischenmenschlichen Beziehung und Zusammenarbeit, auf die Mensch-Maschine Interaktion übertragen: Die Idee des Virtual Companions war geboren. Zu Beginn des Forschungsvorhabens stand noch die Erforschung des Einsatzes solcher Systeme in kreativen Kontexten im Fokus. Durch die Identifikation eines grundsätzlichen Mangels an Gestaltungswissen für solche Systeme in der Forschungsdomäne, wurde dann ein ganzheitlicherer Ansatz verfolgt. Mittels gestaltungsorientierter Forschung wird im Rahmen dieser Arbeit Gestaltungswissen für verschiedene Anwendungsfälle hergeleitet, sowie speziell für die Gestaltung von Virtual Companions. Im späteren Verlauf widmet sich diese Dissertation der Herleitung einer Design Theorie für Virtual Companionship, sowie eines Gestaltungsprozesses, welcher speziell auf die Instanziierung von Virtual Companions zugeschnitten ist. Für den Gestaltungsprozess selbst wird die Verwendung von verschiedenen Methoden und Design Tools vorgeschlagen. Speziell für die Konzeptionsphase wurde die Virtual Companion Canvas vom Autor dieser Dissertation erschaffen, um eine kreative, ganzheitliche und nutzerzentrierte Gestaltung von Virtual Companions, losgelöst von der technologischen Umsetzung, zu ermöglichen.

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List of Acronyms

AI Artificial Intelligence.

CA Conversational Agent.

CAI Creative Artificial Intelligence.

DC Design Cycle.

DSR Design Science Research.

DSRM Design Science Research Methodology.

EBS Electronic Brainstorming.

GMDSR General Methdology of Design Science Research.

IMO Intelligent Moderator.

IS Information System.

ISDT Information Systems Design Theory.

IT Information Technology.

NLP Natural Language Processing.

PSI Parasocial Interaction.

PSR Parasocial Relationship.

RQ Research Question.

VA Virtual Assistant.

VC Virtual Companion.

CHAPTER 1

Introduction

> *Hello, Computer!*

Scotty, talking into the back of a mouse.
Star Trek IV, 1986

In the movie Star Trek IV: The Voyage Home, the crew of the USS Enterprise travels back in time - from the year 2286 to 1986. In one, scene the chief engineer Montgomery Scott (Scotty) is trying to use a 20th-century computer, by talking into the back of its mouse, thinking he could interact with the computer using his voice. The idea of interacting with a computer using spoken natural language actually first came up in 1966 in Episode 13 of the first season of Star Trek when Captain Kirk asks a computer for information.

45 years later fiction becomes reality: Apple introduces the Virtual Assistant (VA) Siri to the mass market in October 2011, enabling a broad range of people to speak with their smartphones. Even before that, Conversational Agents (CAs) were used in human-machine interaction, especially in the form of chatbots. With the achievements in the field of Artificial Intelligence (AI), CAs have become more and more powerful. With Apple's Siri the peoples' awareness of such services grew, and also other companies like Google and Amazon followed this trend. Today more and more companies are using

chatbots for their customer service, people are getting used to talking with Information Technology (IT) and especially in Information System (IS) research the design of CA is of high interest.

1.1. Topic and Context

Due to a significant technological progress in the field of AI, new innovative services and products are made possible (Maedche et al., 2016; Russell and Norvig, 2016; Seeber, Bittner, Briggs, de Vreede, et al., 2019) and especially in IS research AI-enabled systems find considerable attention (Gregor and Benbasat, 1999). With the achievements of Natural Language Processing (NLP), a sub-field of AI, computers are made capable of understanding, analyzing and potentially generating human natural language (Russell and Norvig, 2016). CAs are systems that make use of NLP to interact with humans using natural language (McTear et al., 2016; Russell and Norvig, 2016). The public interest in CAs especially grew with the introduction of Apple's Siri and later of Amazon's Alexa or the Google Assistant, which brought VAs to the smartphones and homes of many people (Diederich, Brendel, and Kolbe, 2019b; Maedche et al., 2016; McTear et al., 2016).

Besides VAs, there are also chatbots, which are distinguished from the VAs in their input/output modality. While chatbots are used on a text basis, VAs are communicated with using speech (Gnewuch, Morana, Heckmann, et al., 2018). Furthermore, they differ from chatbots by following a general-purpose approach assisting their user, like performing their daily tasks (Gnewuch, Morana, and Maedche, 2017; Guzman, 2017). Today's use cases are, for example, executing functions on the smartphone such as creating calendar entries, sending messages or asking for the weather forecast. Thus, VAs are offering a new way of interacting with IT (Morana, Friemel, et al., 2017).

The development of CAs already started in the 1960s with the chatbot ELIZA (Weizenbaum, 1966), which is considered as the first application simulating human conversation. While chatbots in the past worked using simple pattern recognition, todays chatbots are way more capable, due to the development in the field of NLP through deep learning since the 2010s (Knijnenburg and Willemsen, 2016; McTear et al., 2016; Shawar and Atwell, 2007a). Hence, companies are increasingly developing chatbots and enterprise bots for the interaction with their customers (Diederich, Brendel, and Kolbe, 2019b; Maedche et al., 2016).

In a successful business relationship, the service provider promises his customers the most individual value possible and responds to their needs and wishes. Besides the value proposition of the service, the value created through the interaction between service provider and customer (value-in-interaction) is also an essential component of the service (Robra-Bissantz, 2018). At this point, the named technologies enabled through AI can and should be used, to create a personal and collaborative relationship between human and IT. Due to the individual nature of the service itself, AI technologies should be leveraged to automate individual and personalized services. However, the common choice of the term "virtual assistant" for such applications already shows that these are limited to assisting functionalities, whereas the actual interaction with the system should be improved by incorporating social behaviors (Gnewuch, Morana, and Maedche, 2017; Krämer, Eimler, et al., 2011; Rzepka and Berger, 2018). With the so-called Virtual Companion (VC), a transition from assistance to companionship and thus to a collaborative relationship between human and IT is proposed by the author of this dissertation. The VC is designed human-centered and personalized according to the human and represents the interface between the human with his or her task and role and the IT. Enabled by AI and the scalability of the mentioned systems, services can be offered individually and personalized to a broad mass of users with the help of a VC.

In order to actually implement such future-oriented and innovative applications and collaborative human-machine scenarios, it is important to design these services holistic, creative and in a user-centered manner as well as conceptually before the actual technological implementation is initiated. With the growing popularity of chatbots, several platforms emerged, allowing the modelling of CAs conversations (Diederich, Brendel, and Kolbe, 2019b), but they are missing the holistic design of the agent itself. Due to different frameworks and the plethora of tools an extensive documentations for the design of CAs, the difficulty to decide what functionalities to use, is strengthened (McTear, 2018). This inconsistency leads to a need for design knowledge, standards, practical tools and structured procedures to design specific CA applications (McTear, 2018).

1.2. From Assistance to Companionship

The key theory underlying the interaction between human and machines with human-like characteristics, is the social response theory, showing that people tend to treat computers as social actors (Moon, 2000; Nass, Steuer, et al., 1994; Qiu and Benbasat, 2009). The theory describes that individuals' interactions with computers are at their core social, as humans mindlessly apply social rules and expectations to computers (Nass and Moon, 2000; Nass, Steuer, et al., 1994). For instance, Nass, Steuer, et al. (1994) found in an experiment involving a computer tutor with a human voice, that users respond to different voices on the same computer as if they were distinct social actors. Furthermore, they found that humans are willing to collaborate with a computer as a partner by proving that humans accept computers as teammates (Nass, Fogg, et al., 1996) and that the help of a computer leads to an increased motivation of the human to reciprocally help the computer (Fogg and Nass, 1997).

When the machine incorporates characteristics that are normally associated with humans, like interactivity, usage of natural language or a human appearance, users respond by showing social behavior and ascribing social attributions (Moon, 2000). Humans do this, because they are used to it, that only humans show social behaviors and if now a computer acts socially they mindlessly apply known social rules to the interaction with the computer (Fogg, 2002; Nass and Moon, 2000). Thus, social conventions usually guiding interpersonal behavior can also be applied to human-machine interaction (Moon, 2000), to enhance the interaction and investigate the requirements for a collaborative and benevolent relationship between humans and machines. Prior research from the Human-computer interaction community, as well es from the fields of psychology already discussed different characteristics for establishing long-term relationships between humans and machines by incorporating findings from social interactions (Bickmore and Picard, 2005; Danilava et al., 2012; Krämer, Eimler, et al., 2011; Seymour, Riemer, et al., 2018).

This social relationship between a human and a machine can be defined as a companionship and as it happens virtually, it is called virtual companionship. Companionship can be described as having someone familiar that you like spending time with, rather than being on your own and can be regarded as part of friendship as it is often defined as a subcategory of it with a focus on doing things together (Bukowski et al., 1994;

Mendelson and Aboud, 2012). As a companion encompasses a number of aspects of friendship, it differs in specific parts that are friendship-specific, such as an inner and intimate relation, an intense affection, and a high emotional connection (Bukowski et al., 1993; Bukowski et al., 1994; Mendelson and Aboud, 2012). Companions are very different from assistants who are not coequal, who do not cause affections or build up long-term social ties or act proactively. In human-machine interaction, research shows that systems with more social and affective behavior are the most natural and effective ways for humans to interact with (Heerink et al., 2010; Tsiourti, 2018; Young et al., 2008). CAs that inhibit aspects of a companionship can thus offer added value for their user, especially in the case of long-term use. Even though this is certainly not a prerequisite for all applications of CAs, e.g. those which only serve a specific single task.

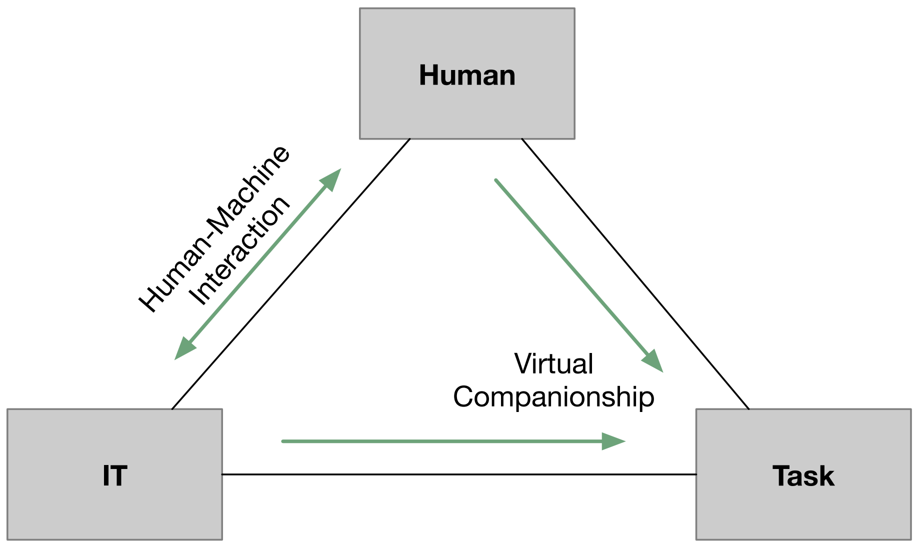

Figure 1.1.: *Human-Machine Interaction and Virtual Companionship in the triad of Human, IT and Task*

Human-computer interaction or human-machine interaction as it is called in this dissertation, is a research field in the area of computer science with intersections to behavioral science and therefore primarily focuses on the interface between humans and IT (Preece et al., 1994). According to the view of the German *Wirtschaftsinformatik*, an IS always consists of the human, IT and a task (Robra-Bissantz and Strahringer, 2020). This triad is also pursued in the context of this research project, which is why, within the context of the virtual companionship, the human-machine interaction is always considered with a focus on fulfilling a task together (see Figure 1.1). This focus is also reflected in the definition of companionship, as it focuses on "doing things together".

With virtual companionship, the human-machine interaction can be enhanced, because it encourages longer-lasting and more intuitive conversations (Bickmore and Picard, 2005; Gnewuch, Morana, and Maedche, 2017; Seymour, Riemer, et al., 2018), increases the likeability and interpersonal trust of the user in a system (Bickmore and Picard, 2005) and builds a foundation to enable collaborative scenarios between humans and machines (Li, Tee, et al., 2013; Seeber, Bittner, Briggs, de Vreede, et al., 2019). virtual companionship is suitable for all applications where a long-term relationship and a more human-like interaction is desired, such as teamwork (Li, Tee, et al., 2013; Seeber, Bittner, Briggs, de Vreede, et al., 2019), in-vehicle assistance (Bengler et al., 2014; Strohmann, Siemon, et al., 2019a), customer relations (Gnewuch, Morana, and Maedche, 2017; Meyer and Strohmann, 2018), creativity support (Strohmann, Fischer, et al., 2018; Tavanapour et al., 2019) or student support (Harvey et al., 2016).

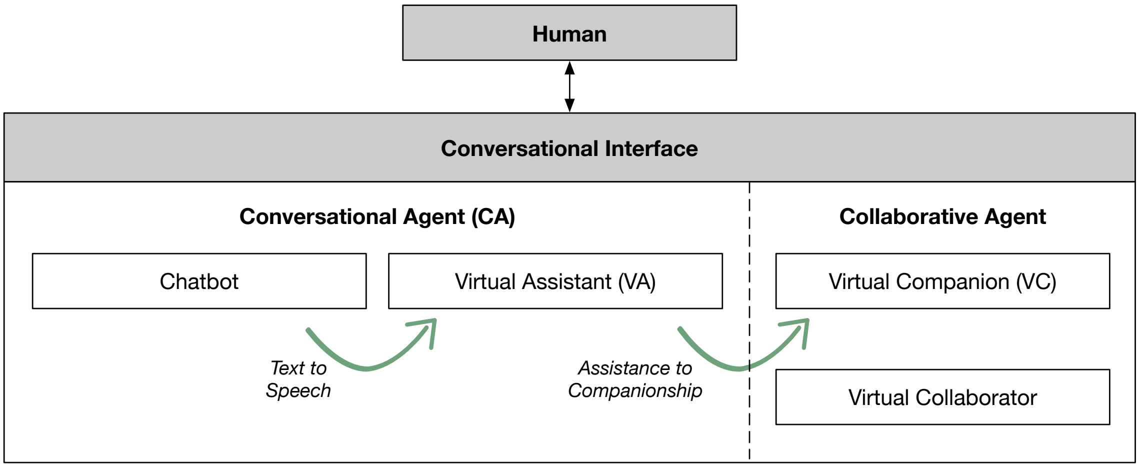

Figure 1.2.: *From Assistance to Companionship*

If a CA represents characteristics of a virtual companionship, it can be called a VC. If it perfectly represents all facettes of a virtual companionship, it might no longer be just a CA, but instead becomes a collaborative agent, as this goes beyond the limitation of a simple "conversation". The collaborative agent can therefore be seen as an evolution of the CA (see Figure 1), with the goal of raising AI to an eye-level and enabling coequal scenarios with AI. Collaboration, defined as the joint effort towards a common goal (Randrup et al., 2016) includes active participation within a collective value generation. Collaboration relies on coordination activities between partners, like the coordination of who does which task when or which activities lead the collective towards the common goal. For this coordination, communication is essentially needed, to transfer information between the partners. (Robra-Bissantz and Siemon, 2019) There are several collaboration principles, like a shared mental model, trust, reciprocity, a common goal or benevolence (Robra-Bissantz and Siemon, 2019; Siemon, Becker, et al., 2017). If now a machine follows those principles of collaboration, a collaborative interaction between the human and the machine can be created.

A collaborative agent therefore does not solely interact in form of a conversation, but actively takes part and autonomously contributes to a given task. Thus, the interaction between the user and the collaborative agent is not limited to a conversation (e.g. speech or text), but is extended to an active contribution, like adding content to a shared document or providing feedback to a composed idea. With the collaborative agent the level of autonomy, activity and ability raises to an eye-level, enabling the participation within collaborative scenarios. This active participation in an interaction and a collaborative scenario in general can be considered as a prequisite for a VC, making it an instantiation of the collaborative agent. If an instance of the collaborative agent leaves out the virtual companionship part and just aims for a collaboration with its user, it is called a virtual collaborator (Siemon, Strohmann, et al., 2019a). Table 1.1 gives an overview of the key terms used in this thesis and especially distinguishes them from the concept of the virtual companionship.

Currently it is difficult to decide what functionalities and characteristics should be used, which is furthermore strengthened by the confusing terminology, different frameworks, the plethora of tools and the extensive documentations (McTear, 2018). This inconsistency leads to a need for design knowledge, standards, practical tools and structured procedures to design specific AI applications, like CAs in general or VCs. This is particularly relevant when more profound and future-oriented topics such as companionship or collaboration between humans and machines are addressed and the machine should be designed accordingly.

Table 1.1.: *Relevant Definitions*

Term	**Description**
Conversational Agent (CA)	Overarching and general term for software that interacts with users using written or spoken natural language. (Diederich, Brendel, and Kolbe, 2019a; Gnewuch, Morana, and Maedche, 2017)
Collaborative Agent	An evolution of the CA, going beyond a simple "conversation" by actively taking part in an interaction and autonomously contributing to a given task.
Conversational Interface	Can also be called the conversational user interface, which is the frontend of the CA or collaborative agent, which allows the user to interact with the agent using text, speech, touch or other input and output modes (McTear, 2017).
Chatbot	Task-oriented or entertaining CA interacted with using written natural language. The focus is on fulfilling a specific task for their user (like ordering a pizza) or just entertain them. (Gnewuch, Morana, and Maedche, 2017; McTear, 2017)
Virtual Assistant (VA)	General-purpose or domain-specific CA interacted with using spoken natural language. The focus is on assisting their users e.g. in their everyday lives. (Examples are Apple's Siri or Google Assistant) (Gnewuch, Morana, and Maedche, 2017)
Virtual Companion (VC)	A collaborative agent instance, which ideally contains all virtual companionship characteristics. The focus is on building a companionship with their user. *Note that a chatbot or VA that realizes all virtual companionship characteristics can then be called a VC.*
Virtual Companionship	A collaborative and friendly long-term relationship between a human and a machine, whereas virtual companionship comprises a user-centered design, an appropriate human-like appearance and behavior, understanding and adoption of the user, a proactive and reciprocal behavior and preserving of transparency, privacy and ethics. All these single characteristics can be included in a CA to enable the development of a human-machine companionship.
Virtual Companion Canvas (VC Canvas)	A visual design tool to design VCs. Focus lies on the conceptual design and not the technological implementation.

1.3. Related Work

To identify relevant related work on CA design in the IS domain, a systematic literature review according to the approach of Webster and Watson (2002) was conducted. A first version of the literature review was conducted in 2017 when the research project was initiated. However, the literature review was updated constantly and the version presented in the following was conducted in December 2019. While the search in 2017 for CA design knowledge in the IS domain identified a lack of design knowledge and in general only few publications concerning CAs, the topic has now gained in relevance and, especially in the past two years, several publications with CA focus have been published, while some also contribute design knowledge for CAs (see figure 1.3).

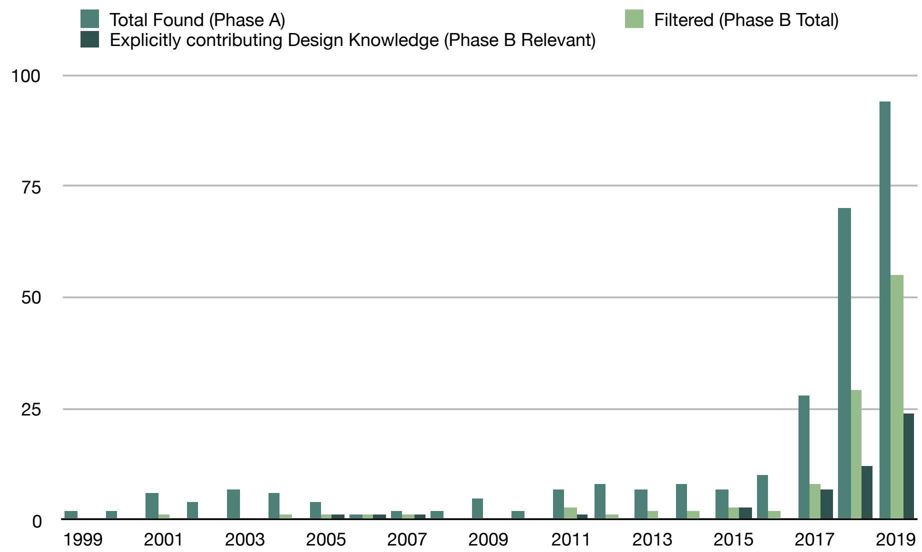

Figure 1.3.: *CA-related Publications per Year in the IS domain*

For the literature search relevant outlets in the IS domain were identified, which are the basket of eight[1] and other IS journals, as well as several IS conferences. The publications were mainly collected using the AIS Electronic Library database. If the outlet was not included in the database, the websites of the respective journal or conference were used. The search query consists of the relevant terms identified in section 1.2:

> *"Conversational Agent" OR "Collaborative Agent" OR "Conversational Interface" OR "Chatbot" OR "Virtual Assistant" OR "Virtual Companion"*

[1]https://aisnet.org/page/SeniorScholarBasket

The analysis of the literature was conducted with the software MaxQDA, as it offers useful tools to code and analyze literature and full-texts. The review consists of the three main phases A, B and C. The results are shown in table 1.2.

Table 1.2.: *Literature Search Results*

				A	B				C
	Name of the Outlet	**Acronym**	**VHB**		**Total**	**R**	**L**	**M**	
Basekt of 8	European Journal of Information Systems	EJIS	A	0					
	Information Systems Journal	ISJ	A	2	2	1	1		0
	Information Systems Research	ISR	A+	1	0				
	Journal of the AIS	JAIS	A	7	3	3			0
	Journal of Information Technology	JIT	A	1	0				
	Journal of Management Information Systems	JMIS	A	8	0				
	Journal of Strategic Information Systems	JSIS	A	0	0				
	Management Information Systems Quarterly	MISQ	A+	7	0				
Other IS Journals	Business & Information Systems Engineering	BISE	B	7	3	1	2		
	AIS Transactions on Human-Computer Interaction	THCI	-	4	2	2	0	1	1
	MIS Quarterly Executive	MISQE	B	3	0				
	Journal of Information Systems Education	JISE	-	1	0				
	Journal of the Midwest Association for Information Systems	JMWAIS	-	1	0				
Ranked IS Conference	International Conference on Information Systems	ICIS	A	56	32	18	14		4
	European Conference on Information Systems	ECIS	B	33	13	6	7		2
	Pacific Asia Conference on Information Systems	PACIS	C	12	3	2	1	1	1
	Hawaii Int. Conference on System Sciences	HICSS	C	18	8	3	5		0
	Wirtschaftsinformatik	WI	C	15	8	3	5		0
	DSR in Information Systems and Technology	DESRIST	C	8	6	3	3	1	2
	Americas Conference on Information Systems	AMCIS	D	49	15	2	13		0
Other IS Conferences				49	15	6	9		
Total				**282**	**110**	49	61	3	**10**

First, 282 publications were collected in Phase A using the search query. Second, in Phase B the abstracts of all publications were read and coded allowing to classify the publications into the three categories relevant (R), less relevant (L) and delete. All publications with a contribution of some kind of design knowledge were classified in the category R. Publications which only contributed some form of prototype were classified in category L. Publications contributed by the author of this dissertation were classified in category M. The coding scheme in the first coding cycle consists of the general codes *Application Context* and *Contribution*. Then in a second coding cycle the application contexts were specified (see table 1.3 for the resulting sub-codes) and the types of design contributions were identified, resulting in the sub-codes: *Design*

Framework, *Construct*, *Design Characteristic*, *Design Principle*, *Design Feature*, *Design Recommandation*, *Design Tool*, *Nascent Design Theory*, *Design Guideline*.

Table 1.3.: *Application Contexts of Filtered Publications (Phase B)*

Application Context	**Count**	**Application Context**	**Count**
General-Purpose / Holistic Approach	26	In-Vehical Assistance	1
Customer Service	13	Storytelling with a Virtual Narrator	1
Teaching or Education	11	Decision Support	1
Health	11	Online Booking	1
Advisor (e.g. Financial or Sustainablity Advice)	8	Smart Home	1
Commerce	7	Gamification	1
Collaboration with Humans	7	Knowledge Management	1
Facilitation	6	Social Media	1
Work / Digital Workplace	5	Insurance	1
Overview	3	Crisis Communication	1
Energy Feedabck	2	Automated Kiosk	1

Third, in Phase C all relevant publications (R) were read and coded in full-text, along the five dimensions: Methodology, Application Context, Type of CA, Type of Design Knowledge and Contribution. The results of the analysis of all 50 relevant publications can be found in Appendix A.1. Phase C resulted in ten highly relevant publications featuring generalized CA design knowledge, whereas two of those were conributed by the author of this dissertation. The 40 other publictions are mostly assesing single design characteristics and features or contributing constructs. Table 1.4 lists the ten resulting publications of Phase C and classifies them according to the five dimensions.

Table 1.4.: *Filtered Publications Contributing Relevant Design Knowledge*

Reference	**Metho-dology**	**Application Context**	**Type of CA**	**Type of Design Knowledge**	**Contribution**
Feine et al. (2019b)	DSR	Holistic Approach	Text-Based CA (Chatbot)	Design Recommandations; Design Tool	Prescriptive Social Cue Design Rules; A chatbot social cue configuration system
Feine et al. (2019a)	DSR	Holistic Approach	Text-Based CA (Chatbot)	Design Principle	Two design principles for designing a chatbot social cue configuration system
Gnewuch, Morana, and Maedche (2017)	DSR	Customer Service	CA	Design Principle	CA classification; 12 meta-requirements and four design principles for CAs in customer service
Gnewuch, Morana, Heckmann, et al. (2018)	DSR	Energy Feedabck	CA	Design Principle	Four design principles for CAs for energy feedback
Hobert (2019)	DSR	Teaching or Education	Text-Based CA (Chatbot): Coding Tutor	Nascent Design Theory	Nascent design theory: Three user stories, six teaching assistants task characteristics, eight meta-requirements and five design principles for a Chatbot-based learning system, software architecture of the system
Kowatsch et al. (2018)	Experiment	Health	Text-Based CA (Chatbot)	Design Characteristic	Assessing the impact of interpersonal closeness cues in text-based healthcare chatbots on attachment bond and the desire to continue interacting; Several design characteristics structured in a codebook for text-based healthcare chatbot designs on interpersonal closeness.
Seeger et al. (2018)	Experiment	Holistic Approach	CA	Design Framework	Framework of anthropomorphic design dimensions (human identity, verbal & non-verbal communication
Tavanapour et al. (2019)	DSR	Facilitation	CA	Design Principle	19 requirements and six design principles for a CA as facilitator
Strohmann, Fischer, et al. (2018)	Design Science Research	Facilitation	Virtual Moderator	Design Guideline	Nine Design Guidelines for Virtual Moderator Design and several Design Characteristics
Strohmann, Siemon, et al. (2019a)	Design Science Research	In-Vehicle Assistance	In-Vehicle Assistant	Design Guideline	15 Requirements and 57 Design Guidelines

From the ten publications only three aim for a holistic approach, by contributing prescriptive knowledge, that can be applied to various application contexts. Feine et al. (2019b) propose a social cue configuration system, with which designers can configure and explore social cue design possibilities and characteristics as well as get design recommendations for CA design. According to the visual design a social cue is for example the *clothing of the chatbot*, in whichs case the possible design characteristics would be *formal* or *informal clothing* and the design recommendation for the application context *banking*: "Keep formal clothing" (Feine et al., 2019b). In their other publication (Feine et al., 2019a), the authors contribute design knowledge for designing such a configuration system itself. Their configuration system is currently available as a beta version under: https://social-cues.org/. The third contribution with a holistic approach is Seeger et al. (2018), who propose a design framework for the anthropomorphic design of CAs, which consists of the dimensions human identity, verbal and non-verbal communication. As an example, they suggest the name and profile picture of a CA as a human identity cue, sentences like "Oh, I am sorry to hear that." as a verbal cue and the usage of emoticons by the CA as a non-verbal cue (Seeger et al., 2018).

Six of the publications contribute prescriptive knowledge in the form of design guidelines, principles or characteristics for specific application contexts, which are customer service (Gnewuch, Morana, and Maedche, 2017), energy feedback (Gnewuch, Morana, and Maedche, 2017), health (Kowatsch et al., 2018), virtual facilitation (Strohmann, Fischer, et al., 2018; Tavanapour et al., 2019) and in-vehicle assistance (Strohmann, Siemon, et al., 2019a). Hobert (2019) contributes more profound design knowledge in the form of a nascent design theory for teaching assistants, going beyond the contribution of just design principles by specifying also constructs, testable propositions or the software architecture of the teaching assistant. However, the nascent design theory by Hobert (2019) is also very specifically tailored to the overall teaching system, of which the assistant is just one part.

1.4. Research Objectives

The literature review in section 1.3 and other recent literature reviews on CAs and AI-enabled systems (Diederich, Brendel, and Kolbe, 2019a; Rzepka and Berger, 2018) identified an increasing interest, but a very limited amount of application independent design knowledge or user-centered and holistic design tools. Currently CAs are mainly used in customer service, commerce or health, but also more profound and long-term scenarios like collaboration are currently gaining interest. However, the variety of application contexts is still limited. Actually Diederich, Brendel, and Kolbe (2019a) identified Strohmann, Fischer, et al. (2018) as the only study addressing CAs in collaborative scenarios to at the end of 2018. While the previous Chapter 1.3 especially looked at the related work in the IS domain, knowledge from other domains has also been considered in the individual research projects. The most relevant prior contribution from the field of psychology concerning VCs (Krämer, Eimler, et al., 2011) is shortly delimited in the following before deriving the research objectives.

Today's practical applications show that the main goal of CAs is to provide personal assistant functionality, whereas the actual interaction with the system should rather be improved by incorporating social behaviors (Gnewuch, Morana, and Maedche, 2017; Krämer, Eimler, et al., 2011; Rzepka and Berger, 2018). Most of these interactions are initiated by the user, not the CA, and are then isolated and transactional, as if they were starting over each time (Seymour, Riemer, et al., 2018). This shift away from one-time transactional contacts also took place in economy, as recurring relationships and contacts with users and customers are nowadays of great importance (Delmond et al., 2016; Keeling et al., 2013). Moreover, recent developments of smart technologies make it possible for CAs to become more intelligent, as well as more human-like (Seeber, Bittner, Briggs, de Vreede, et al., 2019).

In 2011, Krämer, Eimler, et al. addressed the aspect of sociability and especially companionship within CAs as "it becomes more and more feasible that artificial entities like robots or agents will soon be parts of our daily lives." (Krämer, Eimler, et al., 2011, p. 1). These agents are especially relevant for elderly or homebound people (Krämer, Eimler, et al., 2011; Tsiourti, 2018), in service scenarios (Becker, Kopp, et al., 2007) and general long-term interaction scenarios in the private sector, as the acceptance of a social, affective and especially coequal conversational partner can be increased (Becker, Kopp, et al., 2007). However, explicit and applicable prescriptive knowledge for designing and instantiating such agents is still missing. Subsequently, Krämer, Eimler, et al. (2011) discuss the necessity of a theory of companions and conclude that it is not inevitable for all CAs, but "when they have the function to support the owners' health, well-being, and independent living", companionship can be beneficial (Krämer, Eimler, et al., 2011, p. 498). Moreover, Krämer, Eimler, et al. (2011) suggest that due to the user-specific individuality of companionship, the user should be included in the design process, however, the authors do not provide a concrete solution of how to do this.

With the growing popularity of chatbots, several platforms emerged, allowing everyone the design of CAs in a simple way (Diederich, Brendel, and Kolbe, 2019b). While these systems now enable very advanced conversational design with features like self-learning algorithms (Diederich, Brendel, and Kolbe, 2019b), they neglect the holistic design of the agent itself as well as the relationship to its user. Moreover, the difficulty to decide what functionalities to use is furthermore strengthened by the confusing terminology, different frameworks, the plethora of tools and the extensive documentations (McTear, 2018). This inconsistency leads to a need for standards, practical tools and structured procedures to design specific AI applications, like the VC. The social cue configuration system by Feine et al. (2019b) represents a step into this direction and acts as a profound knowledge base for CA design, but misses a creative and user-centered way to holistically design a CA.

Hence, the overarching objective of this research project is to craft design knowledge as well as a user-centered and creative design tool for CAs, which go beyond of simply assisting their users. As this thesis will show, this point of view has evolved over the course of time and work on the research project. While in the beginning it was about developing a virtual moderator supporting the idea generation during brainstormings, it soon became clear that there was a lack of prescriptive knowledge for doing so. After contributing the missing design knowledge, it was realized that it is challenging to apply this knowledge to instantiations. The idea for a design tool to design VC applications was born: the VC Canvas. To contribute the design knowledge in a structured form, the findings about designing virtual companionship are summarized in the form of a nascent design theory (Gregor and Jones, 2007).

Building on these assumptions, this research project pursues the following four objectives:

1. Instantiate innovative CA artifacts to demonstrate that CAs can do more than just assisting their users.

2. Create design knowledge for CAs in various different application domains.

3. Develop a design tool for the design of VCs.

4. Particularly create design knowledge for virtual companionship that is applicable to a variety of application domains and summarize the findings in the form of a nascent design theory (Gregor and Jones, 2007).

Thus, the overarching and general Research Question (RQ) of this thesis is:

> **RQ**: How to design Virtual Companions?

It should be noted that the RQ of this research project has also evolved over time. Whereas in the beginning the focus was to instantiate innovative CAs (Objective 1), the concept of the VC evolved while working on CAs in different use cases and deriving design knowledge for those. This change is therefore also reflected in the formulation of the individual research objectives, as the wording changes from CA to VC.

1.5. Structure and Publications

The publications contained in this dissertation are thematically interrelated and build on each other. They each contain a corresponding section on the theoretical background, therefore, no separate chapter on the theoretical background was written within the framework of this dissertation. Instead, the background was included in the introduction (see section 1.1 and 1.2). The dissertation proceeds as follows: Chapter 2 deals with the methodology, whereas Section 2.1 describes DSR, the research paradigm underlying this research project. Then, in Section 2.4 the research design of this dissertation and research project in general will be presented by putting the six publications into context from a DSR process view. Afterwards, the six publications are included chronologically in Chapter 3 to 8. At the beginning of each chapter the publication is positioned in the overall context of this research project and afterwards the findings of each publication are reflected. Finally, in Section 10, the results are summarized, the implications for research and practice are given and the dissertation is concluded.

In the following the author's publications relevant to this dissertation are chronologically listed. The six publications included in this dissertation are marked in bold and furthermore got an abbreviation in the form of their outlet and publication year (e.g. DESRIST 2017 = 12th International Conference on DSR in Information Systems and Technology).

DESRIST 2017: brAInstorm: Intelligent Assistance in Group Idea Generation.
In Proceedings of DESRIST 2017. Timo Strohmann, Dominik Siemon, Susanne Robra-Bissantz (2017)

PACIS 2018: Virtual Moderation Assistance: Creating Design Guidelines for Virtual Assistants Supporting Creative Workshops.
In Proceedings of PACIS 2018. Timo Strohmann, Simon Fischer, Dominik Siemon, Florian Brachten, Christoph Lattemann, Susanne Robra-Bissantz, Stefan Stieglitz (2018)

Ich fühle mit dir! Können empathische virtuelle Assistenten den stationären Einzelhandel unterstützen?
In HMD Praxis der Wirtschaftsinformatik. Michael Meyer, Timo Strohmann (2018)

Design Guidelines for Creating a Convincing User Experience with Virtual In-vehicle Assistants.
In Proceedings of HICSS 2019. Timo Strohmann, Laura Höper, Susanne Robra-Bissantz (2019)

THCI 2019: Designing Virtual In-vehicle Assistants: Design Guidelines for Creating a Convincing User Experience.
In AIS Transactions on Human-Computer Interaction. Timo Strohmann, Dominik Siemon, Susanne Robra-Bissantz (2019)

Towards the Conception of a Virtual Collaborator.
In Proceedings of the Workshop on Designing User Assistance in Intelligent Systems at ECIS 2019. Dominik Siemon, Timo Strohmann, Susanne Robra-Bissantz (2019)

The Virtual Collaborator - A Definition and Research Agenda.
In International Journal of e-Collaboration. Dominik Siemon, Timo Strohmann, Susanne Robra-Bissantz (2019)

ECIS 2019: Introducing the Virtual Companion Canvas – Towards Designing Collaborative Agents.
In Proceedings of the Workshop on Designing User Assistance in Intelligent Systems at ECIS 2019. *Timo Strohmann, Dominik Siemon, Susanne Robra-Bissantz (2019)*

FDM 2020: A Virtual Companion for the Customer – From Conversation to Collaboration.
In Forum Dienstleistungsmanagement. *Timo Strohmann, Susanne Robra-Bissantz (2020), forthcoming*

Unpublished: From Assistance to Companionship - Designing Virtual Companions.
Unpublished. *Timo Strohmann, Dominik Siemon, Susanne Robra-Bissantz*

CHAPTER 2

Methodology

The german *Wirtschaftsinformitk* traditionally has been focusing the practical relevance of its findings from the very beginning (Robra-Bissantz and Strahringer, 2020). In the very past, *Wirtschaftsinformatik* had the reputation of not being sufficiently scientific and rigorous enough. As in the past years the awareness grew, that IT cannot be thought of without the human, organizations, and society, the decision of whether an IS (consisting of IT, the business task and human being) is considered as "well designed", changed (Robra-Bissantz and Strahringer, 2020). In the past, when the *Wirtschaftsinformatik* was more situated in the area of operations research or computer science, goals such as increasing efficiency were pursued mainly. Nowadays, also effectiveness is seen as essential and, thus, goals such as human satisfaction, sustainability, or customer loyalty are followed (Robra-Bissantz and Strahringer, 2020).

The counterpart of the german *Wirtschaftsinformatik* in the English-speaking area is the IS research and particularly the design-oriented *Wirtschaftsinformatik* is here referred to as DSR (Robra-Bissantz and Strahringer, 2020). DSR has become a well-established research approach in the IS field ensuring the conduction of rigorous and design-oriented research (Gregor and Hevner, 2013). The research design of this dissertation project was conducted according to the principles of DSR. It further consists of several individual DSR projects, each including one or more design cycles. The results of these projects were published in several publications.

The following chapter gives an overview of the DSR approach in general and in regards to this research endeavor. First, the DSR paradigm itself is explained. Then the possible outcomes that can arise within and through DSR are discussed and classified according to contribution types. Finally, DSR frameworks, as approaches for the conduction of DSR and the Information Systems Design Theory (ISDT) as a DSR product are discussed. In order to put the publications of this dissertation into a context, a holistic overview of the several DSR cycles in the single projects is given and explained.

2.1. Design Science Research Paradigm

The IS domain is a multi-paradigmatic research field, as it draws its methodologies and grounding philosophies from multiple fields, that are commonly interested in "understanding the way in which human-computer systems are developed, produce and process information, and influence the organizations in which they are embedded." (Vaishnavi and Kuechler, 2015, p. 2) Thus, due to their nature ISs are complex and grounded in multiple disciplines. Often they are constructed and do something useful, but it is not understood how they can be made better or they have a high impact on people and organizations, which is only poorly understood (Vaishnavi and Kuechler, 2015). This challenge of designing and understanding IS is addressed by DSR, as it follows the approach "exploring by building" (Vaishnavi and Kuechler, 2015). Hence, it allows IS researchers to systematically build and evaluate artifacts, whereas an artifact is the product of a design process (Hevner et al., 2004), which in terms of IS can be, for example, a construct, model, method or instantiation (Vaishnavi and Kuechler, 2015).

Hevner et al. (2004) proposed a framework for DSR in IS, to combine characteristics of behavioral science and design science and depicted "clear guidelines for understanding, executing, and evaluating the research" (Hevner et al., 2004, p. 75). It is designed to ensure that artifacts are designed (construction) based on business needs and requirements (relevance) and are built on applicable knowledge from theories, frameworks and methods (rigor).

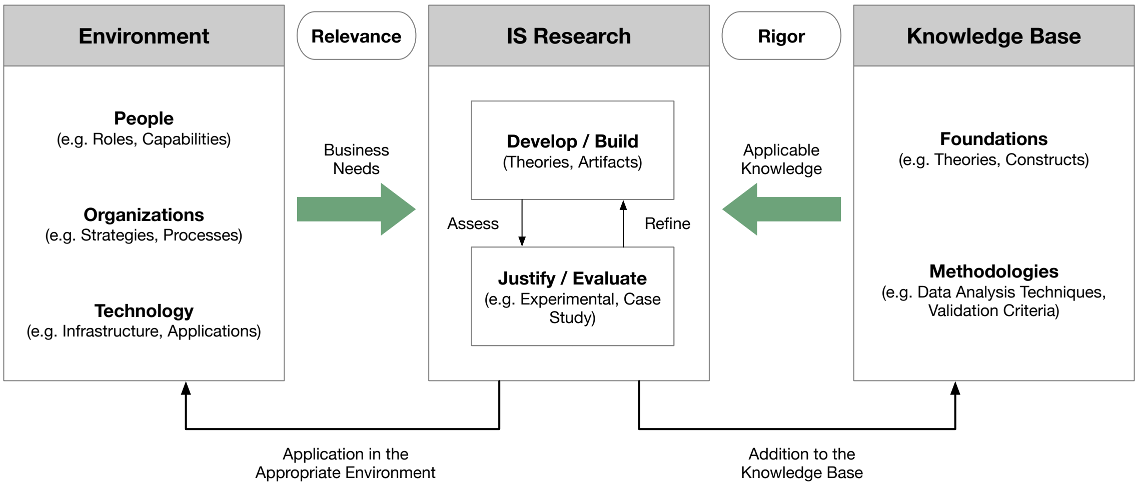

Figure 2.1.: *IS Research Framework according to Hevner et al. (2004)*

DSR relies on an existing knowledge base with applicable theories that help to develop an artifact. Additionally, evaluating and assessing an artifact with existing methodologies that one draws from the knowledge base, ensures one rigorously justifies the results and demonstrates the artifact (Hevner et al., 2004). Hence, within the DSR paradigm, other research methodologies can be used, like a structured literature review or expert interviews for the identification of the problem (Hevner et al., 2004; Peffers et al., 2007). After designing an artifact and subsequently evaluating it, DSR contributes to the business need, as well as to the knowledge base for further research and practice (Hevner et al., 2004).

	Contribution Types	Example Artifacts
More abstract, complete, and mature knowledge	**Level 3**. Well-developed design theory about embedded phenomena	Design theories (mid-range and grand theories)
↕ ↕ ↕ ↕	**Level 2**. Nascent design theory - knowledge as operational principles / architecture	Constructs, methods, models, design principles, technological rules.
More specific, limited, and less mature knowledge	**Level 1**. Situated implementation of artifact	Instantiations (software products or implemented processes

Figure 2.2.: *Design Science Research Contribution Types according to Gregor and Hevner (2013)*

The levels of artifact abstraction in DSR vary and an artifact can take different forms, such as models, processes, instantiations, methods or software. Gregor and Hevner (2013) note that any artifact has a specific level of abstraction and propose three main levels for categorization (see Figure 2.2). An artifact can be described by the two attributes "abstract" and "specific" and by their general knowledge maturity. A specific and limited artifact (level one), such as software products or implemented processes, contribute situated and context-specific knowledge. An abstract and complete artifact (level three), such as design theories about embedded phenomena, contribute a broad and mature knowledge. Design principles and constructs, methods, models, or technological rules (level two) fall between a solely abstract or specific artifact and contribute nascent design theories or operational principles (Gregor and Hevner, 2013).

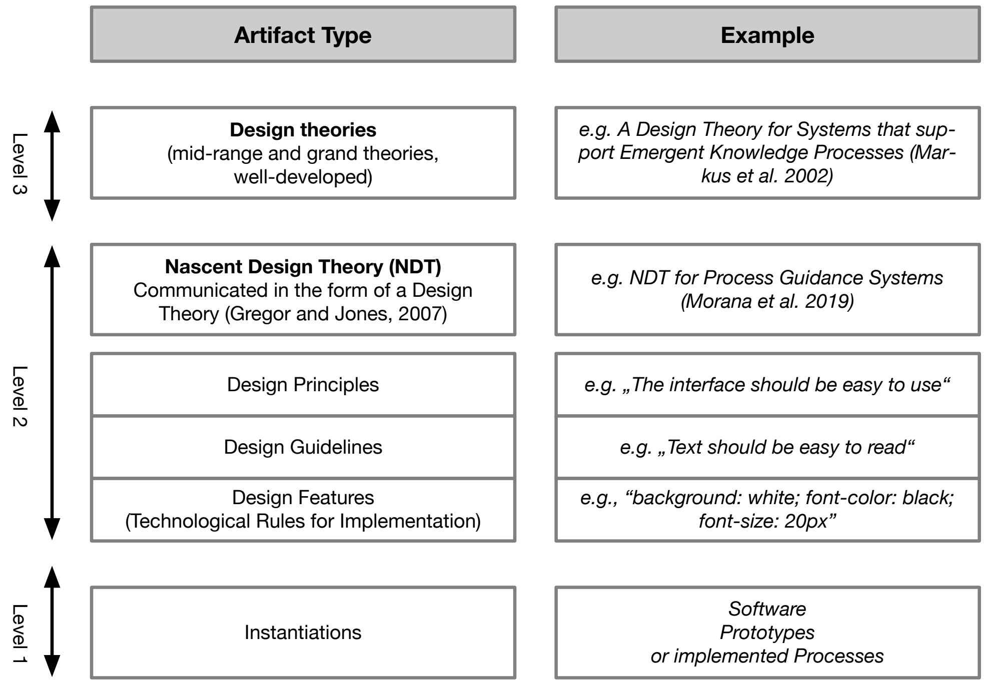

Figure 2.3.: *A Detailed View on Level 2 of Artifact Contribution Types*

In Figure 2.3 a detailed view on level 2 of the artifact contribution types by Gregor and Hevner (2013) is given by the author of this dissertation. According to Gregor and Hevner (2013) level 3 can only be reached when the design theory is well-developed, used, accepted and validated in the research field for several years. Thus, when research results are summarized in the form of a design theory (Gregor and Jones, 2007), this cannot be a design theory yet and may rather be called a nascent design theory. But the contribution is of a higher abstraction level than just a contribution of several application-specific design principles missing out various other components of a design theory. During the work on this research project, it was helpful to take a deeper look at the level of abstraction inside level 2 and the understanding obtained by the author is visualized in Figure 2.3.

For example, Meth et al. (2015) very understandably show the distinction between a requirement, a design principle and a design feature and summarize their results in the form of a design theory. Also, Morana, Kroenung, et al. (2019) give a good example of summarizing their contributions in the form of a nascent design theory. An example for a well-developed design theory is the design theory by Markus et al. (2002) for systems that support emergent knowledge processes (Gregor, 2006). Furthermore, the Interaction Design Foundation [2] shows how a design principle can be distinguished from a design guideline and feature; The design guideline gives more specific instructions to designers and developers of how to adopt a certain design principle and a design feature represents the technological rule for implementation. According to the level of abstraction, the design features are closer to an instantiation (level 1) then design principles, which are usually more generalized and abstract. The classification of artifact types with their different levels of abstraction in Figure 2.3 is based on the assumption of the author of this dissertation. Especially the classification of artifact types on level 2 is used as a basis for the contributions in this dissertation.

2.2. Frameworks for Conducting Design Science Research

There are several frameworks for the conduction of DSR (Peffers et al., 2007; Sein et al., 2011; Vaishnavi and Kuechler, 2015). Two of them are discussed in the following: Peffers et al.'s (2007) Design Science Research Methodology (DSRM) and Vaishnavi and Kuechler's (2007) General Methdology of Design Science Research (GMDSR). For the research design of this dissertation the GMDSR by Vaishnavi and Kuechler (2015) was chosen as the framework for conducting DSR.

Peffers et al. (2007) developed the DSRM as a framework which is at its core, a nominal process model for conducting DSR in IS. It focuses on strengthening the degree to which researchers recognize DSR and view it as legitimate, and it provides guidance for them to conduct and present DSR. The process itself is made up of six phases:

[2] https://www.interaction-design.org/literature/topics/design-guidelines, accessed on 2nd of December 2019

1) Problem identification and motivation, 2) Definition of the solution objective, 3) Design and Development, 4) Demonstration, 5) Evaluation and 6) Communication of the results. Furthermore, the framework incorporates a systematic procedure, as well as practices and principles to carry out a consistent DSR project. For example, they provide different entry points from which a DSR project can be initiated: problem-centered, objective-centered, design and development-centered, and client/context-centered.

Vaishnavi and Kuechler (2015) also introduced a framework for the conduction of DSR in IS, the GMDSR. The process model of the GMDSR comes with five steps for conducting a DSR project: 1) Recognizing the Problem 2) Suggesting a Potential Solution for it 3) Actual Developing the Solution 4) Rigorously Evaluating the Solution and 5) Drawing a Final Conclusion. In contrast to Peffers et al. (2007), they put the focus on the reflection of the design results, for example, in the form of design principles, and on an iterative, evaluation-driven approach. Therefore, they define knowledge flows and several possible outputs that may occur during the design process. The design process model with its knowledge flows and outputs is shown in Figure 2.4

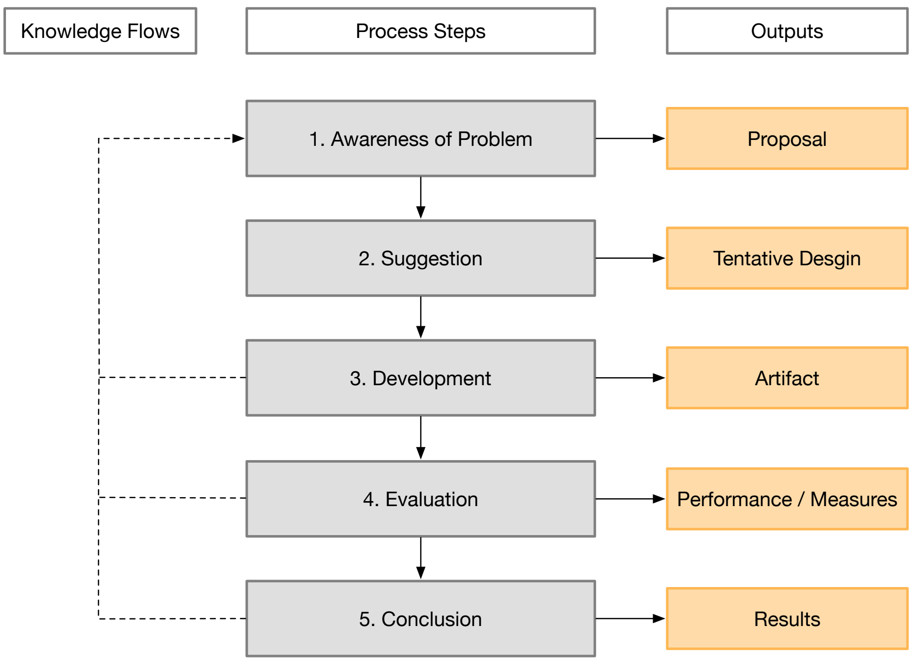

Figure 2.4.: *The General Methodology of Design Science Research according to Vaishnavi and Kuechler (2015)*

According to their process steps, the two frameworks differ as follows. While Vaishnavi and Kuechler's (2015) process includes only the evaluation after the development, Peffers et al. (2007) put demonstration before evaluation. Moreover, Peffers et al. (2007) speak of communication as a last step in the DSR cycle and, therefore, call researchers to face the community. In contrast, Vaishnavi and Kuechler (2015) refer to this step more generally as "conclusion", which indicates that a specific design project has finished. They also say that, in the conclusion phase, researchers commonly contribute results in the form of scientific publications. Apart from adopting a similar process model for conducting a DSR cycle, the two frameworks differ in the overall approach to a DSR project. Kuechler and Vaishnavi (2012) define three general activities for conducting DSR in IS: "1) Construction of an artifact where construction is informed either by practice-based insight or theory, 2) the gathering of data on the functional performance of the artifact (i.e., evaluation), and 3) reflection on the construction process and on the implications the gathered data (from activity (2)) have for the artifact informing insight(s) or theory(s)." (Kuechler and Vaishnavi, 2012, p. 396). While Peffers et al. (2007) mention the two first activities, they do not explicitly mention reflection (though they do not preclude it). As in this dissertation project, several design cycles and DSR projects are conducted, the reflection of the process and data gathered is fundamental to initiate the iterations. Therefore, for the research design of this dissertation the GMDSR by Vaishnavi and Kuechler (2015) was chosen as the framework for conducting DSR.

