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Tools for Wools

Learning from and Designing for Urban Knitters

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by

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Abstract

IT enables innovation. But with computing leaving its traditional hardware shapes behind and increasingly pervading daily life, it also changes its scope of application. Change happens not only on a technological or commercial business level, but also in a social context affecting the quality of human life. Current research trends investigating computing as an enabler in the broadest sense therefore also deal with diverse topics such as aesthetics, creativity and civic engagement. Eventually, (ubiquitous) computing enters areas which previously have been separated from the digital world – even such an unexpected one as urban knitting. Also known as yarn bombing, knitted graffiti and guerilla knitting, it is a globally occurring street art trend which uses traditional handicraft techniques to modify objects in public space. With their knitting, crochet or embroidery urban knitters cover fences, street light poles, park benches, trees and outdoor sculptures. These installations can involve large groups of collaborating craftspeople and vary a lot in size, colours, materials and craft techniques. Skipping traditional craft notions of self-reliance and domesticity in favour of public self-expression, it is worth looking beyond the colourful wool at the underlying messages. Urban knitting is the chosen tool of present-day craftspeople for creatively reclaiming urban infrastructure and expressing personal beliefs and standpoints by leaving individual woolly traces as public comments in shared space. This makes urban knitters a very interesting civic group to study in regard to urban participation, which has become an increasingly important topic for research in Human Computer Interaction (HCI) examining the possible role of computer supported community engagement and urban sustainability.

This Master's thesis therefore deals with the question how the expressiveness of urban knitting can be enhanced by interaction design. It presents a design project which aimed for revealing the narratives inherent in the physical craft artefacts and resulted in the construction of a digitally augmented installation. The research process was characterised by a methodological application of research through design and comprised intertwined and iterative phases of exploration, prototyping and reflection. Thus, the pursuit of technological innovation facilitated learning from and designing for urban knitters: A comprehensive qualitative investigation identified appropriate aspects in existing urban knitting practices for possible IT enhancement. Different user research methods were applied both on an online and face-to-face-level in order to collect rich qualitative data. Subsequent analysis informed the conception of an interactive prototype that integrated physical wool panels, touch sensors and an information device to provide a novel information infrastructure which makes the stories behind the knitting more accessible for the interested public. The final evaluation of this system consolidated the lessons learnt from previous exploration and design phases and added to the understanding of urban knitting as an everyday-creative form of civic intervention.

Kurzfassung

Informationstechnologie ermöglicht Fortschritt. Seitdem Computer aber zunehmend ihre traditionellen physischen Formen verlassen und immer mehr Alltagsbereiche durchdringen, haben sich auch die IT-Anwendungsbereiche stark verändert. Diese Veränderungen sind nicht nur auf technologischer und kommerzieller Ebene spürbar, sondern auch im gesellschaftlichen Kontext. Aktuelle Forschungstrends untersuchen daher Technologie als ein Hilfsmittel im weitesten Sinne. Auf diesem Wege erreicht die Rechnerallgegenwart (Ubicomp) auch Bereiche, die zuvor nur wenig mit der digitalen Welt zu tun hatten. So auch Themen wie Ästhetik, Kreativität, Bürgerengagement und Interventionen im öffentlichen Raum – und somit auch Strickgraffiti (Urban Knitting), einer global auftretenden Form von Straßenkunst, die traditionelle Handarbeitstechniken nutzt, um Objekte im öffentlichen Raum abzuändern. Mit Gestricktem und Gehäkeltem bedecken StrickgraffitikünstlerInnen Zäune, Straßenlaternen, Parkbänke, Bäume und Statuen. Ihre Installationen beruhen häufig auf der Zusammenarbeit großer Handarbeitsgruppen und variieren stark in Größe, Farbe, Material und angewandter Technik. Während traditionelle Werte wie Autarkie und Häuslichkeit zugunsten von öffentlicher Meinungsäußerung in den Hintergrund rutschen, lohnt sich ein Blick hinter die farbenfrohe Wolle auf die unterschwelligen Botschaften. Strickgraffiti ist das kreative Mittel, mit dem moderne HandarbeiterInnen die Gestaltbarkeit des öffentlichen Raum postulieren und ihre persönliche Weltanschauung individuell ausdrücken. Dieser Umstand macht sie zu einer attraktiven Gruppe zur Erforschung von Bürgerbeteiligungsprozessen und urbaner Nachhaltigkeit, einem Thema, das auch in der HCI-Forschung Einzug gehalten hat.

Die vorliegende Arbeit beschäftigt sich daher mit der Frage, wie Strickgraffiti und dessen Ausdruckskraft durch Interaktionsdesign unterstützt werden können. Es wird ein Designprojekt vorgestellt, das die Enthüllung inhärenter Narrative von physischen Handarbeitsstücken anstrebte und zur Entwicklung einer digital erweiterte Installation führte. Der zugrundeliegende Forschungsprozess war vom “Research through Design”-Konzept gekennzeichnet und umfasste drei ineinandergreifende Projektphasen von methodenbasierter Erkundung, Prototypenerstellung und Reflexion. Auf diese Weise führte das Streben nach technologischer Innovation zu Wissenserwerb auf inhaltlicher, technischer und methodischer Ebene: Eine umfassende qualitative Erörterung ermittelte Unterstützungsmöglichkeiten innerhalb aktueller Strickkunst-Praktiken. Die anschließende Datenanalyse führte zur Konzeption eines interaktiven Prototypen, der Handarbeitsstücke mit kapazitiven Berührungssensoren und einem Anzeigegerät kombiniert, um die Geschichten hinter der Strickkunst offenzulegen. Die abschließende Evaluation konsolidierte die gewonnenen Erkenntnisse und trägt zu einem umfassenden Verständnis von Strickgraffiti als eine Form von kreativer Bürgerintervention bei.

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CHAPTER 1

Introduction

This Master's thesis takes up present-day tendencies of pervasive computing. Information and communication technologies have become an omnipresent part of Western urban daily life and the artefacts in our surroundings increasingly connect to the so-called internet of things (IOT). Mark Weiser coined the term *ubiquitous computing* in 1988 when he wrote an influential journal article [89] about his vision of personal computers being replaced by intelligent objects and vanishing into the background. The article starts with the following sentences:

> *"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."* [89, p.3]

While Mark Weiser used a textile reference as an elegant metaphor for the seamless integration of technology into everyday objects, handicraft is literally the chosen application context of the thesis at hand. In fact, this work is about IT-facilitated enhancement of a specific handicraft practice called urban knitting and explores it as an instance of technology invading areas of everyday life which previously had been separated from the digital world. However, progressive IT integration is seen here as a positive endeavour as long as it is accompanied by an accountable design process. This is why this Master's thesis describes an inductive design project in the thematic context of urban knitting which involved mixed methods exploration, iterative prototyping and critical reflection. The outcome of this project was an interactive textile installation of knitted, crocheted and woven art, an instance of ubiquitous computing in terms of a technical means to enhance a given physical object and to reveal its implicit messages and inherent narratives.

The following introduction describes the thematic context of the thesis work in greater detail before summarizing the identified opportunity for enhancement through design, the project's methodological approach and the most important contributions. Outlining the basic motivation, research questions and findings, which guided the design procedure, will enable the reader to understand the big picture drawn by the interrelated project phases.

1.1 Making in the Digital Age

The design project which is described in this Master's thesis is related to current work investigating the meaning of *making* in the broadest sense. As a basic principle, *making* is one of the defining characteristics of human-beings [41]. Throughout human history people have always been making things for improving their daily life, for economical reasons or just because they like to do so. *Making* can induce feelings of empowerment [56], which might be one of the reasons for the recent trends of do-it-yourself (DIY), hobby crafts and maker cultures. Even though the economical structures and the general standard of living in modern Western consumer societies have relieved the individual from the necessity of self-supply, more and more people tend to do certain things themselves [68, 87]. Different types of makers ranging from traditional crafts, handwork, computer-based creativity and hacking grow vegetables in urban areas, build their own furniture, "upcycle" clothing from past fashion trends, code open-source software, create customized objects with 3D printers and laser cutters in so-called "fab labs" or smart up their close environments with micro-controllers and sensors without actually really needing to do so.

Their motivations are clearly manifold. Besides the good feelings to make something with the own hands [56] and the joy of artisan self-expression [4], it also can be a deliberate statement of engaging critically with the objects and artefacts around us [2, 50, 81, 86]. Most people in Western service societies play the role of consumers in a globalised world economy and are sealed off from the producing industry. Through making something themselves they become aware again of the different steps involved in a production process. *Making* implicates not only learning the skills required to manufacture certain objects but also experiencing the amount of work and effort. Turning into (momentary) makers offers therefore new perspectives, and eventually, a hobby knitter who spends some weeks on a pullover pattern might start to question the consequences of the cheap prizes for comparable products at a fashion discounter [85].

However, all these forms of *making* mentioned above result in artefacts which serve practical purposes. The created objects are normally intended to be used in everyday life and to be owned by the creator (or by a friend or relative if given away as a present). This is not the case with a contemporary handicraft called "urban knitting". This particular instance of craft, which will be dealt with in the Master's thesis at hand, is significantly different in this respect and diverts critical making from the practical priorities of DIY towards a tool for public expression.

1.2 Urban Knitting

There is no official definition for urban knitting (just like for most popular cultural phenomenons) but it can be briefly stated as an intersection of handicraft and street art. It is a form of everyday creativity which uses shared public space as its stage. But unlike conventional graffiti artists urban knitters don't work with spray cans. Instead they use yarn, fibres and traditional techniques such as knitting, crochet and embroidery for creating their colourful installations. Classical examples of urban knitting are street light poles, park benches and trees partly or completely covered in knitting. But also more complex objects such as statues, cars, bikes and even buildings have been reported to be knitted up. The installations vary a lot in size, colour, material and craft technique. Urban knitting could be a single granny square subtly wrapped around a small

tree in a park just as well as large-scale monochrome cosy covers for all trees in a boulevard. At the same time, these projects vary a lot in the number of contributors ranging from one single craftsperson to hundreds of craftspeople collaborating together.

Figure 1.1: Examples of urban knitting installations[1]

[1]Photos by jackmac34 (top left, CC0), Rebes (top right, CC BY-SA 3.0) and author (bottom left and right)

According to many newspaper articles, blog posts and non-scientific books[2] urban knitting is reported to be invented by Texan shop owner Magda Sayeg[3] in 2005, when she knitted up a door cosy for her shop. Considering the work of artists such as Rosemarie Trockel, Janet Morton and Freddie Robins who had already used knitting as their chosen medium to create art with, it might not be completely eligible to give her the full credit of the idea to cover objects in yarn. However, Sayeg's ever growing installations together with her knitting crew "Knitta Please" gained much popularity in online and offline media and images of her knitted up trees, sculptures, caravans and coaches were frequently featured across the globe. Additionally, this form of knitted art presented itself as a very inclusive and participatory activity open to join for anyone who can knit - as opposed to the often very exclusive seeming nature of the Fine Arts. This inspired hobby knitters all over the world to become active themselves and establish their own local urban knitting groups. In this manner urban knitting has become a global street art trend. Since it was "invented" in Texas in 2005 it first spread in the world's metropolises such as London[4] and New York[5] and eventually arrived at many small towns and villages too (eg. Aviles in Spain[6], L'Aquila in Italy[7] and Clovelly in England[8]).

