User-Oriented Innovations: On Cooperative Imagination Spaces in R&D Projects to Support Older Adults in Rural Areas with ICT and Sensor Technology

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In the development of digital technologies, a large gap persists between the ideas of what is potentially possible with innovative technologies such as complex algorithms, sensor media, adaptive and self-learning systems on the one hand, and the everyday lives of potential users on the other. This holds especially true for older and often non-tech-savvy people, who are considered as an important target group for emerging digital technologies in the health and ageing development environment. The question of how data-intensive technologies that rely on various sensors for collecting data can be designed to find a meaningful fit within the lifeworlds of older people is therefore crucial within applied informatics research and development (R&D) projects.

This is echoed by German and European funding programs that increasingly demand the involvement of user groups in the form of user-centered or Participatory Design for interdisciplinary projects with academia-industry cooperation. In such projects, cooperation is inherently multiple, i.e. project work is distributed across heterogeneous cooperative settings with different stakeholders and/or actors involved in each setting. So far, however, little attention has been paid to how these multiple forms of cooperation between highly diverse stakeholder groups, each with their own different visions, are linked to each other over a project period that usually lasts several years. There seems to be an assumption that it is sufficient to bring together different disciplines such as technology researchers, e.g., sensor technology or pattern recognition experts, with user research experts as well as representatives of the target group. Through the use of user-oriented methods such as being pursued in Participatory Design or in the Living Lab approach, the bridging of the gap between high-tech ideas and everyday worlds seems easy to implement.

In this chapter, we place this gap at the center of consideration and examine "how common goals, means and processes" (Schüttpelz 2017, 24) can be mutually as

well as inclusively accomplished across heterogeneous cooperative settings within a project. We present our reflections on the use of Participatory Design and Living Lab methods on the basis of a concrete nationally funded interdisciplinary project from a funding line that aims to develop adaptive, self-learning systems for the support of older people in rural areas.

In this way, we would like to provide reflections on the many facets of framing conditions of cooperation in which data practices are always embedded in R&D projects, but which have hardly been addressed so far. To this end, we follow a practice-based approach of Socio-Informatics, a sub-field of applied computer science that pursues a praxeological foundation of research and design work (Wulf et al. 2018). The socio-informatics view takes a close look at the socio-cultural conditions of emergence and processes in cooperative design projects and thus extends classical concepts of applied computer science, such as methods that are labelled under the umbrella of "user orientation" (Kuutti and Bannon 2014). The praxeological approach resonates with recent investigations into media of cooperation in science, technology and media studies that analyze media not only as means or tools enabling cooperation, but also underline their cooperative production which is seen as an ongoing accomplishment (Schüttpelz 2017, 24). Digital media are not just seen as technological artifacts, but as grounded in practices that span all stages of development and use involving various stakeholder groups. We will argue that the setup of joint spaces for anticipating and imagining future technologies along with interlinked media and data practices is crucial when involving target user groups with little or no previous experiences with digital technologies (Meurer et al. 2018; Gießmann et al. 2019). It is our aim to elaborate on the discourses, methods and different interdisciplinary and intersectoral approaches which all come together in an R&D project and thus have impact on the research designs, the final products as well as the imagination spaces which are being collaboratively produced and sometimes fit together better and sometimes less well.

In the remainder of the chapter, we look at two frequently used "user innovation" methods for the field of IT design to support the home life of older people from a socio-informatics perspective, namely Participatory Design and Living Labs. Then we introduce the case of a concrete R&D project to discuss the challenge of building bridges between high tech visions and development goals for adaptive and self-learning systems and real everyday worlds of older people in rural areas through participatory approaches. Building on this, we point out that the establishment of cooperation spaces and media in such highly complex projects must be broken down to a consistently user- and practice-oriented perspective that must also consider additional elements of embedding, such as offers of appropriation support and engagement for older people that help them to develop an interest in information and communication technologies (ICT) and sensor media and which

enable them to participate as competent cooperation partners in the design of media and data practices that are meaningful for them.