It has to be noted that the understanding of DSR and knowledge about conducting it of the author of this dissertation evolved over the course of time. This will become clear in each of the methodology section of the single publications. The first research projects (DESRIST 2017, PACIS 2018 and HICSS 2019) were conducted according to the DSRM by Peffers et al. (2007), whereas then the author switched to the GMDSR by Vaishnavi and Kuechler (2015) for the following research projects (THCI 2019, ECIS 2019, FDM 2020 and Chapter 8). This switch of the DSR framework will also be explained in THCI 2019, as this journal publication is the extension of the conference publication HICSS 2019 and was written when the switch took place.

2.3. Information Systems Design Theory

While Hevner et al. (2004) strengthen the problem-solving nature through the creation of an innovative artifact as the core value of DSR, others value a design theory as the core contribution of DSR (Gregor and Jones, 2007; Walls et al., 1992). Walls et al. (1992)

initially defined an ISDT as “a prescriptive theory which integrates normative and descriptive theories into design paths intended to produce more effective information systems.” (Walls et al., 1992, p. 36). They argue that the IS domain should develop and contribute prescriptive theories to make the development of more effective IS possible.

Because of its prescriptive nature, the ISDT has to be differentiated from and builds upon other theory types in IS research, which are according to the taxonomy of Gregor (2006) the Theories of I) Analysis, which say what is without any causal relationship among phenomena. II) Explanation, explaining how and why some phenomena occur. III) Prediction, which says what is and will be by providing predictions and testable propositions, but without well-developed justificatory knowledge. IV) Explanation and Prediction, providing predictions, testable propositions as well as causal explanations in the form of justificatory knowledge. According to Gregor (2006), the ISDT is the fifth and last type of theory in IS research, which says how to do something, by giving explicit prescriptions for constructing an artifact.

Recently the call for a theoretical contribution has been emphasized (Gregor and Hevner, 2013; Gregory and Muntermann, 2014; Kuechler and Vaishnavi, 2012). Gregor and Hevner (2013) argue that by summarizing the prescriptive knowledge in the form of a nascent design theory, the knowledge contribution and impact of DSR can be substantially increased. Hence, knowledge for researchers and practitioners can be extended, and an initial step towards a comprehensive design theory is provided (Gregor and Hevner, 2013).

There are several frameworks giving prescriptions of how to structure and communicate an ISDT (Gregor and Jones, 2007; Kuechler and Vaishnavi, 2012; Walls et al., 1992) and also frameworks with less complicated approaches like the Explanatory Design Theory (Baskerville and Pries-Heje, 2010). The eight components of an ISDT introduced by Gregor and Jones (2007) are listed and explained in Table 2.1. Moreover, the relation of each component to the corresponding phase of the GMDSR is given in the third column (Meth, 2013; Peffers et al., 2007; Vaishnavi and Kuechler, 2015), showing that the components of the ISDT according Gregor and Jones (2007) are suitable to summarize the outcomes of the GMDSR. Thus, the ISDT for virtual companionship in this dissertation is constructed and summarized according to the eight components by Gregor and Jones (2007).

Table 2.1.: *Eight Components of an ISDT (Gregor and Jones, 2007) and corresponding GMDSR process step*

Component	**Description**	**Corresponding GMDSR process step**
1) Purpose and scope	"What the system is for,"" the set of meta-requirements or goals that specifies the type of artifact to which the theory applies and in conjunction also defines the scope, or boundaries, of the theory.	1. Awareness of Problem
2) Constructs	Representations of the entities of interest in the theory.	3. Development
3) Principle of form and function	The abstract "blueprint" or architecture that describes an IS artifact, either product or method/intervention.	2. Suggestion
4) Artifact mutability	The changes in state of the artifact anticipated in the theory, that is, what degree of artifact change is encompassed by the theory.	5.Conclusion
5) Testable propositions	Truth statements about the design theory.	4. Evaluation
6) Justificatory knowledge	The underlying knowledge or theory from the natural or social or design sciences that gives a basis and explanation for the design (kernel theories).	1. Awareness of Problem & 2. Suggestion
7) Principles of implementation	A description of processes for implementing the theory (either product or method) in specific contexts.	5. Conclusion
8) Expository instantiation	A physical implementation of the artifact that can assist in representing the theory both as an expository device and for purposes of testing.	3. Development

2.4. Research Design

For this research a systematic and iterative DSR approach was followed, according to the GMDSR proposed by Vaishnavi and Kuechler (2015). An overview over all individual DSR projects and publications (green boxes) with their design cycles, their connections to each other, and their outcomes (orange circles) is shown in Figure 2.5. In the following, the individual DSR projects are described in the context of the overall research project.

Project 1: The Virtual Moderator
Project 1 (P1) observes the support of workshops and moderation of creativity methods by a Virtual Moderator. While the contribution of the first design cycle (DC1.1) is an artifact in the form of an instantiation as a prototype, a more general approach was chosen in the second design cycle (DC1.2). By combining smart technologies, the feasibility of a Virtual Moderator was demonstrated with a prototypical implementation in DC1.1 (Outcome 1.1). The prototype was presented at a conference to obtain feedback (Strohmann, Siemon, et al., 2017). The conclusion was the necessity of a more in-depth entry into the theory of moderation and the more intensive study of human moderators, which led to the second design cycle (DC1.2). Besides, a lack of design knowledge for the design of VAs was identified. The application-specific design guidelines (Outcome 1.2) developed in DC1.2 are intended to address this deficiency. With the aggregation of the results from a literature review, and several expert interviews, design guidelines for a virtual moderator were developed (Strohmann, Fischer, et al., 2018).

Project 2: The Virtual Co-Driver
To asses the generalizability of the developed design knowledge, a second application domain was needed. Thus, in Project 2 (P2), the same procedure as in P1 was applied to a different application domain, the in-vehicle user assistance (Strohmann, Höper, et al., 2019). Being aware of the lacking design knowledge for CA design this time, in contrast to P1, first requirements (Outcome 2.1) and design guidelines (Outcome 2.2) for in-vehicle assistants were derived from literature and expert interviews in DC2.1 and then presented at a conference (Strohmann, Höper, et al., 2019). With the findings from DC2.1 and feedback from the conference, DC2.2 was initiated to refine the design guidelines (Outcome 2.3), which were then instantiated in DC2.3 (Outcome 2.5) (Strohmann, Siemon, et al., 2019a).

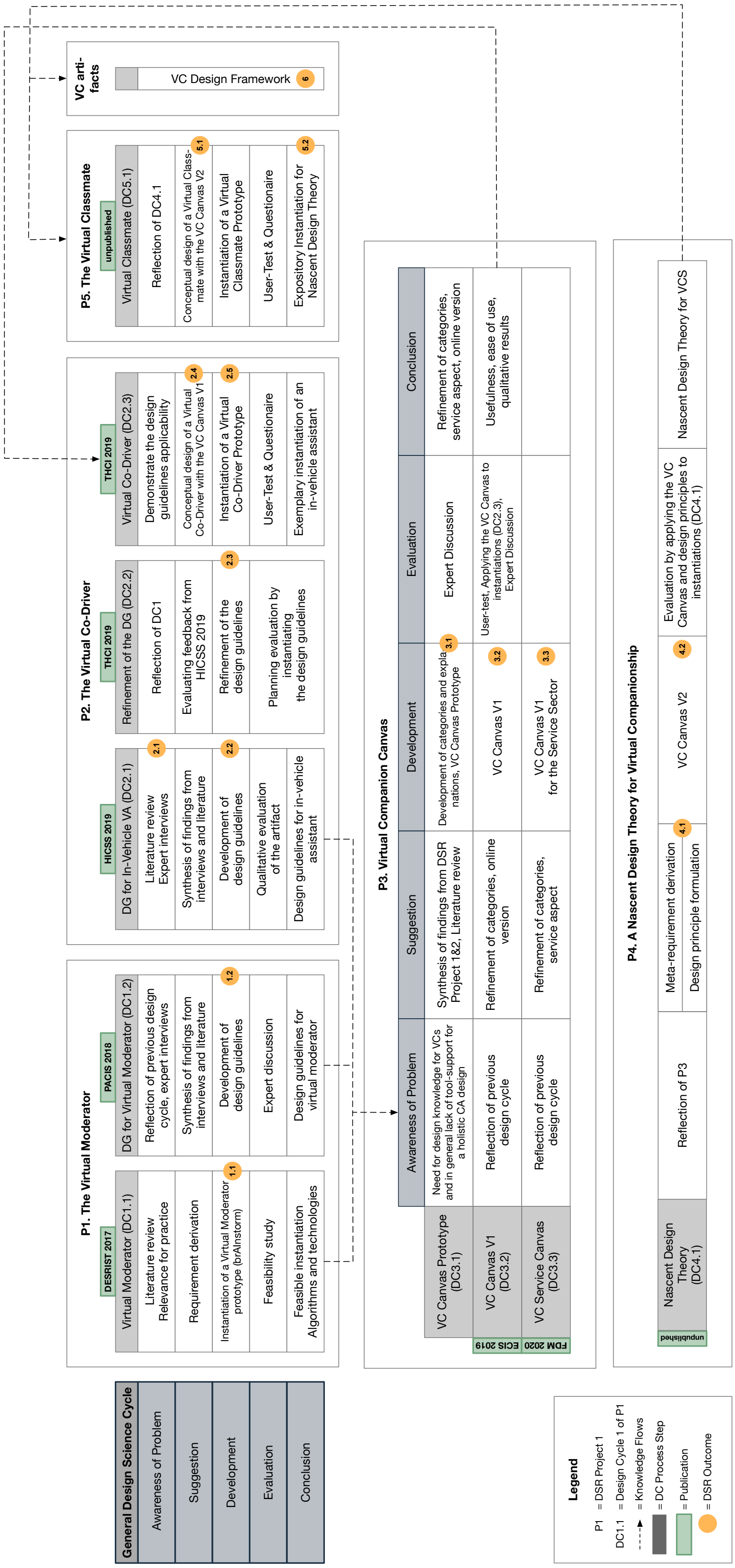

Figure 2.5.: *Research Design*

Project 3: The Virtual Companion Canvas

One of the most important findings from DC1.1 was the lack of domain-specific design knowledge for CAs. This lack was approached with the design guidelines from DC1.2 and DC2.1. What P1 and P2 have shown is that there is a need for more profound support than just assisting users, which led to the proposal of a shift from assistance to companionship and conversation to collaboration (see Section 1.2). The problem that still existed though, was how to apply the developed design knowledge in an early stage of a CA design project, which was solved with a visual tool in the form of a canvas-approach, the VC Canvas. The knowledge gained for the design of conversational and collaborative agents in P1 and P2 was aggregated and then extended with the concept of companionship in DC3.1. The findings led to the development of the VC Canvas prototype (Outcome 3.1). With the feedback of an expert discussion, the VC Canvas prototype was further developed in DC3.2 , resulting in the VC Canvas V1 (Outcome 3.2). As P3 was initiated after DC2.1, it was conducted in parallel to P2, allowing to apply the VC Canvas V1 in DC2.3 (Outcome 2.4).

During the expert discussion, the idea came up that the VC Canvas might be really useful for designing customer services in the service sector featuring a VC. This led to DC3.3 and the proposal of a service-specific version of the VC Canvas (Outcome 3.3).

Project 4 and 5: A Nascent Design Theory for Virtual Companionship

The findings from DC3.1 and DC3.2 were submitted to the workshop "Designing User Assistance in Intelligent Systems" at the European Conference on Information Systems (ECIS) 2019, enabling a discussion with experts from the field (Strohmann, Siemon, et al., 2019b). Based on this feedback, it was decided that it would be a stronger contribution if the VC was not introduced as a new class of applications, but rather the concept of virtual companionship with an associated nascent design theory would be introduced, which could then be applied to a variety of AI applications. Hence, in DC4.1 meta-requirements and design principles for virtual companionship were derived from the literature (Outcome 4.1), and a new Version of the VC Canvas was developed (Outcome 4.2). In Project 5 (P5), the Virtual Classmate was conceptually designed with the VC Canvas V2 (Outcome 5.1) and then instantiated as a prototype (Outcome 5.2) resulting in an expository instantiation for the nascent design theory.

Project 6: The Virtual Companion Design Framework
Based on the experience in the conception and development of various AI applications in the form of CAs and VCs, a design framework especially for the design of VC artifacts is proposed in Chapter 9 (Outcome 6). The VC design process, which is the core of the framework, should help designers to instantiate VC artifacts and is based on the DSR process models by Vaishnavi and Kuechler (2015) and Peffers et al. (2007) and the Design Thinking procedure models according to Plattner (2010a) and Rintisch (2018). The VC design process is then extended to a design framework which, in addition to suggested methods and tools for the individual steps, will in particular contain the design knowledge crafted by the author of this dissertation.

2.5. Ontological and Epistemological Positioning

According to Guba (1990), ontology is defined as the researcher's view on the nature of reality, thus the perception of "what exists" and epistemology is the perceived relationship with the knowledge the researcher is undiscovering. Together the ontological and epistemological stance form a paradigm as a belief system that guides the researcher. According to Orlikowski and Baroudi (1991) there are three paradigms: positivism, critical theory, and interpretivism. However, Design Science is seen as an additional paradigm by some scholars as it differs from the ones in the established classification because it follows the approach for crafting knowledge through the creation of artifacts (Vaishnavi and Kuechler, 2015). Goldkuhl (2011) advocates that design research finds its paradigm home in pragmatism since pragmatism considers knowledge as a way to enhance action and existence. Hevner et al. (2004) states that the philosophical assumptions in IS research are drawn from the pragmatists. They argue that technology and behavior are inseparable in an IS, which is similar to the assumptions of the pragmatists who consider truth and utility inseparable and that scientific research should be evaluated in terms of its practical implications. Also, Vaishnavi and Kuechler (2015) agree that the design science researcher is a pragmatist, as knowledge is crafted through the construction of artifacts. Moreover, Vaishnavi and Kuechler (2015) comprehensively differentiate "Design" as a philosophical paradigm opposed to positivism and interpretivism. They argue that DSR changes the state-of-the-world due to the creation of novel artifacts, because of its nature. Thus, the design science researcher ontologically believes that there are multiple, contextually situated alternative world-states which are socio-technologically enabled. In contrast, the positivist believes that there is a single socio-technical system representing reality. The interpretivist ontologically believes in multiple realities that are socially constructed, but here the design researchers are still different as most believe in a single reality underlying the multiple world-states (Vaishnavi and Kuechler, 2015). However, Vaishnavi and Kuechler (2015) also argue that the philosophical perspective of the design science researcher can change throughout a research project as progress is iteratively made through the single phases (Vaishnavi and Kuechler, 2015).

This research perspective "Design" is followed by the author of this dissertation, meaning that the author ontologically believes that there are multiple, contextually situated alternative world-states which are socio-technologically enabled and epistemologically believes that knowledge is crafted through the construction of artifacts.

CHAPTER 3

Implementing a Virtual Moderator

The first Instantiation

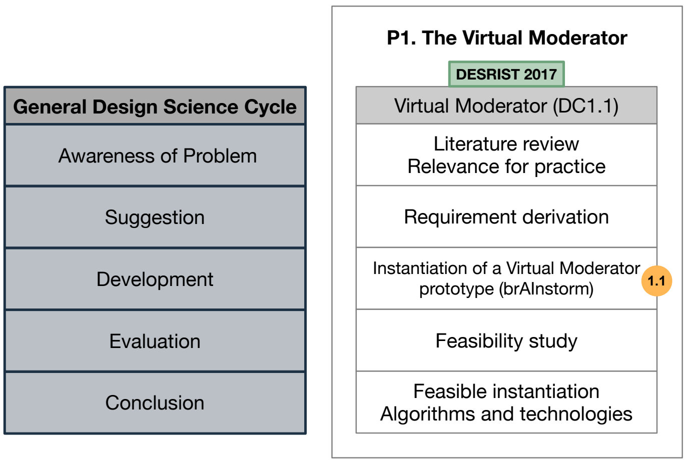

Figure 3.1.: *Positioning DESRIST 2017 in the DSR Project*

The idea for the virtual moderator arose during the planning phase of the dissertation project and thus also represents the first DSR project. After a literature review, the potential of the idea became clear, since the development of AI-based technologies for CAs was very promising. However, the use cases in the IS context were still very limited. At that time in 2016, there was no study in the IS field about CAs or virtual assistants in a collaborative setting with humans. In order to demonstrate the feasibility of such a collaborative use case, an instantiation of the virtual moderator with the associated platform brAInstorm was designed and developed in the design cycle 1.1 (see Figure 3.1).

DESRIST 2017: brAInstorm: Intelligent Assistance in Group Idea Generation

Abstract

Being innovative and producing novel products or services can lead to sustainable success for companies. In order to generate valuable innovations, it is important to come up with potential beneficial ideas. A well-known method for collective idea generation is Brainstorming. As project teams are more and more working globally dispersed, information technology plays and important role for an effective collaboration. With Electronic Brainstorming, individuals can virtually brainstorm. However, an effective Brainstorming facilitation always needs a moderator. In our research, we designed and implemented a virtual moderator that can automatically facilitate a Brainstorming session. We used various artificial intelligence functions, like natural language processing, machine learning and reasoning and created a comprehensive Intelligent Moderator (IMO) for virtual Brainstorming.

3.1. Introduction and Motivation

Organizations are confronted with numerous difficulties to oppose global competition, as in an increasingly interconnected world, the global competition for customers and market shares is growing (Bridge and O'Neill, 2012). An important factor in this setting is played by innovations that can secure economical success (Weerawardena and Mavondo, 2011). To better react to dynamic markets, companies need innovative products and services, as well as beneficial methods for their growth (Somech and Drach-Zahavy, 2013). However, companies and project teams are increasingly composed of employees, who work globally dispersed (Gibson and Gibbs, 2006; Lurey and Raisinghani, 2001). Computer tools that allow real-time collaboration over the internet can help (Gera et al., 2013), as team members can work together from almost any place in the world (Gumienny et al., 2012).

One well-known method for idea generation is Brainstorming, which has been successfully implemented in practice and examined in research (Paulus and Dzindolet, 1993; VanGundy, 2008). Brainstorming is a creativity technique for groups, with the purpose to produce a lot of ideas that may solve a given problem (Osborn, 1953). By leveraging the collective thinking of a group, many ideas can be produced (Nijstad and Stroebe, 2006). In order to accomplish this, it is important to follow basic rules and principles. No criticism, the generation of unusual ideas, quantity breeds quality and the combination and improvement of ideas are rules of Brainstorming. It is largely based on teamwork and is therefore often applied in face-to-face meetings. With the help of information technology, Brainstorming has already been successfully digitized (Barki and Pinsonneault, 2001; Dennis and Valacich, 1993). This so-called Electronic Brainstorming (EBS) has been examined in various research and has been identified to even outperform conventional face-to-face Brainstorming (Gallupe et al., 1992; Mullen et al., 1991). EBS uses synchronous and asynchronous communication as well as other functions to facilitate the Brainstorming process. However, these functionalities do not solely make a Brainstorming session generative. The key to an effective Brainstorming is good facilitation, which in face-to-face sessions is fulfilled by a moderator. A moderator executes several tasks, like the encourage of participants to contribute or the intervention when Brainstorming rules are broken (Kramer et al., 2001; Offner et al., 1996). Besides of the organization and observation of the Brainstorming session, the moderator also acts as an active facilitator by giving input to stimulate the participants and to spark new ideas. Hence, a moderator usually needs special skills and knowledge on how to facilitate a Brainstorming session. In virtual teams and EBS this means, that a moderator always has to be present when conducting a virtual Brainstorming session. In our research, we approach this, by developing a virtual moderator, who can facilitate an EBS session by both, organizing a session and providing creativity stimulating content. Following the DSRM, we designed and implemented a novel artifact in order to approach this problem in an innovative matter (Gregor and Hevner, 2013; Hevner et al., 2004). We strive to deeper understand the interaction between an artificial intelligence and other individuals within a group creativity processes. With our developed prototype, we will provide a first approach on how computer tools can be designed to automatically moderate Brainstorming, which can lead to new insights for research and practice.

3.2. Theoretical Background

As Plucker and Makel show, creativity has various similar, overlapping and synonymous terms, such as imagination, innovation, novelty, uniqueness along with others (Plucker and Makel, 2010). Guilford, who initiated the modern creativity era in psychological thinking, describes creativity as problem solving (Cropley, 2016). In addition, he classifies divergent and convergent thinking as productive-thinking operations that generate new information from existing information in order to produce novel ideas. When a problem needs to be solved, both thinking operations are required. With the help of divergent thinking a variety of responses can be produced. But for reaching a unique conclusion, convergent thinking is needed (Guilford, 1959). This raises the questions, what characteristics a creative individual possesses and if it is possible to design and implement a computer-tool that exhibits creative thinking abilities. As one of the first who looked at creativity and AI, Margaret A. Boden stated why AI must try to model creativity (Boden, 1998). Today, computational creativity is a multidisciplinary endeavour, overlapping with cognitive since and other areas in addition to AI (Besold et al., 2015; Colton and Wiggins, 2012). According to Besold et al. (2015), the target of computational creativity is to model, simulate or replicate creativity with the help of a computer to achieve one of the following ends:

- create a program or computer capable of human-level creativity
- help to understand human creativity
- construct a program enhancing human creativity without necessarily being creative itself (Besold et al., 2015)

In the first step of our research, we designed a computer-tool to enhance human creativity without necessarily being creative itself. Our artifact, ”brAInstorm” , is a web-based tool for collective EBS, with an Intelligent Moderator (IMO), who fulfils various functions of a Brainstorming moderator. In the next section, we outline the technical implementation of our artifact and explain the moderator functions in detail that have been implemented.

3.3. Design of the Artifact

For the implementation of brAInstorm, three important parts have to be considered. The first part is the user interface, which we will derive from basic principles of prior EBS implementations (Javadi, 2012; Link et al., 2016; Nunamaker Jr et al., 1987). The system should allow users to communicate with each other. For this reason a chat will be used. In addition, it should be possible for all participants to add and edit own ideas and to view other ideas. For this feature, we used the open-source chat platform Rocket.Chat[3], where we added additional functionalities, like adding and editing ideas. For the second part, the essential Brainstorming phases, we adopted the process by Gallupe et al. (1992) and implemented it into the system (Gallupe et al., 1992). The process is divided into an individual idea generation and a collective idea evaluation, which is facilitated and organized by IMO, the third part of the artifact (see Fig. 1). Beside of organizing the EBS process, the moderator additionally intervenes, if participants use so-called killer phrases, get impertinent or talk too much. The killer phrases are adopted from Dave Dufour, who defined 50 phrases, which can heavily impair a Brainstorming process (Dave Dufour, 2010). IMO is capable of identifying these phrases and intervenes, even if they are alternated but have the same intentions. In addition IMO, intervenes, when the group drifts away from the topic or the group stagnates. While, the Brainstorming phases are implemented within the Rocket.Chat, IMO is based on the open-source chatbot Hubot, developed by GitHub, Inc[4]. Hubot is written in CoffeeScript in Node.js, can be extended with individual scripts and is connected to Rocket.Chat with a modified adapter. Because Hubot is written in Node.js, it can easily be extended by packages like NaturalNode[5], a general natural language facility, providing algorithms like a part-of-speech tagger. The script based Hubot has hearing and responding functions, but does not offer conversations, context understanding or machine learning. For this reason, Hubot is extended with wit.ai's Bot Engine. Wit.ai[6] is an open-source and extensible natural language platform, offering developers various functionalities for building applications, a user can text or talk to. An Intent Parser, which converts user texts or voice into structured data, extracts the intent and other parameters of a users input. A Bot Engine, combines machine learning with a rule-based

[3]https://rocket.chat/
[4]https://hubot.github.com/
[5]https://github.com/NaturalNode/natural
[6]https://wit.ai/

behaviour, consisting of three key concepts: Stories, actions and an inbox. Stories are rule-like example conversations between the bot and a user, specifying how the bot should react on a certain statement. With the help of wit.ai's predictions, Hubot can execute an action at the needed points in the conversation. Wit.ai's Inbox allows machine learning by collecting all users' expectations. Using this, brAInstorm can be optimized through continuous learning and improvement based on actual usage. With the help of the collected data new stories can be created and existing ones get smarter. This concept can avoid the need for a high amount of example conversations that are usually needed for machine learning. With these functionalities, brAInstorm can offer a comprehensive automated moderation for EBS. Figure 3.2 shows the Brainstorming process within our artifact and the underlying technology behind each function. A screencast of the artifact is available on vimeo.com/203283219 (pw: desrist2017).

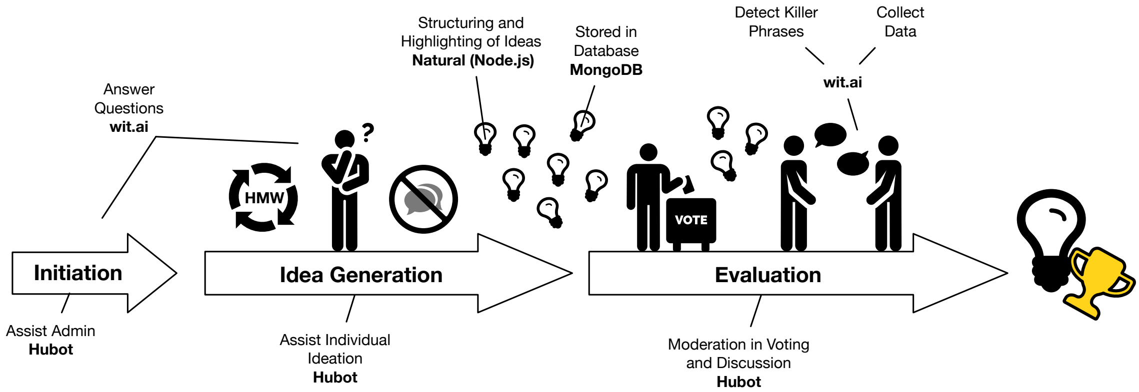

Figure 3.2.: *Brainstorming Phases (Own Figure)*

3.4. Evaluation of the Artifact

In order to evaluate, whether our artifact can fulfill the defined requirements and address the problem, we intent to observe and measure the effectiveness of brAInstorm. Our planned evaluation can be divided into two steps. First, we plan to conduct a set of experiments, where we will specifically assess the functionalities of brAInstorm. We will measure the perceived effectiveness, perceived satisfaction and qualitatively evaluate the perceived virtual moderation (Dennis, Valacich, et al., 1996; Gallupe et al., 1992). The aim is, to observe, whether the participants are satisfied with IMO and whether the Brainstorming process was successfully executed. Following prior research on group creativity and artificial intelligence, we aim to examine, whether specific enhancing and impairing group factors apply, when interacting with an AI systems (Siemon, Eckardt, et al., 2015). The second part of our evaluation is a long-term case study, where we will implement the artifact within an on-going Design Thinking project. Design Thinking is a process or mind-set that can be used to resolve problems and generate innovations (Brown, 2009). Within the Ideation phase, Brainstorming is often used to generate ideas. In our long-term evaluation, we will use brAInstorm for ideation and examine, whether our approach is effective. Both evaluations can lead to valuable insights, for research and practice. Practice can benefit from an innovative artifact that can be used in creative problem solving in virtual teams. New insights on group ideation and the interaction with an artificial intelligence can lead to new interesting insights for research.

3.5. Outlook

With our artifact, we created an innovative solution for virtual Brainstorming that are supported, organized and executed with the help of a virtual moderator. With our evaluations, we plan to examine the applicability of our prototype. Furthermore, we plan to examine the interaction between individuals and an AI, which can contribute to the understanding of group interaction theories. In this context, we take our artifact to next level, by developing an independent artificial participant, a Creative Artificial Intelligence (CAI). Currently we are implementing CAI into our artifact, a creative and active participant that is capable of human-level creativity. In 2015, Siemon, Eckardt, et al. already examined the interaction of participants with an artificial intelligence-like support system (Siemon, Eckardt, et al., 2015). We plan on further investigating this process to validate, whether theories of group interaction apply. In summon, it can be said, that we designed an novel artifact, that can contribute to practice in many ways and change or further develop theories on group interaction.

3.6. Supplement

As the publication DESRIST 2017 was a paper in the protoype track the number of pages was very limited. A detailed documentation and visualization of the developed prototype and its functionality can be found under: http://brainstorm.strohmann.io/. In addition, Figure 3.3 shows a screenshot from a brainstorming session using the prototype, which shows how IMO the virtual moderator tells the participant Rangina not to criticize during the brainstorming.

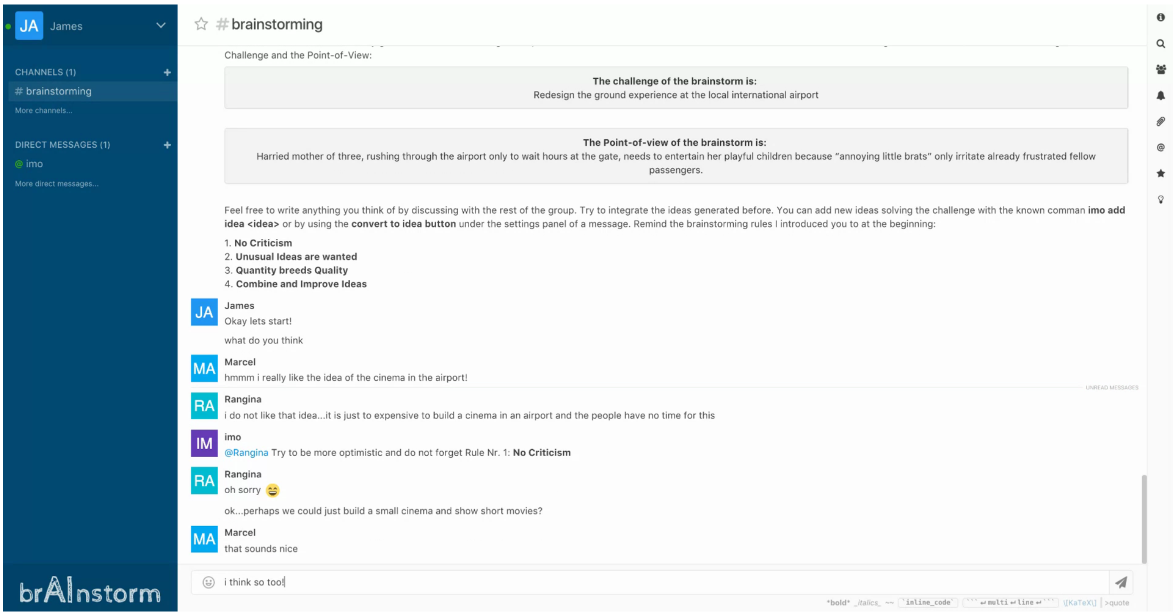

Figure 3.3.: *Screenshot of a Brainstorming Session with brAInstorm*

CHAPTER 4

How to design a Virtual Moderator?

The Need for Prescriptive knowledge

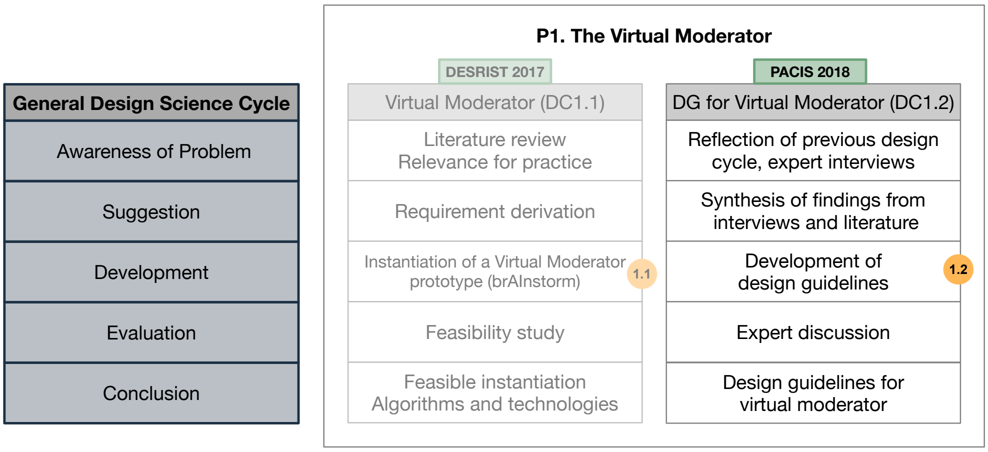

Figure 4.1.: *Positioning PACIS 2018 in the DSR Project*

As a particular challenge in the design process of IMO, the virtual moderator, in the brAInstorm instantiation of the previous chapter, it was noted that there is a considerable lack of structured design knowledge for the design and development of virtual assistants. This applies to both independent and dependent knowledge. To address this problem, it was planned to derive structured prescriptive knowledge for a virtual moderator. For this reason, DC 1.2 was initiated as a second DC within the DSR project 1 (see Figure 4.1) to derive design guidelines for a virtual moderator.

PACIS 2018: Virtual Moderation Assistance: Creating Design Guidelines for Virtual Assistants Supporting Creative Workshops

Abstract

To remain competitive, businesses need to develop innovative and profitable products, processes and services. The development of innovation relies on novel ideas, which can be generated during creative workshops. In this context the Design Thinking approach, a problem-solving methodology based on collaboration, user-centricity and creativity, may be used. However, guidance and moderation of this process require a vast amount of skills and knowledge. As technologies like artificial intelligence have the potential of making machines our collaboration partner in the future, creating VAs adapting human behaviors is promising. To reduce cognitive dissonance and stress on both the moderators and participants, we investigate the potential of a VA to support moderation in a Design Thinking process to improve innovative output as well as perceived satisfaction. We therefore developed design guidelines for VAs supporting creative workshops based on qualitative expert interviews and related literature following the DSRM.

4.1. Introduction

In a world with fierce competition and where constantly new technologies emerge, businesses and professionals need to adapt to challenges and chances. To survive it is inevitable to develop innovative and profitable products, processes and services to remain competitive (Kung and Schmid, 2015; Weerawardena and Mavondo, 2011). The development of innovations relies on the ability to conceive, appraise and refine novel ideas. (Forés and Camisón, 2016; Helpman et al., 2010; Hennessey and Amabile, 2010; Somech and Drach-Zahavy, 2013). As creativity is hindered in competitive environments, sustaining innovation processes relies on creative individuals and groups

(Siemon, Eckardt, et al., 2015). To foster creative thinking in corporate environments dedicated creativity workshops became increasingly popular since cost and time efficiency are major concerns for firms (Gabriel et al., 2015).

As the business environment becomes more complex, problems become wicked. To solve wicked problems, which neither have a definitive formulation or solution, teamwork becomes necessary, as research shows that team efforts outrun the cumulated individual outcome (Bell and Kozlowski, 2008; Buchanan, 1992; Connoly et al., 1993; Nijstad and Stroebe, 2006; Paulus, 2000; Paulus and Nijstad, 2009; Santanen et al., 2000; Santanen et al., 2004). In this context, Design Thinking gained attention in corporate and scientific communities due to its holistic and collaborative approach for the innovation of products, services, product-service systems or processes (Chasanidou et al., 2015). Design Thinking is a problem solving methodology that is used to address *wicked problems* by utilizing creative and user-centered approaches in heterogeneous groups (Brown, 2008; Buchanan, 1992; Carlgren et al., 2014; Stickdorn and Schneider, 2010) . In this iterative and emerging process a variety of methods, tools and techniques engage participants both cognitively and empathically (Brem and Spoedt, 0021). Regardless of what approach is used, these processes rely on a large amount of information and knowledge, which calls for the implementation of knowledge management or group support systems. However addressing both moderators and participants with one system calls for a differentiated evaluation of processes (Gabriel et al., 2015). Recent developments in the field of artificial intelligence may offer the tools to address this issue.

Following this line of thought, we examine how the moderation of Design Thinking workshops may be supported through the utilization of a VA. We explore the components of such a VA and propose guidelines for its design using the DSRM. Our generated design guidelines can be used by researchers, as well as designers implementing specific VAs for the support of creative processes to improve innovative and creative processes like the Design Thinking approach in a workshop setting. The development of our guidelines is based on a qualitative research approach with five expert interviews as well as the review of existing research results. In this paper we address the question: **What are the requirements that need to be considered to design VAs supporting Design Thinking workshops?**

The remainder of this paper is structured as follows. First, we present the theoretical background on Design Thinking and creativity workshops as well as VAs. In the third section, we present our research methodology followed by the guidelines we propose for VAs in the fourth section. Lastly, we discuss the implications, limitations and potentials of these results and conclude our findings.

4.2. Theoretical Background

4.2.1. Design Thinking and Workshop Settings

Design Thinking is a holistic, collaborative approach for the innovation of products, services, product-service systems or processes that is inherently based on creativity, multidisciplinarity, and user-centricity (Brown, 2008; Carlgren et al., 2014; Stickdorn and Schneider, 2010). The origins of Design Thinking can be traced back to the end of the 1960s when Simon Simon (1969) introduced the development of artifacts based on "designerly thinking", which conveyed a design science procedure as a useful interdisciplinary approach in the area of business and economics. The terms "design" and "thinking" connotes a strong connection to the manner designers or the science of design operates (Brenner et al., 2016). Design Thinking is a stand-alone strategic innovation development approach that consists of a process, methods, and a mindset (Brenner et al., 2016).

Design Thinking employs divergent thinking to create choices through insights into consumer behavior, alternative solutions and interactive experiences to improve creative activities such as ideation (Brown, 2008). This not only avoids efficient brainstorming that fosters conservative and inflexible ideas, it also heavily increases complexity, and thus convergent methods are used to empower participants to eliminate options and make choices. As Design Thinking is a user centered approach to problem solving, empathy builds the foundation to reveal the users core needs and problems (Bellet and Maloney, 1991; Brown, 2008). Therefore the Design Thinking process in its entirety is focused towards understanding the context of needs and problems, observing user interaction with humans and objects, refining the issue before coming up with ideas and merging them to a product, service or process prototype, that is presented to and tested with the user (Buchanan, 1992). As the users' issues can be manifold, there is a variety of methods for each process phase (Understand, Observer, Point-of-View, Ideate, Prototype and Test) that allow for a tailored creation process. These phases heavily alter between their intended modes of thinking. Design Thinking relies on inductive (generalization), deductive (prediction of consequences) and also on abductive reasoning (formation of explanatory hypothesis) (Brown, 2008). The latter is considerably less prominent in business and engineering education but vitally important for generating novel ideas (Dunne and Martin, 2006). The underlying Design Thinking mindset involves aspects such as user-centricity and abductive reasoning that are not easily taught and internalized by participants with traditional business mindsets (Heiman and Burnett, 2007). Additionally, while performing Design Thinking workshops, the design of the space and surroundings, such as moveable furniture, tools and materials, visualization of new ideas are used to foster creativity and interaction (Grots and Pratschke, 2009). This interactive communication is considered as an important feature of Design Thinking (Brereton and McGarry, 2000) as the "Design Thinking team" needs to organize, share and develop their ideas in the early phases of the Design Thinking process and must often interact practically during the development of prototypes (Brown, 2009).

Guidance and moderation of this process is usually left to one or two trained design thinkers per group as, although rising in popularity, Design Thinking education is scarce (Heiman and Burnett, 2007). Guiding this process often encounters barriers as participants are accustomed to traditional innovation or decision processes using deterministic and analytical thinking that some Design Thinking phases and methods deliberately avoid in order to foster new ideas (Chasanidou et al., 2015; Heiman and Burnett, 2007). This induces that individuals or groups find themselves stuck in arguments or abandoned by creativity (Morehen et al., 2013). Utilizing dedicated methods within the Design Thinking process while encouraging creativity, interaction and fun as well as providing appropriate surroundings, tools, materials and visualizations to ensure a smooth process therefore is a challenge for moderators. Hence, we investigate the potentials of a VA to support Design Thinking moderation in a Design Thinking process to reduce cognitive dissonance and stress on moderators and participants to improve process success and perceived satisfaction.

4.2.2. Virtual Assistants

There are various synonyms for VAs such as virtual personal assistants (McTear et al., 2016), vocal social agents or digital assistants (Guzman, 2017), voice assistants (McTear et al., 2016) and intelligent agents (Balakrishnan and Honavar, 2001). Similar to the variety of names there is also no single definition, but several definition approaches as well as tasks and characteristics of VA, which are considered below. VAs are computer software programs performing functions in an intelligent manner, like helping users on their own initiative (Skalski and Tamborini, 2007). According to (Balakrishnan and Honavar, 2001) an intelligent manner in terms of VAs can be defined as *"behaviors that would be characterized as intelligent if performed by normal human beings under similar circumstances"* (Balakrishnan and Honavar, 2001). VAs carry out tasks for the users and can answer various questions (Zhao, 2006). The interaction takes place in a human-like way. Thus, VAs need to interact with humans in a social way, follow social norms of interpersonal communication and need to be able to use and understand natural human language (Guzman, 2017; Skalski and Tamborini, 2007; Zhao, 2006). Humans can interact with VAs via voice or text (Chatbots) and the VA might respond either with voice, text or visual information (Pearl, 2016).

According to (Balakrishnan and Honavar, 2001) there are several requirements for VAs to perceive input from its environment and act upon it. To perform an action the VA has to interpret the given input. The actions are then chosen autonomously according to the intended goal to be achieved. As VAs are usually used in dynamic environments, mechanisms to learn and adopt from instruction to instruction are needed for sustainable, reliable operation. Lastly, a VA has to be able to collaborate and communicate in groups.

VAs are used in more and more areas of everyday life (McTear et al., 2016), like Siri, Google Now, Microsoft Cortana, Amazon Echo or Google Home (Pearl, 2016). However, there are only a few examples where VAs support creative processes (Siemon, Eckardt, et al., 2015; Strohmann, Siemon, et al., 2017), but concrete design instructions are missing. (Seeber, Bittner, Briggs, De Vreede, et al., 2018) states that artificial intelligence technology like VAs have the potential to become our smart collaboration partner in future. Hence the opportunities enabled by smart technology for collaborative processes have to be explored. Our Guidelines for VAs supporting the moderation of creative processes are a step into this direction.

4.3. Methodology

The objective of our research is to generate design guidelines that can be used by researchers, as well as by designers to develop and implement specific VAs for the support of creative processes. We follow the DSRM, which aims to create innovative and novel artifacts in order to solve organizational and human problems (Hevner et al., 2004). Several process models and frameworks for Design Science exist that cover the extent and specification of the artifact that is designed within the methodology. According to (Gregor and Hevner, 2013) the levels of artifact abstraction in DSR is vast and ranges from models, processes, instantiations, methods or software. Artifacts can be described by the two attributes "abstract" and "specific" and by their general maturity of knowledge. Design guidelines and constructs, methods, models, or technological rules are artifacts that are in between a solely abstract or specific artifact and contribute nascent design theories or operational principles. In our research, the design guidelines that serve as a foundation for further refinement, adjustment or implementation, thus, represent the design artifact.

The development of our guidelines is based on a qualitative research approach with five expert interviews as well as existing research results. Therefore, we have reviewed literature concerning the topics Moderation, Design Thinking and VAs. The findings of reviewing the literature form the basis of the interview guidelines, as well as for validation and refinement of our proposed design guidelines.

4.3.1. Expert Interviews

Due to the lack of previous research we conducted five expert interviews. Expert interviews have grown in popularity as a reliant method to obtain knowledge that is otherwise hard to discover (Bogner et al., 2009a; Meuser and Nagel, 2009a). As the term expert is used extensively inflationary (Meuser and Nagel, 2009a), in this study the interviewees' expertise is distinguished from "everyday" and "common-sense knowledge" as they have been either participants or moderators in various creativity or Design Thinking workshops for at least two years. Additionally, three participants have an IS research background. Grounded in the novelty of this endeavor the expert interviews were employed as an exploratory tool, and hence conducted as openly as possible as suggested by Bogner et al. (2009a).

4.3.1.1. Participants

Potential participants were directly approached by the researchers. Prior to the selection of the experts, we defined specific requirements. For the purpose of our research, an expert should have at least two years of experience in planning and conducting creativity workshops (e.g. Design Thinking) or experience in being a workshop participant. In order to gain divergent insights, we sought experts from different professions. A background in IS research, ideally artificial intelligence, knowledge management or group support systems, was optional but ideal. We acquired two IS researchers (E1 and E4) with experience as participants in various creativity workshops including Design Thinking. One researcher and Design Thinking coach (E2) and one freelancer, specializing in innovation workshops and change management with a system engineering and design background (E5). One expert is an employee of a financial services company (E3) and works as a manager of innovations. This expert has more than 10 years of workshop experience (participants and moderator). Participants were 31 years old on average, with one female and four male experts. The interviews took place at the workplaces of the experts.

4.3.1.2. Semi-structured Interviews

An interview guideline was developed based on literature from the area of moderation and Design Thinking as well as on prior experience, research on design science and existing design principles for VAs. As the interviews were to be carried out on Design Thinking and creativity workshop experts from different backgrounds, semi-structured interviews were chosen to give the interviewees enough space to elaborate on issues and the possibility to point out aspects that had not come up in the preparation of the guideline. Furthermore, the method should also ensure that all relevant aspects were captured and in regard to the coding process, answers were at least in part comparable. The interview guidelines were roughly divided into six parts according to previous studies such as Cohen et al. (2004) and Pearl (2016), who specified requirements regarding representational (part 4) and interaction design (part 5) of VAs. The whole interview was structured as follows:

- Part 1 introduced the interviewer and again summed up the purpose of the research as the participants had already received relevant information when they were recruited.

- Part 2 asked the interviewee to elaborate on his background as well as his current occupation and relation to the Design Thinking process.
- Part 3 consisted of questions considering the general approach to the Design Thinking process and the tasks of a moderator therein.
- Part 4 asked the interviewee for his evaluation of the potential for support by VAs within the Design Thinking process and the importance of different appearances of such VAs.
- Part 5 included questions as to how interactions with a VA could ideally take place within the situation of a Design Thinking workshop.
- Part 6 concluded the interview with the possibility for the interviewee to give an outlook on how she thinks the future of VAs might look like as well as to state aspects that had not been addressed in the interview.

The interviews were conducted between 20th December 2017 and 25th January 2018 and took between 55 and 65 minutes. After conducting the interviews, they were transcribed and coded in MAXQDA version 18. The following section describes the coding in detail.

4.3.1.3. Coding of the Interviews

The expert interviews are analyzed using codes as an efficient data-labeling and data-retrieval device (Miles and Huberman, 1994). Following Miles and Hubermanns (Miles and Huberman, 1994) advice prior to the first expert interview an initial list of general codes was created. As Saldaña (2015) stated several coding cycles are needed for analyzing qualitative data. The coding effort has therefore been divided into three cycles, going from a general view on the data to a more specific and was done following Saldañas (2015) manual for qualitative researchers. The three coding cycles are visualized in Figure 4.2 with an adapted version of Saldañas (2015) code-to-theory model for qualitative inquiry.

The coding was done collaboratively by four researchers to distribute the effort of conducting and coding the interviews as well as to get different views on the qualitative data. According to (Miles and Huberman, 1994) the first cycle of coding started directly after each interview. With each newly coded interview the codings done so far were refined and aggregated with the new codings. Hence every coding cycle had several iterations. Additionally to the initial list of codes, more codes emerged inductively dur-

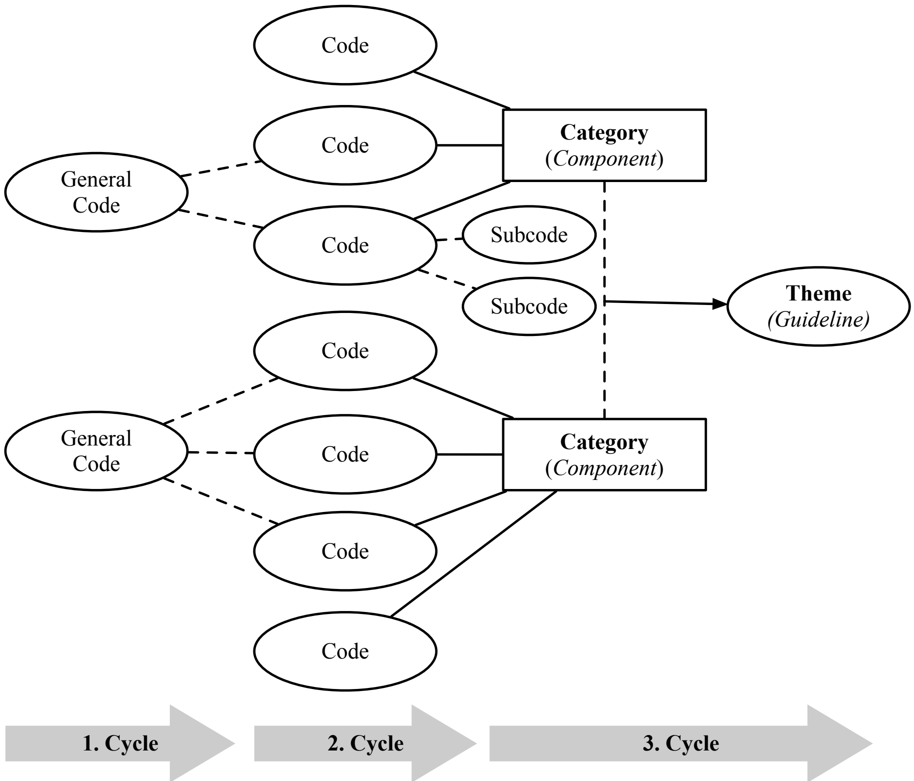

Figure 4.2.: *Code-to-Guideline Model adapted from (Saldaña, 2015)*

ing the analyzing progress and were added to the list (Miles, Hubermann, et al., 2014). The coding effort in the first cycle was distributed to the four researches who coded their respective interviews. One of the researchers was appointed the codebook editor. Following (Guest and MacQueen, 2008) the codebook editor is responsible to update, revise and maintain the list of codes for the group. So, in our case the editor combined and aggregated all codings after each new interview, cycle and iteration.

In the first coding cycle the general codes defined prior are used to get the data structured. General codes like "Tasks of the Moderator" or "Design Thinking Process" were assigned to the data. The first coding cycle structured the data and prepared it for the second coding cycle.

In the second coding cycle the researches dived more into the data and specific codes and subcodes were created. For example, a general code like "tasks of the moderator" got subdivide into subcodes like "acquire participants" or "intervene in case of stagnation". In this phase the actual meaning of the data got uncovered. In summon 219 codes and 537 codings were created.

In the third and last cycle of coding the specific codes and subcodes of the second cycle were combined to categories (components of the guidelines) which were then structured into themes (guidelines).

4.4. Creating the Design Guidelines for Virtual Assistants

The design guidelines were derived from the results of the three coding cycles. As the coding started with a general view, it was specified from iteration to iteration and cycle to cycle. In the last coding cycle the focus was set specifically on possible design guidelines. They were validated and refined using corresponding literature. The final guidelines are structured into three main categories: First **general conditions** for a VA supporting creative processes, second characteristics of the VA and third tasks of the VA (divided into preparation and execution).