1.3 Yarn Bombing, Guerrilla Knitting, Knitted Graffiti

As a popular cultural phenomenon without any standardizing instance or official guidance many different names have evolved for urban knitting which are more or less synonyms for the same thing. While the Guardian wrote about guerrilla knitting[9], the New York Times covered it under the term yarn bombing[10]. The corresponding Wikipedia article[11] also mentions yarn storming, kniffiti, graffiti knitting and urban knitting as further synonyms. All of these words designate textile installations in public space but each of them highlights different aspects of the common activity. Some sound more rebellious than others while some focus more on the used material or a specific handicraft technique.

At this point it shall be mentioned that in this Master's thesis I deliberately favour the term "urban knitting" for referring to any form of this craft-based street art trend. In my point of view this name suits the phenomenon the best because it emphasizes the modernity and adaptability

[2] Eg. the Guardian article http://gu.com/p/25gmy/sbl, the blog post http://www.blouinartinfo.com/contemporary-arts/article/37853-the-wild-and-woolly-world-of-yarn-bombing-street-arts-soft-sensation and the book "Yarn Bombing. The Art of Crochet and Knit Graffiti." (www.leanneprain.com/writing/yarn-bombing) by Mandy Moore and Leanne Prain (All links accessed: 19.7.2015)

[3] `http://www.magdasayeg.com/` (Accessed: 19.7.2015)

[4] Knit the City: `http://knitthecity.com/` (Accessed: 19.7.2015)

[5] Olek: `http://oleknyc.com/` (Accessed: 19.7.2015)

[6] `http://arenasmovedizas.org/beta/project/proyecto-2/` (Accessed: 19.7.2015)

[7] `http://italychronicles.com/patching-laquila-after-earthquake/` (Accessed: 19.7.2015)

[8] `http://www.clovelly.co.uk/clovelly-events/clovelly-yarn-bombing` (Accessed: 19.7.2015)

[9] `http://gu.com/p/25gmy/sbl` (Accessed: 8.7.2015)

[10] `http://www.nytimes.com/2011/05/19/fashion/creating-graffiti-with-yarn.html` (Accessed: 8.7.2015)

[11] `http://en.wikipedia.org/wiki/Yarn_bombing` (Accessed: 8.7.2015)

of craft in an urban context rather than the more or less humorously martial notion of a knitted revolution (as for example guerilla knitting or yarn bombing might suggest). However, I am aware that other terms might be more popular and that also "urban knitting" as a term clearly has its advantages and disadvantages. But still, compared to the other synonyms the simple combination of the two words "urban" and "knitting" puts the constant reinvention of craft best in a nutshell and communicates that the involved craft practices embrace up-to-dateness and are open to individual reinterpretation by striving to strip off traditional connotations (such as the expectation that knitting only takes place at home). The term highlights how knitting can become a performative act by modifying objects of urban infrastructure. However, at the same time it doesn't explicitly acknowledge other craft techniques such as crochet or embroidery which are also often used for creating such installations. The most correct term would probably be "urban handicraft", but in order to stick with any of the official terms I intend to prioritize urban knitting (while using the other words sometimes as synonyms) without meaning to diminish any craft techniques that could be possibly involved in the designated practices.

1.4 Creative Civic Engagement

Beyond its colourful and soft surface, urban knitting has a significantly meaningful core and should therefore be understood as a remarkable form of creative expression. Suiting the adaptability of handicraft urban knitters are very flexible in their choice of particular targets. Size and shape of the public infrastructure often don't matter as much as its location or perceived meaning. With a little preparation and advance measuring urban knitters can create perfectly fitting "tree sweaters"[12] with sleeves for branches for trunks and branches of any size. However, with this adaptability granting them more freedom of design for new installations, their eventual selection will be most certainly made out of a specific reason corresponding with individual motivations. In addition, each urban knitter might have a different reason to engage in crafted graffiti. For some it might be a feminist attempt to make the formerly invisible domestic work of housewives visible [85]. For others it might be a comprehensive "craftivist" tool[13] to address other political and social issues. Hence, urban knitting is often very meaningful in terms of its inherent symbolism. It consists of carefully produced physical artefacts which don't only emerge from the opinions, thoughts and emotions of their creators but also serve as their public comments.

Urban knitting can therefore be understood as the chosen tool of present-day craftspeople for creative expression in public. No matter if the statements are of an aesthetic, feminist, political or social nature, their installations are interpretable as visible interventions which originate from the creators' motivations to criticize and make a change. In this respect, urban knitters represent a new generation of emancipated craft enthusiasts who not only confidently redefine their craft and tools for their own purposes but also reclaim shared urban space as an open stage for public

[12] `http://archive.redshirtknitting.com/?page_id=271` (Accessed: 9.7.2015)

[13] Craftivism as a combination of craft and activism was defined by Betsy Greer on `http://craftivism.com/craftivism-definition/` (Accessed: 19.7.2015)

discourse. But in contrast to spontaneous graffiti throw-ups[14] urban knitting takes a lot of time (and usually doesn't damage public property). Hence, the given topic of discourse must seem important enough and the personal opinion urgent enough to invest the effort. At the same time, the numerous hours of craft work will allow the creators' standpoints to reach a mature and consolidated state. The resulting installations are therefore often full of personal narratives and strong attitudes which are more or less implicitly woven into the artefacts.

1.5 Motivation

Political systems based on the principles of democracy rely on public discourse and active civic participation (cf. Jürgen Habermas's theory of deliberative democracy [37]). Governance can be expected to be most sustainable if it is based on solid opinion making processes of the voters. Additionally, the last decades have shown increasing tendencies to improve democratic systems by involving the citizens more directly. Several initiatives have been undertaken to increase direct democracy and in many cases it has been facilitated by e-government systems and online voting systems. These can be extremely powerful tools, especially on a local level where the topics are more easy for the voters to relate to.

City councils are therefore very interested in supporting civic engagement and local communities. Direct democracy can not only reduce administrative costs but can in the long run contribute to more sustainability and prosperity of cities. Currently, the councils' support is often provided in form of institutionalised distribution of funding and local service provision, but much more innovation is needed in order to unleash the full capacities of participatory municipality and to transform citizens from traditional service consumers into empowered decision-makers. This is where scientific research comes into play. In fact, there are currently several research initiatives within the domain of Human Computer Interaction (HCI) which actively discuss the potentials of technology and design in communities. New keywords and visions have been introduced such as Urban Informatics [25] and Digital Civics [64] which are promising starting points to facilitate innovation.

However, innovation can only come from looking at and experimenting with alternative forms of the status quo. In respect to identifying ways to successfully having people engaged in and contributing to public discourse, it is also worth looking at creative civic engagement such as urban knitting practices and investigate its expressive capacities in relation to IT as a facilitator. Being constantly around for almost 10 years, urban knitting has proven to be rather a movement than a short term craft hype. With many of their practitioners proudly calling themselves "craftivists" it should be discussed as a special form of opinion making and expression [15]. Therefore, it should also be examined through the lenses of HCI and interaction design, how these creative capacitive can be enhanced by technology.

Besides this general relevance for the HCI research domain, I should mention that I also have a personal motivation for choosing specifically urban knitting to investigate as a form of creative civic engagement. Being a hobby knitter myself I have taken part in different urban knitting projects every now and then for the last few years. It is a topic which I'm well-acquainted to and

[14] Throw-up or throwie are graffiti slang words for quickly executed tags. Cf. `https://en.wikipedia.org/wiki/Glossary_of_graffiti` (Accessed: 19.7.2015)

which I personally relate to as a skilful, sociable and rewarding pastime. My positive attitude towards knitted graffiti is based on my personal experience with its techniques and work flows, which I gained during my own projects and workshops, as well as on my knowledge about common practices in this field, which I have observed collaborating with other urban knitters. This background was expected to be quite helpful and beneficial for the work on this thesis.

1.6 Context and Aim of the Work

Having described the most significant characteristics of urban knitting and how it relates to current HCI research interests, the context of this work can be summarized by three main aspects:

- **IT developments** in terms of tendencies towards pervasiveness and connectedness
- **HCI research** exploring civic engagement, urban sustainability and everyday creativity
- **Urban knitting** as a craft and street art practice

While the first two aspects originate from computer science-related research, the latter one is based in popular culture. In this respect, it can be stated that urban knitting sets up the thematic context of this project which gains significance in consideration of current HCI research interests. At the same time the envisaged design realisation stands in the tradition of ubiquitous computing and seeks for a different implementation than standard PC software.

The threefold context is reflected in the over-all research question of this thesis: *"How can interaction design enhance urban knitting in an appropriate way?"* Guided by this research focus and building on related work on IT-enhancement of craft, everyday creativity and urban engagement, this Master's thesis aims to provide the design of a smart equivalent for urban knitting.

However, following a transformative research paradigm design is understood here as an act of critical intervention which needs to be discussed in its detailed context in order to assess its significance within the problem space. This view on design-oriented research implicates to base design decisions on accurate knowledge of the different characteristics, needs and wishes of the user groups to design for as well as to critically reflect on the outcomes in order to state achieved benefits and shortcomings. In a nutshell, it is important to get to know the people involved first before a suitable design idea can be generated and assessed.

1.7 Methodological Approach

Such a holistic approach to the over-all research question and the involved design task required to stretch the project over several phases with different respective intermediate research interests. Figure 1.2 outlines the three project phases together with their respective research questions and contributions.

Both the pragmatic and transformative research paradigm favour the use of a diverse set of methodological tools [54]. The use of mixed methods is believed to strengthen the quality of research outcomes [44] even though the obligation to combine heterogeneous results might