R&D Projects in the Field of Information Technology to Support Health and Ageing

Recent demographic changes in Europe such as increasing life expectancy and reduced birth rates are linked to drastic changes in respect of age structures. The number of people aged 80 and over will have doubled by 2025; yet at the same time, the availability of workers in the care sector will be drastically reduced (European Commission 2015a). In its program "Innovation for Active & Healthy Ageing," the European Commission faces these challenges for the future, attributing ICT and sensor technologies a major role in the development of innovative solutions for preventive and curative measures. Novel technologies are seen as a major driver for quality of life and increasing the agency of the elderly in their everyday lives (European Commission 2015b).

ICT and sensor-based systems are seen as having a high potential for securing the quality of life in rural areas (Trapp and Swarat 2015). Rural areas exhibit special aspects of demographic and structural change and are therefore the focus of particular attention in technology projects. Challenges relate in particular to the provision of public services and health care as well as the mobility of older rural residents. This is based on the increasing dismantling of social and institutional infrastructures, such as the decline of church services in villages or the dwindling of social meeting places and facilities for daily local supplies such as shops, restaurants, or pubs.

In the past decades, a lot of funding has been spent on the development of new digital solutions supporting quality of life and care of older adults, but few innovations have been broadly accepted by its targeted end-users thus far (Chung et al. 2016). Research on barriers of technology acceptance is abundant and diverse. A major reason for the lacking uptake of such digital technologies is seen in belated and inadequate user involvement (Mort et al. 2015). As a result, innovations too often do not address end-users' needs and/or challenge daily routines (Fitzpatrick and Ellingsen 2013). They do not match cultural values, psycho-social needs and do not fit into everyday practices and in turn do not become embedded into the social world they were designed to become part of (Procter et al. 2018). The early and consistent integration of end-users is therefore increasingly seen as a mandatory requirement for product innovation and development. European and German funding programs have been adapted accordingly, launching research policies which encourage project designs that follow a more integrated real-world perspective fostering co-creation and participatory research and design, which puts the inclusion

of primary, secondary, and tertiary end-user groups at the forefront. However, its implementation is demanding and often hesitantly implemented (Rodriguez et al. 2013; Stubbe 2018). Two prominent methodologies that are widely discussed and implemented are the Living Lab and the Participatory Design approach. In the following, main tenets of these approaches will be introduced, then the challenge of applying those methods in R&D projects with older adults will be highlighted by reporting on a project example aiming at the co-development of digital infrastructures supporting societal participation and inclusion of older citizens in a rural German area. Finally, we will subsume possible solutions that might help in paving a way to push the research on IT support infrastructures for older adults into a more practice- and user-based direction.

User-Oriented Innovation Methodologies in Germany: Participatory Design and Living Labs

Participatory Design of software involving future users originated in Scandinavia (Norway) in the 1970s. Its origin was the cooperation between technology researchers, companies, and trade unions. The common goal was to implement the computerization of workplaces in a democratic way. The Scandinavian approach follows three core principles that still guide Participatory Design today (if taken seriously): 1. democratization, 2. emancipation, and 3. product quality (Bødker and Pekkola 2010). In this sense, a participation-oriented IT development approach that pursues product development for older people should enable cooperation with older people as representatives of the target group at eye level. The design, introduction, and evaluation of the jointly developed devices take place in a joint process between the development team and the project participants or co-researchers (Bratteteig and Wagner 2016).

Living Labs is a methodological approach that clearly puts user-involvement to the fore. The term appeared in the 1990s and has since then been used for a wide range of environments and approaches for ICT innovation and development (Følstad 2009). Living Labs are inter- and transdisciplinary social spaces of co-learning, where people from various backgrounds meet on a regular basis to mutually learn from their respective experiences and co-create new solutions for commonly understood problems (Riva-Mossman et al. 2016). The ultimate goal is to create technological interventions or tools that adapt to and work with already existing (care) structures, (human) resources and practices.