The components of each guideline as well as the guidelines themselves are shown in the following visualized in three tables. The components are directly related to the codes from the interview coding. Components with a high relevance (mentioned by 4 or more experts) are highlighted in bold. If there are contrary statements of the experts leading to opposing components, both opinions are listed in the column *Components* with a *"vs."* between them. Some components are divided into subcomponents which are listed as bullet points under the associated component. The literature used for validation and refinement is listed in the column *Supported By*. In addition, several components are corroborated with quotes from the expert interviews. As the interviews were conducted in German language, the quotes are translated into English.

4.4.1. General Conditions for a Virtual Assistant supporting Creative Processes

The first category is about general conditions that should exist for a VA supporting creative processes. Guideline 1.1 reflects the fear of the participants that machines get uncontrollable. As Expert 3 asked: *"How far do I humanize machines, so that I can allow them either manipulate me or not manipulate me?"*. Thus, while designing a VA the designer has to mind ethics, be conscientious and create an environment in which the user feels comfortable.

As all interviewees are moderators themselves it is clear that they do not want a VA to replace them. Looking on this with a technological view, it is also probably too premature to completely replace a human moderator. Instead a VA may first support and collaborate with a human moderator and deepen its functionalities step by step. This is why we propose guideline 1.2 containing tasks and use cases the interviewed experts would like to have support for and also think a VA is able to support.

Table 4.1.: *General Conditions*

<table>
<tr><th>Guideline</th><th>Component</th><th>Supported By</th></tr>
<tr><td rowspan="3">1.1 Create a trustful and transparent environment</td><td>Mind ethics</td><td rowspan="3">(Bostrom and Yudkowsky, 2014)</td></tr>
<tr><td>Be careful with growth of machine intelligence</td></tr>
<tr><td>Minimize feeling of observation</td></tr>
<tr><td rowspan="8">1.2 A VA supporting (not replacing) the human moderator</td><td>Method and tool support</td><td rowspan="8">(Strohmann, Siemon, et al., 2017)</td></tr>
<tr><td>Giving tips and nudges</td></tr>
<tr><td>Provide multimedia-based instructions</td></tr>
<tr><td>Process support</td></tr>
<tr><td>Explain rules and remember to follow them in case of violation</td></tr>
<tr><td>Documentation</td></tr>
<tr><td>Time-keeping</td></tr>
<tr><td>Consequent reminder</td></tr>
<tr><td rowspan="4">1.3 Conditions for proactive actions</td><td>Human moderator has to accept proactive actions / VA has to cooperate with human moderator</td><td rowspan="4">(Friedman, 1989; Pearl, 2016)</td></tr>
<tr><td>proactive action only with high quality</td></tr>
<tr><td>Acting proactively based on events (external or workshop-related)</td></tr>
<tr><td>Context (emotions, hierarchies, no personal criticism, concentration, interruption) and sensitiveness important for proactive features</td></tr>
</table>

Guideline 1.3 summarizes conditions for proactive actions. Although planning and preparing the workshop is essential to its quality, the moderator needs to adjust to the participants needs and the emerging topics. The VA respectively is expected to proactively support ad hoc changes based on events. For example, if the participants are stagnating, the VA needs to recognize this and act on it. In such situations the par-

ticipants would normally not be able to act by themselves, this is why proactive actions are needed. The context of a situation during a workshop is one of the most important components for performing proactive actions mentioned by all experts. When thinking of VA broadly used like Siri or Google Now, they most of the time only act upon command. For a VA moderating a creative process it is vital to refrain from being limited to reactive interaction, but also, for example, act based on a certain event or context. A requirement for that is high quality of the action, meaning it is seen as appropriate by the participants and moderator and it has to fit to the situation. Expert 3 reinforces this by saying: *"Equating machines with humans is heavily depended on the quality. (...) If the assistant expresses unqualified garbage at the wrong time, then it is a tool, I want to turn off."*. Thinking of guideline 1.2 the human moderator has to tolerate and accept a proactive behavior of the VA, as it is prone to interfere with the moderator's course of action. Thus, it may also be conceivable that the VA cooperates with the human moderator by just giving hints for proactive actions.

4.4.2. Characteristics of the Virtual Assistant

The second category contains guidelines concerning characteristics of the VA to ensure a high quality of interaction and representational consistency. Guideline 2.1 aims for the appearance of the VA. Combining the expert's statements it turns out that the VA should appear more like a human than as a robot. While the technology should not be visible (Expert 3 and 5) it has to be clear, that the VA is not a real human, which corresponds to guideline 1.1. Beside to a human appearance, like face and body (Expert 4), the VA may also use gestures or expressions (Expert 2). If the VA interacts using voice, the gender can either be male or female. Expert 4 thinks that a male voice would be more authoritarian, while Expert 1 says it should be possible to choose the gender of the VA.

Guideline 2.2 is all about the way of interaction between humans and the VA as well as the use of intelligent features. As the components of guideline 2.2 orientate on the requirements of Design Thinking experts, they naturally apply to Design Thinking Workshops. However, the examined literature on creative workshops suggests a high coherence for creative workshop support in general, as a similar atmosphere and work modes are intended. The VA should interact with the participants in a natural way, meaning that the participants can use natural language as they would with a human moderator. Several features might be used to make the interaction as natural and sophisticated as possible. Collected knowledge from previous workshops, for example, enables machine learning. With the recognition of emotions and different voices of participants, the VA can respond individually, fit the situation and learn about the participants. Expert 2, for example, said *"The virtual assistant could identify personal characteristics of the participants, in order to be able to act according to them when a critical situation occurs."*. Beside to the proactive actions, mentioned in guideline 1.3, the VA has to be addressable by the participants using an intent, gesture, keyword or button.

Table 4.2.: *Characteristics*

Guideline	**Component**	**Supported By**
2.1 More human than robot	Human appearance (face, body, visual specialties) vs. no human appearance	(Cohen et al., 2004; Pearl, 2016)
	Facial expressions and gestures	
	Technology should not be present / visible	
	Voice (Male vs. Female, Possibility to choose)	
2.2 Seamless way of interaction supported by intelligent features	Lighten the mood (jokes, anecdotes)	(Guzman, 2017; Hassenzahl et al., 2015; Pearl, 2016; Skalski and Tamborini, 2007; Zhao, 2006)
	Visualize, guide and support methods	
	Knowledge about methodology and tools	
	Collect / Use knowledge from previous workshops	
	Recognize emotions	
	Easy to use	
	Different levels of support	
	Reaction by intent, gesture, keyword or button	
	Audiovisual interaction	
	Recognize / Differentiate voices of participants • Measure participation • Identify personal traits / characteristics	
	Natural way of interaction	
	Follow social norms of interpersonal communication	
	Understand natural human language	
2.3 Personality helps for acceptance	Authority	(Cohen et al., 2004; Nielsen, 1995; Pearl, 2016)
	Humanly answer for non-existent functionalities	
	Name	
	Mannerism	
	Show emotions	

Guideline 2.3 is related to guideline 2.1 and focuses on the personality helping for acceptance. Therefore human-related behaviors like mannerisms or emotions as well as a name might help the participants accepting the VA.

4.4.3. Tasks of the Virtual Assistant as Moderation Support

The third and last category is about the tasks of the VA as moderation support. In this respect, we propose three guidelines containing several components and list supporting literature from the field of moderation of creativity and Design Thinking workshops. Guideline 3.1 is all about the preparation of the workshop, so all activities that take place prior to the workshop. According to the interviewees, one fundamental component is the definition of the design challenge. Furthermore, several organizational tasks have to be done in advance, like the preparation of the workshop concept, the acquisition of participants or the organization of dates.

The other two guidelines are related to the execution of the workshop. The support during the workshop is subdivided into active and passive support. The active support (guideline 3.2) refers to actions that are visible for the participants, like the time management.

The passive support (guideline 3.3) involves activities that are invisible for the participants and are all about recognition and detection. These passive activities form the basis for a possible active intervention or contribution. For example, if a problem was detected, like when the group is stagnating (see *Recognize / detect problems*, guideline 3.3), the VA has to intervene (see *Intervene in case of problems*, guideline 3.2). A possible intervention is to motivate the participants using motivational quotes (Expert 1), requiring a fast recognition and reaction.

Table 4.3.: *Tasks of the Virtual Assistant as a Moderator*

<table>
<tr><th>Guideline</th><th>Component</th><th>Supported by</th></tr>
<tr><td rowspan="5">3.1 Preparation of the Workshop</td><td>(Support to) Define the design challenge</td><td>(Brem and Spoedt, 0021)</td></tr>
<tr><td>Prepare methods, tools, concept and time table
• Catalog of methods
• First (introducing) questions
• Dive into topic</td><td rowspan="3">(Adam and Trapp, 2015)</td></tr>
<tr><td>Acquire participants</td></tr>
<tr><td>Organize dates and detail the agenda</td></tr>
<tr><td>(Support) team composition</td><td>(Geschka, 1986)</td></tr>
<tr><td rowspan="7">3.2 Active Support of the Execution</td><td>Motivate, activate and stimulate</td><td>(Adam and Trapp, 2015)</td></tr>
<tr><td>Encourage mindset and create atmosphere</td><td>(Adam and Trapp, 2015; Steinert, 1992)</td></tr>
<tr><td>Intervene in case of problems
(fast recognition and reaction as a requirement, motivation, explain methods, remind to follow rules, make adjustments)</td><td>(Adam and Trapp, 2015; Geschka, 1986; Lempiala, 2010)</td></tr>
<tr><td>Post processing and documentation</td><td rowspan="3">(Brem and Spoedt, 0021)</td></tr>
<tr><td>Keep results of current and prior methods or phases present</td></tr>
<tr><td>Time and process management
• Initiate breaks
• Initiate transition to new phase
• Iteration</td></tr>
<tr><td>Visualize, explain, support and suggest methods and tools</td><td>(Adam and Trapp, 2015; Gabriel et al., 2015; Nielsen, 2012)</td></tr>
<tr><td rowspan="5">3.3 Passive Support of the Execution</td><td>Observe and record activities</td><td rowspan="5">(Adam and Trapp, 2015; Brem and Spoedt, 0021; Lempiala, 2010; Nielsen, 2012)</td></tr>
<tr><td>Recognize / detect if goal is reached</td></tr>
<tr><td>Recognize / detect problems
(Stagnation, disruption, boredom, demotivation, frustration, disorientation, loss of focus, diverging from the topic, misuse or non-acceptance of methods, criticism, violation of rules, too similar ideas, challenge is not the real problem)</td></tr>
<tr><td>Recognize / detect results</td></tr>
<tr><td>Recognize / detect the process</td></tr>
</table>

4.5. Limitations and Potentials of the Virtual Assistant

Several potentials and limitations of the use of a VA for the moderation of Design Thinking workshops were unveiled during the expert interviews. Expert 4 mentions the limited input options of voice- and text-based interaction. Expert 1 extends this view with his concerns, that an interaction with a VA is too restrictive and that a participant would perhaps feel uncomfortable with the intervention of VA. The same issue is addressed by Expert 2, saying that there is probably a lack of interpersonal interaction and relationship between a virtual moderator and a participant. This problem may be approached with the help of guideline 2.1 - 2.3, by creating a VA with human characteristics, personality and offering a natural way of interaction. Expert 1 and 3 are a little bit skeptical about the combination of a human moderator with a VA, because the human moderator might fear he could get replaced by the VA. Beside to the fear of replacement also a conflict between the human moderator and the VA is considered to be possible (Expert 1).

As a VA supporting the moderation of a creative workshop is a collaborative setting with a machine as teammate, there are multiple areas of interest (Seeber, Bittner, Briggs, De Vreede, et al., 2018), that are also to be considered in our case. For example, the impact of smart technologies on existing power and control relationships or to what extent robots can develop social relationships. Our expert's statements directly relate to these questions. Hence the concerns of the experts about VAs moderating a Design Thinking workshop may be viewed more generally as the problem of how collaborative settings including machines can be designed.

Alongside the limitations there are numerous potentials of a VA moderating creative processes. A VA is always accessible (Expert 1 and 3) and can be used asynchronously as well as in global-dispersed workshops (Experts 1, 2, 3 and 4). The number of participants cared of per workshop and even the number of simultaneously conducted workshops is more scalable with the help of a VA. Expert 3 mentions that participants might be more open to a VA than to a human moderator, because there is no fear of criticism. Furthermore Expert 3 supports the usage of VA in work, knowledge and creativity related tasks, as VAs are already convenient in the private environment showing great potential. Expert 3 and 5 see research playing an important role concerning a profound application of VAs in more areas. In their opinion research is needed for a controlled growth in the field of VAs.

4.6. Conclusion

The contribution of this paper is generally interesting for the design of VAs that support creative tasks or group work. We developed design guidelines for VAs supporting such processes with particular focus on the support of Design Thinking workshops. The basis for the guidelines are qualitative expert interviews combined with previous research results in the field. Through the analysis of the expert interviews we gained insights to idea generation and team-based efforts from a moderating perspective.

Three main categories of guidelines were identified in respect to our research question. The first category *general conditions* generally applies to settings in which VAs may support creativity. The second category *characteristics of a VA* contains general design requirements of a VA. While most of the components are also interesting for the design of Design Thinking-independent VAs, there are some moderation specific characteristics like *authority* or workshop specific tasks like *visualize, guide and support methods*. The third category *tasks of the VA as moderation support* is about information, methods and tasks to support Design Thinking that the interviewees frequently use in Design Thinking workshops. Methods used in a Design Thinking Workshop are not necessarily exclusive to Design Thinking or originally might even come from other creative processes. Thus, we suspect that implementing functions providing information and guidance on creativity and visualization techniques, may also provide value in other workshop or even collaborative settings. This applies not only to methods, but also to rules and desired mindsets that foster radically new ideas employed in other creative processes. This is why we suggest to consider the VA components also for other creative processes, after adapting them to the respective rules and conditions of the workshop.

Our focus was not on developing a VA itself, but rather on determining which aspects require attention during the development of a VA. Thus, our guidelines are of high interest for future work in the field of VAs that fulfill more profound and cognitively demanding tasks involving creativity and empathy. As these tasks are challenging even for experienced moderators, the requirements most likely exceed even the latest technological successes in collaborative settings. Nevertheless, evaluation and pursuit of this endeavor is appealing due to the relevance of innovation for economic growth and the cost attached to dedicated time slots for innovation with external experts and no certain outcome.

As shown VAs offer great potential, which should be exploited in smart working environments. Our proposed design guidelines are useful for practitioners who develop VAs supporting creative workshops, but they may also be applicable for other context-sensitive settings with high cognitive workload. By applying the guidelines to an actual development of a VA in future work, they can be evaluated and refined.

CHAPTER 5

How to design a Virtual Co-Driver?

Applying the Methodological Approach to another Application Domain

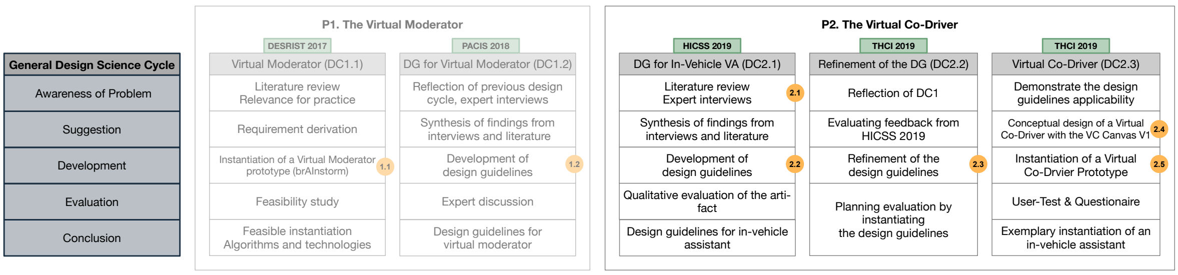

Figure 5.1.: *Positioning THCI 2019 in the DSR Project*

The methodological approach for deriving the design guidelines for a virtual moderator seemed very promising, and the contribution was appreciated in the IS community. However, as the motivation grew to contribute general design knowledge, which should also be applicable to CAs in other use cases, another application domain was being searched for. Due to an identified lack of design knowledge for in-vehicle assistants, the current relevance in practice, and the access to an automotive company, the methodological approach of the PACIS 2018 publication was applied to this context. Thus, another DSR project was initiated and a new Design Cycle (DC) was started (see Figure 5.1.

It should also be noted that the publication in the THCI is based on the conference publication at the HICSS 2019 (Strohmann, Höper, et al., 2019). While the HICSS publication focused solely on the expert interviews and the derived design guidelines, the THCI publication was expanded to include a refinement and extension of the design guidelines, an instantiation as a prototype, and a user test. Between the HICSS and the THCI publication, the idea for the VC Canvas was born, which will be introduced in the following Chapter 6, but will already be used in the design process of this Chapter.

THCI 2019: Designing Virtual In-vehicle Assistants: Design Guidelines for Creating a Convincing User Experience

Abstract

More and more people use virtual assistants in their everyday life (e.g., on their mobile phones, in their homes, or in their cars). So-called vehicle assistance systems have evolved over the years and now perform various proactive tasks. However, we still lack concrete guidelines with all the specifics that one needs to consider to build virtual assistants that provide a convincing user experience (especially in vehicles). This research provides guidelines for designing virtual in-vehicle assistants. The developed guidelines offer a clear and structured overview of what designers have to consider while designing virtual in-vehicle assistants for a convincing user experience. Following design science research principles, we designed the guidelines based on the existing literature on the requirements of assistant systems and on the results from interviewing experts. In order to demonstrate the applicability of the guidelines, we developed a virtual reality prototype that considered the design guidelines. In a user experience test with 19 participants, we found that the prototype was easy to use, allowed good interaction, and increased the users' overall comfort.

5.1. Introduction

An increasing number of people use VAs in their everyday life (McTear et al., 2016). These intelligent software programs support users with various concerns while interacting with them in a seemingly natural and human-like way (Skalski and Tamborini, 2007). Numerous VAs that serve different tasks and operate in different contexts exist. For instance, Apple's Siri, Google Assistant, and Microsoft's Cortana operate on mobile phones and use their sensors to better react to specific contextual information. In contrast, VAs such as Amazon Echo and Google Home operate in smart homes and help users fulfill various tasks (Pearl, 2016). Due to the fast growth in the AI and IT areas, user assistance will soon become increasingly more intelligent (Morana, Friemel, et al., 2017). While user assistance in the past focused more on helping functions in textual form, personal assistants on mobile phones can now process natural language and react in a human way (Morana, Friemel, et al., 2017; Skalski and Tamborini, 2007). With this growing AI technology, one may even find machines in collaborative settings with humans, which will fundamentally change the way we work with information technology (Seeber, Bittner, Briggs, De Vreede, et al., 2018). Beyond using VAs on our mobile phones or in our homes, cars represent another promising context in which we can use VAs (e.g., while driving). In this paper, we focus on VAs in the car, which we refer to as virtual in-vehicle assistants.

In the automotive context, researchers have already examined vehicle-assistance systems that proactively support the driver over the past 30 years (Bengler et al., 2014). They began by examining vehicle dynamics stabilization systems such as anti-lock braking systems (ABS) in the 1980s before examining systems for information, warning, and comfort such as navigation systems or adaptive cruise control in the 1990s and 2000s (Bengler et al., 2014). More recently, the development effort shifted to systems for automated and cooperative driving such as collision avoidance or self-driving technology (Bengler et al., 2014). However, we still lack systematic design guidelines and research approaches and agendas for virtual in-vehicle assistants. Designing a voice user interface (VUI), especially for in-vehicle use, has additional challenges compared to designing one for mobile phones or the home (Pearl, 2016). While driving, users have special needs, desires, and pains. To provide a convincing user experience (UX), designers need to tailor the assistant's character, the way the user handles the system, and the functions to a vehicle context (Pearl, 2016).

We address this challenge with our design guidelines since we lack well-formulated and structured guidance to design in-vehicle assistants in particular. Accordingly, we develop design guidelines for in-vehicle VAs that focus on two design activities: representational design and interaction design. According to Benyon (2014), representational design deals with the system's style, aesthetics, and the overall look and feel. Interaction design concerns the allocation of functions to the user or the machine and how the interaction between user and machine will occur (Benyon, 2014). We focus on these two design activities because they significantly affect how users will perceive a system, how easy and enjoyable they will find it to use, and, therefore, the overall UX (Benyon, 2014).

We developed guidelines, which build on prior research in the field and on qualitative expert interviews, following DSR principles (Hevner et al., 2004). Further, in order to bridge academic research and industry practice, we conducted interviews with experts from the automotive sector who worked on designing and developing in-vehicle assistance.

In this paper, we address the RQ:

RQ: How can one design a virtual in-vehicle assistant that provides a convincing user experience as it concerns representational and interaction design?

The paper proceeds as follows: in Section 5.2, we discuss the theoretical background on UX and VAs. In Section 5.3, we describe our research approach and, in Section 5.3.3, present our proposed guidelines. In Section 5.5, we discuss how we assessed the applicability of the design guidelines with a virtual reality (VR) prototype that simulated a car surrounding for users who talked to our implemented virtual in-vehicle assistant. Furthermore, we discuss how we evaluated the prototype in a user experience test with 19 participants. Finally, in Section 5.5.4, we discuss our results and conclude the paper.

5.2. Theoretical Background

5.2.1. Criteria for a Convincing UX

The ISO standard defines UX as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service" (Wallach et al., 2017, p. 507). Therefore, UX "includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors and accomplishments that occur before, during and after use" (Wallach et al., 2017, p. 507). The UX has a tight correlation with usability as the latter defines how easy users find a product to learn and how effective and enjoyable they find it to use (Rogers et al., 2011). Since these criteria also greatly influence how users experience an interactive product, it makes sense to consider usability principles as well when striving to create a convincing UX (Rogers et al., 2011).

To create good usability, designers often refer to Nielsen and Molich (1990) who developed usability heuristics for designing graphical user interfaces (GUIs). Nielsen (1994) refined the heuristics in the following years in several iterations, which resulted into the following ten heuristics: 1) visibility of the system status, 2) the match between the system and the real world, 3) user control and freedom, 4) consistency and standards, 5) error prevention, 6) recognition rather than recall, 6) flexibility and efficiency of use, 7) aesthetic and minimalist design, 8) help for the users to recognize, diagnose, and recover from errors, and 8) help and documentation (Nielsen, 1994).

According to Zhou and Fu (2007), both a product's usability and hedonic aspects can significantly influence the UX. Hassenzahl (2005) confirms as much in arguing that a product has to provide both a set of functional features and an experience to convince users. Emotions and affects represent integral aspects of such an experience (Hassenzahl et al., 2015). As Schmitt describes, customers want products to "dazzle their senses, touch their hearts, and stimulate their minds" (Schmitt, 1999). Thus, designers should consider UX in this comprehensive way (i.e., as depending on not only a product's pragmatic usability but also its hedonic aspects) during the design process.

5.2.2. Design Principles for VAs

VAs refer to software programs that fulfill tasks and answer questions for users (Zhao, 2006). Therefore, they can process natural language and interact in a human-like way (i.e., follow social norms for interpersonal communication) (Guzman, 2017; Skalski and Tamborini, 2007; Zhao, 2006). We can summarize systems that interact with their user with natural language as conversational agents (McTear et al., 2016). Many today see the chatbot ELIZA (Weizenbaum, 1966) as the first implemented conversational agent that simulated human conversations. Due to advances in natural language processing and machine learning, chatbots today have far more capability then chatbots from the past, which mainly used simple pattern recognition (Knijnenburg and Willemsen, 2016; McTear et al., 2016; Shawar and Atwell, 2007b). In contrast to chatbots, which use a text-based communication approach, VAs use speech (Gnewuch, Morana, Heckmann, et al., 2018). Moreover, VAs assist their users in, for example, fulfilling their everyday tasks (Gnewuch, Morana, and Maedche, 2017; Guzman, 2017). Given that several notable VAs have appeared in recent years (e.g., Siri, Alexa, and Google Assistant), a wide range of users can now use VAs that offer a new way to interact with information systems (Maedche et al., 2016; Pearl, 2016). As voice-based VAs have become more mainstream in recent years (Pearl, 2016), researchers have similarly published more work that focuses on the principles and process of designing VUI. For example, Cohen et al. (2004) give advice for designing interactive voice response systems (an early form of VAs that became common in 2000 and helped callers over the telephone with various concerns). Later, Pearl (2016) transferred Cohen et al.'s (2004) findings to voice-enabled mobile phone apps such as Siri, Google Now, Hound, and Cortana, which did not exist in 2004. She gives advice on what to consider when it comes to designing VUIs and includes statements, tips, and best practices from other experts such as Ian Menzies, senior voice UX designer at Amazon Lab126 (Pearl, 2016).

Pearl (2016) mentions some new requirements and challenges that occur when designing VUIs for cars. For instance, she explains that designers particularly need to focus on minimizing the user's cognitive load when designing in-vehicle assistants because conversations with the VA must not distract drivers from the road and traffic (Pearl, 2016). However, the literature does not offer concrete guidelines with all the specifics that one needs to consider to build VAs that provide a convincing UX (especially in a vehicle).

5.3. Methodology

5.3.1. Design Science Research

For our integrated research design, we adopted principles from DSR (Hevner et al., 2004), a well-established research approach in the IS field (Gregor and Hevner, 2013). We derived the motivation for our research from existing organizational problems and business needs as Hevner et al. (2004) describe in their proposed research framework. We primarily focus on offering researchers and designers guidance in developing and implementing virtual in-vehicle assistants that provide a convincing UX. We developed guidelines following DSR, which focuses on creating innovative and novel artifacts that solve the existing organizational and human problems (Hevner et al., 2004). In contrast to design-based practice in engineering research, DSR relies on an existing knowledge base with applicable theories that help one develop an artifact. Additionally, evaluating and assessing an artifact with existing methodologies that one draws from the knowledge base ensures one rigorously justifies the results and demonstrates the artifact (Hevner et al., 2004). By designing an artifact and subsequently evaluating it, one can contribute to knowledge and theory. The levels of artifact abstraction in DSR vary and range from models, processes, instantiations, methods, or software. Gregor and Hevner (2013) note that any artifact has a specific level of abstraction. An artifact can be described by the two attributes "abstract" and "specific" and by their general knowledge maturity. A specific and limited artifact (level one), such as software products or implemented processes, contribute situated and context-specific knowledge. An abstract and complete artifact (level three), such as design theories about embedded phenomena, contribute a broad and mature knowledge. Design guidelines and constructs, methods, models, or technological rules (level two) fall between a solely abstract or specific artifact and contribute nascent design theories or operational principles (Gregor and Hevner, 2013).

Peffers et al. (2007) further developed a nominal process model for conducting DSR in IS. This process model incorporates a systematic procedure and practices and principles to carry out a consistent DSR project. The model focuses on strengthening the degree to which researchers recognize DSR and view it as legitimate and provides guidance for them to conduct and present DSR. Vaishnavi and Kuechler (2015) introduced a similar but reduced process model that includes five steps for conducting a DSR project. The steps include recognizing the problem, suggesting a potential solution for it, actual developing the solution, rigorously evaluating the solution, and drawing a final conclusion.

In the first design cycle in our research project, we followed Peffers et al.'s (2007) DSR approach. In the second and third design cycles, we conducted DSR according to the framework that Vaishnavi and Kuechler (2015) provide since it follows a similar approach but adopts a reduced process model and expanded underlying DSR activities. We compare the two DSR process models in Table 5.1.

Table 5.1.: *Comparing Peffers et al.'s (2007) and Vaishnavi and Kuechler's (2007) DSR Process Models*

Peffers et al. (2007)	**Vaishnavi and Kuechler (2007)**
Identify problem and motivate	Recognize the problem
Define objectives of a solution	Suggestion
Design and development	Development
Demonstration	Evaluation
Evaluation	
Communication	Conclusion

While Vaishnavi and Kuechler's (2015) process includes only the evaluation after the development, Peffers et al. (2007) put demonstration before evaluation. Moreover, Peffers et al. (2007) speak of communication as a last step in the DSR cycle and, therefore, call researchers to face the community. In contrast, Vaishnavi and Kuechler (2015) refer to this step more generally as "conclusion", which indicates that a specific design project has finished. In fact, they also say that, in the conclusion phase, researchers commonly contribute results in the form of scientific publications. Apart from adopting a similar process model for conducting a DSR cycle, the two frameworks differ in the overall approach to a DSR project. Kuechler and Vaishnavi (2012, p. 396) define three general activities for conducting DSR in IS:

> *1) Construction of an artifact where construction is informed either by practice-based insight or theory, 2) the gathering of data on the functional performance of the artifact (i.e., evaluation), and 3) reflection on the construction process and on the implications the gathered data (from activity (2)) have for the artifact informing insight(s) or theory(s).*

While Peffers et al. (2007) mention the two first activities, they do not explicitly mention reflection (though they do not preclude it). As we conducted several design cycles in our DSR project, we needed to reflect on our process and data we gathered to initiate the iterations.

In our research, we developed two main artifacts in three respective design cycles, which we illustrate in Figure 5.2. According to Vaishnavi and Kuechler (2015), a DSR cycle can have several DSR outputs in the different process steps. Our design cycles (marked with orange circles in Figure 5.2) had the following main outputs: requirements for the virtual in-vehicle assistant (1), design guidelines for the virtual in-vehicle assistant (2.1), refined design guidelines for the virtual in-vehicle assistant (2.2), design of the virtual in-vehicle assistant (3), and VR prototype (4).

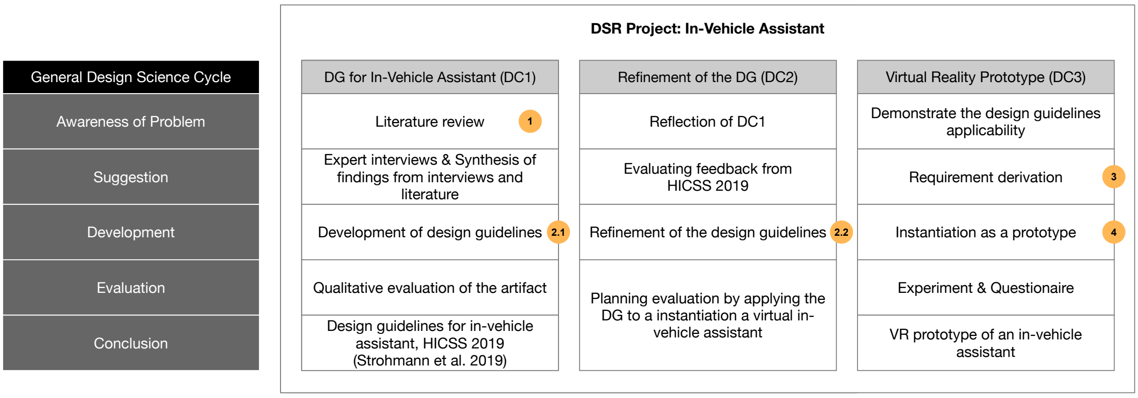

Figure 5.2.: *Design Cycles of the DSR Project*

According to the artifact levels that Gregor and Hevner Gregor and Hevner (2013) present, our design guidelines for in-vehicle assistants (Output 2.1 and 2.2) constitute a level-two artifact since one can apply them in different contexts and they provide technological rules. They build on prior research in the field and on qualitative expert interviews. To bridge academic research and industry practice, we selected primarily experts from the automotive sector who worked on designing and developing in-vehicle assistants. The VR prototype (Output 4) represents a level-one artifact since it contributes situated and context-specific knowledge.

We used the knowledge base to not only develop the artifacts through existing theories and principles but also to evaluate them through established research methods. Thus, we used methods such as systematic literature reviews (Webster and Watson, 2002), expert interviews (Bogner et al., 2009a; Meuser and Nagel, 2009b), exploratory studies, and experiments (Babbie, 2015; Dennis and Valacich, 2001) to design and evaluate the developed artifacts (Hevner et al., 2004).

5.3.2. Expert Interviews

To design and develop guidelines, it made sense to learn from existing research literature on creating a convincing UX and on what to consider while designing VUIs. In reviewing previous findings, we found some requirements for VAs about providing a convincing UX. As the literature has scarcely dealt with designing in-vehicle assistants in particular so far, we could derive only primarily general assistant requirements from the research literature. Thus, to examine the validity of the derived assistant requirements (especially for in-vehicle assistants) and to generate concrete guidelines for the design, we conducted six expert interviews. Expert interviews have become increasingly popular as a reliable method to gain knowledge that one cannot otherwise easily discover (Bogner et al., 2009b; Meuser and Nagel, 2009b). We created an interview guide for the semi-structured expert interviews based on the assistant requirements derived from literature research. The interview guide included various questions that examined how valid they found the derived assistant requirements (especially for in-vehicle assistants) and whether we needed to change or extend them. In addition, the interview guide contained questions that addressed how one could implement the derived assistant requirements from literature into a concrete design. A final question offered the opportunity for the interviewees to mention additional assistant requirements or design implications that the literature had not covered or we had not considered so far.

5.3.2.1. Expert Interview Participants

In selecting the six interviewees, we focused on ensuring that we included participants with various (i.e., a design, psychological, and technological) perspectives on designing in-vehicle assistants. Expert 1, a psychologist, dealt with psychological topics in human-machine interactions (especially in vehicles). Expert 2 also dealt a lot with psychological topics during his studies, but, in comparison to Expert 1, he had a more technological background as he earned his doctorate in automotive engineering. Expert 3, an electrical engineer and project manager, worked for a software-development company in the automotive sector, where he researched and developed speech assistants. Expert 4 dealt with UX design in vehicles and coordinated UX design workshops for VAs. Since we conducted this study in an automotive company context, we interviewed individuals who designed and developed VAs in and around vehicles in their projects. To prevent bias, we also interviewed an independent machine-learning and speech-recognition researcher (Expert 5). Finally, we interviewed a UX designer (Expert 6) to evaluate the design guidelines we created with help from the first five experts. The following table summarizes the experts and their background and qualifications.

Table 5.2.: *Experts*

Expert	Background and qualifications
1	**Psychologist** Focus on human-machine interaction especially in vehicles
2	**Doctorate in automotive engineering** Focus on human-machine interaction, relation to psychology
3	**Electrical engineer** Project manager for research and development of speech assistants
4	**UX designer** Holistic UX design in vehicles and design of Vas
5	**Researcher** Machine learning and speech recognition
6	**UX designer** UX design in several VA projects

5.3.2.2. Expert Interview Analysis

We recorded the expert interviews with the first five experts with an audio recorder to capture all the details in order to transcribe them afterwards. We analyzed the interviews based on Meuser and Nagel's (2009) approach: after the transcription, we paraphrased thematically relevant passages. Next, we used the descriptive coding approach. As Miles, Hubermann, et al. (2014) explain, a descriptive code labels a unit of qualitative data with one word or phrase that summarizes its main topic. We inductively created the applied codes, which means that they progressively emerged as we collected data (Miles, Hubermann, et al., 2014). Specifically, the first author and a research assistant separately conducted the coding and discussed and aggregated their results after each coding cycle. In sum, 40 codes grouped into 15 categories evolved during the coding session. After coding, we compared the experts' statements and linked thematically comparable passages together (Meuser and Nagel, 2009b). We condensed commonly shared expert knowledge regarding the particular topics and connected it to the academic discourse. By relating the results from the expert interviews to the findings in the literature, we ensured that we produced true and relevant assistant requirements for providing a convincing UX for in-vehicle VAs. We extended some requirements and added some additional requirements.

5.3.3. Development of Design Guidelines

Based on the assistant requirements that we derived from literature and the interviews with the first five experts, we developed concrete design guidelines for virtual in-vehicle assistants to help designers fulfill the assistant requirements and, therefore, provide a convincing UX with an implemented VA. For the evaluation, we evaluated the design guidelines with the final expert (Expert 6) who worked on designing the UX for different VA projects for a large German automaker. Having a lot of practical experience with designing VAs, we asked this expert to suggest improvements and to add missing design guidelines. We used her feedback to evaluate the artifact. After the evaluation, we refined the design guidelines with the new insights following Peffers et al.'s (2007) iterative DSR methodology. After presenting the guidelines to the research community, we refined them in a second design cycle (see Figure 5.2).

5.3.4. Virtual Reality Prototype

To show that the design guidelines applied to a real-world scenario (Hevner et al., 2004), we implemented a VR prototype of a virtual in-vehicle assistant based on our proposed design guidelines. Therefore, we defined eight different possible scenarios that might naturally occur while driving a car. We evaluated the prototype in a user experience test with 19 participants, who we subsequently asked for their experiences with and perceptions of the virtual in-vehicle assistant.

5.4. Design Guidelines

In this section, we present the evaluated and refined guidelines for designing virtual in-vehicle assistants. To provide a clearly structured overview, we cluster the guidelines in four thematically related blocks. Thus, while Table 5.3 focuses on guidelines for representational design, we divide the guidelines for interaction design into design guidelines for intuitive conversation (Table 5.4), simple and transparent operation (Table 5.5), and companionship (Table 5.6). All four tables summarize the assistant requirements for a convincing UX that we derived mainly from the existing research literature and then refined and extended according to the expert interviews and feedback we obtained from researchers at the *Hawaii International Conference on System Sciences* (Strohmann, Höper, et al., 2019). Readers can find references to experts' (E) and conference reviewers' (CR) statements in the fourth column in each table. At their core, the tables present the evaluated design guidelines for in-vehicle assistants that will help designers to fulfill the assistant requirements and to provide a convincing UX. To simplify using the guidelines in practice, we prioritize some guidelines based on our findings from analyzing the expert interviews. In the four tables, we bold the guidelines that practitioners should focus on in particular.

Two requirements that have particular salience for in-vehicle assistants compared to assistants in other contexts: Requirement 7 (which refers to reducing users' cognitive load)) and Requirement 14 (which refers to proactive behavior). The experts suggested various vehicle-specific use cases where proactivity could vastly increase users' experience with a VA in a vehicle. For example, according to Expert 5, the user would find it pleasant if a VA proposed an alternative route in a timely manner before the user became stuck in a traffic jam. Expert 2 suggests that, if the VA had access to the technical vehicle data, it could proactively warn users if something needed their attention. To conclude, compared to designing virtual assistants for other contexts, designers should particularly focus on Guidelines 7.1 to 7.4 and 13.1 to 13.4 when designing assistants for in-vehicle use.

As we state in Section 5.3.3, we refined the guidelines in a second design cycle after we presented them to the research community at the Hawaii International Conference on System Sciences (HICSS). We made the following refinements and additions to the design guidelines based on the feedback from the community:

- We added trust as a topic (see Requirement 11) and corresponding design guidelines (see Section 5.4.3.4)
- We added the companionship concept (see Section 5.4.4.1)
- We added the different possible automotive contexts (see Section 5.4.4.4)
- We added the possibility that users would take the VA into another car (see Section 5.4.4.4), and
- We added further supporting literature.

5.4.1. Guidelines for Representational Design

5.4.1.1. Personality and Background Story

As Table 5.3 shows, Pearl (2016) and Cohen et al. (2004) note that a VA needs a consistent personality and a background story to provide a convincing UX (Cohen et al., 2004; Pearl, 2016). All the experts supported that one could improve UX if a VA had a personality because it would allow the VA to build emotional rapport with the user; provide hedonic, playful, and surprising aspects; and make the VA more fun to use. To ensure consistency, designers can create a persona for the VA, which includes a name, background story, and personality traits, during the whole design process. For the background story, Experts 2 and 4 recommended that designers should not try to imitate a humane biographical sketch but rather integrate fictional descriptions. When it comes to defining personality traits, no expert could describe an ideal personality for a VA because it depends on a user's preferences. According to Expert 2, comprehensive user research can help designers to tailor a VA's personality to particular customers. It would be even better if the personality suited individual users and their moods in certain situations by evolving certain personality traits over time based on how the users interacted with the VA. In this case, predefined borders can help designers ensure that the character still represents the brand values.

5.4.1.2. Voice and Linguistic Register

A VA's voice and linguistic register represents another aspect that great influences the VA's look and feel. (Cohen et al., 2004) note that "[w]hatever you decide in terms of the most appropriate register for your application, make sure that it's exercised consistently throughout your dialog" (Cohen et al., 2004, p. 163). All the experts believed that, when designing the linguistic register, designers should take advantage of the conversational norms that users already recognize in order to let the conversation appear more natural. Thus, the VA should use rather informal everyday language though still represent the brand image. For a convincing UX, it makes sense to reflect the user's word choice in how the VA speaks. Nevertheless, Expert 6 warned that designers have to ensure that the VA does not allow someone to manually approve which expressions the VA learns to avoid it from learning undesirable words (filtering).

5.4.1.3. Visual Appearance and Humanity

According to Pearl (2016), designers need to consider whether a VA should have a visual representation. Experts 2, 3, and 4 recommended that a VA should have some kind of visualization because the user needs something to turn towards while speaking and because the VA can use it to give visual feedback. By clarifying the system's different modes (e.g., VA is listening), visual feedback can help users to handle the interaction and to understand the system.

The experts also advised designers to not use an avatar or a human-like visualization but something more abstract such as a flickering light. This advice refers to a concept called the "uncanny valley" that Masahiro Mori invented in the 1970s. Mori (2012) says that a robot with a human-like appearance can make people feel eerie and even fooled when they learn the robot is not a real human. As such, Expert 2 pointed out that a VA should honestly communicate that it is not a human. As Mori invented the uncanny valley theory by observing robots, it does not encapsulate the complexity of situations that feature interactivity as recent findings have shown (Seymour, Riemer, & Kay, 2017). These insights apply to the virtual in-vehicle assistant because the user interacts with it. If a user prefers a more realistic design, designers might follow Seymour, Riemer, et al. (2019) suggestions for designing realistic agents. To avoid raising false expectations, the VA should also communicate that it is just a machine with a limited range of functions. If something falls outside its domain, the VA should clearly state that it cannot help with the topic. While evaluating the guidelines, Expert 6 suggested that the VA could show human errors and idiosyncrasies while talking because they can make the conversation appear more natural and the VA more lovable. Here, designers have to consider whether a VA that mistakenly delivers the wrong content or conducts the wrong function would rather cause users to mistrust it.

Table 5.3.: *Guidelines for Representational Design*

Assistant requirements	Supporting literature	Design guidelines for in-vehicle VAs	Experts
1. An in-vehicle VA needs a consistent personality and a background story.	Cohen et al. (2004, pp. 78, 82) Pearl (2016, p. 72)	1.1. Create a persona for the VA (name, background, personality) and use it as a style guide during the whole design process.	E1-5
		1.2. Do not try to imitate a humane biography with the VA's background story but rather integrate fictional descriptions.	E2 & 4
		1.3. Predetermine one or a few personalities based on user research results and brand values.	E2-4
		1.4. Let the VA evolve some character traits more than others within predefined borders depending on the interaction with the user.	E1
2. An in-vehicle VA has to use a consistent voice and linguistic register.	Cohen et al. (2004, p. 163)	2.1. Decide if the VA should have a default voice or if the user should have the choice between various different voices.	E1-3
		2.2. Take care that different voices also imply different personalities.	E6
		2.3. Use conversational norms that users find familiar.	E1-5
		2.4. Use casual and informal everyday language but ensure that the VA still represents the brand image.	E1 & 4
		2.5. Reflect the user's word choice in the VA's utterances (with filtering).	E1, 2, 4, & 6
		2.6. Allow the VA to evolve a different conversation style and register after some time interacting with the user.	E6
3. An in-vehicle VA needs a visual representation.	Pearl (2016, p. 71)	3.1. Use an abstract and not a human-like VA visualization.	E2-4
		3.2. Give visual feedback.	E3-4
4. An in-vehicle VA should not pretend to be a human.	O'Neill (2018) Villar (2017)	4.1. Communicate honestly that the VA is not a human.	E2
		4.2. Be transparent about the VA's limitations.	E6
		4.3. Integrate human errors and idiosyncrasies regarding how the VA talks but not regarding content or functions.	E2 & 6

5.4.2. Guidelines for Interaction Design: Intuitive Conversation

5.4.2.1. Detecting Voice Interaction

As Table 5.4 shows, an important design decision concerns how the in-vehicle assistant knows when to listen and react to users (Pearl, 2016). Most of today's voice assistants require users to explicitly indicate when they want to speak to the system, such as by using a push-to-talk button or a wake word (Pearl, 2016). Researchers have begun to focus on discovering new methods that involve interpersonal interaction behavior.

As Experts 2, 3, and 4 explained, people indicate to whom they are talking by, for example, looking at the person, calling a name, or saying specific things such that a listener recognizes themselves as the addressee. They propose that, at best, the VA should use these conventions and calculate the likelihood that users will address it in a certain situation by combining relevant information.

Table 5.4.: *Guidelines for Interaction Design: Intuitive Conversation*

Assistant requirements	**Supporting literature**	**Design guidelines for in-vehicle VAs**	**Experts**
5. An in-vehicle VA has to detect when users address it.	Pearl (2016, p. 152)	5.1. Learn from interpersonal communication how people initiate conversations and transfer patterns to the human-machine interaction.	E2-4
		5.2. Collect information to calculate how likely a user will be to address the VA in a certain situation.	E3
		5.3. Be transparent about the functionality of active listening and observing and enable the user to shut the system off completely.	E6
6. An in-vehicle VA has to enable intuitive conversation.	Nielsen (1995) Pearl (2016, p. 226)	6.1. Learn from interpersonal communication to design the interaction to be as natural and intuitive as possible.	E1-6
		6.2. Integrate at least the functions undo, repeat, help, and stop.	E3
		6.3. Let the VA understand short commands and say something in a more natural way.	E2, 3, 5
		6.4. Design flexible dialog that allow the user to access the conversation at any point.	E6

5.4.2.2. Navigation in the Conversation

Every expert had the same opinion on one point: that designers need to design the VA in such a way that the interaction with it resembles interpersonal communication (e.g., as natural and intuitive interaction as possible). To allow users to simply navigate the conversation with a VA, designers need to integrate the functions undo, repeat, help, and stop into it. To create a convincing UX, the VA should ideally understand not only short commands but also more natural speech. As Expert 6 noted, the conversation should not rely on a static dialog flow but on more flexible dialogs that allow users to access it at any point.

5.4.3. Guidelines for Interaction Design: Simple and Transparent Operation

5.4.3.1. Minimizing Cognitive Load

Table 5.5 summarizes the guidelines for designing a system's operation and control aspects. In cars in particular, VAs need to minimize the extent to which they distract users to avoid distracted driving (Pearl, 2016). Expert 5 argued that the more activities a VA can accomplish for users, the less the VA will distract them from their actual task (i.e., driving the car). Nevertheless, listening and speaking still adds cognitive distraction (Pearl, 2016), which explains a VA should provide crisp and clear messages that focus on the most important information (Pearl, 2016). In order to not overwhelm users while they communicate with a VA, it makes sense to break down information and processes into small pieces and to provide next steps sequentially (Moore et al., 2017). Trying to explain complex information through the VUI makes it still unnecessarily complicated for users. In such situations, Expert 4 recommended showing additional visual feedback on the car's infotainment screen to clarify the VA's utterances. Nevertheless, designers should try to use the GUI while driving as less as possible to avoid distracting the driver (Pearl, 2016).

5.4.3.2. Providing Help

In general, a user does not necessarily know what a VA can do and which voice commands it understands because it does not show its functionalities on a screen (Cramer and Thom, 2017). Therefore, VAs need to be able to inform users about their functionalities (Moore et al., 2017). According to Expert 6, an in-vehicle VA also has to have this information available if the user asks for it.

Further, Expert 6 added that setting expectations about a VA's functionalities in the onboarding process can help users to learn what to ask for. In addition, Expert 1 recommended that a VA could proactively inform users about certain functions that they have not used before if it fit the current situation. In line with Cohen et al. (2004), Expert 2 suggested that the VA should give just-in-time instructions for the imminent activity if needed. Here, the VA should not exaggerate and permanently teach the user how to answer because, in the best case, the user should be able to answer intuitively (Giangola and Cao, 2017).

5.4.3.3. Feedback and System Familiarity

As Table 5.5 presents, a convincing UX needs to gives appropriate feedback in a reasonable timeframe to keep users informed (Nielsen, 1995). Designers have to define how much feedback the VA should give about what it understands and about its actions (Pearl, 2016). The possibilities range from explicitly asking users for their permission, to only letting them know what the VA recognized by repeating what the user said, to just doing it without revealing what the VA has understood (Pearl, 2016). Expert 2 emphasized that, even if the VA gives no feedback, it still has to be able to explain what it did and why it did it if the user asks for it.

According to Experts 2 and 3, which kind of feedback is appropriate in a certain situation depends on how confident the VA is that it understood correctly and how critical a mistake and its consequences would be. Further, how familiar the user already is with the system represents another factor that influences how much the feedback should give. Expert 2 noted that it makes sense to let the VA give less and less feedback over time for functions that users use on a regular basis. In general, Experts 1-5 argued that an in-vehicle VA should provide more explanations for novice users and reduce the amount and extent step by step. Nevertheless, Expert 6 explained that, if people do not trust the system, they might want the VA to tell them exactly what the VA understood and what it did although they are already familiar with it. In such case, the VA has to figure out this personal preference in order to behave appropriately.

5.4.3.4. Trustful and Transparent Environment

When interacting and working with ISs of all kind, trust represents a highly important aspect (Schroeder and Schroeder, 2018). In particular, privacy concerns often arise when VAs require a significant amount of personal information from users (Saffarizadeh et al., 2017). However, the more information users reveal, the more value they will get from the VAs. This reciprocal self-disclosure highly relates to trust; therefore, designers need to implement it in a VA so that it openly communicates what data it needs to generate a value. Knowing why a system needs what kind of information therefore increases users' trust in and uncertainty about the system (Saffarizadeh et al., 2017).

A consistent relationship (which includes a consistent voice, appearance, and mode of interaction) that builds over time also fosters users' trust in VAs (Schroeder and Schroeder, 2018). Such a relationship also increases how well users generally perceive the system's expertise, which, in turn, creates trust and lowers uncertainty (Elson et al., 2018). Yu et al. (2018) propose a taxonomy for building ethics into AI including aspects for human-AI interaction, which states that AI should not violate the user's autonomy.

5.4.3.5. Error Handling

Designers have to develop a good strategy to handle errors because they one cannot completely prevent them (Pearl, 2016). First of all, Experts 3, 4, and 5 pointed out that the system should recognize when it understands something incorrectly or that something falls outside its domain to avoid undesired actions. However, repeatedly admitting "Sorry, I don't understand" would also not appear intelligent. Expert 1 suggested that, if the VA at least understood part of what the user said, it could react accordingly and give feedback about what it did not understand by using a simple request. When the VA repeatedly does not understand what the user says or if it recognizes that it cannot help the user with a certain problem, Expert 3 suggested that it could transfer the user to a human customer service agent. An emergency situation (such as a car accident) also represents another use case where it makes sense to automatically call a human agent.