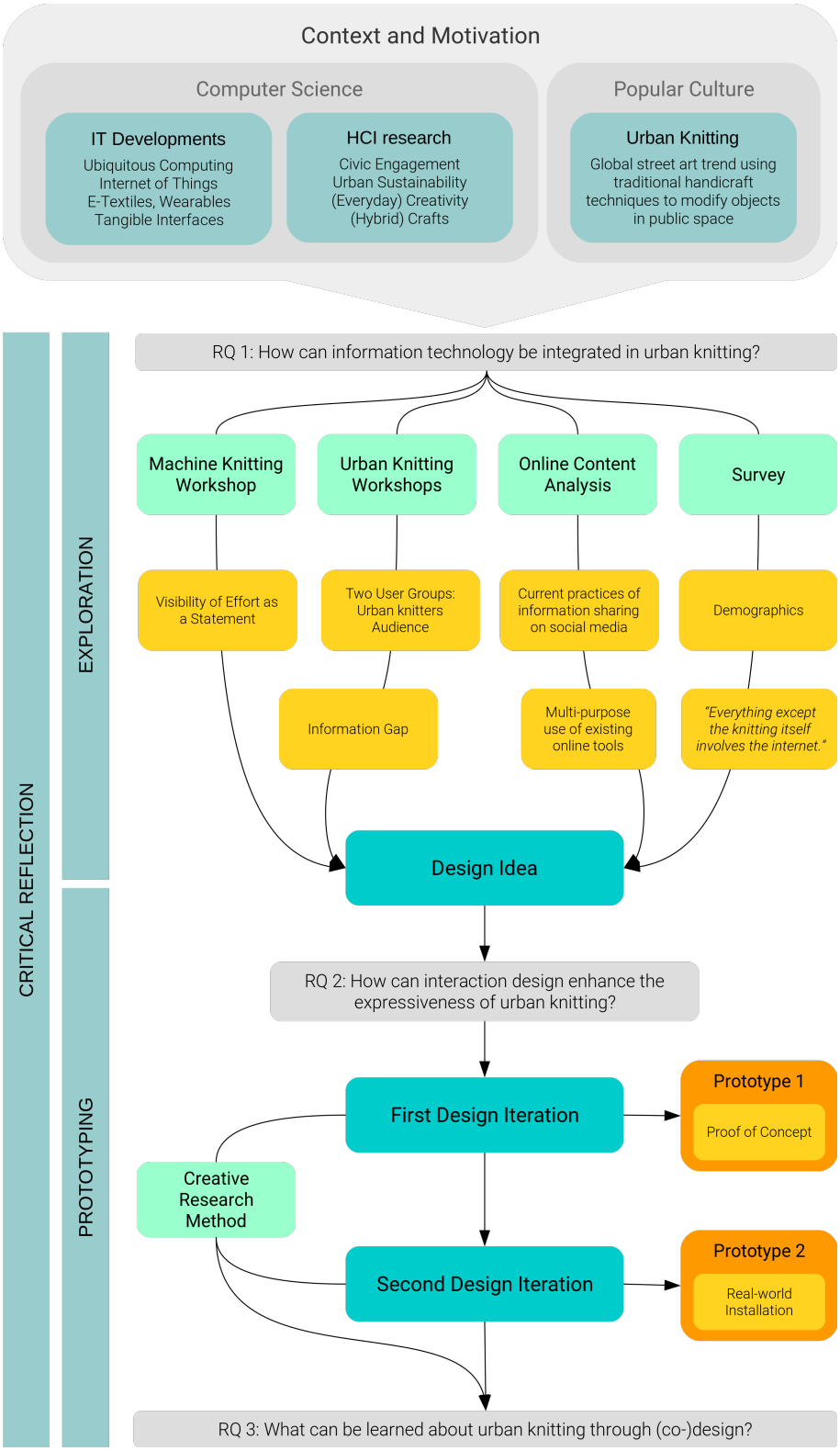


Figure 1.2: Outline of the methodological steps and project phases

make the sense-making process more complex. Each method has its strengths and weaknesses compared to each other [35,44] and each of them is suitable to answer different types of research questions. By taking the time to sequentially applying different methods, collecting different data sets within the same problem space and putting these pieces together as fragments of a bigger picture, seemed to be a promising approach to meet the requirements of well-informed design. This fact was considered when deciding which particular method was appropriate for which project phase in order to satisfy the above mentioned research interest. Since the nature of the overall research question is qualitative, the applied methods collected a foremost qualitative data set. Quantitative data was not excluded by paradigmatic reasons, but it didn't suit most questions asked during the project. When it was applicable, an additional quantitative analytical perspective on the gathered data was introduced.

1.8 Statement of the Identified Design Opportunity

While the exploration phase used a very open inductive approach to investigate the design context without any a-priori assumptions, its result was the concrete decision on a specific design opportunity. This work started out by focussing on urban knitters as its primary target group, but the identification of the information gap between them and their public audience opened up the design space: Previous sections of this introduction already explained how personal narratives, opinions and motivations are an inherent part of urban knitting installations. However, the semantic content of urban knitting faces a problem of ambiguity in the eye of the beholder. The resulting artwork often isn't self-explanatory and hence subject to the individual interpretation of the spectator passing by. At the same time most of the information concerning the context of the creation process largely remains unknown and inaccessible for the public audience.

This is of course a problem shared with other forms of Fine Art, since art is most of the time far from self-evident. A key difference though is that, when exhibited in a gallery or museum, there is usually infrastructure to explain pieces of art in regard to the context in which it was created. Labels or exhibition catalogues tell basic biographic data of the artists and reveal integrated statements and background stories. As it became clear during my observations at urban knitting workshops (cf. chapter 4), an equivalent information infrastructure would also be desirable for making urban knitting more accessible to non-involved passers-by. It was therefore determined to come up with a design that attempted to facilitate direct information exchange between the two groups.

At the same time, the design of such an information system should adapt to the existing practices, respond to the artists' needs and wishes and refrain from interfering with cherished analogue aspects of handicraft. Urban knitters pursue their hobby both on a physical and virtual level in order to plan, create, document and present their pieces of art. They use social media to connect and communicate with peers, online pattern generators for customizing designs and sometimes even CAD-applications to organize and distribute work on more complex installations. This general openness towards high- and low-fidelity tools offers a broad bandwidth of possibilities how and where to integrate a design within the processes of the given problem space. Still it is needed to act with caution in order not to overwhelm urban knitters with any unwanted technologies in any aspects of their practices in which they tend to deliberately prior-

itize the hand over the machine. In many ways urban knitters can be expected to be competent and enthusiastic users. Digital devices and information technology is just as an important component of their everyday life as of any other present-day persons. However, it still is to expect that they constitute a particular user group in terms of a more critical perception of and approach to introducing technologies in the context of their craft activities.

1.9 Research Questions and Contributions

Exploration

Research Question 1: How can information technology be integrated in urban knitting?

The first phase of the project intended to develop a comprehensive understanding of the people involved in urban knitting as user groups to design for. A mixed methods approach was applied including participant observations, an ad hoc questionnaire, online content analysis and an online survey.

The main contributions of this phase were as follows:

- Besides urban knitters another user group was identified for future design: their public audience. Between these two groups there is a information gap. Non-involved spectators often don't understand what the installations are about.
- *"Everything except the knitting":* Internet and IT are used by urban knitters for many different purposes. However, they also set deliberate limits to technology integration. Manual effort adds value to their crafted installation and is an important part of the (political) statement of urban knitting. Design should therefore not interfere with the manual craft production.
- While urban knitters show interest in sharing documentation of specific urban knitting projects online, this kind of information is not easy to find for non-involved installation spectators.

Design / Prototyping

Research Question 2: How can interaction design enhance the expressiveness of urban knitting?

After expanding the focus on two groups in relation to urban knitting practices by including the audience and identifying a distinct informational gap between them as the central opportunity to work on, the following project phase was about generating a concrete design idea and realizing it in form of a testable prototype. Design explored ways how spectators can receive contextualised information specific to an urban knitting installation, as well as how an information infrastructure is able to initiate a more active engagement of the spectators with the installation. Interaction was intended to become as direct and immediate as possible without interfering with the craft design by the urban knitters.

The main contribution of this phase was the implementation of two interactive prototypes which used capacitive touch sensors attached to the craft panels to augment urban knitting. Touching a panel connected to a smartphone app which provided specific information according to the selection. While the first prototype served as a proof of concept, the second one was a real-world augmented installation measuring 175 cm x 120 cm and comprising craft contributions from 26 urban knitters from seven different countries.

Evaluation / Critical Reflection

Research Question 3: What can be learned about urban knitting through (co-)design?

Critical reflection accompanied the whole thesis work. Evaluation at different stages of the project dealt with questions such as:

- What do urban knitters and non-involved spectators think of the design outcome?
- Which benefits were achieved through design? Which shortcomings could be observed? How could they be improved in future work?
- How can the achievements and shortcomings be related back to specific design decisions?

In course of the project also the information capacities of such a prototype design was recognised, which facilitated further analysis of urban knitters, their motivations and world-views. As an instance of research through design the participation of urban knitters allowed its discussion as a creative research method and exploration of the question: What could be learned about urban knitters by creating an installation together with them? In this way, several inciting factors could be identified in this work. The findings also enabled a discussion of the political capacities of urban knitting and how the suggested design helps to reveal these to the broader audience.

1.10 Outline of the Master's Thesis Structure

The chapters of this work are organized as follows: Chapter 2 identifies and discusses related literature. This covers on the one hand publications from other domains which directly deal with urban knitting and on the other hand specific HCI discussions of topics which can be understood as relevant components of knitted graffiti. Chapter 3 presents the methodological approach in greater detail, outlining its basic strategy and the specific project structure. Furthermore, it relates the thesis philosophically to transformative critical theory and describes the project's progress from a user-centred design approach to an instance of research through design. The following chapters document the three intertwined project phases of exploration (chapter 4), prototyping and design evaluation (chapters 5 and 6). At each of these stages main findings will be presented, accompanied by the attempt to integrate them into the bigger picture. The general results of the project will be discussed in chapter 7. Besides highlighting identified achievements and shortcomings of the design, the implemented system and its interventionist role in the context of urban knitting are reviewed in relation to the theoretical model of the

historical Arts and Crafts movement. Finally, chapter 8 concludes by summarizing the main implications and taking a look at potential future work.

CHAPTER 2

Related Work

Urban knitting is a special topic which has not found a lot of attention in scientific research yet. Neither computer science nor other scientific domains seem to have recognized the implications of this crafty form of cultural activism as immediately relevant for their respective research interests. To my knowledge, there have been only very few academic attempts to deal specifically with urban knitting through an analytical lense. These rare pieces of specialized literature are listed and critically reviewed in the beginning of this chapter. However, due to the lack of specific literature the remainder of the related work discussion builds on publications which do not directly deal with urban knitting but which are still pertinent if such activities are viewed as an intersection of crafts, street art and urbanity. These are all topics which have been examined in the field of Human Computer Interaction (HCI), and therefore it will be possible to filter out some important issues from related work which should also be applicable for crafted graffiti.

2.1 Urban Knitting across the Disciplines

Urban knitting is a novel topic to HCI-related research and it is necessary to expand the literature review on other domains. While the work on knitting and crochet in general is growing (even in respect to IT and computer science), very few papers, theses and other publications address this specific form of handicraft. There are several digital tools on the market comprising software, smartphone apps and specialised social networks which assist people in their respective handicraft projects. However, designers and IT developers are reluctant to develop similar specialised tools for urban knitters whose activities go beyond the mere craft process. Since urban knitting is rarely piceked out as a central theme for scientific research or technological design, only three pieces of literature could be found in course of my literature review[1], which directly deal with urban knitting:

[1]The literature search was conducted on different online databases: `http://dl.acm.org/`, `http://ieeexplore.ieee.org/Xplore/home.jsp`, `https://scholar.google.at/` and `http://catalogplus.tuwien.ac.at/primo_library/libweb/action/search.do?vid=UTW` (All links accessed: 23.7.2015)

- *"The role of the Internet in the urban knitting movement"* [23] is a refereed paper by Farinosi and Fortunati submitted at the CIRN Community Informatics Conference in 2012. On the basis of an ethnographic case study of an urban knitting initiative in the Italian small town of L'Aquila, they present the results of their observations and argue that the internet serves as a facilitator and promoter in relation to urban knitting.

- Joanna Mann's journal paper *"Towards a politics of whimsy: yarn bombing the city"* [55] published in 2015 takes a different approach and illustrates the meaning of irrational frivolity for micro-political change by the example of yarn bombing.

- Minna Haveri from Aalto University's School of Art, Design and Architecture wrote a paper about urban knitting as a contribution to the Cumulus Northern World Mandate conference in 2012. It's titled *"Urban Knitting – the Soft Side of Street Art"* [39] and presents her research on Finnish soft art including photos, interviews as well as her examination of the use of craft techniques as a form of artistic expression.