The first Living Labs were artificial laboratories, furnished like regular apartments (Intille et al. 2005; Olivier et al. 2009). Subsequently, researchers and (mainly technology) companies went on to establish Living Labs in real-life environments. This kind of Living Lab can be divided into two sub paradigms: test bed-like set-

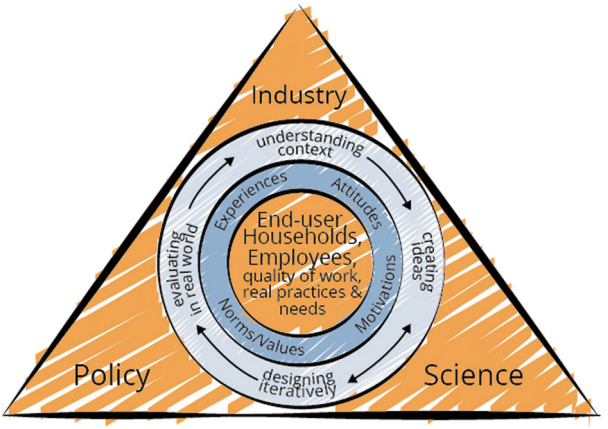
tings primarily for evaluation and innovation purposes, and more private, smaller-scaled household settings (Følstad 2009; Ogonowski et al. 2018). These settings seek to provide a frame for cooperation between researchers, companies, governance, and future users in order to create holistic, sustainable and innovative products.

While methods of participant observation have been applied in workplace studies (Suchman 1987; Hughes et al. 1992) since the 1980s, the penetration of private households for technology research purposes emerged only recently when the trends in ubiquitous computing, home automation and smart homes were demanding a deeper understanding of human practices in private environments. This form of Living Lab supported by ethnographic methods such as diary studies, participant observation or cultural probes can provide a huge variety of qualitative data that may support the researchers in understanding certain practices on a very detailed, personal level as well as in identifying general attitudes, problems and needs (Crabtree 1998).

A specific form of Living Lab that fosters real-world and long-term engagement with research participants is the PraxLabs framework (Ogonowski et al. 2018) as a particular form of the Living Lab approach promoted by the EU in its Open Innovation strategy.[1] The PraxLabs framework combines a mix of methods suitable for research in sensitive contexts and with vulnerable research participants, including ethnography (Randall et al. 2007), Participatory Design (Bratteteig and Wagner 2016) and Value Sensitive Design (Friedman et al. 2008). Within the PraxLabs research framework, end-user participation is given in all phases of the development: (a) during pre-studies in order to find and define requirements; (b) in the reflection of early design prototype versions; (c) during the improvement of the usability and meaningfulness of solutions to end-users, (d) when testing in practice to provide continuous feedback during use (Ogonowski et al. 2018) (see figures 1 and 2).

1 https://praxlabs.de/.

Figure 1: PraxLabs approach



Source: Praxlabs.de, Praxlabs Universität Siegen (2021)

Figure 2: Qualitative Methods in Practice-based IT development

Source: Praxlabs.de, Praxlabs Universität Siegen (2021)

The further away an anticipated future technology is from established practices, the bigger the challenges for user- and practice-oriented research projects. As a consequence, particular attention must be paid to the question of how representatives of the intended target groups can be actively involved in the research and development processes, especially if there is little or no prior experience with digital media. This requires a careful and continuous dialogue and mutual learning between project participants and the development team (Meurer et al. 2018). For R&D projects for and with older people, despite the increasing sensitivity to real-world contexts, there are still several hurdles that need more attention in the future (Hornung et al. 2017).

Challenges in Participatory Technology Development For/With Older Adults

Methodologies denoted as "participatory" are currently displayed in highly diverse ways and so are any associated activities being negotiated and implemented. Approaches range from relatively simple lists of methods for user integration in Ambient Assisted Living (AAL) projects (Nedopil et al. 2015) to more in-depth reflections on what participation and co-design imply for collaborative settings between academic actors and participants from application fields, and what conditions need to be met for successful implementations (Vines et al. 2015). Technology research in the field of elderly care must take into account aspects of age and diversity as well as the diversity of contexts and life situations (e.g., complex care arrangements, cohort effects) but also the qualifications and digital experiences of users (e.g., technology biographies) (Meurer et al. 2018). These considerations must be differentiated between preliminary studies, co-design, application testing, evaluation, and implementation as well as the design of sustainable learning and appropriation settings and urgently require further methodological development (Joshi and Bratteteig 2016).

Additionally, the discussion of a good life across all life spans, especially in old age, is of special interest in current research. However, these debates are often primarily framed in terms of a health-economic oriented rationality that privileges technology-driven design ideas which lack the acknowledgement of everyday practices, lifestyles, norms and value sets of older adults. Despite a highly vibrant research landscape in the field of digital systems for older people, studies show that the transfer of research and development results has progressed only moderately so far. An important reason for this is often evident in the way older people are "configured" as future users. Neven and Peine (2017) point out two major deficits in design processes for older people: Firstly, the definition of research objectives is often guided by deficit-oriented images of ageing. Older people are therefore por-

trayed as passive recipients of technology. As a consequence, secondly, older people appear as mere "research objects instead of as active co-researchers.