Table 5.5.: *Guidelines for Interaction Design: Simple and Transparent Operation*

Assistant requirements	**Supporting literature**	**Design guidelines for in-vehicle VAs**	**Experts**
7. An in-vehicle VA has to minimize the user's cognitive load.	Cohen et al. (2004, p. 119) Moore et al. (2017, p. 5) Pearl (2016, p. 226)	7.1. Let the VA accomplish as many activities for the user as possible.	E5
		7.2. Ensure the VA provides crisp and clear messages that focus on important information.	E4
		7.3. Break down information and processes into small pieces and provide next steps sequentially.	E4
		7.4. Recognize the situational context to choose the best way to provide content (VUI or GUI).	E2, 4
8. An in-vehicle assistant has to be able to inform the user about what it can do.	Cohen et al. (2004, p.127) Cramer and Thom (2017, p.3) Moore et al. (2017, p. 5) Pearl (2016, p. 65)	8.1. Create an additional app or a website to inform users about functionalities but also allow the VA to have this information available.	E6
		8.2. Set expectations about functionalities in the onboarding process.	E6
		8.3. Inform the user proactively about certain unused functions tailored to the current situation.	E1
		8.4. Let the VA give just-in-time instructions for the imminent activity if needed but do not permanently teach the user how to answer.	E2
9. An in-vehicle VA has to give appropriate feedback within reasonable time.	Nielsen (1995) Pearl (2016, pp. 144, 226)	9.1. Define how much feedback the VA should give about what it understands and does.	E2-3
		9.2. Define if and how the user should confirm the VA's actions.	E3
		9.3. Determine appropriate feedback based on how confident the VA is that it understood correctly, how critical a mistake and its consequences would be, and how familiar the user is with the system.	E2-4
		9.4. Take care that the VA is always able to be transparent about what it did and why it did it.	E2

10. An in-vehicle VA has to tailor the interaction style to the user's familiarity.	Cohen et al. (2004, p. 207) Nielsen and Molich (1990) Pearl (2016, p. 47)	10.1. Let the VA change the way that users give feedback over time for functions that they are already familiar with.	E2-4
		10.2. Provide more explanations for novice users and reduce the amount and extent step by step.	E1-5
11. An in-vehicle VA has to create a trustful and transparent environment.	Elson et al. (2018, p. 4) Saffarizadeh et al. (2017, p. 2) Schroeder and Schroeder (2018, p. 477) Strohmann, Fischer, et al. (2018, p. 7) Yu et al. (2018, p. 2)	11.1. Let the VA detect the extent to which the user trusts the system to be able to fit its interaction style to the user's trust level.	E6
		11.2. The VA should incorporate reciprocal self-disclosure by transparently explaining why it needs specific (personal) information in order to generate specific value for the user.	CR
		11.3. The VA should have a consistent voice, appearance, and mode of interaction (preferably voice communication) in order to build trust, establish a relationship, and demonstrate expertise.	CR
		11.4. In order to build trust, the VA should maintain and signalize full autonomy to the user.	CR
12. An in-vehicle VA has to prevent errors but in case also needs a good strategy of handling them.	Cohen et al. (2004, p. 228) Nielsen (1995) Pearl (2016, p. 41)	12.1. Try to prevent errors as much as possible but also create a good strategy for handling the errors if they occur.	E1-2
		12.2. Make sure the system recognizes when it misunderstands something or when something falls outside its domain to avoid undesired actions.	E3-5
		12.3. Create charming responses for when something falls outside the VA's domain.	E2
		12.4. Instead of repeatedly admitting "Sorry, I don't understand", let the VA react to parts that it recognized and enquire about what it did not understand.	E1
		12.5. Enable the VA to ask further questions to elicit information that it needs to conduct a certain task.	E1, 3-5
		12.6. Help the user after a certain number of errors if something falls outside the VA's domain or in critical situations by transferring the user to a human customer service agent.	E2-5

5.4.4. Guidelines for Interaction Design: Companionship

5.4.4.1. The Concept of Virtual Companionship

In this section, we look at the requirements for the virtual in-vehicle assistant that make it more a human companion than a technical assistant. Strohmann, Siemon, et al. (2019b) introduced the virtual companionship concept as an evolution of the virtual assistant. They defined the virtual companion as "a conversational, personalized, helpful, learning, social, emotional, cognitive and collaborative agent, that interacts with its user proactively and autonomously to build a long-term relationship" (Strohmann, Siemon, et al., 2019b). In fact, the virtual companion covers a virtual assistant's characteristics but crucially extends them with more collaborative, companion-like, and human-like characteristics. We introduce such characteristics (e.g., understanding emotions, empathy, proactive behavior, and context awareness) in the following sections. This companion approach can additionally fosters trust since it focuses on building a benevolent long-term relationship over time between the user and the system (Schroeder and Schroeder, 2018).

5.4.4.2. Emotions and Empathy

As we describe in Section 5.2.1, a product has to provide both functional features and an experience to convince users (Hassenzahl et al., 2015). Emotions and moods influence how people experience situations and how they interact in them (Nass, Jonsson, et al., 2005). A VA can recognize the user's emotions by analyzing gestures, facial expressions, text, voice tone, and physiological signs such as heart rate or skin changes (Noga et al., 2017).

To convey the image of an emotionally intelligent assistant, a VA has to not only detect the user's emotions and mood but also react to them appropriately (Noga et al., 2017). Expert 1 suggested that designers should let the VA tailor its communication style and what it says to the user's mood and to possible issues in the current situation. The VA could also react to the user's emotional state via showing emotions itself. However, Experts 1-4 warned designers to take care that, while showing emotions, the VA still has to focus on assisting the user and that it does not behave inappropriately, ridiculously, or strangely. Expert 1 clarified that it depends on the situation and on the individual user (e.g., the user's mood) if showing emotions has a positive or rather a negative effect.

Thus, Expert 6 recommended that designers preset how emotional the VA should be in general but to allow flexible adjustment in some extent.

5.4.4.3. Proactivity

Expert 5 noted that designers can increase UX if a virtual in-vehicle assistant proactively tells the user something that makes the user's life easier or that prevents the user from unpleasant situations. In some situations, proactively addressing the user can even improve driving safety. For instance, Expert 3 suggested that, if the user is not concentrating on the road and a critical traffic situation occurs ahead, the VA can warn the user to prevent a possible accident. Especially during long travels, an in-vehicle assistant can help to keep the driver awake and attentive.

Experts 3 and 4 noted that users could also benefit from a VA that not only proactive speaks but also proactively acts in some situations. Users may find it pleasant if a VA learns about their preferences and does things that they normally want the VA to do automatically after a few times. However, Experts 1 and 2 noted that the VA has to recognize the context and the user's individual preferences to decide whether a proactive utterance or action is appropriate in a certain situation because proactivity can also annoy or distract the user. According to Expert 6, it makes sense to learn from the feedback the user gives to detect the contents and situations in which the user is open to proactive behavior.

5.4.4.4. Context Awareness

According to Pearl (2016), "[o]ne reason many virtual assistants (...) currently struggle with conversational UI is because they lack context" (Pearl, 2016, p. 153). Experts 1-5 agreed that the VA needs to recognize the situational context to behave appropriately. Expert 1, for example, said that: "*The VA has to be aware of the situational context (e.g., the user's mood and aims, the traffic situation, if multiple people are in the car etc.)... to be able to behave appropriately (e.g., regarding showing emotions, behaving proactively and to not always feel addressed).*"

Since users can experience various situations when driving a car, the VA should analyze and keep in mind several different context factors and compositions of such factors when interacting with them. Helmholz (2015) conducted a study to explore different possible automotive contexts (see Figure 5.3) and structured them in a diagram with the three main context categories: place, time, and identity.

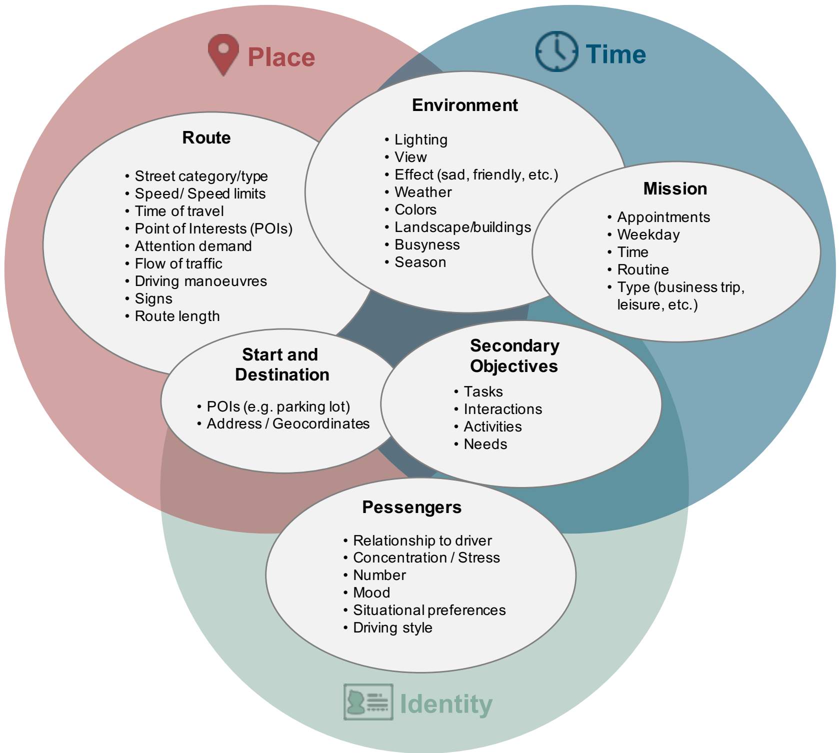

Figure 5.3.: *Automotive Contexts According to Helmholz (2015)*

The three main categories also contain several subcategories and relevant characteristics. The figure shows the different characteristics of the overall context and illustrates its complexity. When designing a VA, designers must consider the various possible context characteristics. If drivers enter a stressful situation, the VA should not address them at the same time. In contrast, if a driver drives a long distance relatively monotonously straight ahead, the VA can certainly provide entertainment. Moreover, the VA also has to remember things about the user and their previous conversations/interactions. The VA might even collect knowledge about the user from other data sources such as the user's calendar to provide a more holistic user assistance. Beyond that, a user should be able to move the VA into another car. Expert 6 noted that designers have to take care that the VA does not bring up something in the conversation that it talked about with the user a few weeks ago and that a human would not be able to remember anymore since it could appear creepy and not human like.

Thus, designers have to define after which period of time a VA should not refer to a certain memory again towards the user.

Table 5.6.: *Guidelines for Interaction Design: Companionship*

Assistant requirements	Supporting literature	Design guidelines for in-vehicle VAs	Experts
13. An in-vehicle VA has to have the ability to recognize, understand and react appropriately to emotions.	Hassenzahl et al. (2015, p. 531) Nass, Jonsson, et al. (2005, p. 1973) Noga et al. (2017) Pearl (2016, p. 146)	13.1. Recognize the user's emotions by analyzing gestures, facial expressions, text, tone of voice and physiological signs of mood such as heart rate or skin changes.	E1, 5
		13.2. Tailor the VA's communication style and the content of what it says to the user's mood and to possible pains in the current situation.	E1
		13.3. Preset how emotional the VA should be in general but allow flexible adjustment in some extent based on the user's preferences, his mood and the current situation.	E6
		13.4. Take care that the VA still focuses on assisting the user so that it does not react emotionally if it is inappropriate, ridiculous or strange.	E1-4
14. An in-vehicle VA has to figure out the right situation for proactive behavior.	Strohmann, Fischer, et al. (2018, p. 7)	14.1. Use proactive behavior to make the user's life easier, prevent him from unpleasant situations or improve his driving safety.	E2-5
		14.2. Learn from the user's preferences and habits to let the VA do things automatically.	E2, 4
		14.3. Be aware of the context and the user's individual preference to decide when and how to say or do something proactively.	E1-2
		14.4. Learn from the feedback the user gives to detect the contents and situations in which the user is open for proactive behavior.	E6
15. An in-vehicle VA has to be aware of the context.	Pearl (2016, p. 153)	15.1. Take care that the VA is aware of the situational context to be able to behave appropriately within the interaction with the user.	E1-5
		15.2. Let the VA memorize things about the user and the interaction with him from previous conversations (preferences, behavior patterns).	E1-5
		15.3. Take care that the VA will not bring up or refer to something they talked about a few weeks ago that a human would not remember.	E6

5.5. Virtual Reality Prototype of an In-Vehicle Assistant

5.5.1. Design of the Virtual In-vehicle Assistant

In order to show that the design guidelines we developed could apply to a real problem, we developed a prototype for a virtual in-vehicle assistant in a third design cycle (see Figure 5.2). Before we instantiated the virtual in-vehicle assistant, we designed the overall VA concept using Strohmann, Siemon, et al.'s (2019) VC Canvas, a tool to design collaborative agents. As we state in Section 5.4.4.1, the virtual companionship concept extends the VA concept, and, therefore, covers all of a VA's characteristics. With the canvas approach that the VC Canvas adopts, we could creatively, collaboratively, and visually conceptualize our virtual in-vehicle assistant as separate from the technological implementation. We designed the VA together as a team by following our design guidelines that we present in Section 5.4. By using the VC Canvas, we could discuss the different features our virtual in-vehicle assistant could have. Furthermore, we could develop a shared understanding about what design guidelines to demonstrate in the instantiation. We present the resulting VC Canvas in Appendix B.1. After we designed our VA in the VC Canvas, we began implementing the instantiation.

5.5.2. Development of a Virtual Reality Prototype

Since we could not feasibly develop and conduct a user experience test of a virtual in-vehicle assistant in a real-world scenario given road traffic and other factors, we developed a VR prototype. In our case, by using a virtual environment, we could create what Witmer and Singer (1998) describe as immersive presence, also known as immersion, which refers to the perception that one exists in a certain place while physically in another. By creating a virtual in-vehicle environment, we could let the participants feel like they actually sat in a car and interacted with an in-vehicle assistant while keeping them in a controlled test setting.

We used the Web-based tools Figma[7] and VRooms[8] to design the virtual vehicle's cockpit. Figma, an interface design application, allows one to design, prototype, and collaborate with others directly in the browser. With VRooms, an add-on for Figma, one can easily design a virtual room in 2D without executing or compiling VR code. The vir-

[7] https://www.figma.com/
[8] https://vr.page/

tual car cockpit displayed the VA in the center console where the radio usually resides. Since interaction with the VA during a car ride mainly occurs via communication, we limited the designed scenarios to a conversation. Therefore, we created eight possible scenarios that naturally occur when one drives a car (see Table 5.7). Each scenario comprised several possible contexts according to the classification we introduce in Section 5.4.4.4. For each scenario, we designed an interaction with the VA while considering our different design guidelines and implemented it using Google's conversational service Dialogflow[9].

Table 5.7.: *Car Scenarios of Our Prototype*

Scenario	Context
1	**Route** (Traffic): Low traffic **Start and Destination** (Address): Berlin
2	**Environment** (Weather): Cold outside
3	**Environment** (View): Poor visibility
4	**Route** (Signs): Waiting at traffic light **Mission** (Time): Morning **Start and Destination** (POI): Work
5	**Route** (Signs): Waiting at traffic light **Mission** (Time): Evening **Start and Destination** (POI): Home
6	**Environment** (Weather): Cold **Route** (Street condition): Frozen
7	**Passengers** (Number): Several
8	**Event**: Tire change is necessary

For example, the fourth context demonstrated how the VA learns from the driver's habits and automatically recognizes when the driver has begun to drive to work. The VA greets the driver and reminds the driver about upcoming work appointments. Moreover, we considered scenarios in which the environment might influence the driver, such as poor visibility due to the weather (third context). In this case, we showed that the VA could not only recognize the environment and explain the car's functions to

[9] https://dialogflow.com/

the driver but also autonomously and proactively switch on things such as the car's headlights.

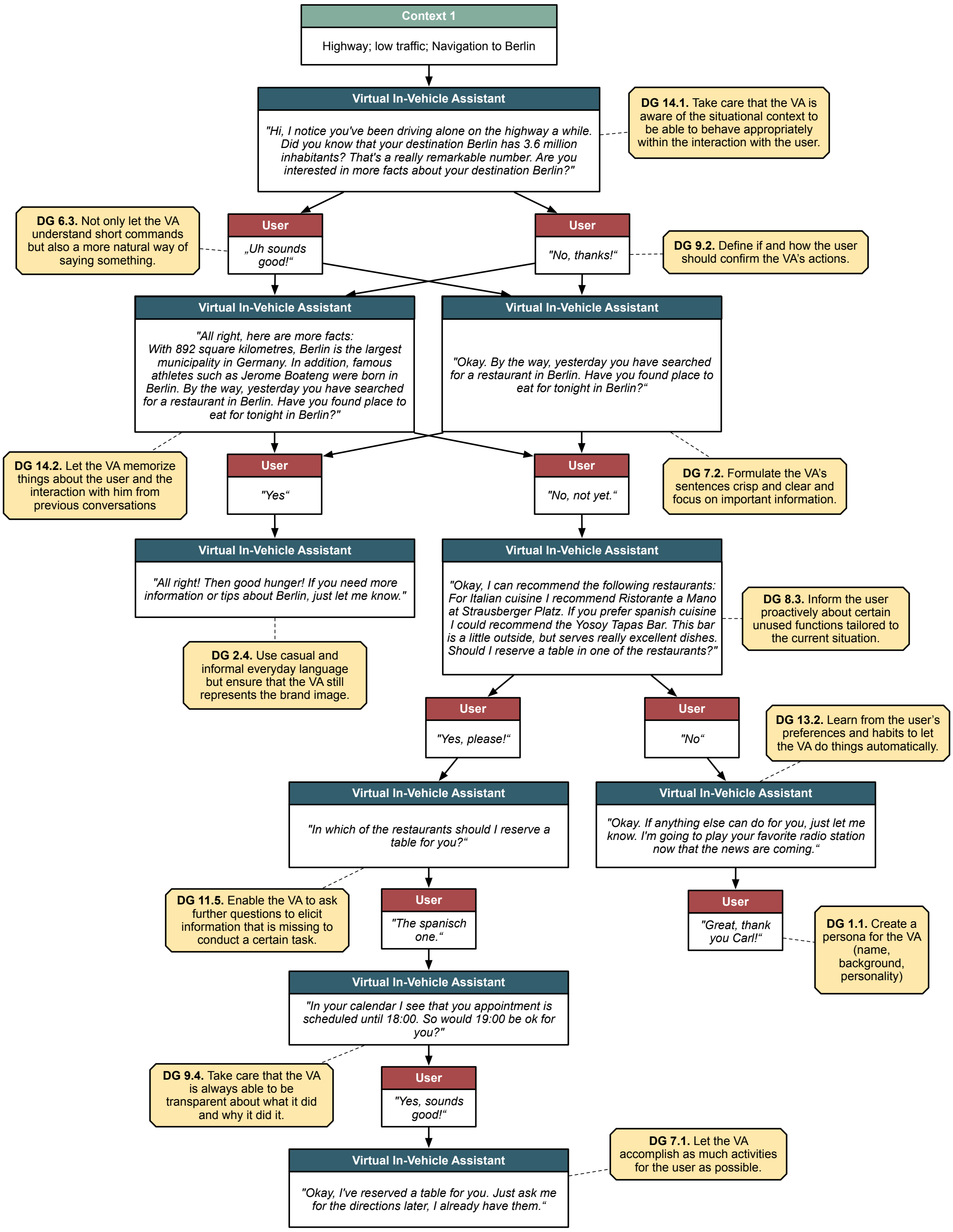

Figure 5.4.: *Exemplary Conversation with the Virtual In-vehicle Assistant*

Figure 5.4 shows an exemplary conversation for the first context (highway, low traffic, navigation to Berlin). At the top, the VA initiates the conversation. Subsequently, it gives the driver some information about the driver's destination to provide some entertainment on the monotonous highway ride. The VA then remembers that the driver searched for a place to eat the day before and asks to reserve a table for dinner. The yellow boxes indicate the design guidelines we used to design the interaction at each step in the conversation.

5.5.3. User Experience Test

Figure 5.5 visualizes our user experience test setting. The participants wore virtual reality glasses that put them into the virtual car cockpit. A researcher initiated the different scenarios in Google Dialogflow. The VA then talked to the participants using a natural voice (a speaker produced the sound). Using a microphone, we recorded participants' answers, which the Google API processed.

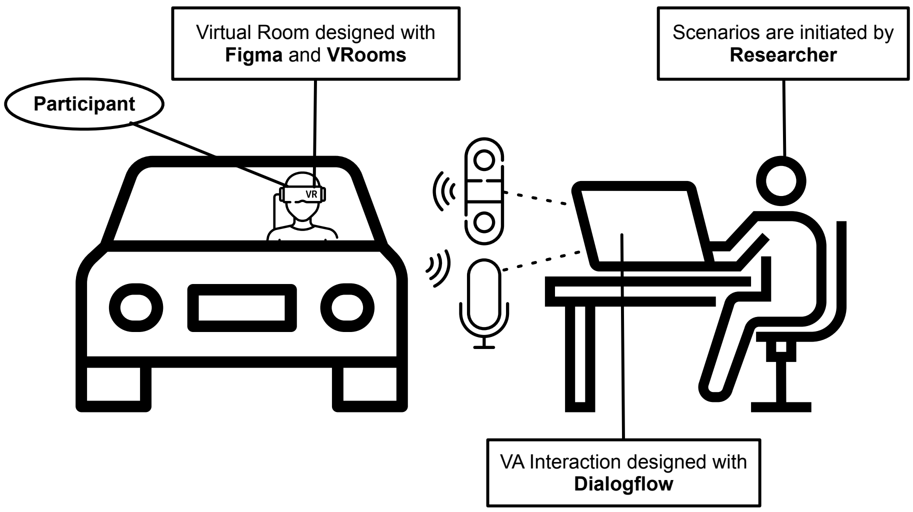

Figure 5.5.: *User Experience Test Setting*

During the user experience test, we presented different situations to the participants. For example, the test showed how the VA could become used to the driver's habits and, thus, automatically recognize that, for example, on a Monday morning, the driver would likely drive to work. To do so, the assistant would greet and remind the driver about the most important appointments on the respective day. It also showed how, in situations with poor visibility, the VA could provide the driver with a recommendation to turn on the car's headlights. Further, the test showed that the in-vehicle assistant could explain the car's functions on the one hand and actively relieve the driver from performing tasks on the other hand by independently switching on the car's headlights. For this purpose, the VA automatically detected situations that include a restricted view. Another longer scenario involved a congestion-free motorway journey in which the VA entertained the user if required. The VA started conversation with the user.

We developed a post-test questionnaire to evaluate the prototype and assess participants' experience with and perceptions of the virtual in-vehicle assistant. The questionnaire covered questions about the system's entertainment, ease of use, playful handling, user friendliness, and perceived pleasure. We rated all items on a seven-point Likert-scale. Additionally, we asked about participants' prior experience with and knowledge about VAs and various open questions to obtain more insights into specific factors that influence users' experience with and perception of the in-vehicle assistant. We provide the full questionnaire and the descriptive statistics in Section 5.5.4.

5.5.4. Results

In total, 19 university students (12 males and 7 females) from various fields took part in the user experience test. Fourteen participants were between 25-30 years old, whereas five were between 20-24 years old. Ten participants owned a car, and nine regularly drove a family/partner or company car. Six participants drove less than 5,000 kilometers a year, seven drove between 5,000 kilometers and 10,000 kilometers, five drove between 10,000 km and 20,000 kilometers, and one participant drove more than 20,000 kilometers a year. Most (75%) participants had already used a VA of any kind; however, 60 percent had never used a VA in a car. The following table shows the descriptive results of the questionnaire.

Looking at the descriptive data, participants rated the prototype overall as easy to use, as increasing their comfort, as having an entertaining atmosphere, and as easy to interact with. In summary, the descriptive data reveals valuable insights about how the participants experienced the VA and its overall benefits. We found support for such a conclusion from our open questions as well since the participants noted that they saw the VA as a suitable tool for operating relevant vehicle functions. In particular, participants that drove more than 10,000 kilometers a year supported this statement. Furthermore, 85 percent of the participants stated that they could imagine using the VA in their everyday driving. When we further asked about the experience of the car drive,

Table 5.8.: *Results of the Post-test Questionnaire*

Value/goal	**Question**	**Mean**	**SD**
Increase of the general comfort	Using the VA during the car ride increased my comfort.	5.16	1.64
Entertainment	Using the VA during the car ride made me feel entertained.	4.47	1.07
Ease of use	Dealing with the VA is clear and understandable.	5.53	1.60
	Overall, I find the virtual passenger easy to use.	5.68	1.14
Interaction	I have the feeling that the VA understands me.	5.05	1.19
	Dealing with the VA was clear and intelligible.	5.53	1.24

participants mentioned "especially the proactivity was a helpful feature", the "courteous communication and beneficial interaction", and the "hints and overarching actions that go beyond the functions of the car [was beneficial]". However, participants also mentioned that the VA's voice sounded too much like a computer, that some actions were unnecessary (helping with headlights, random city information, or generally asking too much). "Sometimes less is more", one participant mentioned. Participants also gave various suggestions to improve the VA, such as the support during long drives (especially during the night) in form of a longer conversation to avoid driver fatigue. They also suggested using specific sensors to detect the driver's mood, emotion, heart rate, and overall condition and offer supporting podcasts, audio books, or a conversation. These aspects essentially support a companion's character and show that the participants perceived the implemented VA as more than a sole assistant. Even though we did not systematically and rigorously evaluate all guidelines in the user experience test, we did cover several guidelines with questions in the post-test questionnaire. In particular, we fundamentally confirmed Design Guidelines 3.1, 5, 6, 7, 9, 12, 13.2, and 14.1.

5.6. Discussion and Conclusion

In this study, we address the scarce concrete guidelines for building virtual in-vehicle assistants that provide a convincing UX in the literature. We close this research gap with several proposed design guidelines for designing virtual in-vehicle assistants. In addition, we discuss how we tested the developed guidelines by applying them to a real project, a VR prototype, which we evaluated in a user experience test. In implementing a virtual in-vehicle assistant, we demonstrate the design guidelines' applicability to real-world scenarios. With our prototype, we did not seek to implement an all-encompassing virtual in-vehicle assistant; instead, we wanted to demonstrate how one can use the design guidelines to conceptualize and implement a VA. According to the DSR contribution types that Gregor and Hevner (2013) present, we contribute two main artifacts as DSR outputs to the knowledge base: a level-two artifact (the proposed design guidelines) and a level-one artifact (our instantiation of a virtual in-vehicle assistant in the form of our VR prototype).

However, designers do not necessarily have to consider all design guidelines necessarily when designing a VA. In addition, designers can apply our design guidelines to other VAs that users do not primarily use in cars and, thus, other contexts since the guidelines cover a broad spectrum. With that said, future work needs to further assess our design guidelines' generalizability according to the context(s) in which they apply them.

Future research on virtual in-vehicle assistants should focus and especially specify aspects such as trust and privacy concerns. Given that organizations continue to collect more and more, concerns that they will potentially misuse private information have risen. Therefore, an in-vehicle assistant should not only disclose what data it collects but also communicate freely what happens to it and how it is stored. As such, Design Guideline 11.2 represents only a small part of how to deal with users' privacy concerns and requires further research. With regard to autonomous driving, we also need to rethink the guidelines. An in-vehicle assistant for drivers who hardly take on any activities themselves may become obsolete. In such cases, one could use other forms of virtual assistance to simulate drivers and, thus, assist or interact with passengers (i.e., the actual users). Future research should also deal with user adaptation and explore how a VA can not only respond to individual users but also interact with users generally in an appropriate way. A VA should have individual preferences (response, proactivity, etc.) for each user in order to create the most possible benefit. Therefore, designers might extend the virtual in-vehicle assistant with cognitive abilities, such as the ones that Ahmad et al. (2018) show, to analyze the user's personality and adapt its behavior accordingly.

Our guidelines focus on providing a convincing UX to ensure that people find an in-vehicle VA valuable to use and that it makes their lives easier. If designers consider all the design guidelines during representational and interaction design, the developed in-vehicle VA will meet all the requirements for a convincing UX.

CHAPTER 6

Introducing the Virtual Companion Canvas

The Need for a Design Tool

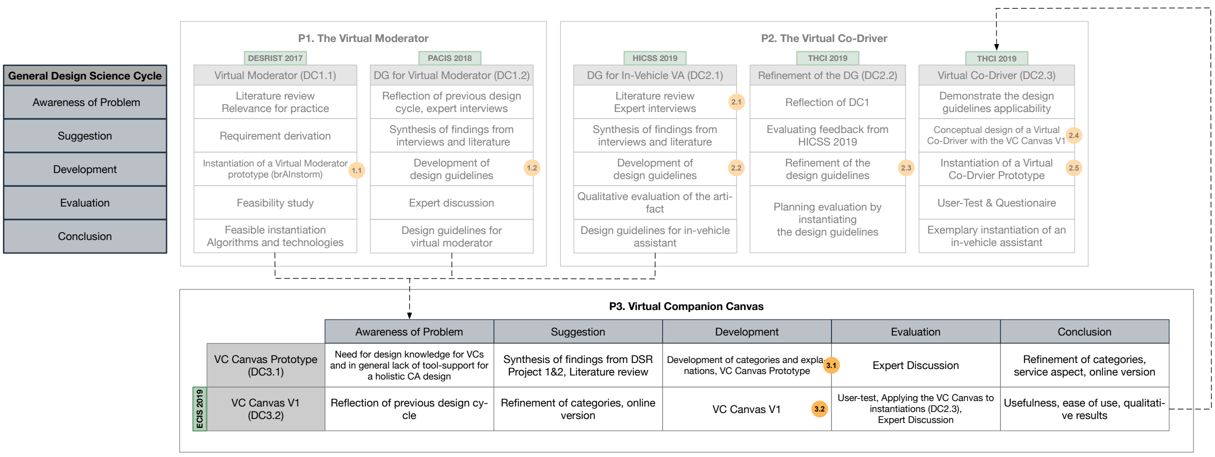

Figure 6.1.: *Positioning ECIS 2019 in the DSR Project*

As explained in the previous chapter, the idea of the VC was born while working on the virtual in-vehicle assistant. In addition to the idea of the VC, the design and development experience also showed that the concept of the CA is often neglected and the actual implementation of interaction patterns is started too quickly before the agent has even been designed in a holistic and user-centered way. For this reason, the goal was to create a visual design tool, with which not only designers but also users can design the VC according to their needs. Figure 6.1 shows how the VC Canvas project evolved from the previous DSR projects. It is deliberately placed below the other projects, because unlike the previous ones, it is not related to a specific application context.

ECIS 2019: Introducing the Virtual Companion Canvas – Towards Designing Collaborative Agents

Abstract

Conversational agents like virtual assistants or chatbots are getting more and more attention within research and practice due to a significant technological progress in the field of Artificial Intelligence (AI). This interdisciplinary field of research led to a variety of different terms, approaches, frameworks, guidelines and views, that in consequence challenges organizations and researchers to systematically understand, design and implement AI-based applications like conversational agents. Moreover, use-cases in which conversational agents do not just assist their user, but rather collaborate with them, will be interesting in the future. We therefore propose the collaborative agent, an evolution of the conversational agent and introduce the VC, an exemplary class of the collaborative agent. As profound design theories and tool support for the design of AI is missing, we introduce the VC Canvas, an approach towards a design theory and a tool to analyze, understand and design VCs, detached from concrete technology. The VC Canvas evolved within a comprehensive Design Science Research project, with currently two contributing design projects containing three design cycles and two successive iterations of the VC Canvas itself. This research paper introduces the concept of the collaborative agent and reports the development of the VC Canvas as well as the results of a conducted experiment.

6.1. Introduction and Motivation

Due to a significant technological progress in the field of artificial intelligence (AI), a number of new services and products emerged (Gnewuch, Morana, and Maedche, 2017; Maedche et al., 2016; Seeber, Bittner, Briggs, De Vreede, et al., 2018). In addition to specific applications in the form of VA, such as Apple's Siri or Amazon's Alexa, companies are increasingly developing chatbots and enterprise bots for the interaction with customers. Besides these practical uses of AI, many scientific articles in this field are published, including design principles and lists of tips on how to design and implement specific AI applications (McTear, 2017). Due to the overarching research endeavor of AI, various definitions and theories from different research areas exist, are combined and used, which additionally makes it hard to understand the comprehensive perceptions of AI. Terms, such as VA, chatbot, virtual agent and conversational interface are often used synonymously, whereby differences can be found in the applied technology, the implemented functions and the different tasks addressed (Gnewuch, Morana, and Maedche, 2017; McTear, 2017; Schuetzler et al., 2014). This leads to diverse perspectives and, above all, challenges both companies and researchers to systematically understand, design and implement AI. The difficulty to decide what functionalities to use is furthermore strengthened by the confusing terminology, different frameworks, the plethora of tools and the extensive documentations (McTear, 2018). This inconsistency leads to a need for standards, practical tools and structured procedures to design specific AI applications, like chatbots or VAs. The commonly used term conversational interface (Këpuska and Bohouta, 2018; McTear, 2017) or conversational agent (Gnewuch, Morana, and Maedche, 2017; Schuetzler et al., 2014) limits the interaction between the system and the user to a conversation. A system that proactively contributes to a given task and autonomously creates content would thus not just be conversational, but rather collaborative. We therefore propose the collaborative agent as an evolution of the conversational agent. In this paper we introduce the VC as a first instance of a collaborative agent. In comparison the commonly used term "virtual assistant", as an instance of a conversational agent, limits the autonomy of the system to assisting functions, neglecting the possibility of systems that act in a coequal way with the user. Thus, applications where AI works in a coequal manner cannot be allocated and called VA.

Within research, especially within DSR, tool support is essential to "increase traceability, collaboration, and quality" (vom Brocke et al., 2017, p. 2) of design projects. When planning and conducting DSR, certain tools can structure, document and present necessary information (vom Brocke et al., 2017), which is specifically helpful besides following established research methodologies, approaches or frameworks (Hevner et al., 2004; Kuechler and Vaishnavi, 2008; Peffers et al., 2007). Therefore, it is necessary to create special tools which are useful for practical developments and applications of AI as well as for design-oriented research in the field of AI. In order to make these design challenges possible, we are proposing a so-called VC Canvas, which is a tool that shows in an easily understandable and transparent way which design characteristics an VC can have. The VC Canvas should be helpful in the design process as well as in the analysis, classification and understanding of existing AI applications. We opted for a canvas approach because of the advantage of visualization, allowing users to not only follow lists and design guidelines, but conceptually design AI without considering specific technologies. Visual approaches have been identified as a successful way to support a reflective communication and a creative generation of complex tasks (Alario Hoyos et al., 2014; Hernández-Leo et al., 2008). With the development of the VC Canvas, we not only aim to introduce tool support for the design of VCs, but additionally follow the overarching objective to contribute a nascent design theory giving explicit prescriptions for the design of VCs (Gregor, 2006; Gregor and Hevner, 2013).

6.2. Theoretical Background

There are many approaches defining AI. One definition that was also used by the IEEE Neural Networks Council in 1996 (Fulcher, 2008), was originated by Rich Rich (1983, p. 3), who defined AI as "the study of how to make computers do things at which, at the moment, people are better". Russell and Norvig (2016) organize this multitude of AI definitions into the following categories: Thinking Humanly, Acting Humanly, Thinking Rationally and Acting Rationally, while the AI definition by Rich (1983) is assigned to the category Acting Humanly. This category has attracted an immense amount of attention in recent years, especially with regard to the modelling of natural human conversations, leading to the concept of conversational interfaces, one of the fastest growing area in AI (Këpuska and Bohouta, 2018; McTear, 2017). For all these systems, enabling a human conversation between an information system and its user, there is a wide-range of terms, like virtual personal assistant (McTear, 2004), virtual social agent (Guzman, 2017), digital assistant (Guzman, 2017), voice assistant (McTear et al., 2016), social agent (Skalski and Tamborini, 2007), intelligent assistant (Lee et al., 2017), cognitive assistant (Coronado et al., 2018), personal robot (Mondal and Nandi, 2018) or conversational AI (Ram et al., 2018). While there is a variety of terms, all have one thing in common, they allow their users to interact with them using natural language. Therefore, these systems can be summarized using the term conversational agent (Gnewuch, Morana, and Maedche, 2017; McTear et al., 2016). The front-end for the conversational agent is then called a conversational interface (see Figure 6.2), which allows the user to interact with the agent using speech, text, touch or other input and output options (McTear, 2017).

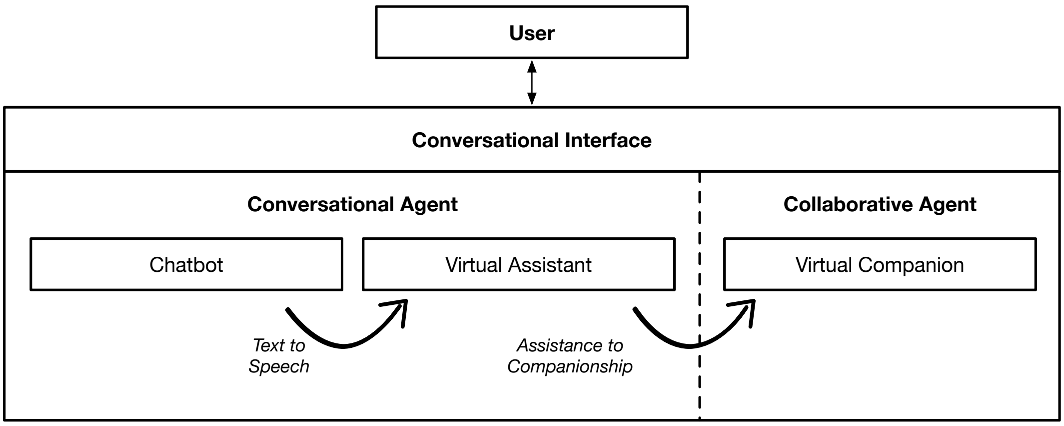

Figure 6.2.: *From Conversation to Collaboration*

The development of conversational agents started in the 1960s with the chatbot ELIZA (Weizenbaum, 1966), which is seen as the first application simulating human conversation. While chatbots in the past worked using simple pattern recognition, todays chatbots are way more capable, due to the development in the fields of machine learning and natural language processing (Knijnenburg and Willemsen, 2016; McTear et al., 2016; Shawar and Atwell, 2007a). As messaging apps have surpassed the use of social networks, the use of chatbots has also gained significantly in relevance, as they can be easily made accessible to users via existing messenger applications such as WhatsApp or Facebook Messenger (McTear, 2017). With the growing popularity of chatbots, several platforms emerged, allowing everyone the design of chatbots in a simple way (Diederich, Brendel, and Kolbe, 2019b). One of the main differences between chatbots and VAs is the input/output modality. While chatbots are used on a text basis, VAs are communicated with using speech (Gnewuch, Morana, Heckmann, et al., 2018). VAs have been made accessible to a wide range of users with the introduction of Apple's Siri, Amazon's Alexa or the Google Assistant. Furthermore, they differ from chatbots by following a general-purpose approach assisting their user, like performing their daily tasks (Gnewuch, Morana, and Maedche, 2017; Guzman, 2017). Today's use cases are, for example, executing functions on the smartphone such as creating calendar entries, sending messages or asking for the weather forecast. Thus, VAs are offering a new way of interacting with information systems (Morana, Friemel, et al., 2017).

The rapid development of smart technologies makes it possible for these agents to become more intelligent and human-like (Seeber, Bittner, Briggs, De Vreede, et al., 2018). In the showcase of Google Duplex, the Google Assistant independently makes a phone call and schedules an appointment with a hairdresser or is making a reservation in a restaurant.[10] Google Duplex is showing the potential of AI development and what one day might be common. Accordingly, scenarios in which people collaborate with machines should already be considered and actively designed today (Seeber, Bittner, Briggs, De Vreede, et al., 2018).

Today the main attention in the field of conversational interfaces is dedicated to VAs and chatbots (McTear, 2017). With the growth of technology driving AI, use-cases in which conversational interfaces do not just assist their user, but rather collaborate with them, will be interesting. We therefore propose the collaborative agent as an evolution of the conversational agent (see Figure 6.2), with the goal of raising AI to an eye-level and enabling coequal scenarios with AI. Collaboration, defined as the joint effort towards a common goal (Randrup et al., 2016) includes active participation within a collective value generation. A collaborative agent therefore does not solely interact in form of a conversation, but actively takes part and autonomously contributes to a given task. Thus, the interaction between the user and the collaborative agent is not limited to a conversation (e.g. speech or text), but is extended to an active contribution, like adding content to a shared document or providing feedback to a composed idea. With the collaborative agent the level of autonomy, activity and ability raises to an eye-level, enabling the participation within collaborative scenarios. In this paper we propose the VC as a first instantiation of the collaborative agent, because we think there will be a shift from assistance to companionship concerning human-machine-relationships

[10] youtu.be/D5VN56jQMWM

(see Figure 6.2). We chose the name VC, as it represents a more comprehensive view on existing and especially future applications of AI and by forming a companionship between a human and a machine a collaborative scenario might be achieved. According to Merriam-Webster (Merriam-Webster, 2003) a companion is defined as "one paid to accompany or assist or live with another, one employed to live with and serve another". While this definition refers to a human-human relationship, it may also apply to a human-machine relationship (Danilava et al., 2012). Therefore, the term Artificial Companion (AC) was first defined by Wilks (Wilks, 2006, p. 5-6) as "(...) an intelligent and helpful cognitive agent which appears to know its owner and their habits, chats to them and diverts them, assists them with simple tasks". Danilava et al. (Danilava et al., 2012, p. 1) who did a requirement analysis for ACs, expanded the AC definition to "(...) an AC is a personalised, multi-modal, helpful, collaborative, conversational, learning, social, emotional, cognitive and persistent computer agent that knows its owner, interacts with the user over a long period of time and builds a (long-term) relationship to the user". According to the definition of Wilks (2006), the term AC also encompasses physical instantiations. Therefore, we substitute the partial term *artificial* with the term *virtual*. This limits the focus on virtual instantiations and separates it from the field of robotics and physical instantiations, subsequently focusing on cognitive abilities of the system.

The following table summarizes the different characteristics of chatbots, VAs and VCs found during our literature review. The table also illustrates how the different characteristics are shared across the different instantiations, for example, that they are all conversational. Furthermore, the table clarifies which features make the VC unique compared to a VA. In our prior research we already looked at the emotions, proactivity, personality and context-awareness of VAs, but these characteristics are not really applicable to the concept of VAs and have thus led to our proposal of the VC, expressed by the dashed line in the table.

Table 6.1.: *Characteristic Development from Chatbot to VA to VC*

Chatbot	**Conversational** (Gnewuch, Morana, and Maedche, 2017; McTear, 2017; Wilks, 2006) **Fulfill simple tasks** (McTear et al., 2016; Wilks, 2006; Zhao, 2006)		
Virtual Assistant		**Visual representation** (Knijnenburg and Willemsen, 2016; Nunamaker et al., 2011; Qiu and Benbasat, 2009; Seymour, Riemer, et al., 2018; Strohmann, Fischer, et al., 2018), **personalized, know its owners, learning** (Danilava et al., 2012; Wilks, 2006)	
Virtual Companion		**Collaborative** (Danilava et al., 2012; Seeber, Bittner, Briggs, De Vreede, et al., 2018; Strohmann, Fischer, et al., 2018), **emotions** (Danilava et al., 2012; Hu et al., 2018; Krämer, Kopp, et al., 2013; Strohmann, Siemon, et al., 2019a; Yang et al., 2017), **proactivity, personality, context-awareness** (Strohmann, Fischer, et al., 2018; Strohmann, Siemon, et al., 2019a)	**Long-term relationship** (Danilava et al., 2012), **mental state that can shift** (Turkle, 2010), **autonomy** (Hecker et al., 2017)

In summary, we define the VC as follows: A VC is a conversational, personalized, helpful, learning, social, emotional, cognitive and collaborative agent, that interacts with its user proactively and autonomously to build a long-term relationship. To detach the design of VCs from the technological implementation, a design tool is needed. Visualization helps to externalize a mental image of a given content, whereas the external visual representation helps to support reasoning (Ware, 2012). The cognitive process of visualization furthermore helps to externalize abstract mental concepts on an individual level or a team level, where several mental images need to adapt to create a shared understanding (Swaab et al., 2002). Inspired by the business model canvas of Osterwalder and Pigneur (Osterwalder and Pigneur, 2010), we use the canvas-approach as a visual and familiar tool for the design of VCs. This allows the discussion of design opportunities and characteristics of VCs in an early phase of the development.

6.3. Methodology

For the development of the VC Canvas we followed a systematic and iterative DSR approach. Hevner et al. (Hevner et al., 2004) proposed a framework for DSR in information systems, to combine characteristics of behavioral science and design science and depicted "clear guidelines for understanding, executing, and evaluating the research" (Hevner et al., 2004, p. 75). It is designed to ensure that artifacts are designed (construction) based on business needs and requirements (relevance) and are built on applicable knowledge from theories, frameworks and methods (rigor). Following this approach, the VC Canvas is successive and iteratively developed based on two different DSR projects, containing three design cycles, as shown in Figure 6.3. This continuous development insures a rigorous process in order to create the VC Canvas artifact. We followed the adapted process model proposed by Kuechler and Vaishnavi (Kuechler and Vaishnavi, 2008), that emphasizes the contribution and knowledge generation of DSR. They argue that within their five steps, various contributions can arise. Not only after an evaluation and conclusion, where design science knowledge emerges, constraint knowledge (circumscription) can already arise within the development and evaluation steps, which contributes to the body of knowledge. This constraint knowledge emerges through the application of theories, instantiations of technology and the analysis when contradictions arise (Kuechler and Vaishnavi, 2008). This model was applied within two DSR projects that all cover the topic of VCs or similar AI applications. These DSR projects are of iterative nature and consists of a number of design cycles that already have been conducted, are currently being executed or will be in the future (see Figure 6.3). As superordinate DSR project, we define the VC Canvas that likewise consists of different design cycles and is iteratively developed based on the contributions of the two existing DSR projects and incidental evaluations.

Project 1 observes the support of workshops and moderation of creativity methods by a virtual moderator. While the contribution of the first design cycle (P1-DC1) is an artifact in the form of an instantiation as a prototype, a more general approach was chosen in the second design cycle (P1-DC2). By combining smart technologies, the feasibility of a virtual moderator was demonstrated with a prototypical implementation in P1-DC1. The prototype was presented at a conference to obtain feedback (Strohmann, Siemon, et al., 2017). The conclusion was the necessity of a deeper entry into the theory of moderation and the more intensive study of human moderators, which led to the second design cycle (P1-DC2). In addition, a lack of design approaches for the design of VAs was identified. The application-specific design guidelines developed in P1-DC2 are intended to address this deficiency. With the aggregation of the results from a literature review and several expert interviews, we were able to develop design guidelines

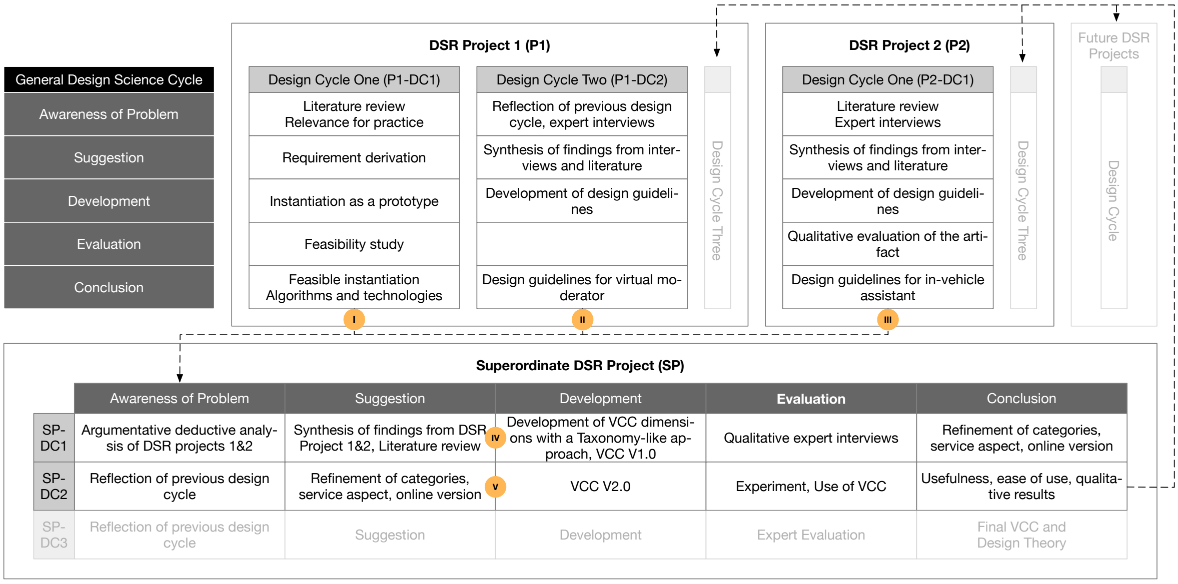

Figure 6.3.: *DSR Approach based on Kuechler and Vaishnavi (2008)*

for a virtual moderator (Strohmann, Fischer, et al., 2018). In Project 2, the same procedure as in P1-DC2 was applied to a completely different use-case, an in-vehicle user assistance (Strohmann, Höper, et al., 2019).

One of the most important findings from P1-DC1 was the lack of applicable design guidelines for the design of VAs. This lack was approached with the design guidelines from P1-DC2 and P2-DC1. Furthermore, all three design cycles have shown that there is a need for a more profound support than just assisting users, which we meet with the shift from assistance to companionship and conversation to collaboration. The problem that still exists is how to apply the developed design guidelines in an early stage of a design project, which we try to solve with a visual tool in form of a canvas-approach. The knowledge gained for the design of conversational and collaborative agents in P1 and P2 was aggregated and then extended with the concept of the companionship, which was assessed in systematic literature review based on the method of (Webster and Watson, 2002). The findings lead to the first development of the VC Canvas. The VC Canvas is thought to generalize and combine the knowledge gained through the previous DSR projects. Its aim is to provide a tool that examines a generalization of the previously covered use cases and an application to other possible use cases. We therefore developed the dimensions of the VC Canvas with a taxonomy-like approach inspired by the structured process of (Nickerson et al., 2013), which is thought to develop a taxonomy based on theoretical foundations and empirical evidence in an iterative manner. The possible characteristics a VC can have are therefore summarized and combined under several categories, which are the dimensions of the VC Canvas. The single iterations of the dimension development are marked with orange circles and roman numbers in Figure 6.3. When which dimension emerged as well as where categories were refined is illustrated in Figure 6.4 in the following chapter.

According to Gregor and Hevner (Gregor and Hevner, 2013) there are three levels of DSR contribution types. Level 1: a situated implementation of an artifact, Level 2: a nascent design theory, representing knowledge as operational principles and Level 3: a well-developed design theory. While the instantiation in P1-DC1 is a level 1 artifact, the design guidelines of P1-DC2 and P2-DC1 are level 2 artifacts. To tackle the lack of operationalizability of these design guidelines, more abstract, complete and mature knowledge is needed. This is the way taken by the VC Canvas, that therefore can be seen as an approach towards a design theory. (Walls et al., 1992) initially defined an information systems design theory (ISDT) as "a prescriptive theory which integrates normative and descriptive theories into design paths intended to produce more effective information systems." (Walls et al., 1992, p. 36). Following this thought (Gregor and Jones, 2007) introduced eight components of an ISDT: 1. Purpose and scope, 2. Constructs, 3. Principle of form and function, 4. Artifact mutability, 5. Testable propositions, 6. Justificatory knowledge, 7. Principles of implementation and 8. Expository instantiation. According to these components the VC Canvas's dimensions are the constructs of the to be developed ISDT, which is planned to be done in SP-DC3. The findings from developing the VC Canvas and the VC Canvas itself are supposed to be applied to future design cycles within the existing Projects 1 and 2, as well as in future DSR Projects concerning other application contexts (see greyed out and lightened areas in Figure 6.3).

6.4. Virtual Companion Canvas

The VC Canvas is thought to support the designing process of VCs by forming a basis for discussion, pointing out relevant VC characteristics structured under different dimensions. As stated before, the dimensions were developed following a taxonomy-like structured process resulting in 5 iterations of dimension development, which are illustrated in Figure 6.4. The way of illustration was inspired by (Remane et al., 2016) who developed a taxonomy of carsharing business models and provided a transparent figure showing their iterations. The five iterations are marked with orange circles and roman numbers, which are linked to the DSR approach in Figure 6.3. In the following section the single iterations are described in depth. Iteration I initially starts with three dimensions: task, conversation and audiovisual characteristics, which resulted from a literature review about VA characteristics and functionalities in P1-DC1 (Strohmann, Siemon, et al., 2017). These three dimensions form a simple basis, which are shared by a lot of existing conversational agents. Note that the single dimensions form a very general category of possible VC characteristics. For example, the dimension conversation contains concepts like the use of natural language (McTear et al., 2016) or the interaction in a social way (Skalski and Tamborini, 2007) and during the design of a VC application-specific characteristics and functionalities will be added in the canvas field.