All of these three publications deal with urban knitting as the specific contextual setting for different aspects relevant for their associated scientific domains. While Mann focusses for example on shared public space by discussing the implications of unexpected whimsical object modifications within urban landscape, Farinosi and Fortunati's considerations highlight the variety of online activities which accompanied a specific installation project. In contrast to these quite specialised approaches Haveri provides a rather general portray of urban knitting as a form of soft public art with activist capacities. It is apparent that there is much freedom for the researchers to individually define the most relevant characteristics according to their focus and rephrase them in respect to their research goals. This might be a legitimate step considering the non-standardized nature of the subject as an informal popular cultural movement, but it would be desirable to see a broader consensus to further build on it.

However, the following characteristics are mentioned in all three papers:

- Urban knitting varies a lot in its visual appearance (eg. large/small, colourful/monochrome, etc.) but it always uses fibre materials and handicraft techniques to produce fabrics which are then placed in public space.

- Craft is used as a reference to tradition. This connotation can serve as a feminist comment, a way to connect with different generations or a strategy to embody a more constructive image than regular graffiti spraying which is associated with vandalism.

- Urban knitting is a joyous and fun activity which often results in textile object designs which are full of humour and irony.

- Besides the physical installations which are located in public space, a part of urban knitting is also taking place online.

- There is a strong social component in urban knitting practices. With the installations themselves being social objects, knitters connect, form communities and meet in order to engage in urban knitting together.

Moreover, all three publications acknowledge a certain political dimension of yarnbombing. However, the views differ in specifying this activist component. While Farinosi and Fortunati see it as an explicitly political instrument located somewhere within the four dimensions of domesticity, street art, DIY culture and urban guerrilla protest, Haveri and Mann also refer to a more implicit activist nature. Haveri spots it being inherent in urban knitting's *"exciting shape and location"* [39, p.12] whereas Mann refers to *"a different form of politics [which] is unintentionally being enacted through the presence of whimsy"* [55, p.66]. Both notions arise through the performative staging of the installations as the unusual combination of craft and urban space, but it remains uncertain if this is a deliberate act by the artists or not.

Having filtered out this common ground from the cross-disciplinary literature, the following sections will add knowledge to it from specific HCI research. However, since this domain has not addressed the topic directly, it is necessary to take a look at some basic components individually and deal with them as fragments of a greater picture. In this manner HCI-related accounts of crafts, street art and civic utilisation of urban space will be summarized and discussed.

2.2 Crafts in HCI

The past few years have seen a growing body of HCI work exploring the intersection of digital technologies and traditional crafts. Numerous publications explore book binding, furniture making, drawing, gardening and handicraft. It might be a bit surprising to see such big interest in a topic which doesn't have anything to do with digital technologies at first sight. However, this initial impression is misleading. Daniela Rosner, who has been one of the most active HCI researchers in this area, described a practical convergence of the two reputed opposites: *"From home improvement to scrapbooking, leisure activities performed 'by hand' increasingly involve digital tools. In turn, software and devices to support handwork are proliferating."* [33, p.2257] Many of the craft-related publications elaborate therefore on the potentials of the DIY movement for HCI [2, 4, 10]. Not only because these often share the same technologies and means for the production of prototypes [81], but also to explore craftsmanship as a valuable source of information for enriching design processes involving future users [6, 13, 66] or for identifying new ways of teaching/learning computer science and interaction design [45, 62].

Naturally, Rosner's studies of knitting [2, 33, 57, 70–74] are of major relevance for this thesis on urban knitting. They are very good recent examples for acknowledging the potential of traditional handicraft for informing computer science and interaction design. Her design suggestions are very careful not to interfere too much with the original practice. Instead, they tend to offer functionality which the users are often familiar with from other situations (eg. annotating) and which are unobtrusively embedded into the craft activity. *Spyn* [70, 70, 72–74] for example, is a system which captures and retrieves information using the knit artefact. The basic idea was to *"[augment] existing creative practice to enhance the sharing of the handcraft process"* [73, p.340].

There also have been other attempts to enhance or improve handicraft activities such as *metamoCrochet* [63] or *Movement Crafter* [66]. Smith et al. [79] experimented with direct sonification of gestures by adding a motion sensor to the crochet needle. The motion was translated to sound which according to the researchers *"helped practitioners to understand and reflect*

upon their own and each other's practice, encouraged discussion and enabled modification of craft technique" [79, p.67]. Other designs went the other way round and had the technology embodying aspects of the craft. Hudson created for example a 3D printer using needle felting technique in order to "print" Teddybears which had a hand-made aesthetic [40], and Wang et al. tried to create a sense of "powerlessness" and stimulate imagination and cultural consciousness with the aid of touch-reactive embroidered artefacts similar in its visual appearance to traditional embroidery [88].

As we have seen there is a lot of HCI work on hybrid crafts, crafts enhanced by technology and technology improved by craft. There are also several debates on a more meta-physical level discussing how craft practices can also inform design in general [6, 82, 90]. However, these discussions will not be discussed here in any further detail. At this point, it is important to realize the many possible combinations of physical craft and digital information. While seeking for a novel hybrid design, designers should act carefully and respect craftspeople's choices where they want to stick with their traditional manufacturing techniques and where they allow technological innovation to happen. As Cheatle and Jackson state, *"[...] the introduction of new computational tools into longstanding and craft-based forms of creative work carry deep implications: both for the experience and organization of work and the values that surround it."* [17, 968]

2.3 Street Art in HCI

Street art is another topic that has been addressed by HCI literature. However, this has happened far less frequently compared to the numerous papers in the context of crafts. Within the past ten years a modest number of publications and research projects have picked up the theme of self-authorized visual markings of urban infrastructure, but in contrast to the vivid critical discussions surrounding crafts existing approaches referring to street art depict it rather fragmentary than holistic. In fact, most papers deal with it almost exclusively in the form of graffiti (cf. [16, 27, 58, 59, 77]) and thereby reduce it on a single subcategory. While the aspects of location-basedness and illegality are foregrounded, the different levels of artistic sophistication, the large range of applied techniques and the diversity of used materials (including stickers, tiles, soap, flower seeds, yarn and wool) is completely ignored. The work surrounding the *MobiSpray* light installations by artist Jürgen Scheible [76, 78] concedes a certain degree of creativity to graffiti, but it still constrains it as a form of purely visual art (which is therefore non-tactile). Only a journal article by Portigal and Norvaisas [65] discusses street art on a more inclusive meta-level which is less genre-specific. However, their attempt is also far from objective or critical as they admit to be enthusiast "street art tourists" wondering about how it co-shapes the perception of a location's culture or history.

Although these works focus on different (partial) aspects, they all have in common that they recognize street art (or graffiti) as a source of inspiration and use it as a "design meme" [59] for the implementation of interactive systems. In many cases, the authors construed the basic characteristics of graffiti as a location-based anonymous social network and identified shortcomings of existing digital networks to create a meaningful link between media and its real-world positioning. In response they came up with different ideas for specialised social media network implementations.

As long ago as 2004 Carter et al. had the idea to *"support in-the-moment and on-site 'person-to-place-to-people-to-persons' content interaction, annotation, augmentation and publication"* [16, p.1207]. Their design was based on the combined use of a plasma poster and a PDA which envisaged the scenario of users leaving public comments on public displays. Some years later similar aims were pursued with different technologies. The rise of mobile devices (and sensor-equipped smart phones in particular) facilitated approaches which exploited its emerging pervasiveness. The systems *PlaceTagz* [77] and *StallTalk* [27] both use QR-codes to create a digital memory for real world places. The codes are printed on stickers which are placed in different locations (or bathroom walls as in the case of *StallTalk*) and link to respective web services allowing people to post anonymous messages. While *PlaceTagz* explored the capacities of such a system to make city dwellers curious and to have them contribute, *StallTalk* perceives itself as a location-based micro-blogging tool.

A similar approach was taken by McGookin et al. who implemented *DigiGraff* [58, 59] in order to investigate the significance of location in producing and consuming social media content. Their design does completely without any visible cues in the physical environment by using GPS to detect the location instead. In contrast to the other systems stated above *DigiGraff* allows annotations to be text or drawings (or a mix of both) and includes concepts of ageing and volatility for tag postings. By choosing a drawing mode such as *brush*, *spray* or *chalk*, users decide how long their message will be retrievable. On the tag viewing side the project explored different visualisation methods using the smartphone display or alternatively a pico-projector.

While *PlaceTagz*, *StallTalk* and *DigiGraff* all present means of communication with their developers focussing on information content, they don't pay much attention to the performative nature of creating such public annotations. This aspect was however the main inspiration for *MobiSpray* by artist Jürgen Scheible [76, 78] which requires users to use mobile phones as spray cans. A software application on a laptop translates the gestures into pictures which are then projected onto objects in the immediate environment. However, the way *MobiSpray* was implemented implies that the resulting light installations only exist as long as the artist and the equipment are around.

As stated above, all these design attempts are inspired by street art but construe the defining characteristics and underlying concepts in quite different ways. While Shamma et al. [78] claim that graffiti can be classified within the three genres of vandalism, identity and political, McGookin et al. [59] find also other more practical purposes of tagging such as contractors spraying on roads and pavements to mark the locations of utilities or commercial advertisers using graffiti as a means of promotion. Scheible sees street art in the tradition of *"our desire to change [...] the appearance of the physical environment to something different, unexpected, and unpredictable"* [76, p.332]. Portigal and Norvaisas advocate to perceive graffiti as a *"colorful trail of inhabitants' interactions with public spaces"* [65, p.12] and as *"an essentially indigenous art form"* [65, p.12]. Their column statement therefore concludes: *"Street art offers urgency, vitality, and humanity. Although it exists as environmental marginalia, it needn't be marginalized."* [65, p.15] This view contrasts Friedman and Horn's pragmatic analysis of graffiti as a means *"used to convey social and political commentary, simple words of thought, marking territory etc."* [27, p.2180].

There is obviously a lack of a holistic critique which would allow to apply the lessons learnt

in the context of sprayed graffiti directly to urban knitting as an alternative form of street art. However, in their entirety the HCI-related discussion of graffiti highlights some factors which are shared with urban knitting, namely the relevance of place, self-authorization and anonymity. Furthermore, the sources agree on that tags are created with a deliberate purpose for the creator which is not necessarily clear to the viewers (and the same also applies to the relation of the content to the annotated location).

2.4 Urban Informatics

Investigating the practices of urban knitters may also refer to the HCI discussion on facilitating different forms of civic participation in urban space. Graffiti is just one expressive form of it. The *PlaceTagz* system by Jan Seeburger [77] for instance, which was mentioned in the previous section, is associated to the research field of urban informatics, which was defined as the *"study, design, and practice of urban experiences across different urban contexts that are created by new opportunities of real-time, ubiquitous technology and the augmentation that mediates the physical and digital layers of people networks and urban infrastructures"* [25]. The publications around urban informatics are therefore another appropriate resource for relevant literature in regard to urban knitting.