In addition, there is a widespread idea of older adults not being capable any more to learn digital practices and of being generally technology-skeptical. These issues point to barriers to access to digital media, ranging from usability issues to stereotypical and images of age and ageing (BMFSFJ 2020). There are numerous findings in the literature that R&D projects are frequently characterized by technology-centricity and stereotyping images of age (Gallistl et al. 2020).

In addition, Bratteteig and Wagner (2012) point out that "user participation has become important not only in the design of IT, but also in areas such as health care, community development and urban planning." Here, one challenge in Participatory Design emerges as central: overcoming the "asymmetry of knowledge" and creating a "symmetry of knowledge" (Fischer 2000) between the designer/developer, who is aware of the "design space," and the users involved, who are aware of the "problem space." What is needed to create this symmetry is a process of mutual learning (see e.g., Hornung et al. 2017) to establish a shared hybrid space or "third space" (Muller and Kuhn 1993) that extends both – the design space and the problem space – towards the design goal.

Project Example: Participatory Design of ICT and Sensor Technologies with Older Adults in a Rural Environment

Cognitive Village (Kurz et al. 2020) was a R&D Project situated at the University of Siegen that aimed at the exploration and development of ICT and sensor technologies for supporting the quality of life and autonomy of older rural residents. There was the basic assumption that new technologies may offer potentials when being embedded in every-day environments and within the local social networks and organizations. Therefore, one of the central project activities aimed at learning from the everyday practices of older adults in the context of their conduct of everyday life in their rural villages for stimulating design ideas for innovative applications. An interdisciplinary research team at the University of Siegen worked together with a group of older residents, with local service providers as well as with representatives of a church community and a technology company building on Living Lab elements and Participatory Design.

There was a huge contrast between the R&D goals in innovative sensor development and the everyday life worlds of the older residents in the village. Thus, setting up a Participatory Design process at eye-level was highly demanding and faced various challenges: How could we spark interest in the local community for some highly abstract sensor technology ideas? And how could we do this from a

community-based perspective, addressing different societal groups in the village? For addressing these issues, a set of different strategies has been pursued.

The initial contact with the village residents was made through information meetings with key people from the region. Participants were representatives of the municipalities, local associations and the church community, the resident general practitioner and volunteer operators of a recently opened village shop. These people took on two essential functions. On the one hand, they themselves contributed ideas on how digital technology could possibly contribute to strengthening the quality of life of older residents in the context of village communities. On the other hand, they acted as multipliers and intermediaries for sparking interest and motivation in the older residents to engage with the research project.

In several meetings, possible themes emerged, including the use of apps and a home application for fall prevention. This proved to be an interesting anchor point for the project as a whole that resulted in possibilities for using pattern recognition software later on. Engaging in a project on fall prevention appeared interesting to a group of 15 older (62–85 years) residents who joined follow-up workshops with the research team. We introduced off-the-shelf devices, such as smartphones, tablet PCs and bracelets as well as tracking applications which proved to be a common starting point to be of interest to the local elderly residents, but likewise for the researchers. With regular meetings around movement tracking (e.g., step counters), it was a starting point for engaging with the data collected by these applications and for exploring potential practices based on such data that relate to existing interests and habits.

In order to make good use of the technical system – and also to be able to discuss possible future developments with the researchers later on – it quickly became clear to the participants that digital competence and experience with technologies would be necessary. Thus, there was a high willingness to embark on the path of technology use of smartphones, tablet PCs and fitness bracelets which had been provided by the research team within the framework of so-called appropriation cafés (see figure 3) that took place on a bi-weekly basis between 2 and 2.5 hours.

The appropriation cafés thus became the central place for joint technology exploration, use and reflection, which were flanked by meetings and workshops with other local actors. As the older co-researchers' experience with the tools in everyday life increased, so did their interest and competence to discuss other options for use. On this basis it became only possible to test and discuss versions of the pattern recognition software in the joint meetings.