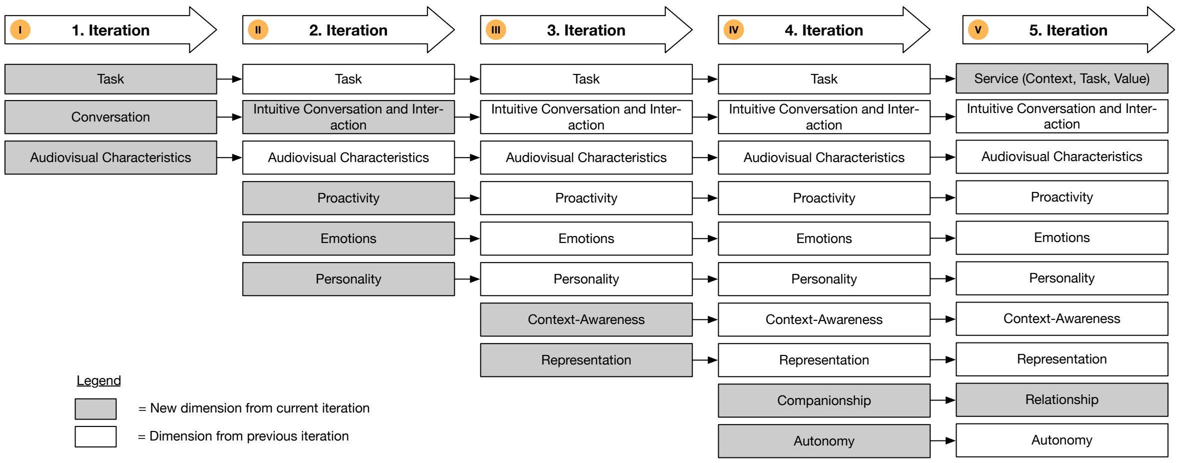

Figure 6.4.: *Development of Dimensions for the VC Canvas*

During the second iteration cognitively deeper dimensions were added: proactivity, emotions and personality, which emerged in P1-DC2 (Strohmann, Fischer, et al., 2018). Moreover, the dimension conversation was extended to "intuitive conversation and interaction" (Strohmann, Fischer, et al., 2018), providing a more holistic view about the way the VC interacts with a human being. The third iteration extends the set of existing dimensions with the dimensions context-awareness and representation (Strohmann, Höper, et al., 2019). Due to the thoughts about the movement from assistance to companionship a systematic literature review about the concept of companionship and its appearance in the field of conversational agents was done in SP-DC1 and thus the dimensions companionship and autonomy were added in the fourth iteration. After this iteration the first version of the VC Canvas was developed by a simple approach of visualizing the ten dimensions using a canvas. This first version was evaluated by presenting it and discussing it with other researchers and an expert from the design field (designer for visual marketing). Based on the collected feedback a second design cycle was initiated (SP-DC2) resulting in the fifth iteration of dimension development. During the qualitative evaluation the service concept emerged. It consists of the user's context, in which the VC is used, the task that the VC should fulfil and the value the VC should create for the user. Furthermore, the dimension companionship was renamed into relationship, as the concept of the "virtual companion", implies a companion-like approach for every dimension. Thus, the name relationship specifies the meaning of the dimension.

With the final set of dimensions after the fifth iteration the whole VC Canvas was recreated and transferred into an online tool. The chosen tool is the web-based, collaborative whiteboard Realtimeboard[11], which enables a distributed, synchronous and collaborative use of the canvas. Based on the feedback of the designer for visual marketing the canvas was redesigned. In contrast to the first version of the VC Canvas, which was black and white, appealing pastel colors and icons where chosen for every dimension, to visually separate the canvas fields. Each dimension additionally got a short explanation, as well as an advice and questions supporting the user. In the case of the category Proactivity the short explanation is "Output without Input", the advice "Should be of high quality and respect the context of the user." and the question "When should the VC independently address the user?".

Figure 6.5 presents a reduced version of the canvas, whereas a full version of the VC Canvas can be found here: bit.ly/ecisvcc. It is divided into two parts: the service concept of the VC and the canvas itself in the form of the VC's dimension with its individual design features and characteristics.

6.4.1. Evaluation

In order to evaluate the current state of the VC Canvas (Version 2.0), we conducted an experiment with 15 participants who were or are currently working on different VC projects. The participants were 14 students and one PhD, who all have experience in the

[11]realtimeboard.com/

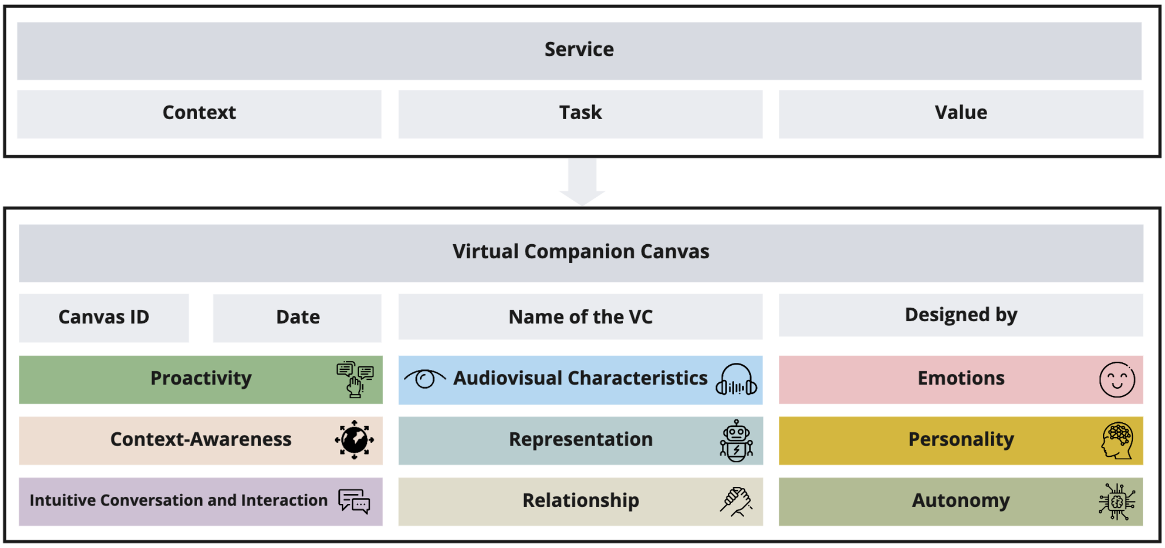

Figure 6.5.: *Reduced Version of the VC Canvas*

development, design or use of VAs, VCs or chatbots. The participants were classified according to use cases and were instructed to freely use and fill out the VC Canvas. A total of nine participants were part of the above mentioned DSR projects each in a new iteration in which the VC concept and the VC Canvas were applied. Five participants of DSR Project 1, a VC to support creativity-intensive processes and four participants of DSR Project 2, an in-vehicle AI support. In addition, other use cases were customer consulting (three participants), medical support in the form of a VC for diabetics (one participant) and the analysis and redesign of existing VAs for everyday support (two participants). With the application to known scenarios (DSR Project 1 and 2) and the application to other use cases or existing VAs, we aim for a better understanding in which use cases the concept of the VC fits. Figure 6.6 shows an excerpt of a filled VC Canvas from one of the participants concerning an in-vehicle VC, displaying the categories Proactivity, Audiovisual characteristics and Emotions. A full version of the completed canvas can be viewed here: bit.ly/ecisexamplevcc.

To evaluate the participant's experience with the VC Canvas, its applicability and usefulness, we constructed a survey, consisting of exploratory questions, as well as the constructs Perceived Usefulness and Perceived Ease of Use of the Technology-Acceptance Model (TAM) (Davis et al., 1989) rated on a 7-point Likert-scale. The TAM was chosen as it provides a well-established and robust instrument to measure the usefulness and ease of use of new information systems (Chuttur, 2009). The aim of the experiment

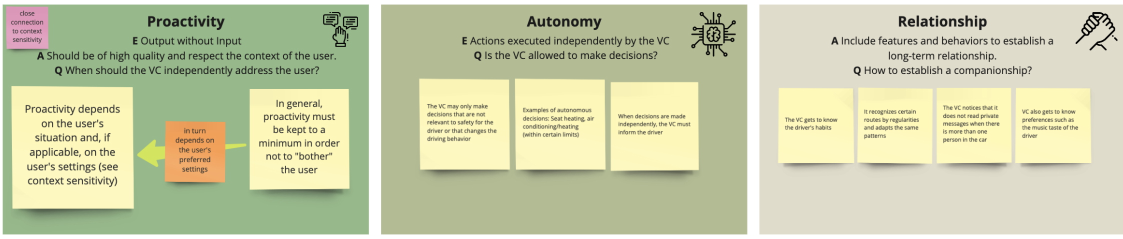

Figure 6.6.: *Excerpt from a filled VC Canvas*

was to gain insights about the applicability of the VC Canvas and to analyze, whether the structure, the explanations and the categories are appropriate or need further refinement. Besides information about prior experience with VAs or similar, we recorded the time the participants were working with the VC Canvas and moreover constructed five open questions asking for positive and negative aspects of the VC Canvas and specific suggestions for improvement. Furthermore, the participants rated the nine dimensions (the dimension of the service concept was excluded) of the VC Canvas according to their relevance for their VC project (ranking scale from 1 to 9). Based on the results, the VC Canvas will undergo another iteration, where the insights of the survey will be considered.

6.4.2. Results and Discussion

We calculated Cronbach's Alpha for the constructs Perceived Usefulness (α=0.83) and Perceived Ease of Use (α=0.72), which both indicate a high internal consistence. The results indicate that the participants rated the VC Canvas as usefulness (M=5.63, SD=1.19) and easy to use (M=5.39, SD=0.98) during their usage (average duration of usage: 64 minutes), which was furthermore stated within the open questions. The answers to the open questions were analyzed with the help of codes as efficient data labeling and data retrieval technique (Miles and Huberman, 1994) using the software MAXQDA version 18. At first, categories were defined as main codes in the first cycle, matching the key aspects of the open questions: Canvas (positive), Canvas (negative), Realtimeboard (positive), Realtimeboard (negative), suggestions for change, autonomous changes. After assigning the categories to all responses in a first coding cycle, the texts were then analyzed at a deeper level during a second coding cycle. During this cycle sub-codes structured into the categories were created, extracting the meaning of the coded passages. In a third cycle the coding was checked and refined. After the last cycle 46 codes and 96 codings emerged in total. Due to the limited space in this publication, the results of the coding are only partially considered here, but furthermore considered for the refinement of the VC Canvas. The category Canvas (positive) contains 12 different codes and 31 codings. The outstanding code in this category is *clear and structured* mentioned 14 times by 11 different participants. Besides, several other aspects are mentioned: *independent expandability* (2 users), *familiarity, because of the business model canvas* (2 users) and *flexibility* (3 users) and more. In contrast the category Canvas (negative) only contains 2 codes and 11 codings, where the two codes are: *Better delimitation of terms and fields* (2 users) and *overloaded, immediately after opening* (7 users). Concerning the software Realtimeboard, 7 users say that they liked the possibility to work collaboratively with the tool and 4 users have highlighted its intuitiveness. Changes made by the participants to the VC Canvas are, for example, the addition of categories, like *data protection and privacy* or *integration of digital services*. Suggestions of change are, for example, *adding more guidance*, *weighting of categories* or *separate the service concept using color*.

The ratings of the nine dimensions however, show a high inconsistency between the participants. The highest rating has the category Representation (M=2.8), followed by Context-Awareness (M=3.5), whereas Emotions was ranked the lowest (M=6.8). However, especially the category Relationship had a high standard deviation (SD=3.7) and was rated twice as the most important category, but also three times as the least important. Calculating inter-rater reliability confirms this inconsistency (Krippendorf's α=0.03) within the rating of the categories. This indifferent rating depends strongly on the use cases. While the participants in the use case, support of creativity-intensive processes, rated Relationship with a low relevance, the dimension was rated as very important for the in-vehicle assistant.

6.5. Conclusion and Outlook

In this research project, we introduced the VC Canvas, a tool to support the analysis, understanding, design and implementation of so-called VCs. Moreover, we proposed the collaborative agent as an evolution of the conversational agent. The DSR project aims to provide a design basis in the form of operationalizable guidelines and an associated design tool to design VCs. However, the overarching objective is to develop a design theory for the design of VCs, combining the findings of the DSR projects 1 and 2, as well as those of the VC Canvas project. After finishing the first two design cycles and contributing the knowledge in this publication, the third design cycle (see Figure 6.3) will be initiated, with the goal of developing an ISDT. The ISDT and a corresponding third version of the VC Canvas is supposed to be evaluated in the third design cycle in a workshop setting with experts from the field of design and development of AI applications.

The first two evaluations of the VC Canvas have resulted in the following suggestions for change to be incorporated. The topic of data protection needs to be considered, which was already covered in DSR Project 1, with the design guideline: "Mind ethics and create a trustful and transparent environment" (Strohmann, Fischer, et al., 2018). In addition, a higher consistency in the explanations, advices and questions of the individual dimensions must be created. It is also conceivable to design the fields generally more complex and to add more guidance. For the future development of the VC Canvas an independent instantiation is also conceivable, which would enable the dynamic adaption of the VC Canvas itself. Thus, the fields could adapt, change or be expanded during filling and depending on the application context. This adaptation can also address the inconsistency of the dimension weighting according to the use case, which also needs to be investigated in future research. Of course, the dimensions of the VC Canvas might change or develop according to upcoming research in the future. This is why, a dynamic and expandable version of the canvas totally makes sense. In addition, the actual implementation of the VCs based on the previously designed VC Canvas can be supported with assistance for the derivation of the concrete technological implementation. The actual implementation can furthermore be compared with the previously planned service concept, to validate if expected values and tasks are addressed by the actual implementation. In general, the findings from the superordinate DSR project are to be applied to Project 1 and 2 in the future, as well as to other DSR projects in other applications scenarios.

In summary, we introduced a valuable tool, that can benefit both research and practice in supporting the planning and designing VCs to create collaborative scenarios with AI.

6.6. Supplement

Since the following publication contains only the final version 1 of the VC Canvas, the prototypes for the VC Canvas will be presented in the following to emphasize and show the iterative procedure for its creation.

Figure 6.7 shows one of the first prototypes of the VC Canvas. It was created with the design software Omnigraffle. The prototype was primarily intended to visualize the canvas approach. In this case, the fields could not yet be filled digitally.

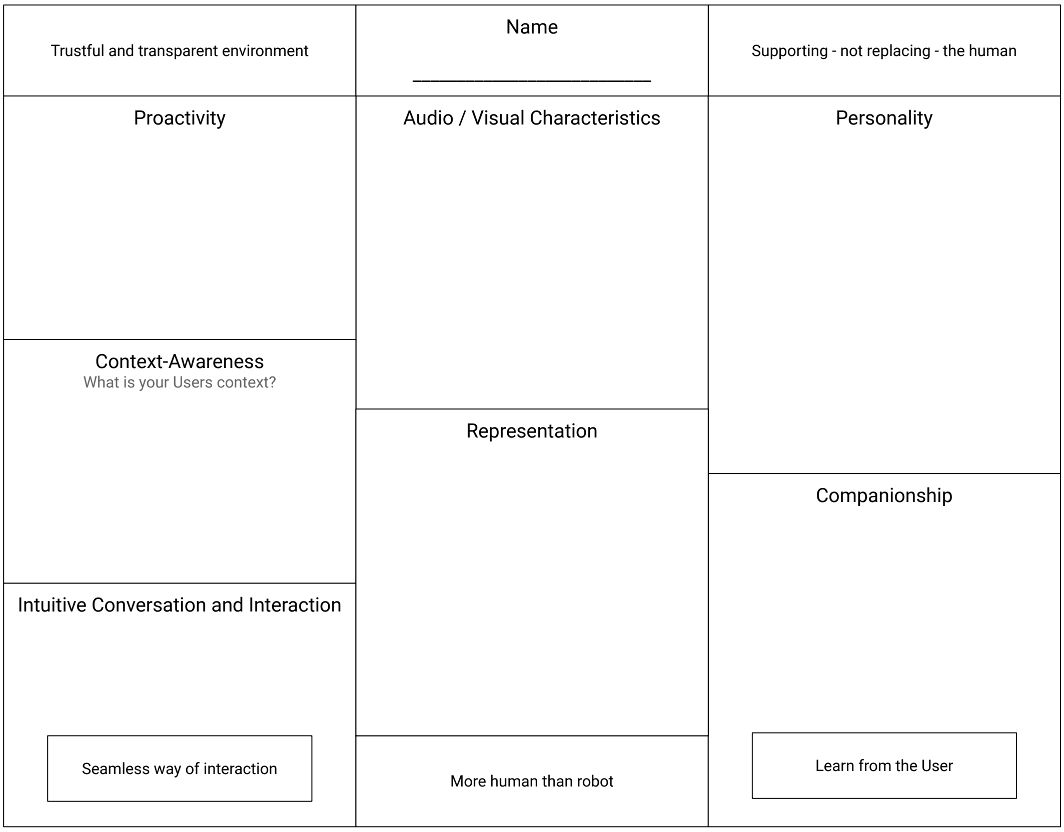

Figure 6.7.: *VC Canvas Prototype 2: Canvas Draft*

To enable a collaborative working on and filling out of the canvas, it was transferred to the whiteboard tool Miro. Figure 6.8 shows a screenshot of the second VC Canvas Prototype in Miro. Here the structure of the fields has already changed.

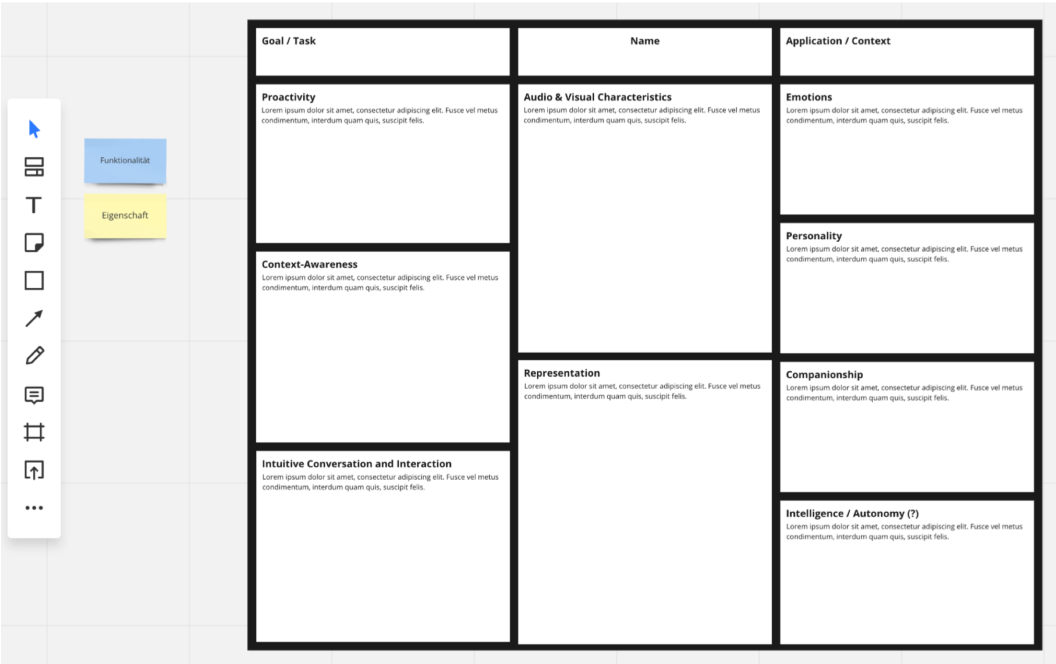

Figure 6.8.: *VC Canvas Prototype 3: Interactive Canvas*

To make the canvas more visually appealing and to better separate the individual fields, the entire canvas was redesigned. In addition, the service concept was added in the final version, as well as first questions and instructions for the individual fields. The final version of the VC Canvas contributed in the ECIS 2019 publication is shown in Figure 6.9

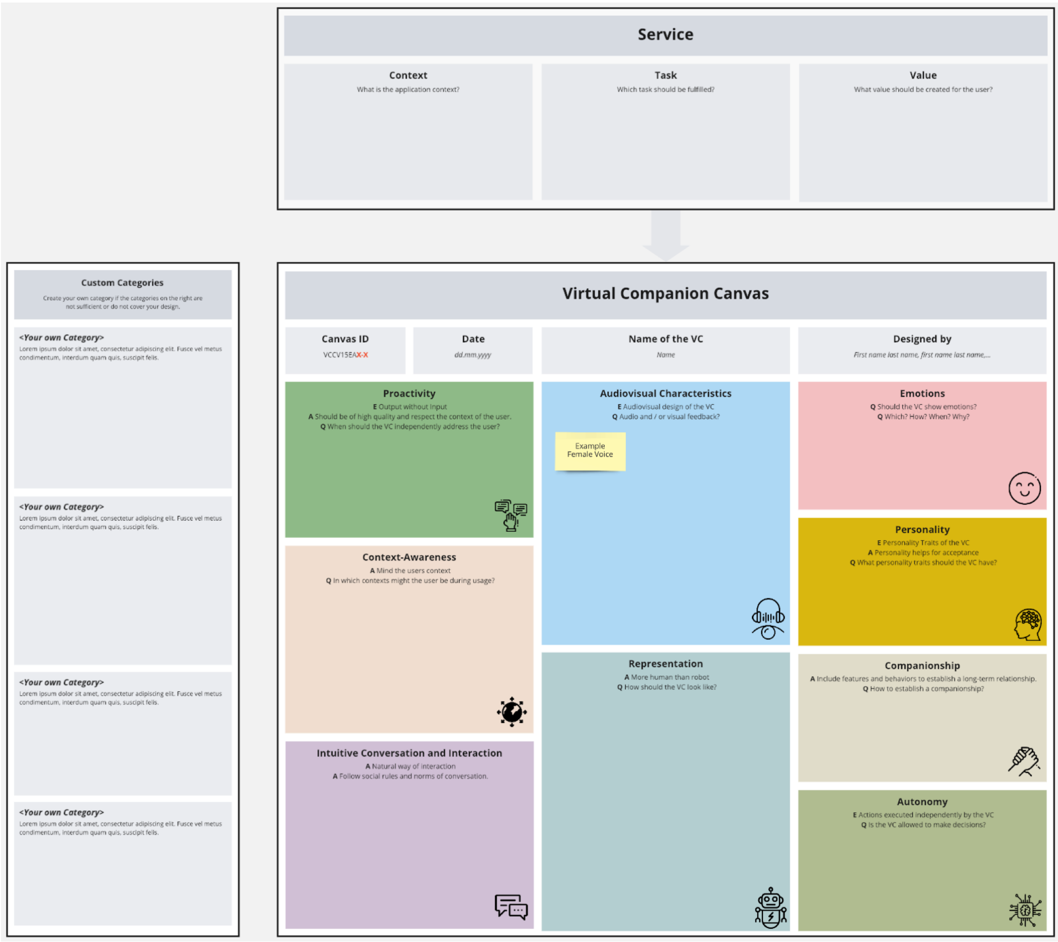

Figure 6.9.: *VC Canvas V1: Redesigned Interactive Canvas*

CHAPTER 7

Designing Virtual Companions for the Customer

The Virtual Companion Canvas in the Service Sector

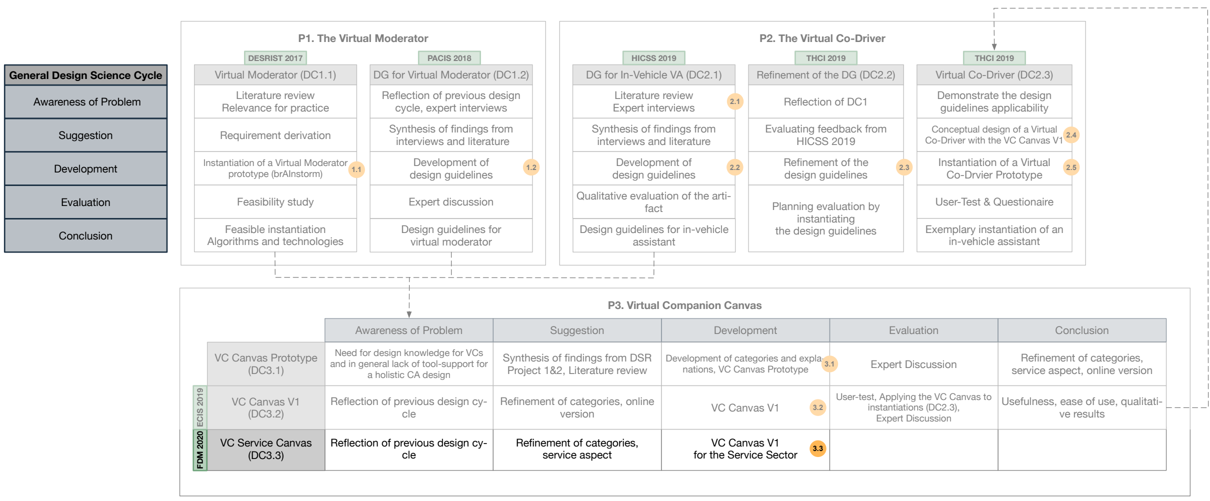

Figure 7.1.: *Positioning FDM 2020 in the DSR Project*

After the publication and discussion at the ECIS 2019, the VC Canvas was iteratively refined, extended, and tested. Since the concept of the VC seemed to be especially interesting for the service sector, a particular version for this context was derived in another DC (see Figure 7.1) and is presented in the following.

FDM 2020: A Virtual Companion for the Customer – From Conversation to Collaboration

Abstract

In our research we introduce the concept of the VC and show its advantages for the service sector. The VC is a new form of artificial intelligence application enabling a collaborative scenario between humans and information technology and thus makes more personalized services possible. In order to design VCs conceptually and detached from the technological implementation, we have developed the VC Canvas as a design tool.

7.1. Introduction

Due to the technological progress in the field of AI, the emergence of various innovative services and products is enabled (Morana, Friemel, et al., 2017; Winter, 2018). Chatbots and VAs are a promising application area of AI. These systems enable the user to interact with IT using natural language in written or spoken form (Stucki et al., 2018) and can be summarized using the term conversational agent (McTear et al., 2016). Common examples of VAs are Apple's Siri or Amazon's Alexa, which are now being used by a wide range of users (McTear, 2017). Chatbots are, for example, used by companies for customer support and thus allow them to handle increasing customer enquiries (Tuzovic and Paluch, 2018).

In a successful business relationship, the service provider promises his customers the most individual value possible and responds to their needs and wishes. Besides the value proposition of the service, the value created through the interaction between service provider and customer (value-in-interaction) is also an essential component of the service (Robra-Bissantz, 2018). At this point, the named technologies made possible by AI can and should be used, to create a personal and collaborative relationship between human and IT, whereas the IT should bridge the gap between provider and customer. Due to the individual nature of the service itself, AI technologies should be leveraged to automate individual and personalized services. However, the common choice of the term "virtual assistant" for such AI applications already shows that these are limited to assisting functions. With the so-called VC, we therefore propose a transition from assistance to companionship and thus to a collaborative relationship between human and IT. The VC is designed human-centered and personalized according to the customer and represents the interface between customer and IT, to bridge the gap to the provider. Enabled by AI and the scalability of the mentioned systems, services can be offered individually and personalized to a broad mass of users with the help of a VC. In addition, the VC itself represents a service in the form of an interaction service.

We propose the VC Canvas as a design-oriented approach and tool, to design the VC in a customer-centric manner, detached from the technological implementation. The visual approach enables a reflective communication and creative approach (Alario Hoyos et al., 2014; Hernández-Leo et al., 2008). Due to the advantage of visualization, we opted for a canvas approach enabling the designer of the VC not only to follow lists and design guidelines, but also to conceptually design the VC without taking a concrete technological implementation into account. For the development of the VC Canvas, we have gathered our knowledge from our previous research projects on the design of conversation agents and conducted a literature research concerning requirements for collaboration- and companionship-specific characteristics of the VC. In several iterations we collected the design dimensions a VC can have and then developed a the VC Canvas based on the dimensions.

With this research project we want to show how a collaborative relationship between human and IT can be created by humanizing the interface with the help of a VC. We introduce the VC and show its advantages for the service sector, as well as use-cases to which the concept can be applied to. With the VC Canvas we provide a design tool to conceptually design VCs.

7.2. Theoretical Foundation

7.2.1. Conversational Agents

The development of conversational agents started in the 1960s with the chatbot ELIZA (Weizenbaum, 1966), which is seen as the first application simulating human conversation. While chatbots in the past worked using simple pattern recognition, todays chatbots are way more capable, due to the development in the fields of machine learning and natural language processing (Knijnenburg and Willemsen, 2016; McTear et al., 2016; Shawar and Atwell, 2007a). As messaging apps have surpassed the use of social networks, the use of chatbots has also gained significantly in relevance, as they can be easily made accessible to users via existing messenger applications such as WhatsApp or Facebook Messenger (McTear, 2017). With the growing popularity of chatbots, several platforms emerged, allowing everyone the design of chatbots in a simple way (Diederich, Brendel, and Kolbe, 2019b). One of the main differences between chatbots and VAs is the input/output modality. While chatbots are used on a text basis, VAs communicate using speech (Gnewuch, Morana, Heckmann, et al., 2018). Virtual assistants have been made accessible to a wide range of users with the introduction of Apple's Siri, Amazon's Alexa or the Google Assistant. Furthermore, they differ from chatbots by following a general-purpose approach assisting their user, like performing their daily tasks (Gnewuch, Morana, and Maedche, 2017; Guzman, 2017). Today's use cases are, for example, executing functions on the smartphone such as creating calendar entries, sending messages or asking for the weather forecast. Thus, VAs are offering a new way of interacting with information systems (Morana, Friemel, et al., 2017).

The rapid development of smart technologies makes it possible for these agents to become more intelligent and human-like (Seeber, Bittner, Briggs, De Vreede, et al., 2018). In the showcase of Google Duplex, the Google Assistant independently makes a phone call and schedules an appointment with a hairdresser or is making a reservation in a restaurant (Leviathan and Matias, 2018). Google Duplex is showing the potential of AI development and what one day might be common. Accordingly, scenarios in which people collaborate with machines should already be considered and actively designed today (Seeber, Bittner, Briggs, De Vreede, et al., 2018).

7.2.2. From User Assistance to an Individual Companion

Today the main attention in the field of conversational interfaces is dedicated to VAs and chatbots (McTear, 2017). With the growth of technology driving AI, use-cases in which conversational interfaces do not just assist their user, but rather collaborate with them, will be interesting. We therefore propose the collaborative agent as an evolution of the conversational agent (see Figure 1), with the goal of raising AI to an eye-level and enabling coequal scenarios with AI. Collaboration, defined as the joint effort towards a common goal (Randrup et al., 2016) includes active participation within a collective value generation. Collaboration relies on coordination activities between the partners, like the coordination who does which task when or which activities lead the collective towards the common goal. For this coordination, communication is essentially needed, to transfer information between the partners. (Robra-Bissantz and Siemon, 2019) The general collaboration activities can be summarized with the phases *Forming*, *Norming* and *Performing* (Tuckman, 1965), whereas the *Forming* brings the potential collaboration partners together, *Norming* plans and coordinates the activities and *Performing* represents the actual value creation. For these general collaboration activities several principles of collaboration exist, like a shared mental model, trust, the yield-shift-theory and common values for the *Norming* or reciprocity, a common goal, team emotional intelligence, cohesiveness and benevolence for the *Performing* (Robra-Bissantz and Siemon, 2019; Siemon, Becker, et al., 2017). If now IT in form of a collaborative AI follows those principles of collaboration, a collaborative interaction between the human and IT can be created. This thought leads us to our proposal of the collaborative agent, as an evolution of the conversational agent, because only when we have this collaborative relationship between human and IT, an individual companion for the human can be created.

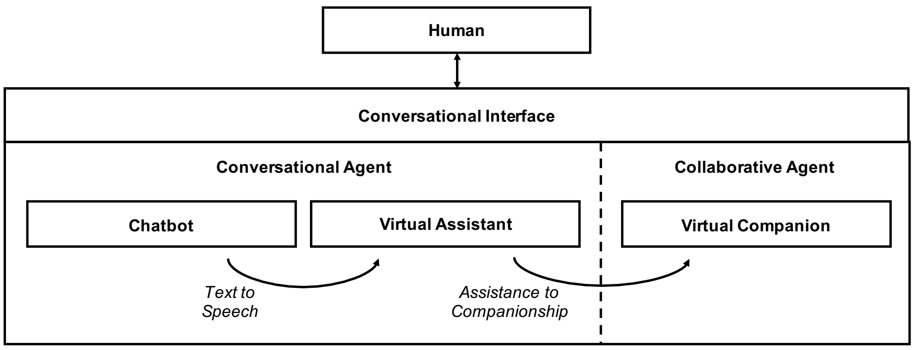

Figure 7.2.: *From Assistance to Companionship and from Conversation to Collaboration*

A collaborative agent therefore does not solely interact in form of a conversation, but actively takes part and autonomously contributes to a given task. Thus, the interaction between the user and the collaborative agent is not limited to a conversation (e.g. speech or text), but is extended to an active contribution, like adding content to a shared document or providing feedback to a composed idea. With the collaborative agent the level of autonomy, activity and ability raises to an eye-level, enabling the participation within collaborative scenarios. In this paper we propose the VC as a first instantiation of the collaborative agent, because we think there will be a shift from assistance to companionship concerning human-machine-relationship.

7.3. The Virtual Companion

7.3.1. Definition and Characteristics

We chose the name VC, as it represents a more comprehensive view on existing and especially future applications of AI. By forming a companionship between a human and a machine a collaborative scenario can be achieved and thus services offered with the help of a VC can be more easily personalized and automated. According to Merriam-Webster (Merriam-Webster, 2003) a companion is defined as "one paid to accompany or assist or live with another, one employed to live with and serve another". While this definition refers to a human-human relationship, it may also apply to a human-machine relationship (Danilava et al., 2012; Krämer, Eimler, et al., 2011). Therefore, the term artificial companion was first defined by Wilks (Wilks, 2006, p. 5-6) as "(...) an intelligent and helpful cognitive agent which appears to know its owner and their habits, chats to them and diverts them, assists them with simple tasks". Danilava et al. (Danilava et al., 2012, p. 1) who did a requirement analysis for artificial companions, expanded the definition to "(...) an artificial companion is a personalised, multi-modal, helpful, collaborative, conversational, learning, social, emotional, cognitive and persistent computer agent that knows its owner, interacts with the user over a long period of time and builds a (long-term) relationship to the user". According to the definition of Wilks (Wilks, 2006), the term artificial companion also encompasses physical instantiations. Therefore, we substitute the partial term *artificial* with the term *virtual*. This limits the focus on virtual instantiations and separates it from the field of robotics and physical instantiations, subsequently focusing on cognitive abilities of the system.

The following table summarizes the different characteristics of current conversational agents like chatbots and VAs found during our literature review and compares them to the characteristics of our proposed form of the VC. The table clarifies which features make the VC unique compared to current conversational agents. Certain characteristics, which are listed here exclusively for the VC, can of course be transferred to current conversational agents as well. For example, in our previous research, we have already looked at the emotions, proactivity, personality and context-awareness of VAs, but these characteristics are not really applicable to the concept of VAs and have thus led to our proposal of the VC.

Table 7.1.: *Comparing Current Conversational Agents with our Concept of the VC*

	Conversational Agents (like Chatbots or Virtual Assistants)	**VC**
Type of Interaction	Conversational (Gnewuch, Morana, and Maedche, 2017; McTear, 2017; Wilks, 2006)	Collaborative
Mode of interaction	Text (Chatbot) and Speech (Virtual Assistant) (Gnewuch et al. 2017)	Text and Speech
Interaction	User => Chatbot (Conversation normally initiated by the user)	Human <=> VC (Conversation can be initiated by either the user or the VC)
Main Focus	Conversation, Support and Assistance (McTear, 2017)	Companionship
Common Context	Customer Support (Chatbot) and Assistance or Smart Home (Virtual Assistance) (McTear et al., 2016; Morana, Friemel, et al., 2017)	Deep interaction into specific parts of the user's everyday life
Autonomy	Low	High
Proactivity	Low	High
Cognitive functions	Understanding natural language, low emotional intelligence (Skalski and Tamborini, 2007; Strohmann, Fischer, et al., 2018)	High emotional intelligence, Deep understanding and learning functions, personality development
Mutability and Adoption	Often static and not user centered (chatbots), low adoption level (VAs)	Getting known and adapting to its user
Service Life	Once to several times (chatbot), several times to often (VA)	Often and long-term
Example	Klarna customer support (chatbot), Apple's Siri or Amazon's Alexa (VA)	Virtual Co-Driver (Strohmann, Siemon, et al., 2019a)

In summary, we define the VC as follows: A VC is a conversational, personalized, helpful, learning, social, emotional, cognitive and collaborative agent, that interacts with its user proactively and autonomously to build a long-term relationship.

7.3.2. The Virtual Companion between Provider and Customer

In a traditional customer-provider relationship, the service and relationship interaction take place directly between the customer and the service provider. If, for example, a customer visits a hair salon to get a haircut, the consultation regarding the haircut represents the service interaction and thus directly contributes to the value-in-use. In contrast, selling hair care products after the haircut represents an indirect contribution to the value-in-use. When the hairdresser asks the customer during the haircut how his wife is doing, this is not part of the service interaction, but part of the relationship interaction. All the individual interaction components mentioned contribute to the value-in-interaction in total.

In this example of the hairdresser as an offline service, the provider has the direct contact to the customer. However, when we talk about digital services, maintaining a direct relationship with the customer is a challenge, especially when a lot of customers should be addressed at the same time. This problem can be solved by humanizing the interface between the customer and the IT with the help of a VC, which thus increases the value-in-interaction. The VC interacts with the customer in a human way and establishes a relationship with him or her. As a direct interface to the service provider, the VC has the knowledge about the service, the provider offers and can bring it together with the customer's needs. With the direct relationship towards the customer, the service has a high degree of personalization. Due to the technological nature of the VC, it can be easily scaled to meet the needs of many customers, leading to the automation of a personalized service. Figure 3 visualizes this relationship with the help of an example.

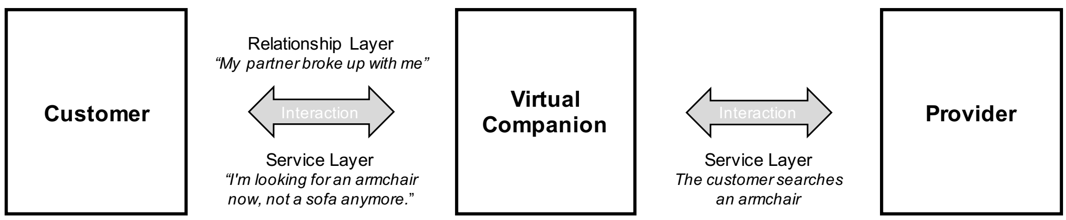

Figure 7.3.: *The VC between Customer and Provider*

In the example, the customer already built a social bond with the VC and thus told it that his/her partner broke up with him/her. This information is kept secret by the VC, but it now knows, that the customer might now search for an armchair instead of the sofa for two, he/she was searching for before. This information is then given to the provider and the personal information about the breakup are kept secret.

In the following we list several use-cases to which we think the concept of a VC can be applied to:

- Student support and guidance
- In-Vehicle companion (accompanying the user in the car) or a mobility companion in general
- Medical support (e.g. a VC for diabetics)
- Shopping companion
- Creativity support (e.g. a companion for idea generation)

We have already considered some of these applications in our research, others have been found during our literature review. By involving the user in the design process of VCs for different application contexts and instantiating VC artifacts in future research and practice, it can be examined to what extent the concept of the VC makes sense in a particular use-case.

7.4. Designing Virtual Companions

To detach the design of the VC from the technological implementation, a design tool is needed. Visualization helps to externalize a mental image of a given content, whereas the external visual representation helps to support reasoning (Ware, 2012). The cognitive process of visualization furthermore helps to externalize abstract mental concepts on an individual level or a team level, where several mental images need to adapt to create a shared understanding (Swaab et al., 2002). Inspired by the business model canvas of Osterwalder and Pigneur (Osterwalder and Pigneur, 2010), we use the canvas-approach as a visual and familiar tool for the design of VCs. This allows the discussion of design opportunities and characteristics of VCs in an early phase of the development.

7.4.1. Design Dimension Development

The VC Canvas is made up of 19 canvas fields guiding the design of a VC, whereas each canvas field represents a design dimension of the VC. The dimensions, each with a corresponding design advice were developed in seven iterations, which are illustrated in Figure 4. The way of illustration was inspired by Remane et al. (2016) who developed a taxonomy of carsharing business models and provided a transparent figure showing their iterations. In the following section the single iterations are described in depth. The first iteration initially starts with three dimensions: task, conversation and audiovisual characteristics, which resulted from a literature review about conversational agent characteristics and functionalities (Strohmann, Siemon, et al., 2017). These three dimensions form a simple basis, which are shared by a lot of existing conversational agents. Single dimensions form a general category with several possible VC characteristics. For example, the dimension intuitive conversation contains concepts like the use of natural language (McTear et al., 2016) or the interaction in a social way (Skalski and Tamborini, 2007) and during the design of a VC, application-specific characteristics and functionalities can be added and collected in each canvas field.

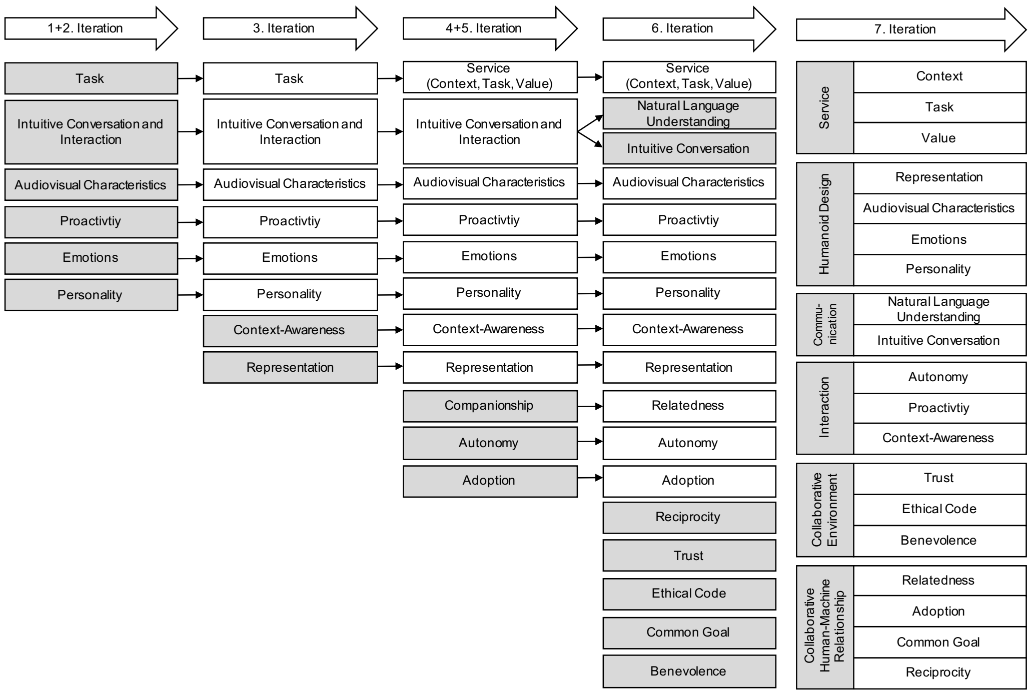

Figure 7.4.: *Development of Dimensions for VC Design*

During the second iteration cognitively deeper dimensions were added: proactivity, emotions and personality (Strohmann, Fischer, et al., 2018). The third iteration extends the set of existing dimensions with the dimensions context-awareness and representation (Strohmann, Siemon, et al., 2019a). As we follow the approach of moving from simple user assistance to a human-machine companionship the dimensions companionship (Krämer, Eimler, et al., 2011), autonomy (Krämer, von der Pütten, et al., 2012; L'Abbate et al., 2005) and adoption (Park et al., 2012) were added in the fourth iteration. After this iteration the first version of the VC Canvas was developed by a simple approach of visualizing the ten dimensions using a canvas. This first version was evaluated by presenting it and discussing it with other researchers and an expert from the design field (designer for visual marketing). Based on the collected feedback a fifth iteration of dimension development was initiated. During the qualitative evaluation the service concept emerged. It consists of the user's context, in which the VC is used, the task that the VC should fulfil and the value the VC should create for the user. Furthermore, the dimension companionship was renamed into relatedness, as the concept of the VC, implies a companion-like approach for every dimension. Thus, the name relatedness specifies the meaning of the dimension.

As a the establishment of a virtual companionship between a human an IT can be seen as a form of human-IT collaboration (Li, Tee, et al., 2013), principles and theories of collaboration (Robra-Bissantz and Siemon, 2019; Siemon, Becker, et al., 2017) need to be taken into account. Thus, in a sixth iteration we assessed design dimensions aiming for a collaborative environment and relationship, resulting in the five added design dimensions: reciprocity (Blau, 1968; Homans, 1958; Krämer, von der Pütten, et al., 2012), trust (Al-Natour, Benbasat, and Centefelli, 2010; Saffarizadeh et al., 2017; Schroeder and Schroeder, 2018), ethical code (Anderson and Anderson, 2011; Turilli and Floridi, 2009; Veruggio et al., 2016; Yu et al., 2018), common goal (Randrup et al., 2016) and benevolence (Randrup et al., 2016). In a final seventh iteration we grouped the several design dimensions into the six design categories: service, humanoid design, communication, interaction, collaborative environment and collaborative human-machine relationship. The following figure lists the single design dimensions, each with its design advice, as well as the reference to existing literature.

Table 7.2.: *Design Categories, Dimensions and Advices for a VC*

Design Category	Design Dimension & Advice	Reference
Service	**Context**: Define the general context in which the VC will be used.	(Sammut, 2001)
	Task: Define the task the VC should fulfill.	(McTear et al., 2016; Zhao, 2006)
	Value: Define the value, which should be created for the user.	(Wikström 1996; Massaro et al. 1999)
Humanoid Design	**Representation**: Create an appropriate representation of the VC following the approach "more human than robot".	(Seeger et al., 2018; Seymour, Riemer, et al., 2018; Strohmann, Fischer, et al., 2018)
	Audiovisual Characteristics: Create a verbal (text and speech) and non-verbal (e.g. emojis) design.	(Seeger et al., 2018)
	Emotions: Integrate the use of emotions into the VC as well as the understanding and reaction upon the user's emotions.	(Becker, Kopp, et al., 2007; Yang et al., 2017)
	Personality: Design the VC's personality traits according to the potential user's personality traits.	(Robert, 2018)
Communication	**Natural Language Understanding**: Collect phrases and tasks the VC should be able to understand and do.	(McTear et al., 2016; Zhao, 2006)
	Intuitive Conversation: The VC should be able to lead an intuitive conversation and should learn over time.	(Gnewuch, Morana, and Maedche, 2017; Strohmann, Fischer, et al., 2018)
Interaction	**Autonomy**: Define the extent to which the VC is allowed to act autonomously	(Krämer, von der Pütten, et al., 2012; L'Abbate et al., 2005)
	Proactivity: Let the VC act in a proactive behavior	(Strohmann, Fischer, et al., 2018)
	Context-Awareness: Mind the user's context. Collect possible contexts in which the user can be.	(Strohmann, Siemon, et al., 2019a)
Collaborative Environment	**Trust**: Build a trustful and transparent environment and preserve privacy.	(Saffarizadeh et al., 2017; Schroeder and Schroeder, 2018)
	Ethical Code: Build an ethical code the VC should follow. (e.g. discriminatory behavior is not adapted or responded to)	(Anderson and Anderson, 2011; Veruggio et al., 2016)
	Benevolence: The VC should act in good faith and not against the user.	(Randrup et al., 2016)
Collaborative Human-Machine Relationship	**Relatedness**: Design the VC according to the user's preferences and needs.	(Krämer, Eimler, et al., 2011; Park et al., 2012)
	Adoption: Let the VC adopt to the user.	(Park et al., 2012)
	Common Goal: The VC should find and follow a common goal with its user and provider or should adapt the user's goals.	(Randrup et al., 2016)
	Reciprocity: Balance cost and reward in collaborative activities. (the user has to invest something, e.g. information, to get something back from the VC, e.g. a good service)	(Blau, 1968; Homans, 1958; Krämer, von der Pütten, et al., 2012)

7.4.2. The Virtual Companion Canvas

With the final set of dimensions after the seventh iteration the whole VC Canvas was recreated and transferred into an online tool. The chosen tool is the web-based, collaborative whiteboard tool Miro, which enables a distributed, synchronous and collaborative use of the canvas. Based on the feedback of the designer for visual marketing the canvas was redesigned. In contrast to the first version of the VC Canvas, which was black and white, appealing pastel colors and icons where chosen for every dimension, to visually separate the canvas fields. Each canvas field additionally shows its design advice.

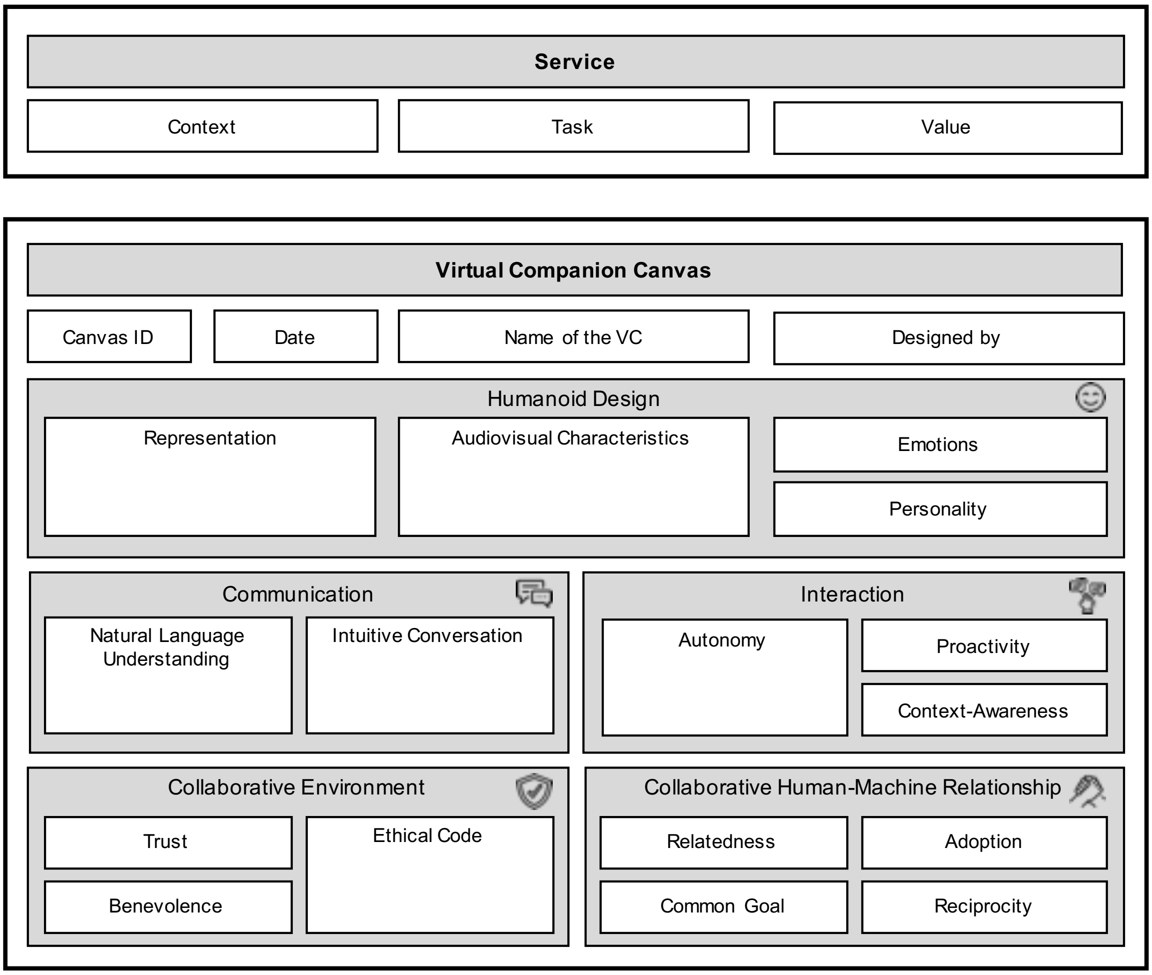

Figure 7.5.: *Reduced Illustration of the VC Canvas*

Figure 6 presents a reduced illustration of the VC Canvas, whereas the original, full and colored version of the VC Canvas can be found here: bit.ly/fdm_vcc. It is divided into two parts: the service concept of the VC and the canvas itself in the form of the VC's design dimension with place for individual design features and characteristics.