The definition above was derived by Foth, Choi and Satchell, who described urban informatics also as a thematic paradigm which interprets the urban context as the intersecting triad of people, place and technology [25]. However, there are many different possibilities how these three components can be combined. As Cranshaw points out, research in this area has developed into two major directions emphasizing either the "human factor" or the technological potentials [18]. So, on the one side there are studies which investigate existing and potential relationships between new technologies and urban societal processes, while the other side focusses on complex system implementations of big data concepts which operate on a large scale.

Literature from the more technical stance often deals with urban computing in terms of the integration of smart sensing, processing and actuation technology into urban spheres [47]. Such systems provide interesting application opportunities for data mining and machine learning and serve rather top-down initiatives of commercial or governmental interest. However, despite all technological enthusiasm there are also severe risks of misuse (eg. citizen surveillance, commercial exploitation of big data, reinforcement of power hierarchies, etc.) and system designers need to act with much care. Cranshow therefore calls for more discussions on an ethical level:

> *"Urban computing is an emerging field with immense promise. With global urbanization trends projected to continue, and with ubiquitous and sensing technology beginning to saturate city life, technologies designed for cities have great potential to improve the lives and well beings of a significant fraction of the world's population. And yet, as with any new technology, there are also associated risks and deep ethical questions raised by urban computing. [...] As it matures as a field, urban computing will need to develop an ethical framework for self-regulation."* [18, p.5]

The other research side which emphasizes the "human factor" or aspects of people-place interaction, rather tend to shift their attention on bottom-up grassroot initiatives. Since these

are often described as spontaneous, non-hierarchical and volunteer-driven communities who could benefit from specific strategies for communication tools, creative media and information dissemination [49], they open up a dynamic space for design explorations. Typical studies of this kind have constituted rather smaller-scale experiments to learn from citizen practices. Common strategies involve the creation of so-called in-between infrastructure [11, 67] providing common ground for different groups or conducting in-the-wild technology probes [36, 48, 50, 51] where different citizen groups are provided with new gadgets and researchers can learn how they are eventually used.

An important aspect in urban informatics research is the claim that designing for citizens seeks to provide new forms of empowerment: Citizens shall be encouraged to participate and actively experiment with new infrastructures [11]. People shall publicly share their personal memories and thoughts and collectively reflect the self-consciousness of a city [10, 67]. Test persons shall tinker with maker hacks [36,48,51] or autonomously engage in participatory sensing [50].

However, there is a debate on if these strategies have been really successful and about what real empowerment could look like. Foth et al. [24] for example identified two common weaknesses in present urban informatics research: neglecting the hybrid role of urban space and a lack of meaningful strategies. The first aspect of hybrid spaces would involve an emphasis on location-based technologies whereas more powerful strategies should offer more than giving citizens a voice in form of a like-button. Again there is a call to learn from urban guerrillas which they understand as *"innovative small-scale movements or sub-cultures with the potential to grow and mainstream"* [24, p.728]. Balestrini et al. on the other hand seek the problem within current research practices of academia and identified several tensions which hinder *"HCI's capacity to produce both research and social contributions"* [3, p.35]: novelty obsession, short-term evaluations and insufficient in-situ method integration for impact assessment within the field.

A very constructive suggestion is to embed more participatory strategies in the studies. Caldwell and Foth for example argued that DIY practices in media architecture, which combines the digital and the physical, have the potential capability to increase citizen control and to trigger, enhance, and amplify urban experiences [14]:

> *"We argue that enabling users, i.e., residents, citizens, people, of media architecture to not only 'use' – even in the most participatory manner – but also to become DIY designers and creators in their own right, may lead to citizen control."* [14, p.9]

This participatory DIY approach would however involve more transdisciplinary effort in social, spatial and technical research, increased use of participatory design approaches and providing open source repositories of implementations and documentation under creative common licensing which would facilitate future tinkering and expansion. A similarly profound and transformative approach is described by the term of *"digital civics"* in a journal article by Oliver and Wright [64]. Here "real" citizen participation shall be achieved by creating relational rather than transactional public services.

From the perspective of urban informatics and digital civics urban knitters can be seen as a grass root group of citizens who very actively engage with the urban infrastructure surrounding them and augment it accordingly to their individual interpretations and associations. Their

location-based craft installations would therefore represent multi-layered narratives turning public places into such hybrid spaces as depicted in [9, 10, 25] for example. The results of their interventions can be both encountered physically in real space and virtually in its online documentation shared in social media. All these layers indicate the ways how the knitters view and use their urban environment, which is also one of the major points of interest in urban informatics.

2.5 Summary

In this chapter I have reviewed literature pointing out different relevant aspects for dealing with urban knitting in a design project. The main insights in relation to the thesis project will be briefly summarized here once again.

Since knitted graffiti is a special topic which has not found any exclusive attention in HCI research yet, I first discussed three specific publications from other sciences including urban planning, arts and media sciences. Despite their different focus these pieces of work found some common ground. They emphasised several characteristics such as the variation in visual appearance, handicraft being used as a commonly understood reference, the importance of public space and practice-related community building. However, as these are mainly reports of observed practices, they were too vague for providing any ideas for concrete design opportunities.

After these specific discussions of urban knitting from a non-technological perspective, I referred to HCI literature. Due to the lack of publications in this domain directly dealing with knitted graffiti, I needed to perform more or less "indirect" research based on papers about different related aspects. Since urban knitting can be understood as the intersection of crafts, street art and urbanity, these three sub-topics were the keywords for further literature review. Work on street art and urban informatics for example discussed the relevance of place, self-authorisation and anonymity. Urban knitters could be construed as a grass root group of citizens who actively engage with their surroundings while being active on multiple layers (eg. locally and online).

The HCI work on traditional crafts was another relevant influence for this Master's thesis. Crafts is described here as increasingly developing towards hybrid crafts, a practical convergence of the original activity and digital technologies. Such novel partnerships of tools and practices can take place on different levels. Technology can enhance craft and create systems such as *Spyn* [73], *metamoCrochet* [63] or *Movement Crafter* [66], as well as craft can improve technology for example by giving it back hand-made aesthetics. The literature which has been reviewed in this thesis mainly focussed on craft processes and how technology can fit into these. This is a distinct approach to for example dealing with the physical outcomes in terms of "hybrid artefacts" (eg. e-textiles and wearables). Since hybrid crafts can facilitate both the creation of regular and enhanced objects and the focus of this Master's thesis was primarily on the producing urban knitters, the literature scope on progress instead of objects suited the project very well. The main finding here was to recognize that technology integration can be a highly disruptive intervention. It is therefore important to respect the practitioners' choices to accept or reject the suggested design modifications.

CHAPTER 3

Methodology

The design project which is described in this thesis involved an holistic approach consisting of three intertwined stages of exploration, design and evaluation, and took its time to get to know the future users first before offering them a solution suggestion for a putative problem. Moreover, it included principles from mixed method research, research through design (RtD) as well as from the transformative research paradigm. The following chapter will therefore outline these concepts before explaining how they eventually formed the three project phases.

3.1 Mixed Methods Research

Every scientific study - even those in the field of Media Informatics and HCI - needs to be specific about their methodological choices. While some research paradigms favour either quantitative or qualitative methods [35], there is also the pragmatic choice to make use of the respective strengths of both and to conduct methods which best suit the respective purpose. The latter seemed most applicable for this thesis project and therefore it was decided to apply such an mixed methods approach [38, 44, 61]. Apart from simply being more flexible on a methodological level until the design space is sufficiently explored, this decision also relates to the multidisciplinary evolution of computer science as I will point out in the following:

Computer Science is not only a relatively young science, but it is also highly multifaceted containing many different specialised sub-domains. While some of these deal with computation per se, others are rather defined by their purpose than by its tools. Besides several essential domains which build a solid basis for the entirety of computer science[1], other domains build on this ground and use it as an tool to apply in different specific areas. Such applied computing domains comprise for instance visual computing, medical informatics and computational intelligence. Each of them is highly specialised in their respective concerns and examine how computation can best assist their purposes no matter if the goal is to improve an algorithm for

[1] Such fundamental research includes for example computer engineering, computational logic and software engineering which deal with computation itself as a material on different levels to develop and advance.

real-time computer graphics rendering or to find a visualisation assisting doctors in their diagnosis work.

Also media informatics and related HCI[2] are such applied computer science domains. The latter openly embraces its interdisciplinarity as it often deals with issues and concepts which usually belong to other sciences. In this sense, it is a science that originates from engineering but evolves more towards social sciences. While the first does well with logical deduction and positivist principles, the latter has a tradition in constructivsm and rather qualitatively motivated research. Media informatics is accordingly just in between these "extremes" and would be a perfect field for mixed method research [38,44] while leaving a certain paradigmatic freedom to the researchers.

This is also where research through design (RtD) comes into the game. As an alternative research model to traditional straight-forward examinations (such as for example controlled experiments) it will be used for framing the design project which is described in this thesis. It fits in here perfectly since *"[...] RtD is intrinsically multidisciplinary and enjoys both conceptual and methodological contributions from other disciplines bringing different assumptions, expectations, and practices to the table for discussion"* [80, p.76] The following section shall therefore outline the general concept of research through design and highlight its most important characteristics.

3.2 Research through Design

Research through design (RtD) is a still evolving conception which understands design as a way to engage in science and create new situated knowledge. Since the British educationalist and writer Christopher Frayling has first written about *research through art and design* in his influential article "Research in Art and Design" [26], an adaptation of this concept has also found its way into the domain of HCI. In 2007 Zimmerman, Forlizzi and Evenson proposed it as a formalised model which *"allows interaction designers to make research contributions based on their strength in addressing under-constrained problems"* [91, p.493]. This quote indicates the origins of RtD: The problem that design does not really fit into traditional research frameworks and a-priori hypothetical thinking. Design cannot provide a theory, which is falsifiable in the Popperian sense, since it just constitutes one possible solution for a defined problem. However, it does offer something else: A basis for critical discussion and reflection and a possibility of finding a good design which has an impact on a given problem. Or as Gaver had put it in his discussion: *"The difficulty of verifying design theory, at least through falsification, is not a flaw for research through design, as long as that theory can lead to productive research programmes."* [31, p.941]

Even though Zimmerman et al.'s model of RtD has been much acclaimed, there has been an active debate ever since. It is obviously still arguable what exactly can count for research through design and what not. Frayling, who wrote out of an art **and** design perspective, included here materials research, development work and action research [26]. Basballe and Halskov identified

[2]Both domains are incorporated in the same official academic program of computer science taught at the Vienna University of Technology.

"a practical or experimental approach to generating knowledge, which is communicated to others" [5, p.58] as their common characteristic. In HCI context this is supposed to be incorporated by designed artefacts. However, design can be a lot of different "things" such as for instance prototypes, products, sketches, models and process documentation. The research value comes from the reflection upon these objects and by critically discussing how knowledge is embodied by it and how it could affect communities on a practice and research level [5]. While there have been efforts in the HCI community to make the RtD model more efficient in regard to theorisation by further convergence and standardisation, there is also an active resistance. Gaver for example argues that it lies within the nature of design to be generative and to function in areas which are underspecified by theory [31]. Therefore it should be accepted as pre-paradigmatic research which implicitly builds on an (invisible) consensus on design values[3] and which is rather concerned with what is being made (ontology) than with how it is made (epistemology).