Figure 3: Appropriation café in action

Source: Author's picture

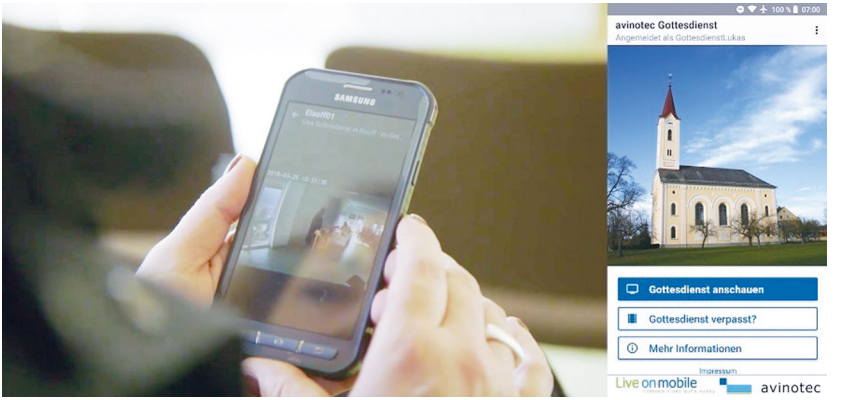
The regular appropriation cafés form a central element of the Participatory Design process established within the Cognitive Village project. Older people want to understand what they can use technology for, so it has to be meaningful for them to embark on the learning journey. However, the creation of meaning does not fall from the sky, but needs certain frameworks, such as the accompanied first steps of using the devices and software and the joint finding of anchor points in the life worlds and interests of the users in conversations and joint explorations with the researchers. Through this dialogue-based joint exploration phase, interests were awakened, motivation strengthened and the necessary media skills for participation in the design process were learned (Struzek et al. 2017).

However, this kind of participatory research is not a linear process when many different groups of actors on the ground as well as an interdisciplinary team work together. A number of ideas were developed, elaborated, discussed and discarded. Some project ideas, however, were implemented in such a way that they are still valid after the end of the project.

After a couple of months, when the constant group of 15 co-researchers had committed themselves as regular research participants, we started to discuss the question of how we could interest more people in the technology exploration process. We were able to create stronger links to the village shop volunteers and the church community. The "core" group started to have fun thinking about how to

make the joint technology exploration process more visible to other older village residents. In some following Participatory Design workshops the group developed ideas on how a church camera for streaming Sunday church services and a digital blackboard in the village shop could be implemented and they took part in an iterative prototyping phase. Both digital systems then had been implemented and the group developed ideas and measures for promoting the new tools among other older adults in the village.

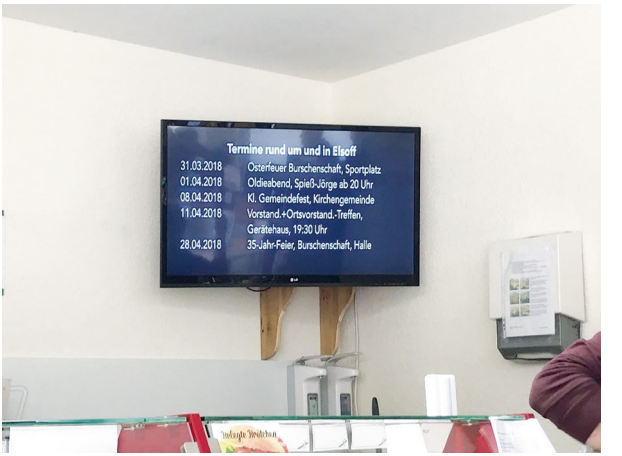
Figure 4: Church camera



Source: „Gut vernetzt im Alter," Arte (2018)

All in all, different lines of development of digital technology had been followed – the "high tech" pattern recognition project as well as the participatory development processes for the more mundane village shop blackboard and the church camera to broadcast Sunday Mass. In the end, this strategy proved successful for setting up a sustainable Participatory Design process which grounded IT development in real-life circumstances of older adults as well as in the social fabric of a local community. The mundane technologies have been handed over to the village shop operators and the parish after the project ended. The part of the pattern recognition project did not end in a market-ready project, which also was not the aim of the R&D funding line. However, the pattern recognition scientists had great opportunities for learning and grounding their algorithm development processes in a real-world setting.