7.4.3. Example: The Mobility Companion

To illustrate our concept of the VC with an example, we have developed the idea of the Mobility Companion. In this example, the service provider is a fictitious international mobility service company. The company covers a variety of mobility services, such as car and e-scooter rental, the sale of leasing contracts for cars or the booking and planning of train or flight journeys. The main goal is to move people from A to B in a relaxed and stress-free manner. The customer in this scenario is a human, who wants to move in his or her everyday life.

In order to be able to offer its services even more user-centered, personalized and automated to each customer, the company opts for the use of a VC: The Mobility Companion. It is designed according to the needs of the users and adapts individually to the individual human. Because of this user-centered design of the companion, it is possible for the users to establish a relationship with the Mobility Companion. The Mobility Companion thus becomes an everyday companion and is the first address if the user wants to move, since the companion knows all of the company's transport services and can provide those tailored to the respective user. Moreover, the companion thinks autonomously and approaches the user proactively, because he knows the habits of the user. In return for the high-quality mobility advice and the promised confidential handling of personal data, the users are willing to share their information with the companion. Under the following link you can find a draft of a VC Canvas for the Mobility Companion: bit.ly/fdm_vcc_example. In the following, two different fictitious user-companion relationships are presented.

Scenario 1: Thomas, 46 years old, Employee of a Consulting Company

Thomas opts for the male version of the Mobility Companion "Carl". He values a trustworthy handling of his data. Because of the transparent description by Carl, about what he does with the data, Thomas trusts Carl. Since his employer is rolling out the Mobility Companions throughout the company, Thomas is allowed to permit access to his work calendar and work e-mails. He prefers to keep his private chat sessions secret.

On the basis of Thomas' calendar and habits, the companion knows when he has to go to work and can inform him in advance when Thomas has to leave based on his knowledge of the traffic situation and Thomas' preferred form of transportation. When business trips are scheduled, Carl plans these for Thomas in advance. As Thomas' daughter reaches the age of majority, Carl also helps him purchasing a car for her and has the appropriate insurance at his hand.

Scenario 2: Laura, 22 years old, Student

Laura opts for the female version "Clara" of the Mobility Companion. Since Laura is used to share her life on social media, she doesn't think so much about sharing her data with Clara and gives her full access. Since Clara is now familiar with Laura's chat history, she knows, for example, that Clara wants to visit her girlfriend in Berlin next weekend. A cheap ticket for a distance bus is thus recommended immediately when the two have arranged their meeting. During the stay of Laura with her girlfriend in Berlin, Clara suggests that they can go on a city tour with a rented e-scooter, because moving around with those is so much more fun than walking.

The two scenarios are fictional, but illustrate the use case of a Mobility Companion and the value, which can be created with the concept of a VC. Current mobile applications for transportation and mobility planning are very impersonal and the user has to do a lot by himself. In our fiction of the Mobility Companion the user can be significantly supported in a much more personalized interaction with the help of a VC. Due to the mobility company's comprehensive service offer and the scalability of the VC as an IT service, many different users can be personally supported and communicated with in all their personal situations in an automated way.

7.5. Discussion and Outlook

In this research project, we introduced the VC Canvas, a tool to support the analysis, understanding, design and implementation of so-called VCs. Moreover, we proposed the collaborative agent as an evolution of the conversational agent. Our research provides a foundation to design future personalized AI applications in the customer and service provider relationship.

We encourage researchers and practitioners to use our VC Canvas for the design of their collaborative agents or in particular VCs. Through the technological implementation of VCs for different application areas, knowledge about this new kind of AI application can be deepened and practical problems can be solved. Our VC Canvas is also built in an expandable manner and can thus be adapted according to changing requirements. The development of a completely interactive version of the VC Canvas is also conceivable. This future interactive version would adapt interactively to the corresponding use cases and provide in-depth suggestions for the design of the VC. In our vision we see VCs for single use-cases as a first step on the way to a complete and overarching VC for the human, which is designed completely personalized and supports the user in all areas of his or her life. This user-centered VC would then form the interface to different service providers.

In summary, we introduced a forward-thinking concept to automate the personalization of services for customer in form of the VC. Moreover, we proposed a valuable tool, that can benefit both research and practice in supporting the planning and designing of VCs to create collaborative scenarios with AI and thus personalized and automated services for the customer.

CHAPTER 8

A Design Theory for Virtual Companionship

Summarizing the Findings

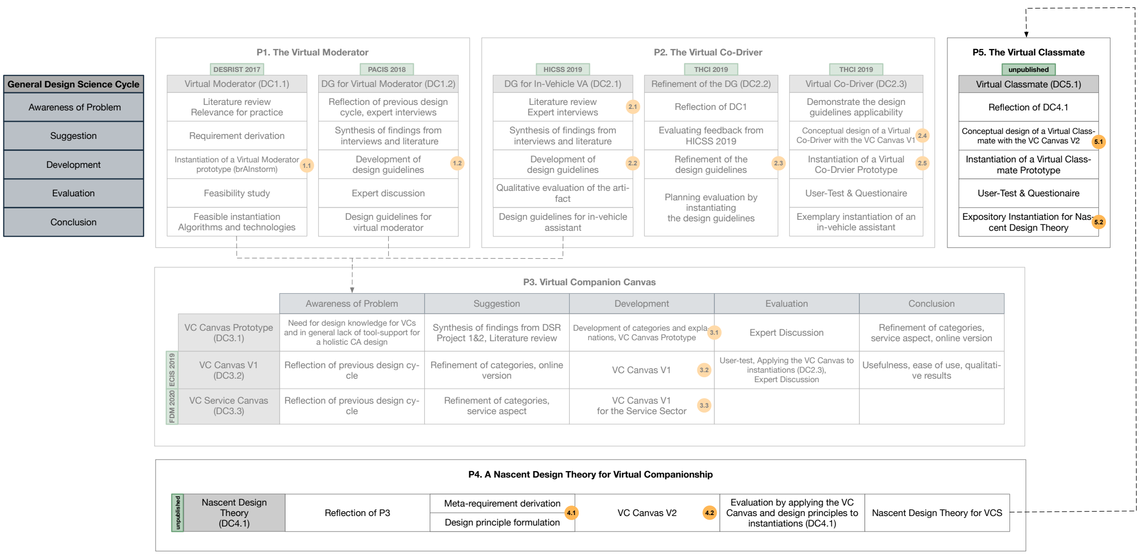

Figure 8.1.: *Positioning the Design Theory in the DSR Project*

In the two previous publications (ECIS 2019 and FDM 2020), the primary focus was mainly on the well-founded design and derivation of the VC Canvas as a design tool for the conceptual design of VCs. The concept of the VC was always considered, but at the same time, there was a considerable need for further explanation. The discussion at the ECIS 2019 was especially dedicated to this topic. The result was to not introduce the VC as a completely new entity of a CA but to focus more on the concept of the virtual companionship and to derive prescriptions of how this concept can be used for other CAs. Thus, two DSR projects were initiated (see Figure 8.1), aiming to derive a nascent design theory for virtual companionship and to instantiate the prescriptions in a new application context, which resulted in the virtual classmate.

From Assistance to Companionship – Designing Virtual Companions

Abstract

A lot of today's interactions with conversational agents like virtual assistants or chatbots are limited to assistance functions, whereas the actual interaction with the system should rather be improved by incorporating social behavior. Due to a significant technological progress in the field of AI, conversational agents have the potential to become even smarter, deepen the interaction with their users and consequently overcome their merely assistive function. Since humans are treating computers as social actors, theories from interpersonal relationship can be applied to the human-machine interaction. These theories enhance the interaction and investigate the requirements for a collaborative and benevolent relationship between humans and machines, which results in a virtual companionship. As profound design knowledge and tool support for the design of such AI applications is missing, in this research paper six design principles for virtual companionship with an associated design tool, the VC Canvas are proposed in this research paper. The VC Canvas is thought to help the designer, to include the user in the design process of the virtual companionship, since companionship is a complex and individual concept. The meta design and the VC Canvas evolved within a comprehensive Design Science Research project with three design cycles. With the artifact *Sarah*, a Virtual Classmate supporting students, an example is provided of how to instantiate the proposed design. With six derived testable propositions, *Sarah* is evaluated in an

experiment with 40 participants. The results indicate, that the instantiation *Sarah* successfully meets the formulated meta-requirements. The findings are summarized in a nascent design theory for virtual companionship and due to the degree of generalization, the design principles and the VC Canvas can be adapted to different application domains by researchers, as well as practitioners.

8.1. Introduction and Motivation

Due to a significant technological progress in the field of AI, a number of new services and products emerged (Gnewuch, Morana, and Maedche, 2017; Maedche et al., 2016; Seeber, Bittner, Briggs, de Vreede, et al., 2019). Beside early AI research that aimed at building a general human-like intelligence (Kurzweil, 2005), there is a research stream focusing on a more specific definition, involving features such as problem solving, knowledge representation or reasoning and learning (Russell and Norvig, 2016). Such applications are called AI-enabled systems and find considerable attention especially in IS research (Gregor and Benbasat, 1999). In addition to current applications in form of virtual assistants, such as Apple's Siri or Amazon's Alexa, companies are increasingly developing chatbots and enterprise bots for the interaction with customers (Diederich, Brendel, and Kolbe, 2019b; Maedche et al., 2016; McTear et al., 2016). These systems are called conversational agent, as they allow their users to interact with them using natural language (Gnewuch, Morana, and Maedche, 2017; McTear et al., 2016). Conversational agents are already used in a number of applications today, ranging from the execution of functions on the smartphone, such as creating calendar entries or sending messages to smart home control or customer service (Gnewuch, Morana, and Maedche, 2017; McTear et al., 2016; Rzepka and Berger, 2018). Hence, conversational agents are offering a new way of interacting with information technology (Morana, Friemel, et al., 2017). Recent literature reviews on CAs and AI-enabled systems (Diederich, Brendel, and Kolbe, 2019a; Rzepka and Berger, 2018) identified an increasing interest, but a limited variety of application contexts, mainly used in marketing, sales and support, thus demanding future research on more long-term scenarios like collaboration (Diederich, Brendel, and Kolbe, 2019a). Additionally, today's applications show that the main goal of conversational agents is to provide personal assistant functionality, whereas the actual interaction with the system should rather be improved by incorporating social behaviors (Gnewuch, Morana, and Maedche, 2017; Krämer, Eimler, et al., 2011; Rzepka and Berger, 2018). Most of these interactions are initiated by the user, not the conversational agent, and are then isolated and transactional, as if they were starting over each time (Seymour, Riemer, et al., 2018). However, more recent developments of smart technologies make it possible for conversational agents to become more intelligent, as well as more human-like and even enable collaborative scenarios between machines and humans (Seeber, Bittner, Briggs, de Vreede, et al., 2019).

As research has shown, humans are treating machines like social actors and mindlessly apply social rules and expectations to them (Nass and Moon, 2000; Nass, Steuer, et al., 1994). Thus, theories from interpersonal relationship can be applied to the human-machine interaction, to enhance the interaction and investigate the requirements for a collaborative and benevolent relationship between humans and machines. Prior research already discussed different characteristics for establishing long-term relationships between humans and machines by incorporating findings from social interactions (Bickmore and Picard, 2005; Danilava et al., 2012; Krämer, Eimler, et al., 2011; Seymour, Riemer, et al., 2018). Social relationships are regarded as important conditions that can contribute to psychological well-being. Companionship, a special form of friendship, is perceived as an important aspect to strengthen psychological well-being (Rook, 1987). Companionship can be described as having someone familiar that you like spending time with, rather than being on your own and can be seen as part of friendship as it is often defined as a subcategory of it with a focus on doing things together (Bukowski et al., 1994; Mendelson and Aboud, 2012). Thus, a companion encompasses a number of aspects of friendship, but differs in specific parts, such as an inner and intimate relation, an intense affection, and a high emotional connection (Bukowski et al., 1993; Bukowski et al., 1994; Mendelson and Aboud, 2012). Subsequently, companions are very different from assistants who are not coequal, who do not cause affections, who do not build up long-term social ties and who do not act proactively in contrast to companions. In human-robot, human-machine or human-computer interaction, research shows that systems with more social and affective behavior are the most natural and effective ways for humans to interact with (Heerink et al., 2010; Tsiourti, 2018; Young et al., 2008), also enhancing believability (Becker, Kopp, et al., 2007). Even if this is certainly not a prerequisite for all applications of conversational agents, e.g. those who serve a specific single task, conversational agents that inhibit aspects of a companionship can offer added value, especially in the case of long-term use. In 2011, Krämer, Eimler, et al. addressed the aspect of sociability and especially companionship within conversational agents as "it becomes more and more feasible that artificial entities like robots or agents will soon be parts of our daily lives." (Krämer, Eimler, et al., 2011, p. 1). These agents are especially relevant for elderly or homebound people (Krämer, Eimler, et al., 2011; Tsiourti, 2018), in service scenarios (Becker, Kopp, et al., 2007) and general long-term interaction scenarios in the private sector, as the acceptance of a social, affective and especially coequal conversational partner can be increased (Becker, Kopp, et al., 2007). However, explicit and applicable prescriptive knowledge for designing and instantiating such agents is still missing. Subsequently, Krämer, Eimler, et al. (2011) discuss the necessity of a theory of companions and conclude that it is not inevitable for all conversational agents, but "when they have the function to support the owners' health, well-being, and independent living", companionship can be beneficial (Krämer, Eimler, et al., 2011, p. 498). We build on the work of Krämer, Eimler, et al. (2011) and address the limitations and outlooks shown, which relate above all to the difficulty to derive design decisions from theory. Hence, the overarching objective of this research paper is to approach this by constructing a design theory for so-called virtual companionship that can help building conversational agents with aspects of companionship, whenever companionship is identified as a beneficial added value. Moreover, Krämer, Eimler, et al. (2011) suggest that due to the user-specific individuality of companionship, the user should be included in the design process, but do not provide a concrete solution of how to do this.

Building on these assumptions, our research pursues the following three objectives: (1) Deriving theoretically grounded design principles for virtual companionship that can be applied to conversational agents summarized in the form of a nascent design theory (Gregor and Hevner, 2013; Gregor and Jones, 2007), (2) Creating a design tool for the user-centered design of virtual companionship and (3) Instantiating the theoretically grounded design principles in the form of artifacts and the evaluation of these artifacts. The nascent design theory therefore serves the purpose of creating prescriptive knowledge and aims to address the design-oriented question:

Q: How to design Virtual Companionship?

With virtual companionship, the human-machine interaction can be enhanced, because it encourages longer-lasting and more intuitive conversations (Bickmore and Picard, 2005; Gnewuch, Morana, and Maedche, 2017; Seymour, Riemer, et al., 2018), increases the likeability and interpersonal trust of the user in a system (Bickmore and Picard,

2005) and builds a foundation to enable collaborative scenarios between humans and machines (Li, Tee, et al., 2013; Seeber, Bittner, Briggs, de Vreede, et al., 2019). virtual companionship is suitable for all applications where a long-term relationship and a more human-like interaction is desired, such as teamwork (Li, Tee, et al., 2013; Seeber, Bittner, Briggs, de Vreede, et al., 2019), in-vehicle assistance (Author citation 2019c, Bengler et al. 2014), customer relations (Gnewuch, Morana, and Maedche, 2017; Meyer and Strohmann, 2018), creativity support (Author citation 2018, Tavanapour et al. 2019) or student support (Harvey et al., 2016).

For the development of our nascent design theory for virtual companionship, we followed a systematic and iterative DSR approach (Hevner et al., 2004) following the adapted process model proposed by Kuechler and Vaishnavi (2008) that emphasizes the contribution and knowledge generation of DSR. Our DSR project contains three DCs with several outcomes, resulting in the nascent design theory and an associated design tool for virtual companionship as our main contribution. When planning and conducting DSR, certain tools can structure, document and present necessary information (vom Brocke et al., 2017), which is especially important when working with users. Thus, we are proposing a so-called VC Canvas, which is a tool that presents in an easily understandable and transparent way which design characteristics virtual companionship can have. The VC Canvas is thought to include the user in the design process, as companionship is a user-centered concept (Krämer, Eimler, et al., 2011). Thus, it supports the designer of the virtual companionship and can also help to analyze, classify and understand existing conversational agent and AI applications regarding their possible virtual companionship characteristics. With the VC Canvas, we help to instantiate the prescriptions of our nascent design theory for virtual companionship for the design of VC, which is the term we use for conversational agents incorporating virtual companionship.

The paper proceeds as follows: in Section 8.2, we discuss the theoretical foundations and related work and in Section 8.3, we describe our research approach. In Section 8.4 we derive theoretically grounded meta-requirements (meta-requirements) and design principles for guiding the development of virtual companionship instantiations. We then introduce the VC Canvas, as well as present an expository instantiation, the Virtual Classmate *Sarah*. In Section 8.5, we summarize our findings in the form of a nascent design theory and finally, in Section 8.7, we conclude the paper and give an outlook.

8.2. Theoretical Foundations and Related Work

8.2.1. Conversational Agents

Conversational agents are systems that allow there users to interact with them using natural language (Gnewuch, Morana, and Maedche, 2017; McTear et al., 2016). The development of conversational agents started in the 1960s with the chatbot ELIZA (Weizenbaum, 1966), which is seen as the first application simulating human conversation. While chatbots in the past worked using simple pattern recognition, todays chatbots are way more capable, due to the development in the fields of machine learning and natural language processing (Knijnenburg and Willemsen, 2016; McTear et al., 2016; Shawar and Atwell, 2007a). The public interest in conversational agents especially grew with the introduction of Apple's Siri and later on Amazon's Alexa or the Google Assistant, which brought virtual assistants to the smartphones and homes of many people (Diederich, Brendel, and Kolbe, 2019b; Maedche et al., 2016; McTear et al., 2016). One of the main differences between chatbots and virtual assistants is the input/output modality. While chatbots are used on a text basis, virtual assistants are communicated with using speech (Gnewuch, Morana, Heckmann, et al., 2018). Furthermore, they differ from chatbots by following a general-purpose approach assisting their user, like performing their daily tasks (Gnewuch, Morana, and Maedche, 2017; Guzman, 2017). Today's use cases are, for example, executing functions on the smartphone such as creating calendar entries, sending messages or asking for the weather forecast. Thus, virtual assistants are offering a new way of interacting with information systems (Morana, Friemel, et al., 2017), but, as stated before, only by providing personal assistant functionalities, whereas the actual interaction with the system should be improved by incorporating social behaviors (Gnewuch, Morana, and Maedche, 2017; Krämer, Eimler, et al., 2011; Rzepka and Berger, 2018).

The developments of smart technologies make it possible for conversational agents to become more intelligent, as well as more human-like and even enable collaborative scenarios between machines and humans (Seeber, Bittner, Briggs, de Vreede, et al., 2019). When these more human-like features and behaviors are attributed to an conversational agent it is called an anthropomorphic conversational agent (Pfeuffer, Benlian, et al., 2019; Seeger et al., 2018). Whereas, anthropomorphism in the human-machine context refers to the tendency of humans "to imbue the real or imagined behavior of non-human agents with human-like characteristics, motivations, intentions, or emotions" (Epley et al., 2007, p. 864). With the growing popularity of chatbots, several platforms emerged, allowing everyone the design of chatbots in a simple way (Diederich, Brendel, and Kolbe, 2019b). While these systems now enable very advanced conversational design with features like self-learning algorithms (Diederich, Brendel, and Kolbe, 2019b), in our opinion they neglect the holistic design of the agent itself as well as the relationship to its user. For this purpose we suggest the use of our VC Canvas, which can be used for the conceptual design of a VC.

The following table gives an overview of the terms used and especially distinguishes them from the prior introduced key concept of this study: the virtual companionship.

Table 8.1.: *Relevant Definitions*

<table>
<tr><th colspan="2">Term</th><th>Description</th></tr>
<tr><td colspan="2">Conversational Agent (CA)</td><td>Overarching and general term for software that interacts with users using written or spoken natural language. (Diederich, Brendel, and Kolbe, 2019a; Gnewuch, Morana, and Maedche, 2017)</td></tr>
<tr><td colspan="2">Chatbot</td><td>Task-oriented or entertaining CA interacted with using written natural language. The focus is on fulfilling a specific task for their user (like ordering a pizza) or just entertain them. (Gnewuch, Morana, and Maedche, 2017; McTear, 2017)</td></tr>
<tr><td colspan="2">Virtual Assistant (VA)</td><td>General-purpose or domain-specific CA interacted with using spoken natural language. The focus is on assisting their users e.g. in their everyday life's. (Examples are Apple's Siri or Google Assistant) (Gnewuch, Morana, and Maedche, 2017)</td></tr>
<tr><td colspan="2">Virtual Companion (VC)</td><td>A collaborative agent instance, which ideally contains all virtual companionship characteristics. The focus is on building a companionship with their user.
Note that a chatbot or VA that realizes all virtual companionship characteristics can then be called a VC.</td></tr>
<tr><td rowspan="2"></td><td>Virtual Companionship</td><td>A collaborative and friendly long-term relationship between a human and a machine, whereas virtual companionship comprises a user-centered design, an appropriate human-like appearance and behavior, understanding and adoption of the user, a proactive and reciprocal behavior and preserving of transparency, privacy and ethics. All these single characteristics can be included in a CA to enable the development of a human-machine companionship.</td></tr>
<tr><td>Virtual Companion Canvas (VC Canvas)</td><td>A visual design tool to design VCs. Focus lies on the conceptual design and not the technological implementation.</td></tr>
</table>

8.2.2. Computers are Social Actors

The social response theory is the key theory underlying the interaction between human and machines with human-like characteristics, showing that people tend to treat computers as social actors (Moon, 2000; Nass, Steuer, et al., 1994; Qiu and Benbasat, 2009). The theory describes that individuals' interactions with computers are at its core social, as humans mindlessly apply social rules and expectations to computers (Nass and Moon, 2000; Nass, Steuer, et al., 1994).

For instance, Nass et al. (1994) found in an experiment involving a computer tutor with a human voice, that users respond to different voices on the same computer as if they were distinct social actors and to the same voice as if it was the same social actor, regardless if the voice was in the same or different computer.

Moreover, when the machine incorporates characteristics that are normally associated with humans, like interactivity, usage of natural language or a human appearance, users respond by showing social behavior and ascribing social attributions (Moon, 2000). Humans do this, because they are used to, that only humans show social behavior and if now a computer acts socially they mindlessly apply known social rules to the interaction with the computer (Fogg, 2002; Nass and Moon, 2000). Thus, social conventions usually guiding interpersonal behavior can also be applied to human-machine interaction (Moon, 2000).

8.2.3. Theories of Interpersonal Relationship

An interpersonal relationship is an advanced and close connection between one or more persons that can take on different forms, such as friendship, marriage, neighborhood or companionship (Kelley and Thibaut, 1978). As an important and pervasive human need, meaningful interpersonal relationships arise over time and exist when the probable course of future interactions differ from that between strangers (Hinde, 1979). Depending on the nature of the relationship, there are a number of theories that are established in relationship science, the study of interpersonal relationship (Berscheid, 1999). Theories relevant to companionship are the Need for Belonging (Baumeister and Leary, 1995), the Social Exchange Theory (Blau, 1968; Homans, 1958), the Social Penetration Theory (Altman and Taylor, 1973), the Equity Theory (Walster et al., 1978), the Common Ground (Clark, 1992), the Theory of Mind (Carruthers and Smith, 1996; Premack and Woodruff, 1978) and Interpersonal Trust (Rotter, 1980).

As social beings, humans have a strong desire to have interpersonal relationships motivated by the need to belong (Baumeister and Leary, 1995). This leads to an interest in building and maintaining positive and warm relationships in their pursuit of happiness (Baumeister and Leary, 1995; Krämer, von der Pütten, et al., 2012). Building and maintaining functioning relationships involves a reciprocal behavior, in which costs and rewards are in balance (Blau, 1968; Homans, 1958). This social exchange drives relationship decisions, establishes a norm between the partners and subsequently maintains and stabilizes the relationship (Blau, 1968; Homans, 1958; Krämer, Eimler, et al., 2011). This equitable input-outcome ratio leads to a coequal and evened relationship in the long run, as the Equity Theory describes (Sprecher, 1986; Walster et al., 1978). When interpersonal relationships are formed, a common ground is necessary and also builds over time (Clark, 1992; Krämer, Eimler, et al., 2011), leading to the ability to better take the mental perspective of your relationship partner and predict his/her actions (Carruthers and Smith, 1996; Premack and Woodruff, 1978). This phenomenon often describes as being "soulmates" or "mindreaders", forms and describes deep interpersonal relationships and is especially relevant for communication between human interactants (Krämer, Eimler, et al., 2011). This smooth functioning is highly influenced by interpersonal trust, which is an indispensable condition in relationships and describes the willingness to be vulnerable to the actions of your relationship partner (Rotter, 1980). A trustful relationship then leads to individual well-being, an overall better communication and interaction and subsequently to a benevolent relationship (Rotter, 1980; Schroeder and Schroeder, 2018).

8.2.4. Related Work

The fact that humans can feel a sense of a social relationship with an individual whose existence is from artificial nature, is nothing new: Horton and Wohl (1956) originated the Parasocial Interaction (PSI), which describes the non-reciprocated manner of an audience member interacting with a media persona. PSI can potentially become a Parasocial Relationship (PSR), which is the ongoing process of affective and cognitive responses outside the viewing time, leading to the establishment of a long-term relationship (Stever, 2017). While the original concept of PSI and PSR mainly refers to media personas from the television as the human‘s counterpart, recent research has shown that the concepts can also be applied to the human-machine interaction (Krämer, von der Pütten, et al., 2012). By applying the theories of interpersonal relationship to the human-machine interaction, a new form of relationship between human and machine can be crafted: the virtual companionship, which we elaborate in this publication. Prior research already followed similar approaches, like the concept of the artificial companion (Danilava et al., 2012; Wilks, 2005), the relational agent (Bickmore and Picard, 2005) or the suggestion of Seymour et al. (Seymour, Riemer, et al., 2018) to build relationships with visual cognitive agents, which is more a side-product of their main research interest to use natural face technology for the creation of realistic visual presence. In their research Krämer, Eimler, et al. (2011) propose a theoretical framework for the design of artificial companions by applying theories from social science to human-machine interaction. Bickmore and Picard (2005) successfully demonstrated the relevance and benefits of long-term human-machine relationships in a study on an exercise adoption system. Based on the concept of Wilks (2005), Danilava et al. (2012) made a first attempt of a requirement analysis and also Krämer, Eimler, et al. (2011) build a solid foundation with their theoretical framework.

Krämer, Eimler, et al. (2011) discussed aspects of sociability and developed a theoretical framework for sociable companions in human-artifact interaction. Their identified theories were grouped into a micro-, meso- and macro-level according to their level of sociability in order to guide among other things, the "implementation of the companions' behaviors" (Krämer, Eimler, et al., 2011, p. 475). A fundamental focus of their work lies on the subdivision of interpersonal theories according to the aspect of sociability, thus already confining the definition of companionship. Furthermore, they raised several questions concerning the usefulness of their approach as well as its benefits for deriving guidelines. Despite that, we see that their theory of companions is a solid ground, already approaching virtual companionship with a variety of important theories on which we will build up upon.

However, according to recognized approaches, how prescriptive knowledge is crafted and presented in DSR (Gregor and Hevner, 2013; Kuechler and Vaishnavi, 2008), design knowledge for virtual companionship needs further elaboration to effectively support the instantiation of VC artifacts. Moreover, Krämer, Eimler, et al. (2011) emphasize that due to the user-specific individuality of the companionship, design decisions should not solely be derived from theory. They suggest to include the user in the design process but do not provide a concrete solution of how to include the user.

8.3. Methodology

For the development of our nascent design theory for virtual companionship and the VC Canvas we followed a systematic and iterative DSR approach. Hevner et al. (2004) proposed a framework for DSR in IS, to combine characteristics of behavioral science and design science and depicted "clear guidelines for understanding, executing, and evaluating the research" (Hevner et al., 2004, p. 75). It is designed to ensure that artifacts are designed (construction) based on business needs and requirements (relevance) and are built on applicable knowledge from theories, frameworks and methods (rigor). According to this approach, the nascent design theory and VC Canvas are successive and iteratively developed in three DCs (Figure 8.2) following the adapted process model proposed by Kuechler and Vaishnavi (2008), that emphasizes the contribution and knowledge generation of DSR. This continuous development insures a rigorous process in order to create our nascent design theory and the VC Canvas artifact. The overall DSR project was initiated due to the insights of prior DSR projects on conversational agent design, in which we derived design knowledge for virtual facilitation (Strohmann, Fischer, et al., 2018) and developed a prototype and design knowledge for in-vehicle assistance (Strohmann, Höper, et al., 2019; Strohmann, Siemon, et al., 2019a). While these two use cases seem to be different, they especially share two problems: First, a design tool is needed to help with the design of a conversational agent with the given prescriptions. Second, the relationship between the human and machine needs more attention. This initiated DC1, were we approached this by developing specific tool-support and further investigating the relationship between human and machines. In DC1, we developed a first version of the VC Canvas and evaluated it within a user-test and a workshop with other experts from the field (Strohmann, Siemon, et al., 2019b). DC2 was initiated, because we wanted to make the concept of virtual companionship applicable to all kinds of conversational agents and therefore, more theoretical grounding was needed. The third DC is called the Virtual Companion Design Cycle (VCDC), as it generally encompasses all DCs in which VC artifacts are developed based on the results from DC1 and DC2.

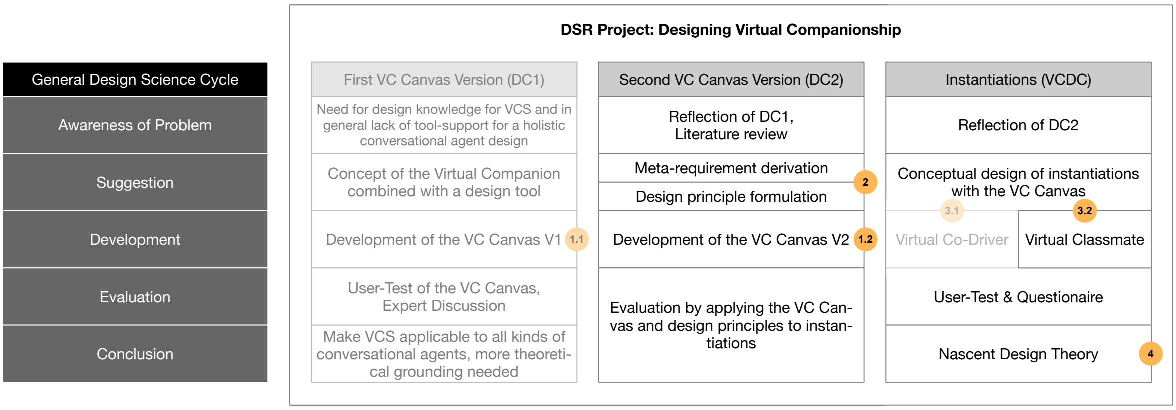

Figure 8.2.: *DSR Approach based on Kuechler and Vaishnavi (2008)*

Kuechler and Vaishnavi (2008) argue that within their five steps, various contributions can arise. Not only after an evaluation and conclusion, where design science knowledge emerges, constraint knowledge (circumscription) can already arise within the development and evaluation steps, which contributes to the body of knowledge. This constraint knowledge emerges through the application of theories, instantiations of technology and the analysis when contradictions arise (Kuechler and Vaishnavi, 2008). Consequently, a DC can have several DSR outputs in the different process steps. Our DCs had four main outputs, which are numbered and marked with orange circles in Figure 8.2. The main contribution of this paper is our nascent design theory for virtual companionship (4), which includes the meta-requirements and design principles for designing virtual companionship (2). To involve the user in the design process and help to follow the design principles, we created a design tool for the design of virtual companionship: the VC Canvas (1.1 = Version 1, 1.2 = Version 2). The expository instantiation of the virtual co-driver (3.1) is based on the first version of the VC Canvas (1.1) and is part of a completed research project (Author citation 2019c). The instantiation of the Virtual Classmate (3.2) was conceptually designed with the second version of the VC Canvas (1.2) and was then developed and evaluated. The Virtual Classmate is presented as expository instantiation in this paper. According to three levels of DSR contribution types by Gregor and Hevner (2013) our instantiations in DC3 are level 1 artifacts and the design principles, the VC Canvas and the nascent design theory for virtual companionship are level 2 artifacts. By summarizing our results and contributions in the form of a nascent design theory we aim to extend the body of knowledge for researchers and practitioners and provide an initial step towards a comprehensive design theory (Gregor and Jones, 2007).

8.4. Designing Virtual Companionship

8.4.1. Deriving Design Principles for Virtual Companionship

According to Gregor and Jones (2007), meta-requirements are derived to serve a whole class of artifacts, rather than a single instance of a system. Moreover, they are part of a design theory and define its purpose and scope (Gregor and Jones, 2007). Based on our underlying theories of human-machine interaction and interpersonal relation, we derive 25 meta-requirements (abbreviated with MR) for virtual companionship. To address the meta-requirements, we translate them into design principles (abbreviated with DP). For the formulation of the design principles we follow the suggestion of Chandra et al. (2015) for action and materiality oriented design principles, which "prescribe *what* an artifact should enable users to do and *how* it should be built in order to do so." (Chandra et al., 2015, p. 4043). Following this approach, our design principles are formulated in this manner: "The system should do this (*What*) in order to ensure that (*Why*) by providing this feature (*How*)".

Due to the high individuality of the concept of companionship, it is difficult to derive design decisions solely from theory (Krämer, Eimler, et al., 2011). Each person has his/her own ideas and requirements for a satisfactory companionship, which is coined by individual characteristics and behavior that the user likes (Bukowski et al., 1993; Krämer, Eimler, et al., 2011) **(MR1)**. In order to create an artifact that is tailored to the user **(MR2)**, it is thus necessary to directly include the user into the design process.

User-centered design is a term that describes design processes in which end-users influence how a design takes shape using a variety of methods, such as participatory design (Abras et al., 2004). Due to the variety of different methods for involving users in the design process, the focus is not on one particular method, but rather on general user involvement. This means that the user is directly involved in the design process (co-creation) and his/her specific demands for features, functions and characteristics will be implemented. Within DSR, tool support is essential to "increase traceability, collaboration, and quality" (vom Brocke et al., 2017, p. 2) (**MR3**). When planning and conducting DSR, certain tools can structure, document and present necessary information (vom Brocke et al., 2017), which is specifically helpful besides following established research methodologies, approaches or frameworks (Hevner et al., 2004; Kuechler and Vaishnavi, 2008; Peffers et al., 2007). Particularly when involving end-users (often non-researchers) into the design process, it is helpful to use collaborative tools to acquire and consider the needs of the actual user of the to-be-designed artifact (Sanders and Stappers, 2008). The involvement of users is an all-encompassing process that is individually shaped according to the design and development process. By involving user, corresponding design decisions are made, which affect the entire scope of the VC, which is why the involvement of users is not formulated as a design principle, but as an design guideline. Thus, we propose the single design guideline:

> **DG**: *Directly integrate users into the design (co-creation) in order to shape the VC according to his/her preferences by using an appropriate design tool.*

According to the Social Response Theory users attribute human characteristics to non-humans and imbue their behavior with human-like characteristics (Moon, 2000; Nass and Moon, 2000), leading to an adapted interaction with machines that are fundamentally social (Nass and Moon, 2000). Humans are usually only used to build a companionship to another human. If now a virtual companionship should be created between a human and a machine, the machine should as well be designed with a human-like appearance and behavior, which is possible according to the Social Response Theory **(MR4)**. However, it is important to consider current standards, norms and values of the society for the responsible and accepted use of trusted forms and applications of AI (e.g. degree of autonomy, independency or human-likeliness) (Abbass, 2019) (**MR5**). With technological progress, the socially accepted standard is also developing over time. Whereas in the past no one would have spoken with his smartphone it is already or will be common in the future. Recent research has shown that the Uncanny Valley theory (Mori, 2012) is also applicable to conversational agents (Gnewuch, Morana, Adam, et al., 2018b; Seeger et al., 2018; Seymour, Yuan, et al., 2019), which should therefore be taken into account when designing the VC (**MR6**). The theory argues that individuals have a greater affinity for machines that are more realistic, until the machine looks so human-like that users find its non-human imperfections disturbing. This is the point where the affinity dramatically drops and is referred to as the Uncanny Valley. Mori (2012) suggests that with a very high degree of realism and thus anthropomorphism the Uncanny Valley can be overcome and when the human imitation could no longer be distinguished from a real human, affinity would reach its highest degree. We emphasize that we refer to conversational agents, which usually interact with their users via a messaging platform or a speech interface. These have to be distinguished from embodied conversational agents (Cassell, Bickmore, et al., 1999), which refer to virtual representations of humans, including a physical appearance with bodily gestures and facial expressions, which would require more profound requirements (Seeger et al., 2018). According to Seeger et al. (Seeger et al., 2018), who developed a framework for the design of anthropomorphic conversational agents, it is important to not follow a "more is more" approach when designing the appearance and behavior of a conversational agent, but rather balance human identity (e.g. a human-like representation or demographic information like gender or age), non-verbal (e.g. hand gestures, facial expressions or the use of emojis) and verbal (e.g. the choice of words and sentences) characteristics **(MR7)**. Qiu and Benbasat (2009) investigated the construct of social presence referring to the feeling of being with another and describing a quasi-social relationship between human and machine, which can be used to measure the users perception of an agent's social characteristics. By incorporating a human-like appearance and behavior the social presence can be increased (Qiu and Benbasat, 2009). Thus, we propose:

> **DP1**: *Design a human-like appearance and behavior according to the user's preferences and current socially accepted standards in order to build social presence. When designing the appearance and behavior mind the uncanny valley and do not follow a more is more approach, but rather balance the human identity, non-verbal and verbal design.*

In order to understand the behavior and language characteristics of the user, it is important to get to know him or her (Danilava et al., 2012; Seymour, Riemer, et al., 2018) **(MR8)**. Understanding the user better over time, steadily improves the ability to adapt to him or her (Park et al., 2012) **(MR9)**. This ability is important to not only maximize a better interaction, but also helps to establish a common ground and mutual language (Danilava et al., 2012; Krämer, Eimler, et al., 2011; Turkle, 2010). When interpersonal relationships are formed, a common ground is necessary (Clark, 1992; Krämer, Eimler, et al., 2011) (**MR10**), leading to the ability to better take the mental perspective of the relationship partner and predict his or her actions (Carruthers and Smith, 1996;

Premack and Woodruff, 1978). The VC should therefore use a language that is familiar to the user (Park et al., 2012) **(MR11)** and must be designed to understand his or her language as good as possible **(MR12)**, as this is an inevitable condition for a satisfactory communication (Gnewuch, Morana, and Maedche, 2017). Additionally, the rule of attraction, where the machine adapts to the user can subsequently enhance the overall communication satisfaction (Hecht, 1978; Nass, Moon, et al., 1995; Park et al., 2012). Thus, we propose:

> **DP2**: *Enable adaptivity and maximize natural language understanding in order to build a common ground and overall enhance the communication satisfaction by incorporating the user's habits, parlance and personality.*

The Social Exchange Theory assumes that relationships are driven by rewards and costs, whereas costs are elements that have a negative value for the individual, like effort put into the relationship (Blau, 1968; Homans, 1958). In opposite, rewards are elements with a positive value, like acceptance or support (Blau, 1968; Homans, 1958). Applied to a human-machine relationship the costs of the user could be his personal data or attention and the rewards of the machine would be support or information of high quality. To stable the relationship, cost and rewards should be balanced in the virtual companionship (Blau, 1968; Krämer, von der Pütten, et al., 2012) (**MR13**). Therefore, the VC should reward the user when costs are invested (**MR14**) and incorporate a reciprocal exchange (**MR15**) in order to build an equal relationship (Blau, 1968; Gouldner, 1960; Krämer, von der Pütten, et al., 2012). Collaborative tasks could be given to the user and the VC in order to reward the user in fulfilling the task and encourage a reciprocal exchange (Kapp, 2012). Moreover, the VC has to act proactively and reactively by, for example, demanding and asking, as well as, giving and answering in an equal measure (L'Abbate et al., 2005; Strohmann, Fischer, et al., 2018) (**MR16**). Thus, we propose:

> **DP3**: *Balance cost and reward in order to ensure a reciprocal relationship by returning benefits and acting proactively as well as reactively in an equal measure.*

This reciprocal exchange of information, however, must be subject to a set of guidelines that protect the privacy of the user. As in a close relationship, user information should be kept confidential and not disclosed to third parties (Elson et al., 2018; Solove,

2004) (**MR17**). The user should also be able to determine what he or she wants to disclose and what information is necessary to obtain what value (Fischer-Hübner et al., 2016; Schroeder and Schroeder, 2018; Taddei and Contena, 2013) (**MR18**). The handling of this information must therefore be transparent so that it is clear to the user how it is stored and what added value it creates (Saffarizadeh et al., 2017; Turilli and Floridi, 2009) (**MR19**). Another important aspect in the design of AI is the observance of ethics (Yu et al., 2018). Due to the abundance of different perspectives and ethical norms, such as the machine ethics (Anderson and Anderson, 2011) or roboethics (Veruggio et al., 2016), developers should adhere to the ethical commitment and also design the VC as someone who adheres to ethical principles (**MR20**). By incorporating a transparent treatment of the users' information, preserving privacy and implementing ethical rules, the users interpersonal trust in the VC can be increased (Fischer-Hübner et al., 2016; Al-Natour, Benbasat, and Centefelli, 2010; Saffarizadeh et al., 2017; Schroeder and Schroeder, 2018; Turilli and Floridi, 2009). Thus, we propose:

> **DP4**: *Treat information transparently, preserve privacy and mind ethics in order to build interpersonal trust by following and respecting an ethical code, providing information about data security and letting the user decide what information he/she wants to disclose.*

It is in the nature of people to form social attachments, as "human beings are fundamentally and pervasively motivated by a need to belong, that is, by a strong desire to form and maintain enduring inter- personal attachments." (Baumeister and Leary, 1995, p. 522) This need to belong is the motivator for human beings to seek company of others (Krämer, von der Pütten, et al., 2012). (**MR21**). A VC, designed according to the needs and preferences of its user would allow the user to have someone familiar and likeable spending time with her/him and would therefore enable the feeling of being with each other, rather than being alone (Krämer, Eimler, et al., 2011; Qiu and Benbasat, 2009; Seymour, Riemer, et al., 2018). This feeling of being with each other is essential for a companionship, since being with someone is the central part of our companionship definition. So this kind of feeling should also be triggered in the human being interacting with the VC, like in a human-human relationship, to reach a virtual companionship (**MR22**). Due to its artificial nature, the VC can and should always be available to its user. As we stated before companionship can be seen as a part of friendship (Bukowski et al., 1994; Mendelson and Aboud, 2012), thus an overall goal of the VC could be oriented at principles of friendship (Fehr, 1996; Rawlins, 2017) in order to make and maintain friendship (**MR23**). As virtual companionship can be seen as a form of human-machine collaboration (Li, Tee, et al., 2013), also principles of collaboration (Siemon, Becker, et al., 2017) can be taken into account, whereas collaboration is defined as the joint effort towards a common goal (Randrup et al., 2016) (**MR24**). Because of the human need to belong, "people seek frequent, affectively positive interactions within the context of long-term, caring relationships" (Baumeister and Leary, 1995, p. 522). As a lot of today's conversational agents merely engage with their users as if they were starting over each time an interaction takes place, building long-term relationships with its user over time can be seen as a huge advantage to enhance the human-machine interaction (Bickmore and Picard, 2005; Krämer, von der Pütten, et al., 2012; Seymour, Riemer, et al., 2018) (**MR25**).

> **DP5**: *Establish a warm, positive and long-term relationship in order to ensure a constant reuse and thus stimulate and maintain companionship by following principles of friendship and collaboration.*

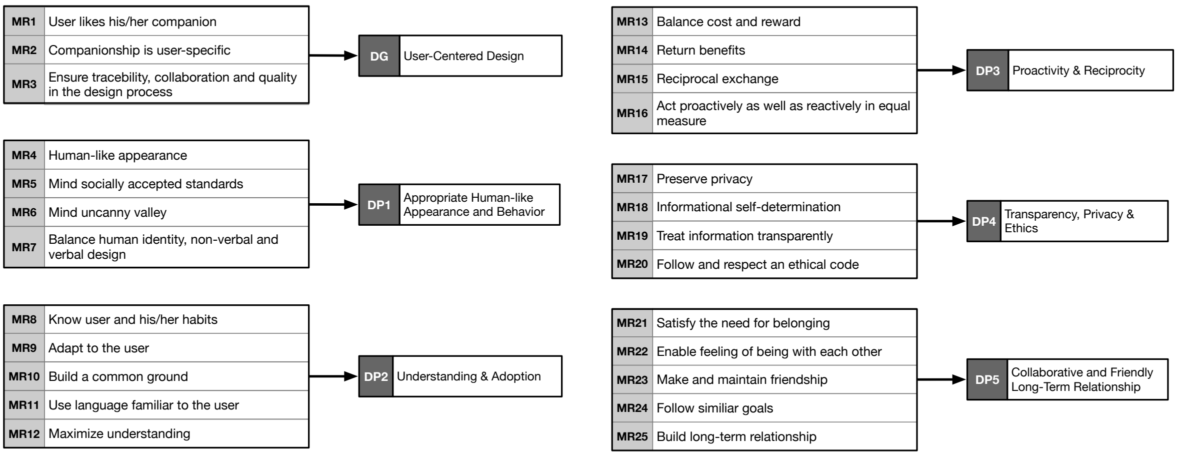

Figure 8.3.: *Meta-Requirements translated into Design Principles*

In sum we derived 25 meta-requirements and five design principles and one desing guideline for virtual companionship, each with its short title, which are illustrated in Figure 8.3. We also created a short title for each DP, which can also be found in Figure 8.3. It is important to note that an exact delimitation or definition of when virtual companionship is reached is not necessarily possible nor desirable, as different characteristics can be implemented to different degrees. Designers should therefore follow the design principles to their own needs, leading to companionship in CAs based on the individual case of application.

8.4.2. Virtual Companion Canvas

In line with the prescription of DG, which is tailoring the virtual companionship to the actual user with a user-centered design approach, we are proposing the so-called VC Canvas, a design tool that allows the designer to include the user in the design process of the VC by letting the user define the characteristics of the VC according to his or her preferences. We opted for a canvas approach, because of the advantage of visualization, allowing users to conceptually design their own VC. Visual approaches have been identified as a successful way to support a reflective communication and a creative generation of complex tasks (Alario Hoyos et al., 2014; Hernández-Leo et al., 2008). The VC Canvas is based on the five design principles we derived in Section 8.4.1. While DG forms the basis for the VC Canvas as a design tool, the five design categories of the canvas are each based on DP1-DP5 and equal the short titles from Figure 8.3. To specify the design categories, we have derived 12 canvas fields based on our prescriptions of each design principle. For example, the first design category is "Appropriate Human-like Appearance and Behavior" with its canvas fields: 1.1 "Human Identity", 1.2: "Verbal", 1.3: "Non-Verbal". Additionally, we added the design category "Application", which defines the application context (Sammut, 2001) and task (McTear et al., 2016; Zhao, 2006) of the VC, as well as the value (Grönroos, 2011; Wikström, 1996), which should be created for the user. The canvas fields of the design category Application are prefilled by the designer of the VC, to give the users guidance and an application context for designing their VC. For each canvas field, various questions were derived from relevant literature, giving concrete tasks to the user to fulfill and questions to answer. The structure of the canvas with its canvas fields, as well as the questions and requests with associated references can be found in Appendix C.1.

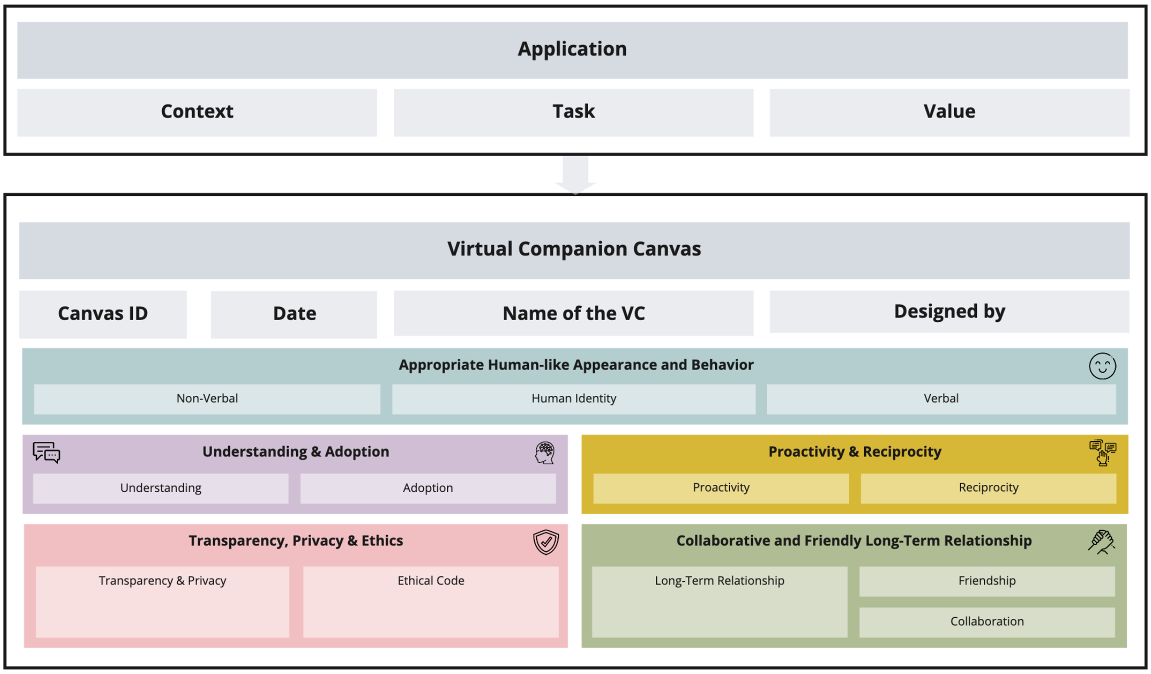

Figure 8.4.: *Reduced Version of the VC Canvas*

The first versions of the VC Canvas were designed with pencil and paper, following simple illustration software. Based on the feedback of a designer for visual marketing the canvas was redesigned. In contrast to the first version of the VC Canvas, which was black and white, appealing pastel colors and icons where chosen for every canvas field to visually separate the canvas fields. For the final version of the VC Canvas, which will be used by the users in the design process of the VC we needed a tool, that allows to share the VC Canvas with users. We choose the web-based, collaborative whiteboard tool Miro[12], which enables a distributed, synchronous and collaborative use of the VC Canvas. Figure 8.4 presents a reduced version of the VC Canvas, whereas a full version can be found in Appendix C.2 and under the following link: `http://bit.ly/bisevcc`.