In Storni's personal perspective on RtD he highlights three key values for its successful implementation: *"RtD is rigorous when it is modest, accountable, and generative."* [80, p.76] Based on the pre-paradigmatic interpretation of design by Gaver, these three adjectives can serve as a general guideline for the thesis design project since they imply big concepts. **Modest**, for example, is perceived here in the sense of staying true and not to claim more than a researcher or designer can. As Gaver stated *"research through design is likely to produce theories that are provisional, contingent, and aspirational"* [31, p.937]. In some way, it is even a bit speculative and doesn't refrain from trying out different things. Trying out different possibilities implies that design, and therefore also RtD, is **generative**. It does not only constantly create new artefacts but it also produces new knowledge through its empirical effects [80]. Popper's concept of falsifiability, which is the defining principle of (post-)positivism and which has successfully guided progress in natural sciences over the last centuries, just doesn't apply here. Rather than making statements about what is true, design has a provocative fictional appeal and focusses on what could be. Furthermore, it also questions what might be the "right thing" [91]. In this sense it also becomes **accountable**. As Gaver states, *"a designed artifact is a 'theory nexus': the choices made by designers reveal both the issues they think are important, and their beliefs about the right way to address those issues."* [31, p.944]. Practically, this requires the designer/researcher to be a critical thinker and thorough documenter by pointing out the important features of the design as being one possible ultimate particular. As Storni suggests, this could be done by *"explicitly discussing embedded assumptions, rationales, and criteria for inclusions and exclusions (of concepts, of particular types of users, of design features, etc.) so that those enjoying the results can better understand where the knowledge came from"* [80, p.76].

The design project described in this Masters' thesis shall explicitly apply a research through design approach and strive for these three important qualities. However, based on the values of design it is also seen strongly relating to the transformative research paradigm, as will be argued in the next section.

[3]The commonly shared values of researchers and designers that employ RtD are according to Gaver user-centred design, exploration of a rather wide space of potential designs, valuing of craft and making as a route to discovery and the capability of design to generate richer situated understandings.

3.3 Relating to a Transformative Research Paradigm

Research through design acknowledges the transformative implications of design. Since design is an active attempt to change the current state into a preferred one [31, 91], design is per se not value-free [80]. In fact, it is to consider as a political statement of the designer and in this sense it highly relates to the transformative research paradigm which shall be outlined in this section.

According to Noella Mackenzie and Sally Knipe [54], the transformative paradigm arose during the 1980s and 1990s mainly as an active critique of existing dominant research practices controlled by those in power. The modelling as a research paradigm of its own right is attributed to social scientist Donna M. Mertens. This is how she outlined its basic characteristics in her own words:

> *The transformative paradigm with its associated philosophical assumptions provides a framework for addressing inequality and injustice in society using culturally competent, mixed methods strategies. The recognition that realities are constructed and shaped by social, political, cultural, economic, and racial/ethnic values indicates that power and privilege are important determinants of which reality will be privileged in a research context."* [61, p.212]

Mertens builds on Guba and Lincoln's metaphysical theory of three specific philosophical stances which describe a researcher's worldview and therefore define a paradigm [35]: the ontological, epistemological and methodological question. Mertens however also adds an axiological assumption in order to explicitly discuss the defining role of ethics. Figure 3.1 shows a table which Mertens used to list the positioning of the four basic beliefs which are associated with the transformative paradigm.

Basic Beliefs of the Transformative Paradigm

Ontology: There are multiple realities that are socially constructed, but it is necessary to be explicit about the social, political, cultural, economic, ethnic, racial, gender, age, and disability values that define realities. Different realities can emerge because different levels of unearned privilege are associated with characteristics of participants and researchers. Transformative researchers need to be aware of societal values and privileges in determining the reality that holds potential for social transformation and increased social justice.
Epistemology: To know realities, it is necessary to have an interactive link between the researcher and the participants in a study. Knowledge is socially and historically located within a complex cultural context. Respect for culture and awareness of power relations is critical.
Methodology: A researcher can choose quantitative or qualitative or mixed methods, but there should be an interactive link between the researcher and the participants in the definition of the problem, methods should be adjusted to accommodate cultural complexity, power issues should be explicitly addressed, and issues of discrimination and oppression should be recognized.
Axiology: Three basic principles underlie regulatory ethics in research: respect, beneficence, and justice. The transformative axiological assumption pushes these principles on several fronts. Respect is critically examined in terms of the cultural norms of interaction within a community and across communities. Beneficence is defined in terms of the promotion of human rights and an increase in social justice. An explicit connection is made between the process and outcomes of research and furtherance of a social justice agenda.

Figure 3.1: The four basic beliefs of the transformative paradigm of research according to Mertens [61, p.216]

While the traditional research paradigms of (post-)positivism and constructivsm mainly debate what is real and what can be known on the levels of ontology, epistemology and methodology, transformativism also asks who will benefit of a given research effort. For Johnson and Onwuegbuzie it is a deliberate conditional decision *"whether one wants to take a critical theory/transformative-emancipatory [...] approach or a less explicitly ideological approach to a study"* [44, p.20], whereas for Romm it is a general question of *"the researcher's responsibility to consider the uses that will be made of their work, and to take into consideration the way in which research outcomes can be linked to social justice [...]"* [69, p.139]. As Norma Romm further points out the paradigm therefore incorporates existing research traditions, which are concerned with more equitable social relationships, such as critical theory, Neo-Marxism, feminist theories, participatory/emancipatory initiatives and action research and gives them a common paradigmatic ground to operate on: *"All of these traditions [...] provide options for researchers to use the 'research space' as a forum for instituting change towards more just, more democratic, and more equitable social relationships, including knowledge relationships."* [69, p.138]

Admittedly, this Masters' thesis and the resulting design will not change the world to a better. However, it still agrees and identifies with many of the previously mentioned aspects. Knitting, handicraft and crafts in general are topics which traditionally have been exposed to marginalisation. Yet the decision to address these topics in the form of a Masters' thesis in Computer Science is a transformative decision. It objects stereotypical undermining by taking it seriously as an adequate research context. This said, it is my explicit goal to engage in responsible design and seek together with future users for suitable solutions to existing issues. The chosen design approach therefore should be user-centred and participatory and in accordance with Storni it also has to be modest, accountable and generative, which I would argue to be manifest guidelines when design is considered as an application domain for the transformative research paradigm.

3.4 Project Structure

Now that we have discussed the fundamental theoretical principles, the practical structure of the design project can be outlined. While the transformative research paradigm can be called the project's underlying worldview or its basic motivation framework, the mixed methods approach and the concept of research through design should be used as a toolbox. On a more practical level, this means that RtD and mixed methods research with a transformative twist should be incorporated in a methodological approach which consisted of three components. In this Master's thesis they are called exploration, design and evaluation, and depending on if these components are viewed on a temporal or correlational level they were consecutive, overlapping and interconnected.

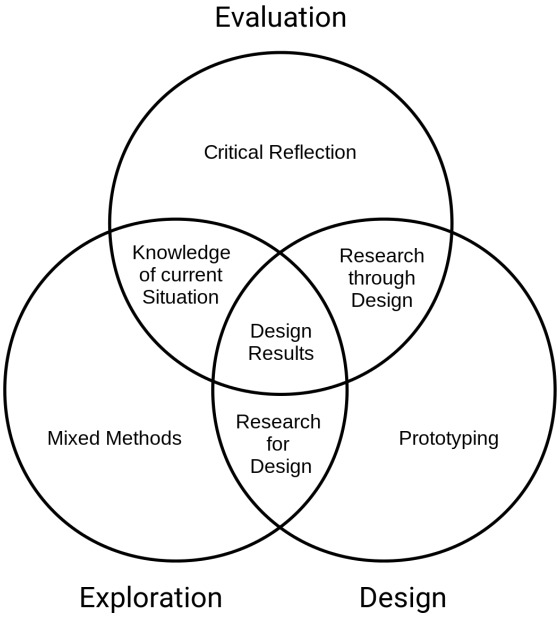


Figure 3.2: View on the intertwined Project Threads

Figure 3.2 pictures these phases or intertwined threads on an abstract logical level emphasising their synergistic dynamics. While each of the research threads has its own guiding focus and toolkit, their combination leads to new knowledge on different levels. For example, exploration on the one hand is concerned with investigating current practices and given opportunities by means of a mixed methods approach. On the other hand design uses prototyping to generate potential enhancements of given opportunities. However, it is the interplay of both phases that combines them in a reasonable and effective way. Exploration serves then as research for design and provides the necessary knowledge about a suitable design opportunity. In the same way evaluation and critical reflection build on the image of the current situation according to the exploration outcomes as well as the generative and transformative implications of research through design. Eventually, the combination of all three perspectives results in informed, reflected and experimental design.

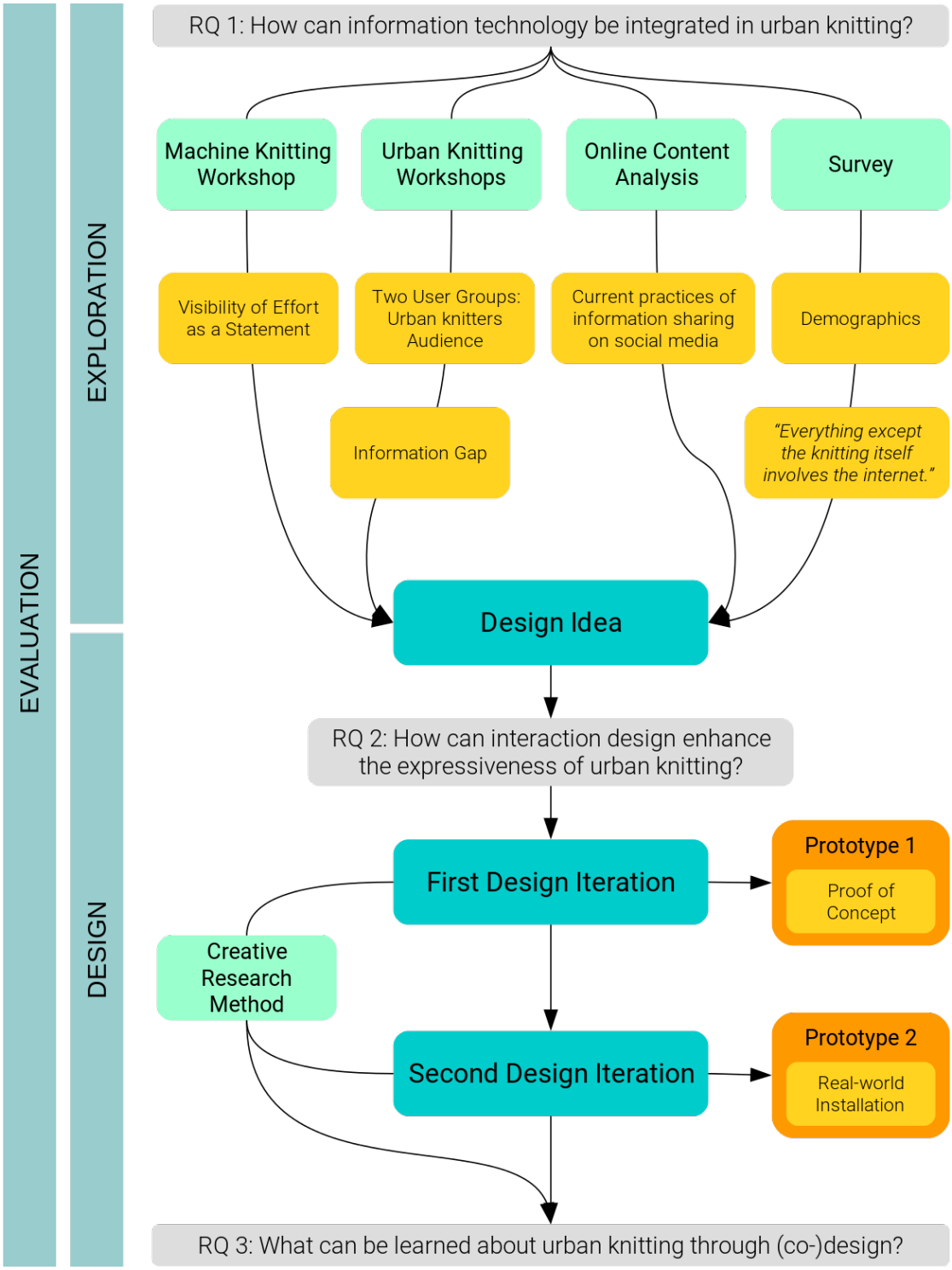


Figure 3.3: Outline of the project phases in relation to research context, methodological phases, research questions and applied methods