Figure 5: Digital blackboard in the village shop displaying local event dates



Source: Author's picture/aviontec Gottesdiesnt GmbH

Discussion: Grounding Technology Development in Real-World Settings

Participatory Design is time and resource-intensive and thus most often takes place in small-scale settings. Thus, integrating this approach in a Living Lab research design that aims at bringing together a range of different stakeholders in a village poses several challenges.

Firstly, there is the need to bridge between research ideas and goals for "high tech" data-intensive digital technologies (e.g., pattern recognition algorithms) and actual everyday life settings of older adults. How can we talk about future technologies with people who are barely familiar with "simple" smartphones – if at all? How can we at least find some links between algorithm research which most of the time takes place in a lab and real life contexts of older adults which are most of the time not digitized so far? If we wish to take participation and grounding of R&D research in everyday life seriously, we need to be in those contexts and enroll the topic from both sides. The pattern recognition colleagues most of the time stayed in their lab, but from time to time visited our workshops with the older research partners. We as socio-informatics researchers built the bridges between the different stakeholders.

Grounding a technology research project in a local community at first needs to spark interest in the people. Meetings with local "door-openers," i.e. communal

actors, engaged people in local associations and the like are important to talk to at first and let them help to get in touch with community residents.

Next, the aspect of "enabling for co-design" (Hornung et al. 2017) is of utmost relevance if the project wishes to invite older residents for a long-term participation. Our approach in organizing meetings with coffee and cake and providing a comfortable atmosphere provides low-threshold opportunities for getting in touch with each other to negotiate a topic that is of interest to the participants from the viewpoint of their individual life-worlds. In addition, bringing in off-the-shelf devices such as smartphones and tablets and slowly trying out applications in relation to their interests helped in finding anchor points in their everyday life that made technology use interesting to them and helped us in turn to gain a better understanding of their interests and needs. The workshops thus served as learning spaces where a dialogic form of learning could take place between "us" and "them." After several months of getting familiar with the devices and software for their own usage interests, amongst others, the movement tracking applications, they felt familiar with the devices and were eager to think about how they can inspire their fellows and friends about the use of these technologies.

The two other systems were simple technology-wise, but rather complex to be implemented in community structures. The church camera and the blackboard served as "boundary objects" to other older residents who had neglected or hesitated to engage with the project and with digital technology in general. In a joint approach with members of the parish and the village shop volunteers, those systems stayed after the project and might spark reflections and conversations about follow-up projects in the village. At least, these off-the-shelf technologies have helped to establish practice-based options of what digital technology could be used for and provide the ground for a next follow-up project.

Conclusion

Participatory Design and user-oriented IT development approaches are very popular today – however they are used in highly differing ways.

Participatory Design work in a Living Lab setting comes with a lot of challenges, which need to be taken seriously, otherwise there would be no chance to truly ground the research in real-life practices and structures.

Introducing off-the-shelf products as a first step for starting a joint exploration and sense-making journey proved successful. In addition, the implementation of technology in community spaces is being seen as a long-term strategy for sparking interest for a further engagement with the digital world by creating opportunities to explore, experience and talk about the tools to other people in the community.

Having said this, it implies to take on a long-term perspective for the development of community-based strategies for technology introduction, beyond individual project time frames (Meurer et al. 2018). Locally based Participatory Design projects should best be understood as just one step in a regional long-term Living Lab collecting a vast range of experiences and feeding them back into both IT development and community development.

It has been shown that the establishment of common data practices with existing technologies is helpful to develop constructive and concrete visions in Participatory Design processes. Those practices should be considered in their diversity and the interconnectedness of disciplinarity, interdisciplinarity and intersectoral imaginative spaces and practice worlds, when aiming at sustainable implementation strategies.

The chapter also showed that an understanding of cooperation as "mutual making of common goals, means and processes" (Schüttpelz 2017, 24) is helpful to build bridges for sustainable technology development for older people in rural areas between high tech visions and current living conditions. In the future, it will only be possible for a high level of technological innovation to reach the everyday worlds of the target groups and to offer added value as successfully implemented sociotechnical systems by reconciling the visions and also the cooperation ideas of all stakeholder groups involved in the project. In this context, an integrated perspective on technology and community development on the ground is inevitable.

Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 262513311 – SFB 1187 "Media of Cooperation".

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