8.4.3. Deriving Testable Propositions and Constructs

To asses our proposed design prescriptions we derive testable propositions (abbreviated with TP) as truth statements (Gregor and Jones, 2007; Walls et al., 1992). The

[12] `https://miro.com/`

propositions are generally formulated, so they can be tested by instantiating VC artifacts (Gregor and Jones, 2007). Based on our theoretical foundation we derived five testable propositions for the evaluation of VC artifacts with respect to the proposed effects (see Section 8.4.1) on the following constructs: Social presence (Qiu and Benbasat, 2009), Communication satisfaction (Hecht, 1978), Reciprocity (Kankanhalli et al., 2005), Trusting Beliefs (Qiu and Benbasat, 2009), Trust and Reliability (Ashleigh et al., 2012), Friendship: Stimulated Companionship (Mendelson and Aboud, 2012) and Friendship: Help (Mendelson and Aboud, 2012).

> **TP1**: *According to DP1, an appropriate human-like appearance and behavior of a VC leads to users having increased feeling of social presence.*
>
> **TP2**: *According to DP2, maximizing understanding and adopting to the user of a VC leads to users having higher communication satisfaction.*
>
> **TP3**: *According to DP3, a proactive and reciprocal behavior of a VC leads to users having a higher perception of reciprocity.*
>
> **TP4:** *According to DP4, preserving transparency, privacy and ethics in a virtual companionship leads to users having increased trusting beliefs and a higher feeling of trust and reliability in the VC.*
>
> **TP5:** *According to DP5, a collaborative and friendly long-term relationship leads to users having a higher feeling of a supportive companionship.*

If a long-term study is not feasible, we suggest using the construct Usage Intention (Qiu and Benbasat, 2009) to predict a possible reuse over a longer period of time (Venkatesh et al., 2003), which encourages a long-term relationship.

8.4.4. Virtual Classmate: An Exemplarily Instantiation and Experiment

For a first assessment of the nascent design theory and our developed design principles, we designed an exemplarily instantiation following our DG and all five design principles. As mentioned before, it is not always possible or necessary to precisely define when a CA can be seen as a VC, since companionship can be implemented to a different extent. The following prototype shows a number of companionship characteristics that differentiate it from current CAs. In addition, our goal is not to build on current specific technological developments, since AI is constantly changing, meaning that each design principle can be implemented differently, firstly because of the current technological advancements and secondly because of the capabilities of the developer. With the exemplary instantiation we want to show that with the help of our nascent design theory and the design principles an added value can be created by companionship properties. Thus, we tested the prototype against another instantiation, which explicitly does not follow any of the design principles and is based on functions of current available virtual assistants. It was designed based on answers and reactions from currently existing virtual assistants, such as Apple's Siri and Google's Assistant. Both instantiations contain exactly the same information and thus offer the user equivalent support. The VC has taken on the role of a Virtual Classmate for students during their studies at university as this scenario is a promising application of virtual companionship (Harvey et al., 2016; Woolf et al., 2010).

In order to follow our design guidelines, we asked a group of four students to mutually work with the VC Canvas and create a VC based on their own views and preferences. Their filled VC Canvas can be found in Appendix C.3 and under the following link: `http://bit.ly/bise_vcc_sarah`. Based on their VC Canvas, the authors than implemented the VC *Sarah* in form of a simulated conversation, representing all design principles. The following figure provides both, an overview of *Sarah* and the implemented design principles and an overview of the implemented virtual assistant without the companionship characteristics. The full simulated conversation of both agents (originally in German language) can be seen in the Appendix C.4. Moreover, the prototypes can be viewed online: *Sarah* (`http://bit.ly/prototype_sarah`, pw: bise2020) and virtual assistant (`http://bit.ly/prototype_va`, pw: bise2020).

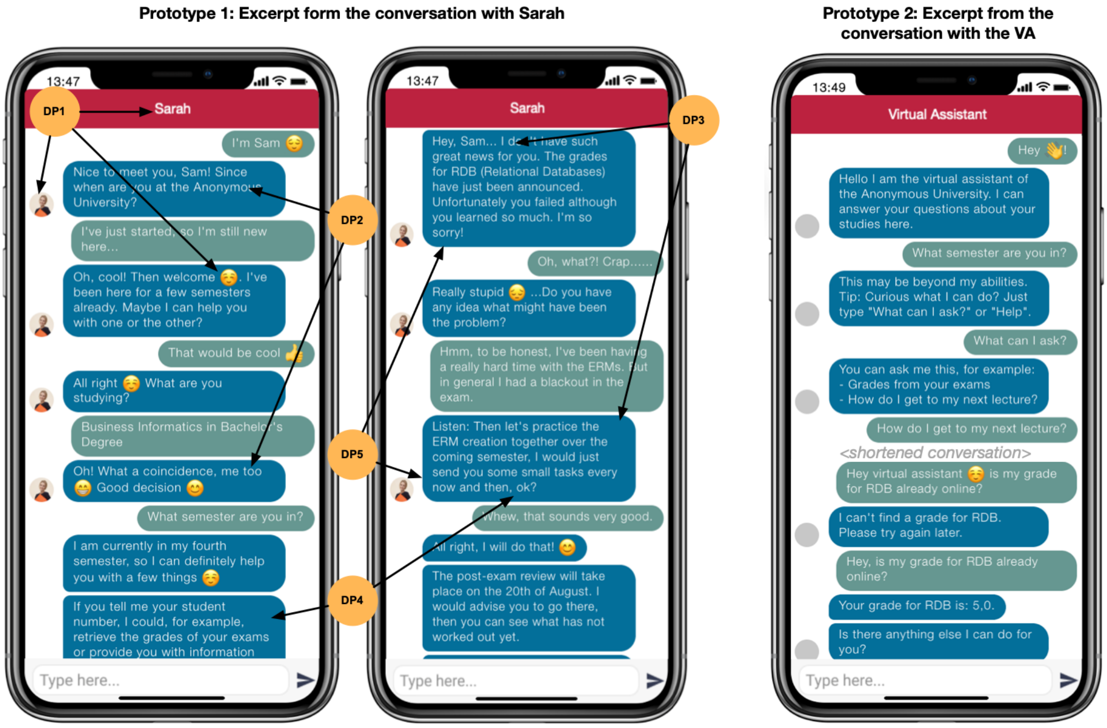

Figure 8.5.: *Sarah vs. Virtual Assistant*

The orange circles refer to the respective design principles at the particular positions in the conversation and VC design. According to our design guideline, the VC is designed according to the students' preferences, which are the profile picture, the retrieval of grades and that the VC should be in the same course of study, but in a higher semester (see VC Canvas in Appendix C.3). According to DG the VC has a human name, a human profile picture and uses natural language combined with the usage of emojis. Following DP1 *Sarah* wants to get known to the student and builds a common ground: "me too". According to DP2 *Sarah*, for example, offers the student to learn together with him by providing tasks and according to DP3 the VC transparently shows which information is used for what and asks the student for his approval. DP4 is generally followed in the fictitious example, since *Sarah* and the student are still in conversation after one semester (see explanation of the time jump in Appendix C.4: "in the meantime one semester has passed").

The goal of our evaluation is to provide first "evidence that the theory leads to some developed artifact that will be useful for (...) making some improvement" (Venable et al., 2016, p. 79), which is in our case an added value due to companionship characteristics. We follow the "The Human Risk & Effectiveness" evaluation strategy (Venable et al., 2016), as our nascent design theory is highly social or user oriented. Our formative evaluation is therefore conducted as early as practicable and can be seen as a starting point for evaluations in real situations and over the long run (Venable et al., 2016).

Deriving from our initial design-oriented question ("How to design Virtual Companionship?"), we propose that *Sarah* is a VC that is rated better by users in the context of a Virtual Classmate than a virtual assistant without companionship features, subsequently offering added value to the user. In order to evaluate this proposition, we conducted a repeated measure experimental design, in which 40 participants rated both versions, the interactions with *Sarah* and the virtual assistant, whereas the order of the interactions was presented randomly. With the results, we can additionally assess, whether a Virtual Classmate is an appropriate scenario in which virtual companionship can be beneficially implemented.

To address a user-centered design, four students were asked to use the VC Canvas to design a Virtual Classmate according to their preferences (see Appendix C.3). Their input was used to design a fixed conversation protocol resulting in a simulated interaction with *Sarah* which was shown to the participants. After each simulated interaction, the participants were given a questionnaire with the aim to assess the testable propositions TP1-5. A post-interaction questionnaire was developed consisting of 53 items, representing the above mentioned nine constructs (see Section 8.4.3) and six open questions, as well as general demographic questions. The items were independently translated into German language by two researchers, mutually aggregated and independently backward translated to ensure validity. The items were randomly arranged within the questionnaire. All constructs used a 7-point Likert-scale (7="totally agree"). An excerpt of the questionnaire with exemplary items for each construct can be found in Appendix C.5.

Participants were randomly recruited by distributing the experiment via internal student mailing lists from a German University. Overall 61 participants started the experiment, from who 40 (male=27, female=13, age_{mean}=25) fully completed the experiment. The resulting data was tested for their type of distribution using the Shapiro-Wilk test (SW).

The results indicate non-normal distribution (p<0.01 for all constructs) leading to the use of the Wilcoxon rank sum test (due to ordinal scaled data and repeated measures) to test, whether the participants rated *Sarah (S)* better than the virtual assistant classmate (VA). Cronbach's alphas (α) for all constructs were computed and are presented in Table 8.2, as well as the descriptive statistics.

Table 8.2.: *Results of the Experiment*

Construct	**MeanS**	**Mdn_S**	**SD_S**	**$Mean_{VA}$**	**Mdn_{VA}**	**SD_{VA}**	α
Social Presence	5.52	6	1.28	2.49	2	1.67	0.96
Trusting Beliefs	5.78	6	1.16	4.21	4	1.87	0.91
Perceived Usefulness	5.33	5	1.4	4.01	4	1.75	0.84
FS: Stimulating Companionship	4.89	5	1.52	2.98	3	1.77	0.93
FS: Help	5.51	6	1.38	3.55	4	1.97	0.89
Reciprocity	5.02	5	1.71	3.39	3	1.76	0.86
Usage Intention	5.09	6	1.78	3.83	4	2.01	0.96
Communication Satisfaction	5.33	6	1.61	3.86	4	2.05	0.89
Trust and Reliability	5.26	5	1.38	4.55	5	1.73	0.79

The involvement of users in the design process depends on many factors, making an operationalization to what extent this involvement was successfully, not expedient or feasible. While in some cases the direct involvement of users is possible throughout the entire development process, it is often not achievable to involve users in exactly all phases of the development, e.g. due to confidential aspects. We therefore rely on the approach of asking the designers (e.g. in interviews) to what extent the developed prototype meets their requirements is appropriate. After involving the four students into the design of the VC, we presented Sarah to them and asked, whether she represents their views and perception. The students answered that they "find the interaction very successful" and that she appropriately represents their idea, which they presented with the VC Canvas. Despite the small number of users who were involved in the design process, we argue that this involvement is one way to follow our design guideline and accomplished a user-centered virtual companionship. A set of Wilcoxon Signed-ranks test indicated that the participants rated the social presence higher for the interaction with *Sarah* than for the one with the virtual assistant (Z = 11.98, p < .001), meaning that *Sarah* had an appropriate human-like appearance and behavior (TP1 confirmed). Communication satisfaction for the interaction with *Sarah* was rated higher than for the interaction with the virtual assistant ($Z = 12.17$, $p < .001$), meaning that *Sarah* understands and adopts better to the user (TP2 confirmed). Reciprocity was rated higher for the interaction with *Sarah* than for the one with the virtual assistant (Reciprocity: $Z = 8.63$, $p < .001$), meaning that *Sarah* has a better reciprocal behavior (TP3 confirmed). Trusting beliefs, as well as trust and reliability were rated higher for the interaction with *Sarah*, than for the interaction with the virtual assistant (Trusting beliefs: $Z = 11.92$, $p < .001$, Trust and Reliability: $Z = 4.33$, $p < .001$), meaning that *Sarah* is a transparent VC that respects privacy (TP4 confirmed). Stimulating companionship and help were rated higher for the interaction with *Sarah*, as well as usage intention, than for the interaction with the virtual assistant (Stimulating Companionship: $Z = 10.91$, $p < .001$, Help: $Z = 12.39$, $p < .001$, Usage Intention: $Z = 6.38$, $p < .001$), meaning that Sarah has a better collaborative and friendly long-term relationship with the user (TP5 confirmed).

The answers to the open questions revealed, that the virtual assistant was "cold and without emotions" and that, even though the communication was "clear" and "goal oriented", it was "too rigid" and "impersonal". In contrast to that, *Sarah* was rated as "humanlike", "personal", "friendly" and with emotions. Furthermore, the participants highlighted the proactivity of *Sarah* valued her empathy and adaptivity. Besides that, *Sarah* was rated significantly higher in all nine constructs, meaning that *Sarah* is an appropriate VC that is preferred compared to a virtual assistant in the context of a Virtual Classmate. Our exemplary instantiation shows that, although not all design principles were followed and implemented to the same extent, user involvement only took place to a certain degree, and the comparison instantiation deliberately avoided companionship characteristics, virtual companionship can offer an added value compared to other, especially currently existing CA. Additionally, the VC Canvas was rated as an appropriate tool to involve users into the design and the context of a Virtual Classmate can be defined as an appropriate use case for virtual companionship.

8.5. Discussion

Research in the field of human-machine interaction has already proven the relevance and benefits of establishing and maintaining a long-term relationship between humans and machines (Bickmore and Picard, 2005). Also, theoretical contributions concerning virtual companionship were made (Krämer, Eimler, et al., 2011), prescriptive design knowledge for designing virtual companionship to successfully support the instantiation of VC artifacts in research and practice, as well as strategies to include the user in the design process were missing. We addressed this shortcoming in our research by systematically deriving one design guideline and five theoretically grounded design principles and by providing a corresponding design-tool, the VC Canvas. With the instantiation of the Virtual Classmate *Sarah* we have shown how to use the VC Canvas in the design process, how to instantiate the five design principles and proved with five testable propositions that the proposed meta design successfully meets the formulated meta-requirements. In Table 8.3 we summarize our findings in the form of a nascent design theory (Gregor and Hevner, 2013; Gregor and Jones, 2007) extended with the component design tool containing our VC Canvas.

With the progress in the field of AI, the technical possibilities for the implementation of the individual design principles will evolve over the time. As we rather formulated general design principles, they can be used in a wide variety of contexts in order to bring virtual companionship into human-machine relationship. By not offering specific design features, the use of novel technologies for implementation is left to the designers and developers. From a practical perspective, we offer a design guide with a set of theoretically grounded design principles combined with a practical design tool in the form of the VC Canvas, with which not only new artifacts can be instantiated, but also existing ones can be enhanced with virtual companionship. The VC Canvas can be used by researchers and practitioners throughout the design process of a VC, primarily as a continuous tool that serves as an integration of the user throughout the entire development process, be it for the general conception and definition of a VC, for requirements engineering, for the alignment of any implemented features or as a rapid prototyping tool.

8.6. Limitations

Even though our research provides valuable insights and implications for research and practice, they include a variety of limitations. First, the concept of virtual companionship is not universal nor transferable to all use cases and generally not suitable for every user, as new technological advancements are oftentimes accompanied by acceptance difficulties (Davis, 1989). This includes AI applications, such as chatbots or

Table 8.3.: *A Nascent Design Theory for VCS*

Component	Description
Purpose and Scope	Explicit prescriptions for developing VCS between humans and machines based on a set of 25 meta-requirements. We propose one design guideline and five theoretically grounded design principles for VCS and provide the VC Canvas as a design tool to include the user in the design process.
Constructs	We derived and built upon nine constructs related to VCS design: • Social presence (Qiu and Benbasat, 2009) • Communication satisfaction (Hecht, 1978) • Reciprocity (Kankanhalli et al., 2005) • Trusting Beliefs (Qiu and Benbasat, 2009) • Trust and Reliability (Ashleigh et al., 2012) • Friendship: Stimulated Companionship (Mendelson and Aboud 2012) • Friendship: Help (Mendelson and Aboud, 2012) • Usage intention (Qiu and Benbasat, 2009) • Perceived Usefulness (Qiu and Benbasat, 2009)
Principle of form and function	We derive five theoretically grounded design principles for guiding the development of VCS instantiations.
Artifact mutability	The degree of generalization of our design principles can be adapted to different application domains. The Virtual Classmate Sarah supports and proves the design principles presented in this paper and two instantiations the Virtual Co-Driver (Author citation 2019c) and the Virtual Classmate Sarah support the VC Canvas.
Testable propositions	We derived five testable propositions to evaluate whether the proposed meta design (DP1 to DP5) successfully meet the formulated meta-requirements (MR1 to MR25).
Justificatory knowledge	The nascent design theory and design principles are grounded in research on human-machine interaction and interpersonal relationship (see Section 8.2)
Principles of implementation	We provide an example of how to instantiate the proposed design in the form of the VC artifact Sarah.
Design tool	We provide the VC Canvas as a design tool to include the user in the design process according to our design guideline and help the designer to instantiate VC artifacts.
Expository instantiation	We conceptually designed and then developed two VC prototype instantiations based on the prescriptive knowledge: The Virtual Classmate Sarah and the Virtual Co-Driver (Strohmann, Siemon, et al., 2019a).

conversational agents, as well as possible VCs that are likely to encounter basic acceptance problems, as already mentioned by our participants ("I don't need a friend, only information"). However, the objective of virtual companionship is not to increase the acceptance of any form of conversational agent, but to create an added value through aspects of companionship. Subsequently, a VC is certainly not a technology that everyone uses or accepts to the same extent.

Second, our nascent design theory represents only a small part of how trust can be promoted. Trust is a complex and all-encompassing concept which is characterized by a number of aspects. When designing VCs with a specific focus on the aspect of trust, other literature should be consulted in addition to DP4, such as that by (Sunyaev et al., 2015), who deal with different aspects of quality of privacy policies or studies on trust engineering (Lankton et al., 2015; Söllner, Hoffmann, and Leimeister, 2016). While we focus on aspects of interpersonal trust, trust in artifacts and/or IT additionally helps building technology trust (Söllner, Hoffmann, Hoffmann, et al., 2012). The same applies to the other design principles, which due to their different characteristics can take on a different significance in the development of VCs and, depending on their importance, determined by the designers, bring further theoretical considerations with them.

Third, we leave out concrete design features purposely in our nascent design theory. The technological implementation is not the scope of our study, as the technological possibilities of how to implement conversational agent improve with technological progress over time. For this reason, we have consciously separated the conceptual design of virtual companionship from the technological implementation and it is left to the designer of how to implement the conceptual design of the VC. Moreover, the rather general design principles can be used in a wide variety of contexts.

Fourth, the focus of our study was not to actually develop a virtual classmate. The VC in form of the virtual classmate as an exemplary instantiation should underline and demonstrate the instantiability of our design theory, the application of the VC Canvas and address our testable propositions. Therefore, our two prototypes are both simulated conversations and not real applications. Since virtual companionship characteristics can take on different shapes, specific features were chosen with the involvement of the user's in order to explicitly demonstrate the added value of these properties compared to current existing CAs and not to deliberately try to maximize any group effects.

Fifth, our evaluation is fulfilled with the restriction to a quantitative survey in the form of a questionnaire. In explorative approaches in particular, qualitative user tests or interviews are desirable, as they could provide more precise and deeper insights into the use of the prototype. This could enable causal relationships to be recognized more precisely and behavioral patterns to be better examined. Furthermore, we have not conducted a long-term study. Instead, we tried to use the construct usage intention to predict a potential long-term use and thus favored formation of a companionship. In a long-term study an absolute usage measuring would be preferable by any means.

8.7. Conclusion and Outlook

In our research we brought concepts of an interpersonal relationship to the human-machine interaction with the overarching goal to answer the question of how to design virtual companionship. Therefore, we followed and successfully met our three research objectives: we derived five theoretically grounded design principles and one design guideline as part of a nascent design theory for virtual companionship (1) and instantiated those with the help of our proposed design tool, the VC Canvas (2), into the VC artifact *Sarah* (3), a Virtual Classmate supporting students. With our work, we have not only addressed currently existing issues about social relationships between humans and machines (Krämer, Eimler, et al., 2011), but have also created prescriptive knowledge and, above all, provided designers a tool to design VCs. Our nascent design theory therefore provides a valuable early contribution that offers a lot potential for further research. First, with the degree of generalization of our design principles, they can be adapted to different application domains, as well as different technological implementations. For example, DP2 "Understanding and Adoption", can be implemented by either a self-learning algorithm that automatically adapts the VC to the user's needs and habits or by defining a representative user-class and designing the VC based on the preferences of this user-class. By leaving out concrete design features, the decision of how to implement the conceptual design of the VC is left to the designers. With *Sarah* we exemplarily showed how certain design principles can be instantiated and how resulting features might look like. Future research should now investigate other scenarios and application domains, such as the previously mentioned VCs for elderly and homebound people (Krämer, Eimler, et al., 2011; Tsiourti, 2018) and provide more specific instantiations. Additionally, selected features based on the design principles should be evaluated in laboratory experimental settings to investigate causal relationships to further extend the nascent design theory with concrete design features. Furthermore, we highly invoke on using the VC Canvas not only to design new VCs, but reconsider currently existing conversational agents by involving users into the development or refinement process. In this case, the iteratively developed VC Canvas serves not only as guidance for designers, but can also be further developed and refined by them and any involved user.

Even though virtual companionship is not applicable for all contexts or use cases, we think that it is a valuable approach of addressing current issues with existing conversational agents concerning long-term relationships, whenever they have the function to support the owners' health, well-being, and independent living by incorporating social behavior and especially companionship.

CHAPTER 9

The Virtual Companion Design Framework

An Explorative Case Study

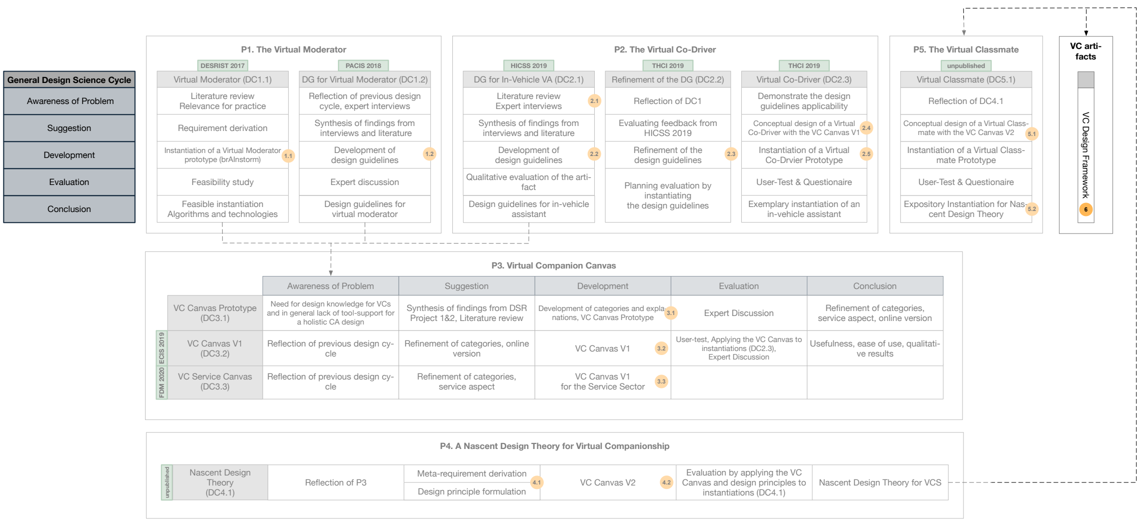

Figure 9.1.: *Positioning the VC Design Framework in the DSR Project*

The VC Canvas was developed to provide a visual and easy to use design tool for the design of VCs. In the following chapter, a closer look is taken at the design process for the instantiation of VC artifacts and where the VC Canvas should be used. Furthermore, the experiences of the author of this dissertation will be summarized and integrated into the so-called VC Design Framework. This design framework in turn reflects the seventh component, which is Principles of implementation, of the ISDT according to Gregor and Jones (2007), as it gives concrete guidance of how to instantiate VC artifacts. For the evaluation of the framework, an explorative case study was conducted in the context of a master seminar at the university. The results are also documented in the following chapter.

9.1. The Process, Methods and Tools

The experience and publications of the author of this dissertation have shown that the well-known DSR process models (Peffers et al., 2007; Vaishnavi and Kuechler, 2015) are suitable for the instantiation of VC artifacts. However, the design and development phase of VC plays a significant role in the design process and should be performed iteratively with different methods and tools, as well as in a user-centered manner with early prototypes. The approach of the author of this dissertation was, therefore, to derive a simpler, visually clear yet methodologically grounded, iterative, and user-centered process specifically for the design and development of VC artifacts.

Besides DSR as a very popular research paradigm in the IS domain, there are other design-oriented approaches to create innovative artifacts in the context of research, business, or IT, such as Design Thinking. Design Thinking is a holistic, collaborative approach for the innovation of products, services, product-service systems, or processes that is inherently based on creativity, multidisciplinarity, and user-centricity (Brown, 2008; Carlgren et al., 2014; Stickdorn and Schneider, 2010). Studies have shown that there are a number of similarities between DSR and Design Thinking and that Design Thinking can be integrated into DSR (Becker, Meyer, et al., 2020; Dolak et al., 2013; Robra-Bissantz and Strahringer, 2020). One of the differences is, for example, the constant and iterative cycle of problem identification and definition, allowing diverging and converging phases in the design process (Dolak et al., 2013).

In order to specifically integrate this user-centricity and iterative design into the VC design process, it is derived on the basis of DSR, as well as Design Thinking. In table 9.1 six VC design process steps based on the DSR process models by Vaishnavi and Kuechler (2015) and Peffers et al. (2007) and the Design Thinking procedure models according to Plattner (2010a) and Rintisch (2018) are derived.

Table 9.1.: *Deriving the VC Design Process*

Step	**VC Design Process**	**Description**	**Reference**
1	Discover	Identify Problem & Motivate	Identify Problem & Motivate (Peffers et al., 2007), Awareness of Problem (Vaishnavi and Kuechler, 2015), Discover (Rintisch, 2018)
2	Define	Define & Collect Requirements, Challenges and Objectives	Define Objectives of a Solution (Peffers et al., 2007), Suggestion (Vaishnavi and Kuechler, 2015), Define (Plattner, 2010a)
3	Ideate & Design	Create the Conceptual Design	Design & Development (Peffers et al., 2007), Development (Vaishnavi and Kuechler, 2015), Ideate (Plattner, 2010a)
4	Prototoype & Develop	Implementation	Design & Development (Peffers et al., 2007), Development (Vaishnavi and Kuechler, 2015), Prototype (Plattner, 2010a)
5	Rollout	Continuous Refinement during Real-World Usage	Deliver and Deploy (Rintisch, 2018), refining CAs (Li, Miller, et al., 2019)
After 3 and 4	Demonstrate Test Evaluate (DTE)	Evaluate to iterate the artifacts	Evaluation (Peffers et al., 2007; Vaishnavi and Kuechler, 2015), Demonstration (Peffers et al., 2007) Test (Plattner, 2010a)

The VC design process should help designers to instantiate VC artifacts. Particularly the conceptual design is emphasized in which the VC Canvas should be used by the designer to conceptually design the to be developed VC before starting with the technical implementation. This addresses a shortcoming of current services for CA design, which have their main focus on designing the actual conversation between the user and the agent (Diederich, Brendel, and Kolbe, 2019b), and hence missing the support of a holistic agent design, featured by the VC Canvas. Furthermore, the process provides three key outcomes: the conceptual design, a prototype, and the agent itself. The prototype and agent differ in that the prototype primarily simulates or visualizes the behavior of the VC, and the agent can process actual requests. Each of the outcomes should be demonstrated, tested, and evaluated (DTE) to develop the VC in a user-centered manner and ensure the best possible result. If the VC is to be used in a real-world scenario, continuous learning and refinement are essential for the user experience, since it is proven that CAs should have the ability to improve their functionality through communicating with humans and learn from the mistakes they make (Li, Miller, et al., 2019).

Based on the development and design experiences of VCs of the author of this dissertation, Figure 9.2 proposes methods and tools for the individual phases with which the different outcomes can be designed and developed.

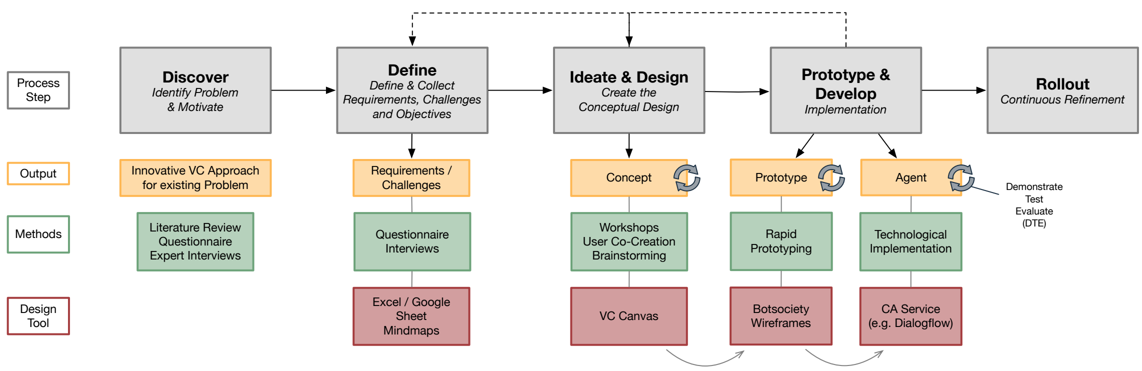

Figure 9.2.: *Methods and Tools in the VC Design Process*

Since the three design tools for the creation of the artifacts are central to the design framework, they are presented in the following.

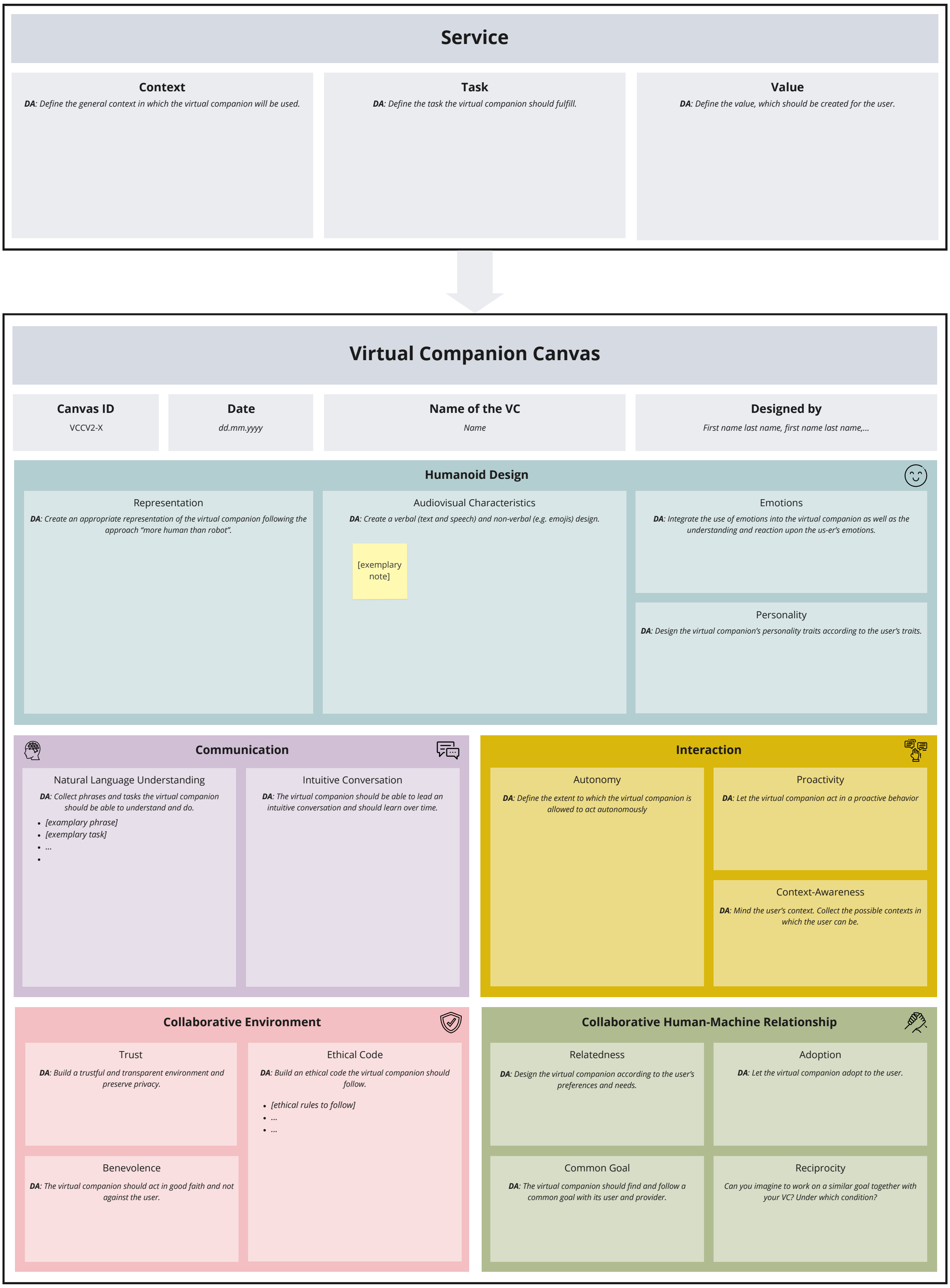

Figure 9.3.: *Final VC Canvas*

VC Canvas The VC Canvas is the design tool crafted by the author in several iterations and publications. As the individual publications show (ECIS 2019, THCI 2019, FDM 2020, and Chapter 8), the VC Canvas can take many different shapes and forms and can be adapted to different application contexts. Since the VC canvas can be used in the collaborative whiteboard tool Miro, the individual fields can also be easily adapted. The final proposed version is shown in Figure 9.3 and can be used from the following link: http://bit.ly/vc_canvas. The individual fields have been well-founded and iteratively derived from the literature and experience from several projects. The final version of the VC Canvas is mainly the one developed in FDM 2020 in Chapter 7. Workshops, user co-creation and brainstorming are suggested as methods for the Ideation and Design phase.

Figure 9.4.: *Botsociety User Interface*

Botsociety Botsociety[13] is an online prototyping tool which offers a very fast-forward and intuitive solution for designing conversational interfaces. It allows the design of conversations between a user and a bot for different platforms like WhatsApp, Google Assistant, Facebook Messenger, and many more. The conversational flows, which are prototyped by the designer, immediately appear as a conversation in the prototype, and

[13] `https://botsociety.io/`

the tool can be used collaboratively by several designers. The final prototype can then be distributed via a hyperlink to be viewed and tested by potential users. Figure 9.4 shows a screenshot of the Botsociety user interface.

Dialogflow Dialogflow[14] is a Google service for the development of voice and text-based CAs. Therefore, it uses NLP techniques and offers a visual backend with which the logic of the agent can be created using core NLP concepts like the intent, entities, and conversation parameters. Figure 9.5 shows a screenshot of the Dialogflow user interface.

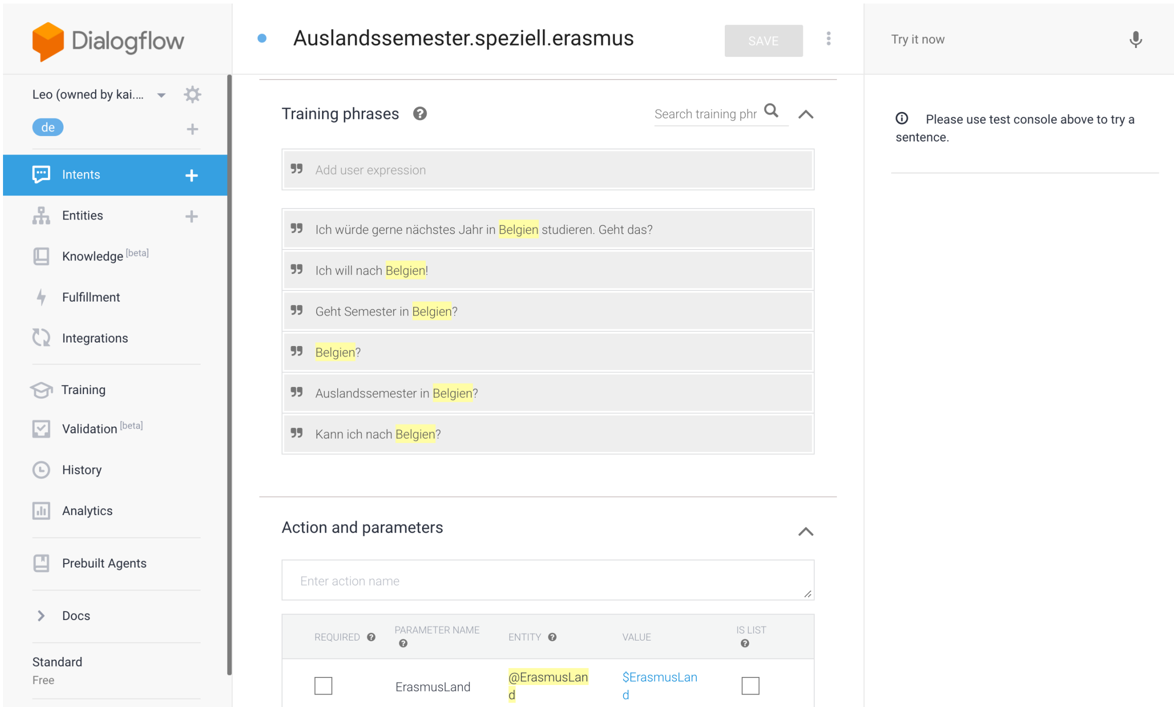

Figure 9.5.: *Dialogflow User Interface*

9.2. The Case Study

In order to test and evaluate the VC Design Framework, a problem is first required, which is described in the following:

First semester students at universities in particular face the challenge of having to find their way around in a new, confusing, dynamic, and widely spread environment (Har-

[14] `https://dialogflow.com/`

vey et al., 2016). There is no central contact person for questions that arise regarding orientation at the university and the organization of studies. In addition, the responsibilities of different topics are not always clearly defined. Nor is the availability of the contact person guaranteed at all times (Harvey et al., 2016). Information accessible via information portals is often not intuitively accessible (Eisman et al., 2012).

As a result, students and university staff have to spend a great deal of time and effort in obtaining information in order to process individual requests for information, some of which are identical or frequently repeated (Eisman et al., 2012). As a result, student satisfaction decreases, and the time capacities of staff are tied up unnecessarily.

The aim of this project is, therefore, to develop a virtual classmate based on a qualitatively well-founded requirements catalog and to exploratively evaluate, and iterate the concept, prototype and agent of a virtual classmate afterward. To evaluate the VC Design Framework with its suggested tools and methods, a master seminar with ten master students was conducted from the 12.11.2019 until the 6.2.2020. The ten students were divided into three groups, two with four students and one group with two students. In order to better structure the responsibilities within the teams, the students could assign roles (team leader, user, and market researcher, developer) within the groups themselves.

The author of this dissertation instructed all three groups as they conducted the proposed VC design process, which are more specifically the following steps:

- Analysis of the problem definition and gathering of user requirements through explorative short interviews with students, conduction of market analysis for student assistance systems as well as a literature analysis concerning publications in the problem field. This first step combines the first two process steps of the VC Design Framework and resulted in a structured list of user problems and requirements, challenges, and required information.

- Creation of the conceptual design by using the VC Canvas with the help of the brainstorming method (inside the group as well as with students from different departments) and defining the required functional scope.

- Development of exemplary prototypes in Botsociety and their evaluation with the help of a quantitative survey as well as open questions.

- Implementation as an agent in Dialogflow as well as iterative development and refinement through user tests.

Discovery and Planning Since the problems of students and the requirements of the virtual classmate are not the focus of this chapter, the results are only summarized as examples for the overall understanding. The main identified problems aggregated from the different groups can be clustered into five main categories, which are:

- **General Organization**: IT, accesses, regulations, rules, applications
- **Timetable**: Lectures, choice of subjects, possible combinations, specialization
- **Orientation**: Rooms, institutions, leisure time, initiatives, student life, events, offerings
- **Social Connection**: Meet people, find study groups, meet fellow students, find buddies/mentors
- **Study Organization**: Course of studies, choice of study, deadlines and modalities, registration for examinations, rights

Ideation and Design During the phase Ideation and Design, several creative concepts of a possible virtual classmate were created by the students using the VC Canvas according to the design guideline proposed in Chapter 8. Several concepts for a virtual classmate like "Leo", "Carolo" or the duo "Gnu Günther and Samy Singvogel" came up during this phase. As an example an excerpt of the VC Canvas by group 2 is illustrated in Figure 9.6

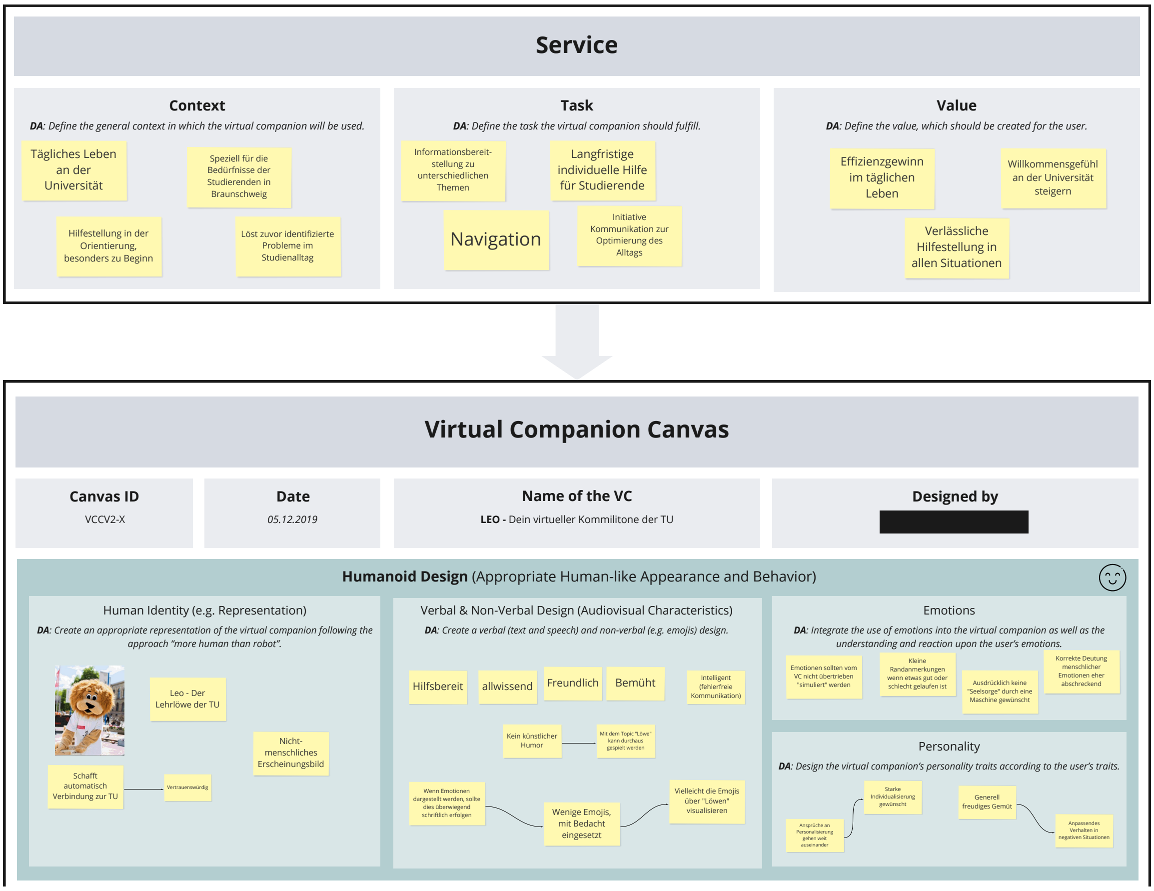

Figure 9.6.: *Concept of Leo, VC Canvas Group 2*

Development After finishing the ideation and design phase, all groups have transferred the conceptual design of the virtual classmate into prototypes with the help of Botsociety. For instantiating the artifacts the design principles for virtual companionship proposed in Chapter 8 were taken into account. The prototypes were then evaluated with a quantitative survey, based on the testable propositions of the nascent design theory for virtual companionship (Chapter 8), as well as some open questions. With the help of the data collection, also the VC Canvas was refined. In the course of the evaluation, it was also checked whether the requirements of the VC Canvas were reflected in the prototype and whether the expectations of the students were fulfilled. Figure 9.7 exemplary shows screenshots of two prototypes created by group 1.

Figure 9.7.: *Screenshot of the two Protoypes LeoBot and Carolo, Botsociety Prototype Group 1*

Based on the evaluation of the VC Canvas as well as the Botsociety prototype, the groups could now choose the final concept of the virtual classmate, which was then transferred into an agent using Dialogflow. To keep the implementation effort within limits, the groups could choose two of the previously defined problem areas. For the problem areas, the required intents, entities, and parameters were defined and structured with the help of Google Sheets. For the training of the agent, they defined and collected exemplary phrases that a user would possibly ask the agent concerning a certain intent. For example, in the previous Section in Figure 9.5 the intent is called "Auslandssemester.speziell.erasmus", one of the training phrases is "Ich würde gerne nächstes Jahr in Belgien studieren. Geht das?" and the parameter is "ErasmusLand". Figure 9.8 shows screenshots of an user interaction with the final agent of group 3.

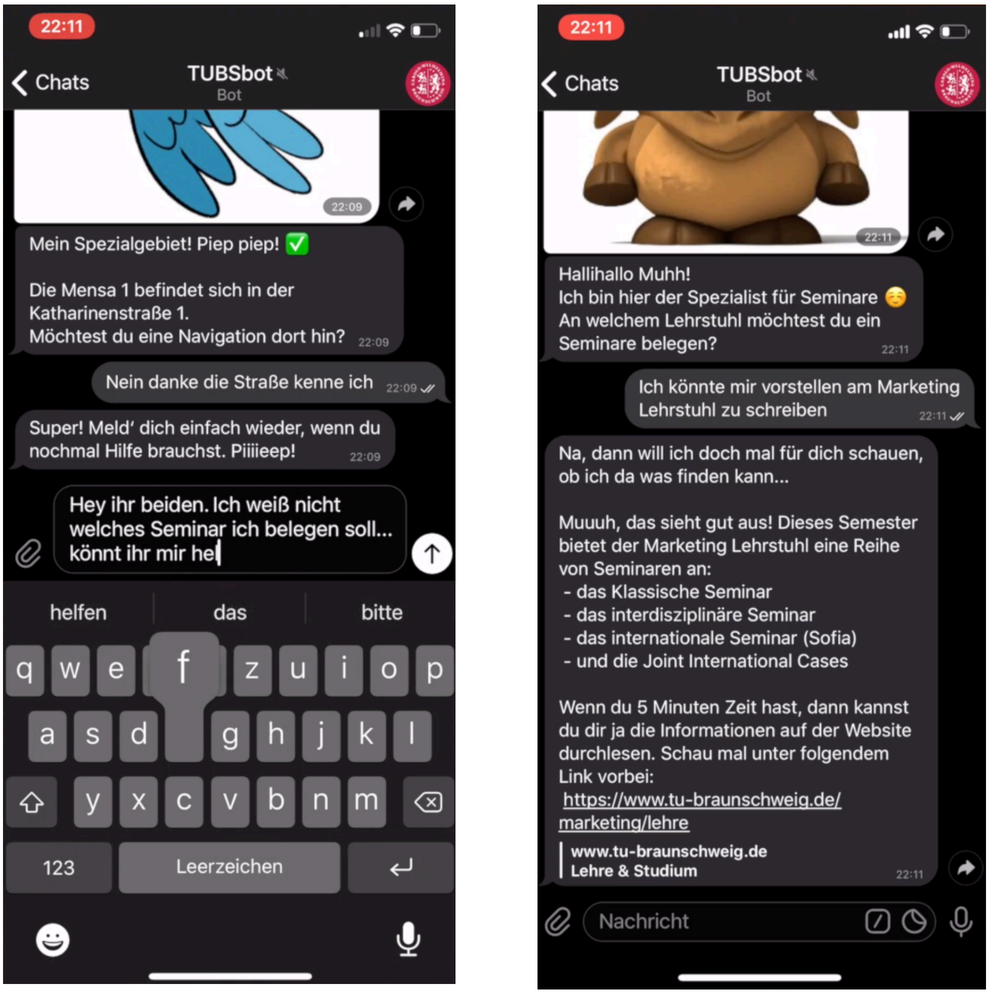

Figure 9.8.: *Screenshots of an User Interaction with Gnu and Sammy, Dialogflow Agent Group 3*

9.3. Evaluation

Throughout the project, two surveys were answered by the students. One at the beginning of the project and one after the entire project had been completed. The aim of the first survey was to ask for prior experience concerning the usage, design, or development of CAs. The average age of the students was 25,1. There were five male, as well as five female students. All of the ten students are studying M.Sc. Technology-Oriented Management. Eight out of the ten students have used a CA before, and out of these eight, four people use CAs regularly in their everyday life. Four of the ten students have experience with designing CAs from which two already implemented a CA.

The aim of the second survey was to collect feedback concerning the whole VC Design Framework. Therefore four open questions, based on the Design Thinking method Feedback Capture Grid (Plattner, 2010b) were asked:

- What did you like about the VC Design Framework?
- What can be improved in the VC Design Framework?
- What did you dislike about the VC Design Framework?
- Do you have a brand new idea for the VC Design Framework? If so, please explain it briefly.

Furthermore, an additional fifth question was asked concerning the separation of the design and implementation phase: "Did the separation into the conceptual design (VC Canvas), prototyping (Botsociety), and implementation (Dialogflow) help you in the design process? If so, what did you like about it? If not, what did not help you, and what would you change?".

The answers to the open questions were analyzed with the help of codes as efficient data labeling and data retrieval technique (Miles and Huberman, 1994) using the software MAXQDA version 18. At first, categories were defined as main codes in the first cycle, matching the key aspects of the open questions: Positive, Negative, Suggestion for improvement, and Separation into conception, design and development. After assigning the categories to all responses in a first coding cycle, the texts were then analyzed at a deeper level during a second coding cycle. During this cycle, sub-codes structured into the categories were created, extracting the meaning of the coded passages. In a third cycle, the coding was checked and refined. After the last cycle, 53 codes and 77 codings emerged in total. In the following, the results of the coding are listed and in three tables and interpreted.