Figure 3.3 gives an overview how the three methodological threads formed the thesis work on a practical level. It also illustrates how research questions, studies and contributions were interrelated. Even though the project phases altogether served the overall-research question *"How can interaction design enhance urban knitting in an appropriate way?"* and formed the project outcome, it is important to point out that each of the phases had a distinct interim research focus:

- **Exploration** focussing on **Research Question 1**:
  How can information technology be integrated in urban knitting?
- **Design** dealing with **Research Question 2**:
  How can interaction design enhance the expressiveness of urban knitting?
- **Evaluation** guided by **Research Question 3**:
  What can be learned about urban knitting through (co-)design?

Methods were chosen corresponding to the respective questions and produced specific outcomes which altogether contributed to the eventual design results. The following sections shall describe the three phases in detail.

Exploration

The exploration phase constituted a starting point for the design project and was concerned with the examination of current practices in the field of urban knitting. Thorough knowledge of the status quo was needed to strive for the over-all aim of the thesis. It would only be possible to elicit novel opportunities for interaction design enhancing urban knitting, if I (as the researcher) had detailed knowledge about the setting, activities and groups of people which are involved in this form of cultural activism. Therefore, the initial step of the project was to explore the problem space and to get to know all these factors guided by the interim research question: *"How can information technology be integrated in urban knitting?"*

Due to the previously identified lack of concrete literature and scientific resources in this context (cf. 2), this needed to be done empirically. Since the exploration was expected to address qualitative as well as quantitative issues, a mixed method approach was envisaged which resulted in the following studies:

- Participant observations in a machine knitting workshop
- Observations and an ad hoc questionnaire in the context of urban knitting workshops
- Analysis of online content published in mainstream social media
- Online survey for urban knitters

The use of mixed methods should serve two purposes: On one hand it was supposed to deliver a diversified data set which could be used to analyse the current situation. Considering the qualitative nature of the over-all research question and the purpose for the exploration phase to

inform later design, the mixed method approach was expected to mainly make use of qualitative methods - however, quantitative methods were not to be excluded as a matter of principle. Where quantitative interim questions were to arise, there it would accordingly be considered to be applicable to operate with such methods. According to Mertens [61], this adaptiveness is an epistemological requirement because an interactive link between the researcher and the different communities under examination needs to be established which is based on trustful partnerships. At the same time, the use of mixed methods (or even a variety of either quantitative or qualitative methods) can also be helpful to legitimate the respective research purpose: *"A qualitative dimension is needed to gather community perspectives at each stage of the research process, while a quantitative dimension provides the opportunity to demonstrate outcomes that have credibility for community members and scholars."* [61, p.212]

On the other hand the mixed methods approach also allowed to operate more flexibly. At the beginning of the project, only the context was defined (urban knitting) but a particular design problem to deal with was still to be found. Here comes in a practical advantage of the transformative research paradigm as it openly embraces methodological flexibility which is also applicable on an organizing level concerning the timing of method use within a given research process. In this sense it is also legitimate to make use of methods even before a research problem or a research question have been specified. This practice to go into a problem field without any a-priori assumptions makes much sense considering the paradigm's ontological belief that reality is constructed. Since a number of parallel realities can exist for different co-existing groups and cultures, it is an important task for the researcher to examine and review them for existing power-related hierarchies before being able to determine an eventual research focus. In the case of the given design project, the exploration phase should therefore not only gather many different viewpoints in the context of urban knitting but also provide sufficient critical knowledge in order to filter out the most problematic issues inherent in these perspectives.

In fact, the main contributions of the mixed method approach in the exploration phase were the following insights:

- Two user groups were identified for future design: Urban knitting artists and their public audience. Between these groups there is a information gap which on the one hand can create a whimsy effect [55], but on the other hand counteracts the mediation of underlying messages and inherent narratives.

- The visibility of manual effort inherent in hand-made textiles is an important part of the (political) statement of urban knitting. It adds value to the artefact and emphasises it as a medium for the creators' messages. Design should therefore not interfere with the manual production of the crafted installation.

- There is already a lot of specific urban knitting information available on the internet. Besides many other practical purposes social media is often used to promote installation and share related online documentation. However, this kind of information is not easy to find for non-involved installation spectators.

All of these findings had some influence on the evolving design idea of an augmented interactive urban knitting installation. This concept was not only the most concrete outcome of the

exploration phase but it also constituted an entry point for the subsequent design stage.

Design

The aim of the next project phase was the development of a prototype which should implement the design idea as well as embody the knowledge which had been acquired in the preceding user studies. In this way, the design was directly guided by the outcomes of the previous exploration phase. The collected data would inspire a design idea as well as inform specific design choices. Thus the guiding research question was for this phase: *"How can interaction design enhance the expressiveness of urban knitting?"*

However, design dealing with this question was not expected to proceed linearly but rather iteratively. It was considered a rather open process which could involve the construction of several prototype versions before a sufficient design quality was achieved. The final outcome should be a testable prototype. It should achieve a good level of fidelity to allow test users to quickly understand the idea and have an interaction experience which is close to a real product.

In the thesis work two design iterations were conducted:

1. A first prototype served as a proof of concept. Tests with users provided feedback on if the design idea was going into the right direction.

2. A second prototype was built striving for a more realistic result. It involved a group of experienced urban knitters contributing crafted panels for a flexible, portable and interactive real-world installation.

The first-hand data by the urban knitters, which was gathered during the prototype implementation, was also used for further analysis in terms of a creative research method and deepened the knowledge about urban knitters, their motivations and their craft-related world-views. Visual creative research methods are an approach for the investigation of specific target groups which are invited to express themselves in creative visual artefacts (eg. collages, photos and videos) instead of only text. This research concept was introduced by David Gauntlett and will be described and discussed in further detail in chapters 5.5 and 7.3.

Evaluation

The prototypes were concretised results of the design phase and offered solid ground for concluding evaluation. While closing up reflection was mainly concerned with the specific research question *"What can be learned about urban knitting through (co-)design?"*, evaluation also took place on other levels. In fact, the whole project was accompanied by critical reflection. Rather than an independent stage of its own right the evaluation phase was more like a continuous attendant. It made sure that relevant characteristics were identified during the exploration stage and used this learning as a basis of critical comparison during the design. Due to its persistence the evaluation component will not receive a chapter of its own (in contrast to Exploration and Design) but rather be integrated and specifically addressed in the affected sections of chapters 4, 5, 6 and 7.

CHAPTER 4

Exploration

As stated in the previous chapter, the thesis project comprised three intertwined methodological components. The first stage involved wide-ranging exploration of the problem space and intended to build sound and comprehensive knowledge of the protagonists in the context of urban knitting. It was not only important to identify the different acting groups involved but also to develop a better feeling for their defining ambitions and practices. Several user research methods were conducted in order to reveal and collect different facets of this characteristic data. As typical for the adaptable approach of the transformative research paradigm, this gained knowledge would also help to distil existing problems within the given context and contribute to sharpening the research and design focus from here. The chapter at hand therefore provides detailed documentation and discussion of the applied methods which involved participant observation, ad hoc interviews and questionnaires, social media content analysis and an online survey.

4.1 Machine Knitting Workshop

Computer science has a strong tradition in increasing efficiency. In this respect it seemed natural to first question what would happen if the most time-consuming handicraft part of urban knitting was accelerated by the use of machines. The first explorative approach was therefore a very literal attempt to investigate the question how technology could be integrated into urban knitting. The insights from the literature review suggest that removing the craft aspect might mean the loss of many positive features which are intrinsic to craft activities. However, this is just one single fragment of the bigger picture if we understand urban knitting as an intersection of craft, street art and urbanity. Since the outcome of such a scenario would still remain the same (namely a custom produced textile fabric) and the related work dealing with the other thematic components does not indicate any implicated importance of the installation objects being necessarily handmade, the experiment of mechanised textile production was expected to serve as a good starting point for the research project.

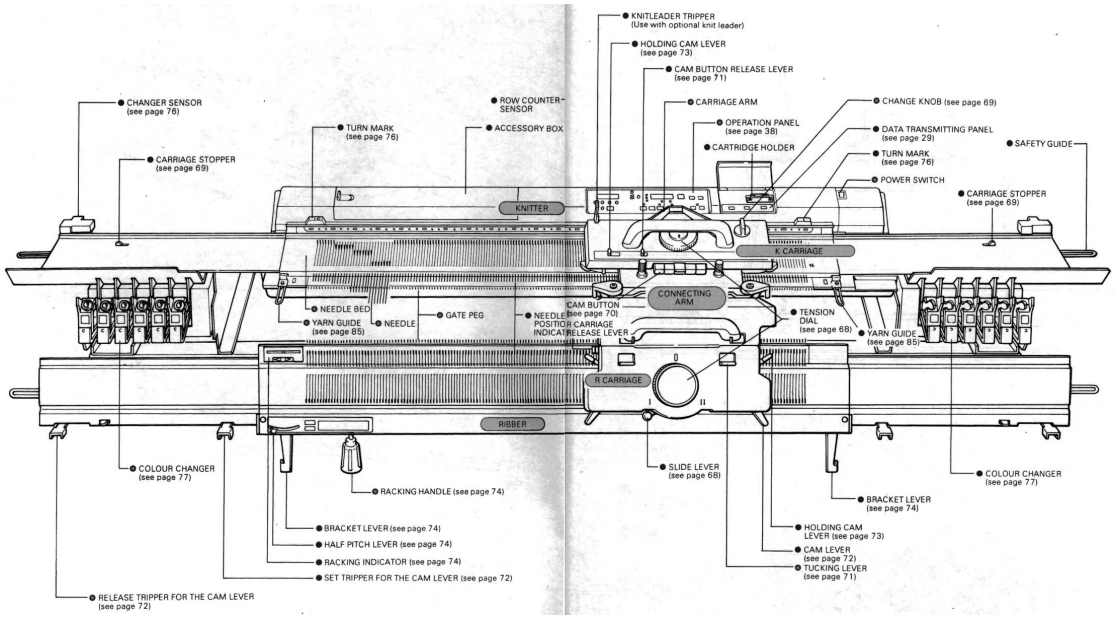


Figure 4.1: The parts of a Brother knitting machine as depicted in a manual[1]

Knitting machines (cf. figure 4.1) are devices which are used to create knitted fabrics in a fully or semi-automated way and therefore serve exactly the above-mentioned purpose. Professional versions of such machines are very expensive and can normally only be found in textile-producing industry. However, some manufacturers such as Brother, PASSAP and Silver Reed designed smaller simplified versions of such machines for household use. Such domestic knitting machines became quite popular as from the 1950s. In the 1970s some models were equipped with electronic control units and later products could even be programmed directly using an internal computer. As the popularity of such machines decreased within the last few decades, many manufacturers stopped the production. Nowadays, machine knitting seems to be rather the special interest of some passionate practitioners and most home knitting machines can only be bought second-hand.