Table 9.2.: *Survey Results: Positive and Negative Aspects of the VC Design Framework*

Category	Code	Student (S)
Positive	Create a technical product without programming	S8
	Get to know different systems and methods	S7, S6
	Continuous feedback	S6
	Enables co-creation with users	S6
	Creates understanding for the tasks	S9, S7, S4, S3
	Supports going through the phases	S4, S3
	Good structure / phases build logically on each other	S9, S7, S3
	Seems to be scientifically grounded and design oriented	S2
	Clear description and separation of the process steps	S9, S2
	User-centered design	S6, S2
	Development tailored to bots and independent of the use case	S2
	Iterative procedure	S6, S5, S1
	Short cycles create fast results	S8, S6, S5, S1
	Explorative approach without too much science	S1
Negative	Rollout was missed out	S9
	Distribution of the team-roles unclear	S8
	Too little time for development in Dialogflow	S7, S4, S3
	Not all areas of the VC Canvas necessary for the virtual classmate	S6, S2
	Process a little too rigid => more agility	S5
	Required data for the development difficult to obtain	S3, S1

Table 9.2 illustrates the positive and negative aspects contributed by the students. When you go through the positive aspects, several core themes become clear. The many iterations and the user-centered approach were very well received by the students (Strength 1), as results were achieved quickly (Strength 2), and a lot of feedback could be collected from the users. The fact that not every step has to be worked out in a completely scientific way, but rather in a very design-oriented and explorative way (Strength 3), was also appreciated. Overall, the framework helped the students to go through a process in a structured and understandable way and, above all, to get to know different tools and methods (Strength 4). S1 sums it up pretty well: *"All in all, I like the strongly explorative approach, in which you actually just do things and don't have to prove or show them extensively in advance. It's fun to see quick results and to use them to improve and expand the "product" iteratively."*

Actually, there are not many negative points. What was also noticed in the course of the supervision was that due to the limited time available for the seminar, there was too little time for the development of the virtual classmate (Issue 1). Furthermore, all students had little or no development experience (Issue 2), which is not conducive to the implementation in Dialogflow, even though the service can be operated without programming knowledge. This is also reflected in the students' comments and again shown in the feedback according to Dialogflow in Table 9.3: Three students state that they had too little time for the development and four students report that they had restrictions due to a lack of IT know-how. Furthermore, in the context of the use case (support of students at university), one needs a lot of information and data, which were not all realistically accessible during the seminar (Issue 3). Furthermore, two students are of the opinion that not all areas of the VC Canvas are necessary for the design of a virtual classmate (Issue 4). One student also says that the process sometimes seemed too strict, and he would have liked more agility (Issue 5).

Table 9.3.: *Survey Results: Separation of Conception, Design and Development in the VC Design Framework*

Category	Code	Student (S)
General	Identifies aspects that need to be revised	S6
	Motivating to have small work packages	S6
	Findings were always well transferred to the next phase	S6
	Targeted development of problem areas	S6
Dialogflow	Too little time	S7, S4, S3
	Restrictions due to lack of IT know-how	S9, S8, S3, S1
Botsociety	Planned functions can be illustrated	S2
	Simple tool for quick user feedback	S1
VC Canvas	Creates an overall understanding of the development	S1, S5
	Intuitive to use	S5
	Conceptual design important and sensible for further implementation	S5, S2

Table 9.3 specifically illustrates the aspects concerning the separation of the phases into conception, design and development of the VC. Student 6 strengthens several pros for the separation of the different phases, like that the workload is divided, and the findings from each phase can be transferred to the next one (Strength 1 again). Student 3 emphasizes that the VC Canvas especially helps as an orientation throughout the

whole design process: *"The Canvas helped me because it allowed me to stick to my Canvas in all other steps of the process, so I always had a guide and checkpoint."* Student 2 emphasizes that functions planned can be well illustrated with the help of Botsociety, and also Student 1 says that it is a simple tool for quick user feedback (Strength 5). Concerning the VC Canvas, Students 1 and 5 emphasize that it improves the overall understanding at an early stage (Strength 6). Moreover, it is intuitive to use and has a sensible structure for further implementation (Strength 7). For example, Student 1 compares the VC Canvas to the Business Model Canvas (Osterwalder and Pigneur, 2010): *"There is definitely a lot of added value in dealing with the VC Canvas before prototyping. Similar to the BMC, you understand what you want to do before you do it. So I am definitely a friend of the VC Canvas."*.

Table 9.4.: *Survey Results: Suggested Improvements for the VC Design Framework*

Suggested Improvement	**Student (S)**
VC Canvas filled even more iteratively	S9
Integration of a concrete review phase	S9
Concrete definition of what will be implemented in the next steps	S6
More attention on the planning phase	S6
More concrete descriptions in the lower part of the VC Canvas	S5
More agility	S7, S3
Derive realistic functions to be implemented according to the VC Canvas	S4
Instructions for the individual steps and examples	S2
Central tool in which the process is incorporated	S2
Addition of further methods	S2
Application of Scrum	S7
Checklists	S6
Kanban board for development	S2
Even more time for the conception and the prototype	S1
IT specialists required for more complex use cases	S1
Integrate more open feedback sessions with users	S1

Another part of the questionnaire was the question about suggestions for improvement. For this, the students had several ideas and suggestions, which are listed in table 9.4. For example, Student 7 suggests to use Scrum for the development phase: *"(...) Application of the agile project management method Scrum for the development and continuous improvement of the bot. In this case, for example, the team leader would be a Scrum Master and the market researchers would be the Product Owners, and every month an MVP would be available, which could be optimized in the next sprint."*.

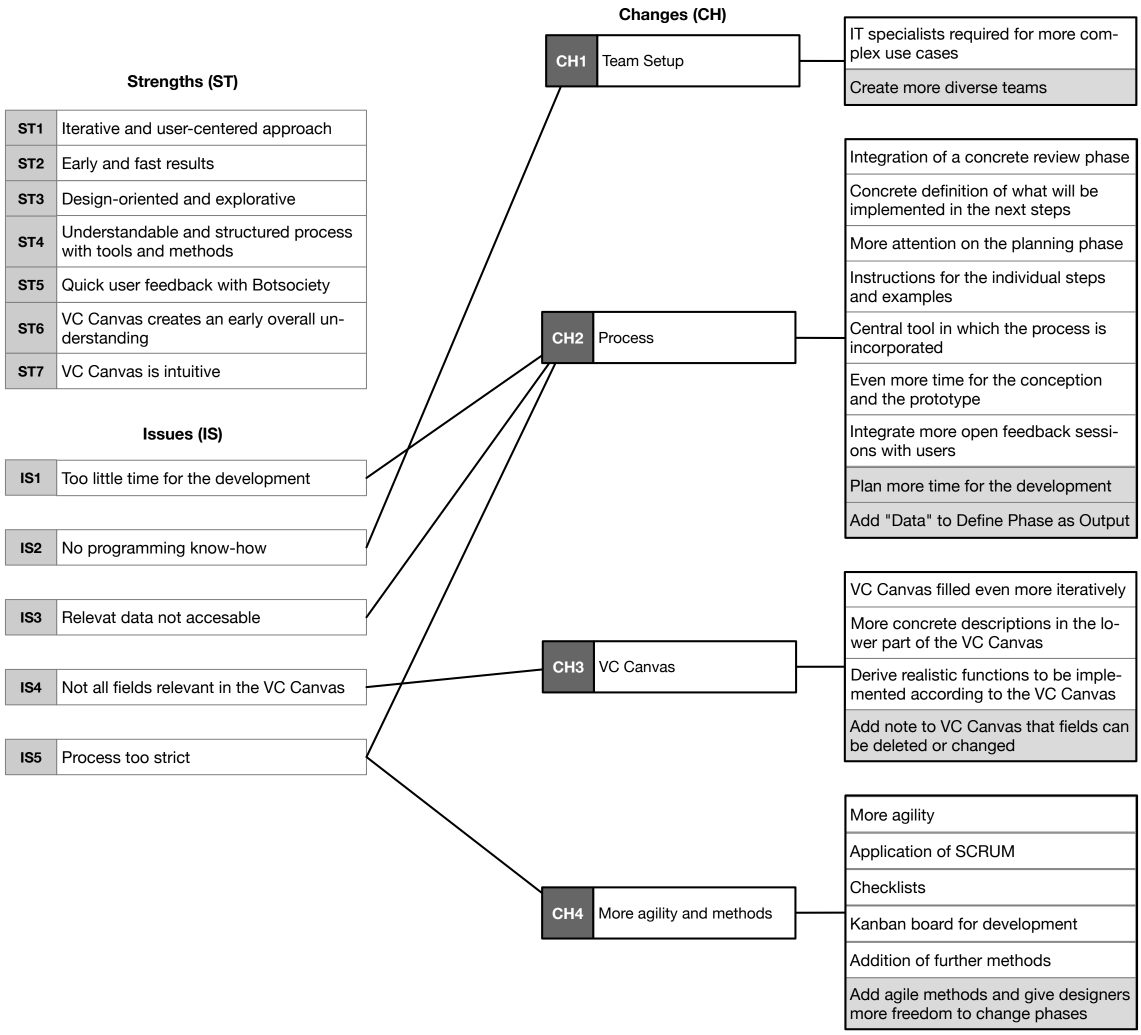

Figure 9.9.: *VC Design Framework: Strengths, Issues and Changes*

The suggestions for improvement were aggregated into the four main change areas: Change 1: Team Setting, Change 2: Process, Change 3: VC Canvas, and Change 4: More agility and methods. Then they are specifically assigned to the previously identified issues in order to remedy those with the potential changes. In addition to this assignment, Figure 9.9 also shows the derived strengths of the VC Design Framework, as well as suggestions for change made and added by the author of this dissertation (grey change boxes).

Based on the findings of the evaluation and especially the four change areas, the VC Design Framework was adapted and refined. The updated version of the VC Design Framework is shown in Figure 9.10. Not all suggestions for improvement could be taken into account, as points such as "central tool in which the process is incorporated" are very complex. Specifically, the methods Scrum and Kanban (Change 4) are added, a Check and Refine is added between the artifacts (Change 2), and Data is added as an Output of the Define Step (Change 2).

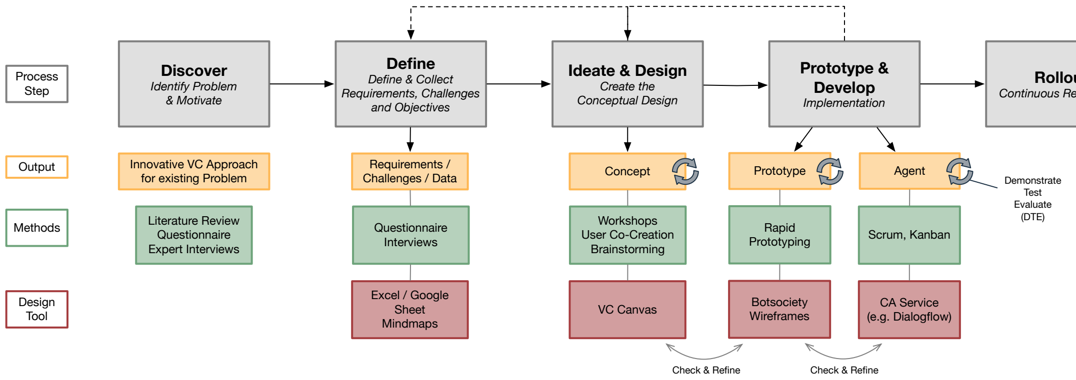

Figure 9.10.: *Refined VC Design Framework*

The VC Canvas got refined according to Change 3 and can be accessed under the following link: http://bit.ly/vc_canvas_refined. Moreover, the following six guidelines (G) for conducting the process are formulated:

- In case there is a facilitator/person in charge of the process - G1: The facilitator introduces each phase with explanations but gives the designers the freedom to go through the process on their own. (Change 4)
- G2: Create a realistic schedule for the process in the planning phase, which can be flexibly adjusted and contains buffers. (Change 2)
- G3: Put together a diverse and interdisciplinary team and take special care that all necessary competences are available. (Change 1)

- G4: Check in the team whether all requirements and findings from the previous artifacts and phases have been transferred to the next artifact (Check and Refine), as well as iterate and refine the previous artifacts.
- G5: Use the VC Canvas during user tests to collect the feedback.
- G6: Iterate and test as early as possible.

In summary, it can be said that the VC Design Framework was a success within the master seminar. The students' feedback was very positive, and several VC artifacts were successfully designed and implemented. Furthermore, beneficial feedback for the further development of the framework could be collected. Overall, a profound design framework was derived to help practitioners and researchers for the instantiation of VC artifacts. It shows especially how design tools can be integrated into the design process to instantiate and iterate VC artifacts.

CHAPTER 10

Conclusion

The first chatbot ELIZA was developed in the 1960s (Weizenbaum, 1966). The technological progress during the last years in the field of AI made computers way more capable of understanding, analyzing and generating human natural language (Russell and Norvig, 2016) and led to a hype about chatbots and VAs. As the literature review in Section 1.3 has shown, the interest in the IS domain about CAs grew exponentially. The findings of this dissertation specifically contribute to this body of knowledge. By instantiating artifacts in different application contexts, it was shown that the interaction between human and machine must not only be one-sided as it still often is today (the machine assists the human), but that human and machine can also do things together and collaborate. The concept of the virtual companionship evolved during the work on this research project, leading to the main general RQ: *How to design Virtual Companions?* To answer the RQ, a DSR approach was followed, in which artifacts of different levels were iteratively designed, enhanced and contributed. Overall, well-founded prescriptive knowledge for the design of VCs could be crafted and contributed.

The following chapter summarizes the results and contributions according to the predefined research objectives. Furthermore, the implications for research and practice are stated and finally the limitations with guidance for future research and an outlook are given.

10.1. Summary of the Results and Contributions

In Section 1.4 the RQ (How to design Virtual Companions?) and four respective objectives of this dissertation were derived:

1. Instantiate innovative CA artifacts to demonstrate that CAs can do more than just assisting their users.
2. Create design knowledge for CAs in various different application domains.
3. Develop a design tool for the design of VCs.
4. Particular create design knowledge for virtual companionship that is applicable to a variety of application domains and summarize the findings in the form of a nascent design theory (Gregor and Jones, 2007).

In order to show how the RQ was answered and the individual objectives were achieved, the VC design process from the previous Section 10.1 is used to show the respective contributions of the individual publications. Moreover, Figure 10.1 illustrates where the crafted design knowledge should be used throughout the VC design process and from which process step which instantiated artifact originated.

Objective 1 was fulfilled by generally working in a very innovative and development-oriented manner throughout the entire research project and the approach was pursued to always underpin or confirm the proposed functionalities, concepts and prescriptions with prototypes or actual software artifacts. This led to a variety of level 1 artifacts, shown in Figure 10.1: The virtual moderator IMO (Chapter 3) capable of facilitating brainstorming sessions, the virtual co-driver Carl (Chapter 5) accompanying car drivers, the concept of the mobility VC (Chapter 7), the virtual classmate Sarah (Chapter 8) and several other concepts, prototypes and agents for virtual classmates (Chapter 9) supporting students. Besides to the instantiated artifacts presented in this dissertation, even more artifacts were designed or assessed: a virtual colleague for the retail personnel (Meyer and Strohmann, 2018), the concept of a virtual teammate (Siemon, Strohmann, et al., 2019a), a VC supporting the idea management of creative people, a VC for entrepreneurs supporting their daily business and early phase of creating the business and a VC for diabetics helping them to keep track of their diet and interpret data.

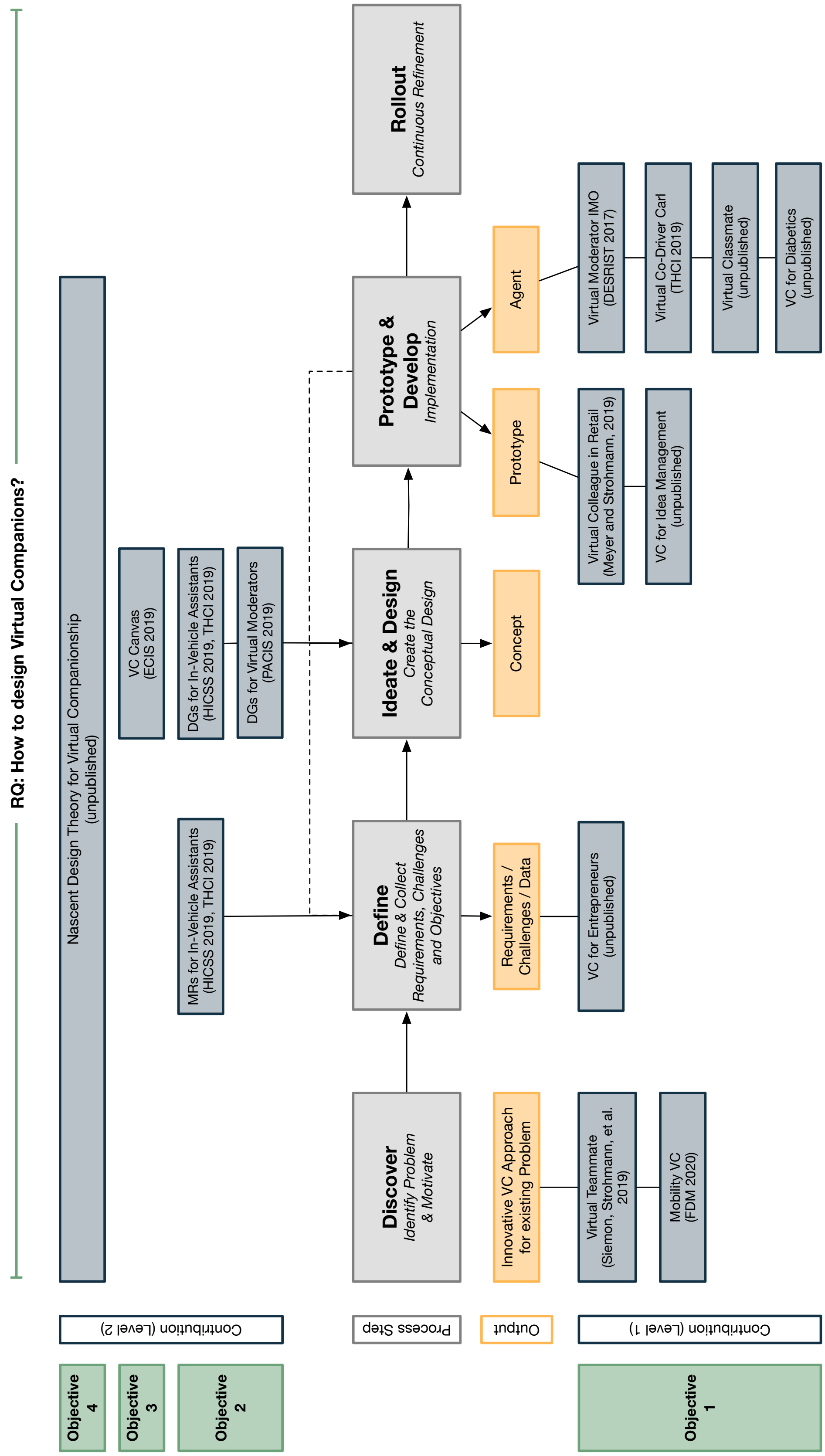

Figure 10.1.: *Contributed Design Knowledge shown at the VC Design Framework*

Objective 2 was tackled by systematically deriving prescriptive knowledge for the design of virtual in-vehicle assistants (Chapter 5), as well as for the virtual moderator (Chapter 4). Objective 3 was achieved by systematically deriving and crafting the VC Canvas as a visual and easy to understand design tool for VCs (Chapter 6 and 7). It should be noted that there are inconsistencies in the canvas fields and design categories between the different publications (ECIS2019, FDM2020 and Chapter 8), as the VC Canvas evolved over time. At their core, all three VC Canvas versions have the same design areas, but with varying degrees of emphasis. Whereas the version from ECIS2019 represents the first version of the canvas, the one from FDM2020 has a strong service focus. The canvas version proposed in Chapter 8 is again slightly different as it is specifically tailored to the proposed meta-design of the virtual companionship. In summary, it can be said that the VC Canvas itself does not have to have rigid fields and names, but rather that the general visual and canvas-based design approach has proven itself for the design of VCs.

Finally, objective 4 was fulfilled by deriving a nascent design theory for virtual companionship in Chapter 8. Since in Chapter 9 the principles of implementation have been left open and a general need for a process model especially suited for the design of VCs was seen by the author of this dissertation, the VC Design Framework was derived in Chapter 9. The four objectives were thus achieved through the individual publications and contributions. Thus, also the overall and general RQ was answered in a broader sense by the entire contributions illustrated in Figure 10.1 and in a narrower sense, answered by the proposed VC Design Framework in Chapter 9.

10.2. Implications for Research and Practice

There are several implications for research and practice, which are summarized in the following. From a theoretical perspective, this research project provides the following implications: First, the concept of VCs as an evolution of assisting CA applications was derived, elaborated and shown, how it can be instantiated in different application contexts, as well as how the interaction between human and machine can be enhanced with it.

Second, the body of knowledge for application-specific CAs in the contexts of vehicles, creative workshop facilitation and collaborative scenarios is extended. Prescriptions for the design of in-vehicle assistants are given in the form of design guidelines, which focus on providing a convincing UX to ensure that people find an in-vehicle VA valuable to use. In the context of facilitation and collaborative scenarios, design guidelines for a virtual moderator supporting creative workshops were developed and contributed. Both design guideline sets serve as a basis for researchers and practitioners to instantiate artifacts in the two contexts: in-vehicle assistance and virtual moderation. In addition, the level of abstraction is generalized to such an extent that these guidelines could also provide guidance in other contexts.

Third, the body of knowledge on CA design is extended with a nascent design theory for virtual companionship. The nascent design theory is summarized and contributed according to the anatomy proposed by Gregor and Jones (2007), thus it contains among other components theoretically grounded design principles and testable propositions for the evaluation of virtual companionship. As the design principles are formulated rather general, they can be used in a wide variety of application contexts in order to bring virtual companionship into human-machine interactions.

Fourth, the design areas and possible forms of a VC were derived iteratively and theoretically. They are brought together in the form of the VC Canvas, which presents them visually and understandable and serves as a design tool for the design of VC artifacts. Moreover, the VC Canvas demonstrates how a visual approach can be used for the complex design of AI-based artifacts.

From a practical perspective, this research project provides the following implications: First, it was shown in general which potential AI-based applications offer and how forward-looking and innovative approaches of companionship and collaboration between human and machines can be designed and implemented. For example, Chapter 3 demonstrates the technical feasibility of a virtual moderator, or Chapter 5 shows how a virtual co-driver should be designed.

Second, it was shown that virtual companionship has the potential to improve the interaction between human and machines. This potential can and should be used by service providers in their interactions with their customers. By providing a VC, a personal and collaborative relationship can be created in a scalable way and thus increases the value for their customers.

Finally, the proposed VC Design Framework offers a process, tools and methods for designing VCs. It shows how the VC Canvas as a very visual and easy to understand design tool can support the conceptual design of VCs detached from the technological implementation. Practitioners can use the proposed process, tools and methods to instantiate VC artifacts or enhance existing applications. Moreover, the VC Design Framework has shown how AI-based applications can be designed in a user-centered manner.

10.3. Limitations and Outlook

There are several limitations of the conducted research project that have to be taken into account when interpreting the implications, which at the same time provide guidance for future research. First, thanks to AI, today's technology is already relatively advanced, but its potential is far from being exhausted. Especially in the field of NLP, even more progress can be expected with increasing computing power. Many of today's use cases in the form of chatbots and VAs still reflect the relationship that IT assists the human. Thus, on the one hand, people's perception needs to evolve so that VCs are accepted by them and, on the other hand, the technology needs to become even more advanced so that more powerful VCs can be realistically implemented. However, the use of chatbots in the area of customer support, for example, has shown that people tend to quickly accept new technologies like the chatbot as an alternative for a real human being supporting them, if they work satisfactorily (Stucki et al., 2018). Therefore, it is promising that as the technology evolves, real VCs will become possible and accepted.

Second, not all instantiated artifacts have been fully evaluated, such as the virtual moderator in Chapter 3 or generally contributed such as the listed unpublished level 1 artifacts in Section 10.1. Thus, there is still potential for further development in the single instantiated artifacts themselves and in their evaluation. However, with the prescriptive knowledge created and contributed within this dissertation project, researchers and practitioners are encouraged to apply the knowledge to their own applications and further instantiate and evaluate VC artifacts.

Third, the VC Canvas is currently still static in its fields. These can be adjusted manually by the designers, but it would be desirable if they would adapt dynamically to the conditions in the respective application context. In general, the VC Canvas has still potential to be further developed. For example, it could be enhanced with an own platform which proposes and collects design characteristics for the individual fields for and from the users. In addition, this potential platform could also suggest or offer different canvas fields depending on the application context.

Fourth, the VC Design Framework was evaluated with students who participated in a graded master seminar. There would definitely be further potential to evaluate the design framework in a practical environment. Since it is difficult to get such an access to conduct the entire VC design process over a longer period of time, the alternative of the master seminar was a good opportunity. However, researchers and practitioners are encouraged to use the proposed VC Design Framework with its process, tools and methods for the instantiation of VC artifacts.

Fifth, the generalization and abstraction of design knowledge is often not so easy and strongly dependent on the underlying justificatory knowledge. It has not yet been proven that the proposed nascent design theory for virtual companionship is complete, this is why the theory is explicitly called "nascent". In order for the nascent design theory to reach the artifact level 3 according to Gregor and Hevner (2013), further research and a general acceptance and reuse in the community is necessary. With additional design cycles the nascent design theory could either be applied to further use cases or could be extended and refined on the basis of alternative theoretical perspectives. Through the derivation of the VC Design Framework, general principles of implementation are proposed of how to instantiate VC artifacts. Chapter 9 also showed where the prescriptions of the nascent design theory for virtual companionship should be applied throughout the design process. However, to provide more specific principles of implementation, design patterns or features that describe how certain characteristics of a VC can be instantiated, could be added to the design theory in future research.

To take up the example from Star Trek mentioned at the beginning of this dissertation: in 1966 it was still a fiction to speak with computers. Today, it is already normal that we speak with Siri on our smartphone or with Alexa at home. Even though the concept of the virtual companionship may still feel like fiction today, this dissertation has shown the potential of VCs and how they should be designed and can be implemented. From the perspective of the author of this dissertation it will be normal in the future that humans collaborate with machines and build companionships with them.

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APPENDIX A

Appendix Chapter 1

Appendix of Chapter 1

A.1. Coded Literature Review Results from Phase B (Relevant)

Table A.1.: *Coded Literature Review Results from Phase B (Relevant)*

Reference	Methodology	Application Context	Type of CA	Type of Design Knowledge	Contribution
Abdulrahman and Richards (2019)	Literature Review and Experiment	Collaboration with Human	Embodied CA	Design Framework	Computational Framework for a cognitive and emotional agent
Al-Natour, Benbasat, and Cenfetelli (2007)	Literature Review	Advisor: General Advisor	Online Virtual Advisor	Construct; Design Characteristic	Rapport and Intimacy; 15 Design Characteristics positivley influencing Rapport and Intimacy
Al-Natour, Benbasat, and Cenfetelli (2015)	Experiment	Commerce	Online Shopping Assistant	Construct	Perceived Personality Similarity
Appiah Otoo and Salam (2018)	Field Survey and Structural Equation Modeling	Customer Service	Intelligent Voice Assistants	Construct	Service Satisfaction and Service Loyalty
Benbasat and Wang (2005)	Experiment	Commerce: Online Product Recommendation	Online Product Recommandation Agent	Construct	Trust in Agent (Competence, Benevolence, & Integrity)
Benlian et al. (2019)	Experiment	Smart Home	Smart Home Assistant	Design Characteristic	Anthropomorphic Design of the physical Device (Anthropomorphism Absent vs. Present)
Derrick et al. (2011)	Literature Review	Holistic Approach	Embodied CA	Design Principle	Four Design Principles for SPECIES Agent Design
Diederich, Brendel, Lichtenberg, et al. (2019)	Experiment	Customer Service	Text-Based CA (Chatbot)	Design Feature	Assessing Design Feature for Fast Request Fulfillment in Chatbot Interactions: Buttons during Conversation
Diederich, Janssen-Müller, et al. (2019)	Experiment	Customer Service	Text-Based CA (Chatbot)	Design Feature	Assessing Design Feature for Emulating Empathetic Behavior: Sentiment-Adaptive Answers
Diederich, Lichtenberg, et al. (2019)	Experiment	Advisor: Sustainable Mobility	Text-Based CA (Chatbot)	Design Characteristic	Several Design Characteristics for Anthropomorphic Design; Assessing Anthropomorphic Cues and Persuasive Design of CAs
Feine et al. (2019b)	DSR	Holistic Approach	Text-Based CA (Chatbot)	Design Recommendations; Design Tool	Prescriptive Social Cue Design Rules; A chatbot social cue configuration system
Feine et al. (2019a)	DSR	Holistic Approach	Text-Based CA (Chatbot)	Design Principle	Two Design Principles for Designing a Chatbot Social Cue Configuration System
Gnewuch, Morana, and Maedche (2017)	DSR	Customer Service	CA	Design Principle	CA Classification; 12 Meta-Requirements and Four Design Principles for CAs in Customer Service

Gnewuch, Morana, Heckmann, et al. (2018)	DSR	Energy Feedback	CA	Design Principle	Four Design Principles for CAs for Energy Feedback
Gnewuch, Morana, Adam, et al. (2018a)	Experiment	Customer Service	Text-Based CA (Chatbot)	Design Feature	Assessing the Role of Typing Indicators in Human-Chatbot Interaction (None, Graphical or Textual)
Gnewuch, Morana, Adam, et al. (2018b)	Experiment	Customer Service	Text-Based CA (Chatbot)	Design Feature	Assessing the Response Time of Chatbots (Dynamically delayed vs. Near instant)
Hobert (2019)	DSR	Teaching or Education	Text-Based CA (Chatbot): Coding Tutor	Nascent Design Theory	Nascent Design Theory: Three User Stories, Six Teaching Assistants Task Characteristics, Eight MRs and Five DPs for a Chatbot-based Learning System, Software Architecture
Kowatsch et al. (2018)	Experiment	Health	Text-Based CA (Chatbot)	Design Characteristic	Assessing the impact of interpersonal closeness cues in text-based healthcare chatbots on attachment bond and the desire to continue interacting. Several Design Characteristics structured in a Codebook for Text-based Healthcare chatbot designs on interpersonal closeness
Kraus et al. (2019)	Focus Groups and Survey	Commerce	Voice Commerce	Design Recommendations	Comparative Analysis between E-Commerce and Voice Commerce by investigating voice commerce customer satisfaction predictors and comparing these with those of e-commerce,
Kretzer et al. (2015)	DSR	Advisor: BI-based Recommender	Report Recommandation Assistant	Design Principle	One MR and One DP for RPA
Lankton et al. (2015)	Survey	Holistic Approach	Technology's Humanness	Construct	Trust: Assessing technology's humanness by matching a technology's humanness with the technology trusting beliefs
Lechler et al. (2019)	Literature Review	Overview: Overview of Feedback-giving CAs	Text-Based CA (Chatbot)	Design Principle	Six Archetypes of Feedback-Related Chatbots and six DPs for Feedback-Related Chatbots
Liu et al. (2019)	DSR	Advisor: Advisory for Design Techniques	Text-Based CA (Chatbot)	Design Principle	Four MRs and five DPs and four Design Features for an advisory platform for design techniques, whereas one Design Feature is a conversational agent
Meier et al. (2019)	DSR	Health	Text-Based CA (Chatbot)	Design Principle	Eleven MRs and four DPs for a conversational agent to enhance health awareness; System Architecture
Nguyen and Sidorova (2017)	Keyword Search and Text Analysis	Holistic Approach	Virtual Assistant	-	A comparative study of user reviews for assistant and non-assistant mobile apps
Nguyen and Sidorova (2018)	Experiment	Customer Service	Virtual Travel-Planning Assistant	Construct	System Satisfaction
Obinali (2019)	Experiment	Holistic Approach	Voice Assistants	Design Characteristic	Assessing the perception of gender in voice assistants

Pfeuffer, Benlian, et al. (2019)	Literature Review / Meta Review	Holistic Approach	CA	Design Feature; Research Agenda	Categories of anthropomorphic features from a user perspective; Classification of CAs; Suggested topics for a research agenda for the BISE departments
Pfeuffer, Adam, et al. (2019)	Experiment	Holistic Approach	CA	Design Characteristic	Assessing gender stereotyping in judge-advisor systems and the role of egocentric bias
Qiu, Jiang, et al. (2006)		Commerce	Intelligent Agent	Design Guideline	Four design guidelines for presence in online shopping
Rietz et al. (2019)	Experiment	Collaboration with Human	Text-Based CA (Chatbot)	Design Feature	Assessing the impact of anthropomorphic and functional chatbot design features in enterprise collaboration systems on user acceptance
Saffarizadeh et al. (2017)	Experiment	Holistic Approach	CA	Construct	Assessing privacy concerns, trust, and self-disclosure in conversational agents
Schöbel et al. (2019)	Experiment	Teaching or Education	Avatar in Digital Learning	Construct, Design Characteristic	Assessing the The Role of Emotional Attachment, Satisfaction, and Cognitive Load in Digital Learning
Schroeder and Schroeder (2018)	Experiment	Holistic Approach	Text-Based CA (Chatbot): Cleverbot	Construct	Assessing trust in machines by investigating how the mode of interaction affects willingness to share personal information with machines
Seeger et al. (2017)	Experiment	Holistic Approach	Text-Based CA (Chatbot)	Construct	Assessing anthropomorphic design and trustworthiness of Cas
Seeger et al. (2018)	Experiment	Holistic Approach	CA	Design Framework	Framework of Anthropomorphic Design Dimensions (Human Identity, Verbal & Non-Verbal Communication
Seymour, Riemer, et al. (2017)	Experiment: Wizard-of-Oz	Holistic Approach	Embodied CA	Design Feature	In this study we suggest that interactivity operates on an independent, orthogonal dimension to appearance, and that interaction can "overcome the valley" in affinity due to matching and common human non-verbal cues. We hypothesize that these cause the user to process the avatar differently
Seymour, Riemer, et al. (2018)	Experiment: Wizard-of-Oz	Holistic Approach	Embodied CA	Potentials and Implications	Potentials and Implications of Natural Face Technology for the Creation of Realistic Visual Presence: Building Relationships with Visual Cognitive Agents
Siddike and Kohda (2018)	Literature Review; Conceptual Development	Advisor: General Advisor	Cognitive Assistants	Construct	Framework of trust determinants in people's interaction with CAs where reliability, attractiveness, and emotional attachment positively affect the intention of people in society
Sjöström et al. (2019)	DSR	Teaching or Education	Text-Based CA (Chatbot)	Design Feature	Architecture for chatbots in a learning context
Sohn (2019)	Experiment	Holistic Approach	Conversational User Interface	Construct	Assessing how the mere presence of messaging services on websites influences website users' privacy concerns.

Stock and Merkle (2018)	Experiment	Work / Digital Workplace	Assistive Robots	Construct, Design Characteristic	Assessing employee trust in assistive robots. (Humanoid Robot vs. Android Robot vs. Human)
Stock, Merkle, et al. (2019)	Experiment	Customer Service	Robot	Design Characteristic	Investigating customer responses to robotic innovative behavior cues during the service encounter
Strohmann, Fischer, et al. (2018)	DSR (Literature Review, Expert Interviews)	Facilitation	Virtual Moderator	Design Guideline	Nine Design Guidelines for Virtual Moderator Design and several Design Characteristics
Strohmann, Siemon, et al. (2019a)	DSR (Literature Review, Expert Interviews, Prototyping and User Test)	In-Vehicle Assistance	In-Vehicle Assistant	Design Guideline	15 Requirements and 57 Design Guidelines
Tavanapour et al. (2019)	DSR	Facilitation	CA	Design Principle	19 Requirements and 6 Design Principles for a CA as Facilitator
Wagner and Schramm-Klein (2019)	Qualitative Interviews	Holistic Approach	Digital Voice Assistants	Design Characteristic; Design Recommendations	Investigating the anthropomorphism of digital voice assistant. 5 Upper Categories and 12 Sub-Categories for anthropomorphic design.
Winkler et al. (2019)	Experiment	Teaching or Education	Smart Personal Assistant	-	Assessing the value of smart personal assistants as tutors for complex problem tasks
Wuenderlich and Paluch (2017)	Qualitative Interviews, Experiment	Customer Service	Service Agent	Design Characteristic, Construct	Assessing the user perceptions of AI-based service agents (Perceived Authenticity)

APPENDIX B

Appendix THCI2019

Appendix of Chapter 5

B.1. VC Canvas for the Virtual In-vehicle Assistant of the VR Prototype

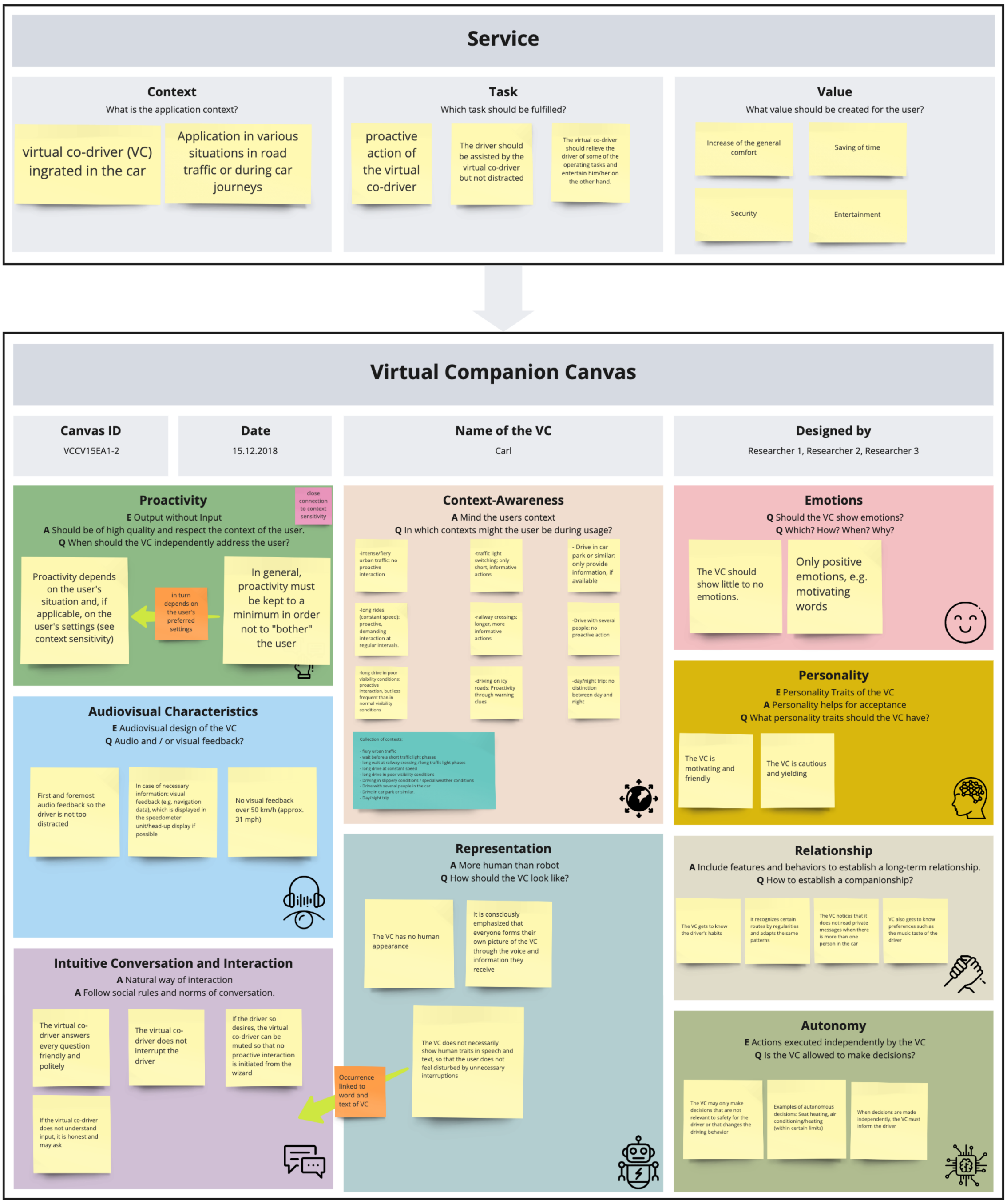

Figure B.1.: *VC Canvas for the Virtual In-vehicle Assistant of the VR Prototype*

APPENDIX C

Appendix Chapter 8

Appendix of Chapter 8

C.1. VC Canvas Structure and Questions

Table C.1.: *VC Canvas Structure and Questions*

Design Category	Canvas Field	Question/Request to User	Reference for Questions/Requests to User
Application	Context	What is the application context?	(Sammut, 2001)
	Task	Which task should be fulfilled?	(McTear et al., 2016; Zhao, 2006)
	Value	What value should be created for the user?	(Massaro et al., 1999; Wikström, 1996)
Appropriate Human-like Appearance and Behavior	Human Identity	How should the VC look like? Design your preferred demographics (gender, name, age and ethnicity). What personality traits do you prefer?	(Robert, 2018; Seeger et al., 2018; Seymour, Riemer, et al., 2018)
	Verbal	Which emotional expressions should the VC show (congratulations, apologies or concerns) and How? What about non-task related questions, like small talk?	(Bickmore and Cassell, 2001; de Visser et al., 2016; Al-Natour, Benbasat, and Centefelli, 2010; Seeger et al., 2018)
	Non-Verbal	What emotions should the VC show and how (e.g. with Emojis)? In case of an animated representation: what about hand gestures, eye contact or facial expression?	(Cassell, Nakano, et al., 2001; Seeger et al., 2018)
Understanding & Adoption	Understanding	Collect some phrases and tasks you would ask your VC to answer and do.	(McTear et al., 2016; Zhao, 2006)
	Adoption	To which extent should the VC adopt to you? (e.g. habits, language or personality)	(Park et al., 2012; Robert, 2018)
Proactivity & Reciprocity	Proactivity	To which extent is the VC allowed to act autonomously? In which cases is the VC allowed to contact you proactively?	(L'Abbate et al., 2005; Strohmann, Fischer, et al., 2018)
	Reciprocity	How much do you value a balance between effort and reward?	(Blau, 1968; Homans, 1958; Krämer, von der Pütten, et al., 2012)
Transparency, Privacy & Ethics	Transparency & Privacy	What privacy concerns do you have, when sharing personal information with your VC? In which way could the VC support you in a transparent way that you trust the VC?	(Elson et al., 2018; Fischer-Hübner et al., 2016; Al-Natour, Benbasat, and Centefelli, 2010; Saffarizadeh et al., 2017; Schroeder and Schroeder, 2018; Turilli and Floridi, 2009)
	Ethical Code	Do you have suggestions for an ethical code the VC should follow?	(Anderson and Anderson, 2011; Turilli and Floridi, 2009; Veruggio et al., 2016; Yu et al., 2018)
Collaborative and Friendly Long-Term Relationship	Collaboration	Can you imagine to work on a similar goal together with your VC? Under which condition?	(Randrup et al., 2016; Seeber, Bittner, Briggs, de Vreede, et al., 2019; Strohmann, Fischer, et al., 2018)
	Friendship	Can you imagine to develop a friendship with your VC? Under which condition?	(Krämer, Eimler, et al., 2011)

C.2. VC Canvas Chapter 8

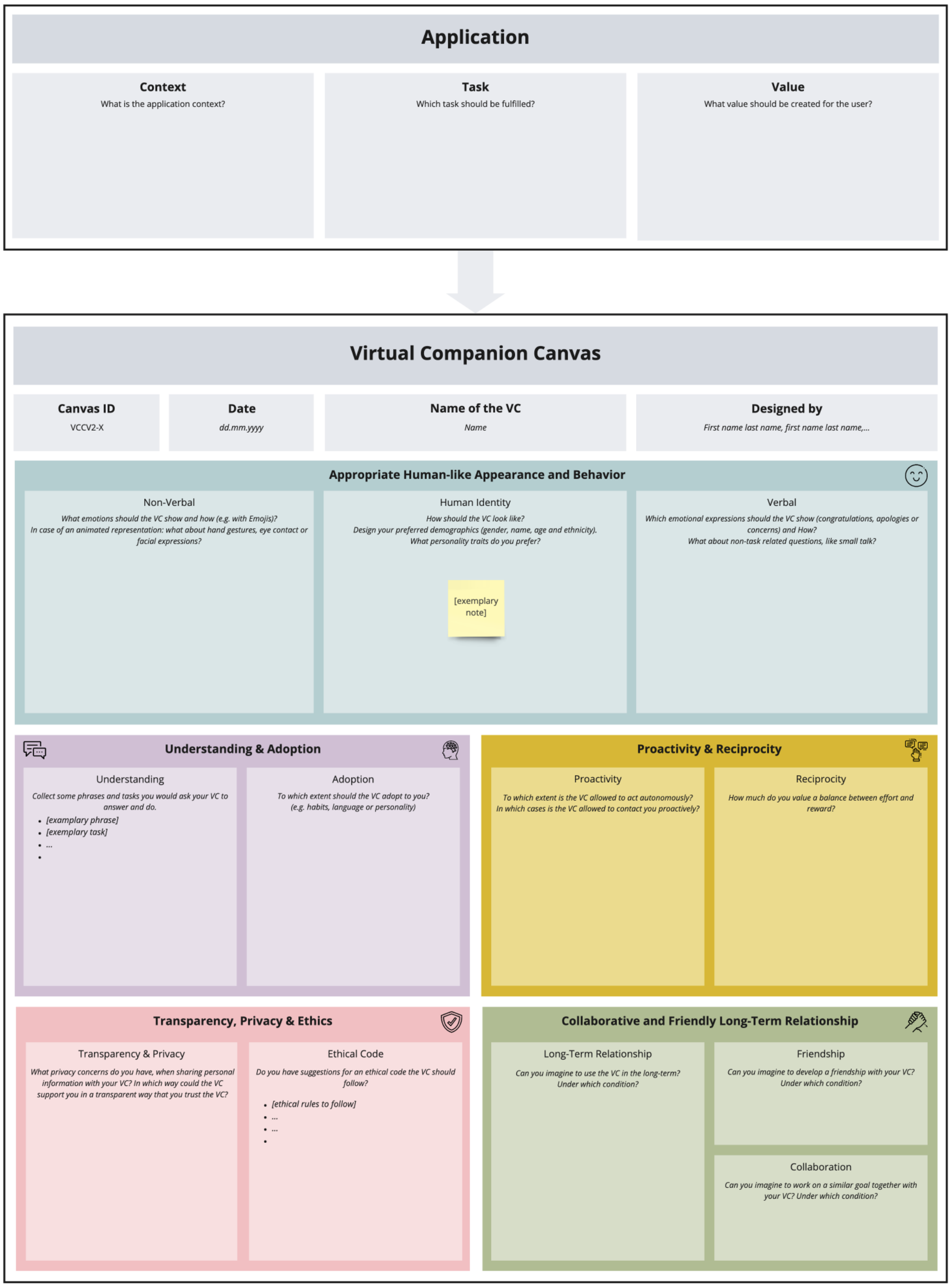

Figure C.1.: *VC Canvas Chapter 8*

C.3. Filled VC Canvas for a Virtual Classmate

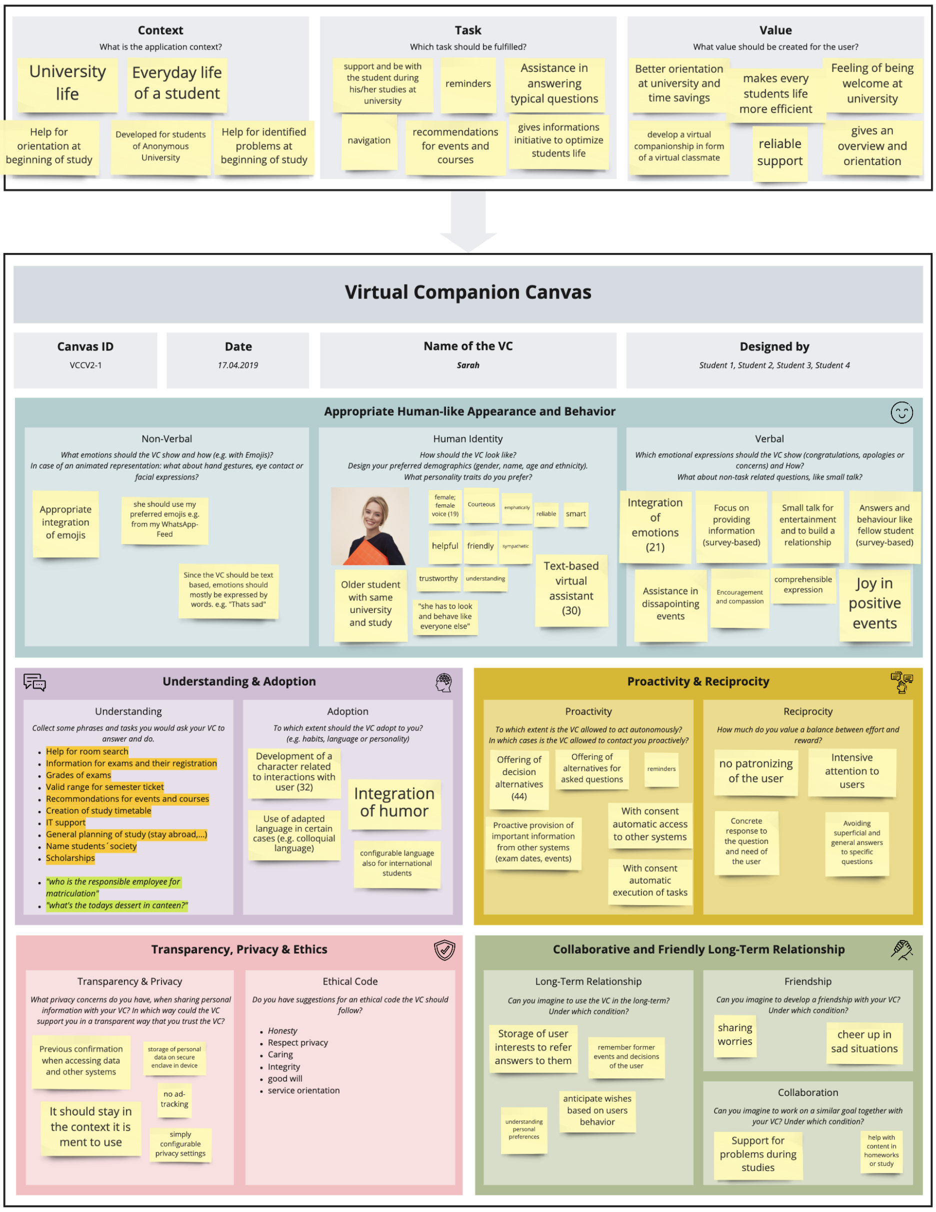

Figure C.2.: *Filled VC Canvas for a Virtual Classmate*

C.4. Full Conversation with Sarah and the Virtual Assistant

Figure C.3.: *Full Conversation with Sarah and the Virtual Assistant*

C.5. Excerpt from the Questionnaire

Table C.2.: *Excerpt from the Questionnaire*

Construct	**ID**	**Exemplary Item$_{\text{Sarah}}$**	**Exemplary Item$_{\text{VA}}$**
Social Presence	SOPR1	I felt a sense of human contact in Sarah.	I felt a sense of human contact in the virtual assistant.
Trusting Beliefs	TRBE2	Sarah has been very effective in her role as a Virtual Classmate.	The virtual assistant has been very effective in her role as a virtual fellow student.
Perceived Usefulness	PEUS3	Using Sarah can increase my effectiveness.	Using the virtual assistant can increase my effectiveness.
Friendship Scale: Stimulating Companionship	FSSC6	Sarah is enjoyable to be with.	The virtual assistant is enjoyable to be with.
Friendship Scale: Help	FSHE1	Sarah helps me when I need it.	The virtual assistant helps me when I need it.
Reciprocity	RECP2	When I contribute, I expect Sarah to contribute.	When I contribute, I expect the virtual assistant to contribute.
Usage Intention	USIN2	If I have access to the Sarah, I predict I would use Sarah as a Virtual Classmate.	If I have access to the virtual assistant, I predict I would use the virtual assistant as a Virtual Classmate.
Communication Satisfaction	COSA8	I was very dissatisfied with the conversation. (inverted)	I was very dissatisfied with the conversation. (inverted)
Trust and Reliability	TRRE2	I can rely on Sarah to handle my information confidentially.	I can rely on the virtual assistant to handle my information confidentially.