This development of declining demand significantly complicates the process for beginners to give it a try. It's usually not easy anymore to gain access to such a machine and there are only few expert users around who can be consulted for help and advice. Moreover, there are considerable differences between different knitting machine models. In combination with different types of patterning this constitutes a considerably complex learning task for every beginner. I found out about a local textile artist and designer in Vienna who is specialised on fabrics production and who periodically offers workshops for people being interested in knitting machines. The name of this textile designer is Veronika Persché[2,3] and she has more than 15 years of expertise in

[1] The BROTHER CK35 USER MANUAL is available online: `http://www.aboutknittingmachines.com/BrotherKnittingMachine.html` (Accessed: 03.08.2015)

[2] `http://www.persche.com/en_info.asp` (Accessed: 03.08.2015)

[3] All people mentioned by name in this thesis consented to being stated and quoted.

operating such devices. I had the chance to take part in one of her workshops which took place on three consecutive days in October 2014. Being a handknitter myself this was a good opportunity for participant observations and experiencing the practical implications of outsourcing the craft from the hands to a knitting machine. I was particularly interested in which way the producing activity would feel different and how the crafted outcome would compare to knitting created by hand.

Data Collection and Workshop Setting

Data was collected directly on site in form of hand-written notes which were typed and complemented later on. Photos were taken occasionally with a digital camera. The workshop took place at Veronika's studio[4] from October 10 until 12 2014. It started with an introductory kick-off evening which was followed by two full days of hands-on training. We happened to be a very small working group. Apart from myself there was only one other participant. He introduced himself as Manfred, a 51 year-old shop manager who was on long-term sick leave at that time due to burnout. He told us that he had bought a used Brother knitting machine on eBay just because he was interested in mechanics and wanted to find out how such a machine works. It turned out to be a good deal for him because the machine was in good condition and the seller had included a lot of original extra parts. He had taken the whole machine apart in order to clean it. Even though he got to know it quite well on a technical level this way, he still couldn't figure out how to use it properly. He had done some research on the internet, but he described himself just not being the learning type who can learn practical skills by reading. He would lack patience and therefore needed to learn hands-on instead, at best guided by someone who could answer questions and give him some practical tips. This need for assistance while learning was also his reason to join the workshop. He hoped to pick up some solid basics which would help him to get going with his own machine at home. With his mechanical curiosity and his wish to become a fabrics producer himself even though he had never really engaged in handicrafts before, Manfred constituted a quite different participant compared to me who was just interested in trying it out and compare the process and outcome to hand knitting. Observing how he was acting during the workshop therefore enriched my observations with an alternative external point of view.

Veronika kept the course quite open and flexible and offered to adjust its content to the specific wishes and questions of us participants. We were invited to ask questions and use the time not only to practice and experiment but also to work on an own project if we wanted to do so. She had prepared two basic knitting machines for us to use and since both Manfred and I considered ourself as beginners, we decided to start with the very basics. First, Veronika showed us how to do regular knitting stitches. Depending on how quickly we learned we could try to do more complex patterns later on. So instead of producing a pullover or any other machine-knitted garment, we decided to rather try different techniques and stitches instead while producing different test samples without any intended purpose. The general atmosphere was friendly, relaxed and casual. Figure 4.2 gives an impression of the workshop setting at Veronika's studio.

[4] Veronika Persché - Strickdesign, Steinergasse 8/2, A-1170 Vienna

Figure 4.2: The two other attendees at the machine knitting workshop: Veronika (right) gives advices to Manfred (left) while using the knitting machine.

Participant Observations related to Machine Knitting

In course of the workshop Manfred and I learned how to cast on, knit and cast off. However, we soon noticed that the knitting machine's capabilities were limited compared to hand knitting. In fact, as Veronika also stated, the machine can't do everything which the hand can. For example, a single-bed machine can only knit but can't purl. However, it is a lot faster than hand knitting. A single push of the carriage can produce up to 200 stitches in contrast to one stitch at a time when done by hand. Regarding the materials we learned that the machines usually knit with thin Merino yarns coated with paraffin wax and winded on cones, but it is possible to experiment with other materials, too. Veronika showed us for example some of her samples created with nylon fibres, steel wool or fluorescent twines.

During the workshop we only used manual knitting machines (cf. figure 4.3) and produced different patterns exclusively by manual manipulations of the cartridge settings and the needle positions. But knitting machines can also work with formalized patterns in order to achieve more complex textile designs which would be very exhausting to do manually. Older knitting machines achieved such patterns by using punch cards while later versions used optical scanners

Figure 4.3: The knitting machine which I worked on

and plastic template sheets. Eventually, the machines became electronic and could work with patterns previously designed on a TV screen or computer. Veronika showed us her PPD, a cartridge reading/writing device that used to be plugged in on the TV. With the aid of a TV-card she has the device connected to her PC. To create new patterns she uses a software package called *DesignaKnit8*[5] which comprises different tools such as *Stitch Designer* and *Graphics Studio* which is comparable to Windows Paint (just that one pixel would be one stitch). It is a tool highly specialized on knitting designs offering a lot of assistance. Structure patterns can be achieved just as well as multi-coloured ones. But Veronika also mentioned a major shortcoming of the software regarding unpredictable measurements. The design software completely ignores that the knitted piece will naturally be distorted due to the fact that knitting stitches don't have the same width as length. Therefore the user would still have to do a test piece and calculate an adjusted number of rows for the final design.

I noticed that Veronika often sounded more like a mechanic or engineer than a handicraft person when she was talking about her craft. Even though knitting machines have been traditionally advertised as wonder tools for getting knitting quickly, easily and automatically done (cf. figure 4.5), machine knitting itself constitutes quite a dexterous hybrid activity between textile materials, different handicraft techniques, mechanical skills and engineer-like debugging. In this

[5]DesignaKnit8 is a software product for Windows 98 by Knitcraft Inc.: `http://www.knitcraft.com/knitcraft/downloads/dak/DAK8_Upgrade_features.pdf` (Accessed: 03.08.2015)

sense working with knitting machines might not be too different from making practices which can be observed in present-day hacker spaces. I was therefore wondering how Veronika feels about the *OpenKnit* project[6], which is a critical maker's attempt to build an open-source, low cost, Arduino-based knitting machine that should be capable of "printing" sweaters. I assumed that this would be a good alternative to the current situation where all knitting machines have to be bought second-hand. Veronika was interested but still she didn't seem to be too optimistic about the project's success chances. She knew about other similar attempts which had failed in the end because the developers simply had underestimated the complexity of such machines. It would be of course desirable if the project worked out and enabled makers all over the world to simply build their own knitting machines (or fabricate replacement parts with 3D-printers if something is damaged). Since the domestic knitting machine production was discontinued, the dependency on limited second-hand equipment led to the dominance of just a few specialised (re-)sellers in Europe who drastically increased the prices. Veronika mentioned for example that there is one specialised shop in Vienna where she hardly ever buys equipment because it is so expensive. Online markets such as eBay might be a good alternative regarding the price but shipping can be risky for the fragile machines. Veronika has therefore found another way to save money: She has bought second-hand machines in Portugal and Turkey and picked them up herself. She told us for example about her journey to Istanbul where she bought a wool winding machine first hand from a small textile manufactory instead of choosing a far more expensive retailer from Germany.

Figure 4.4: Work in progress fabricated on a knitting machine

[6] `http://openknit.org/` (Accessed: 03.08.2015)

Figure 4.5: Three knitting machine adverts[7]

Experiences of Learning and Complexity

My personal first experiences of working with a knitting machine was that its was astonishingly difficult. Even though I had already suspected that there must be more effort involved in machine knitting than the vintage adverts in figure 4.5 tried to make consumers believe, I was surprised by the number of steps required to perform a so-called "quick cast-on". Many steps are neither automated nor assisted by the machine and this makes it very easy to do mistakes. I also found it quite confusing that there are so many different details and settings to check which are located on different components of the machine (eg. up at the thread holders, the settings on the carriage, the position of the needles, etc.). Even as an experienced hand knitter who knows at least all the basic knitting concepts and stitches, it's not as easy as one might think.

On the contrary, my previous craft knowledge even caused another problem: I had quite a hard time accepting that I had lost direct control over the crafting process and that I could not actively influence the outcome during production. Veronika had already seen this issue in previous workshops and told me about a former participant who was an avid hand knitter and who dropped out in the middle of the course because she just didn't like this feeling of losing the control over her knitting. This perception of control loss might indicate a major side-effect of what happens when handicraft is outsourced to a machine and suggests that the envisaged increase in efficiency might come at cost of an indispensable altering in the experience quality of the production process. At least for hand knitters this can be very irritating when they learn how to use the machine and realize that the activity of machine knitting has only little to do with the conventional handicraft.

Also Manfred seemed to struggle with learning how to use the machine even though he had a bit more experience with the machine than me. Mistakes and visual flaws in his knitting

[7] Image sources from left to right: Lulu's Vintage Blog, Millie Motts, Grandma's Attic (All accessed: 04.08.2015)

seemed to frustrate him. There was a particular situation, when he commented that machine knitting would require a lot of patience and that he was afraid that he would lose his temper soon. Veronika answered that resilience certainly was a big part of machine knitting. She stated that trial and error was the standard way of designing machine knitted fabrics. Many steps would certainly get easier and better with more experience, but still machine knitting would always involve a lot of planning in advance and require to perform many additional working steps in order to prepare for the final outcome. But at the same time she also gave us the outlook on a certain spontaneity facilitated by mastery which also reflects in her own handling of the machines: *"I don't think too long, just try out things and before you know it something is already there."* I therefore suspect that even though machine knitting is a procedure which is intrinsically less flexible than hand knitting a certain degree of expertise still allows a great deal of experimentation and quite spontaneous forms of textile expressions. However, this also implicates that it requires a lot of time and practice to get there which can be a very challenging process for novices. Manfred for example complained loudly about his fails, swore and constantly criticised his incapability to do it right. While he automatically blamed himself as simply being incompetent, he wouldn't even think of blaming the machine. However, I argue that the design of the knitting machines could have supported our learning process more. Both Manfred and I would clearly have benefited if the machine had offered a functionality which had helped us remembering the right sequence of required working steps. Moreover, beginners need to see their progress quickly and experience successes to stay motivated. I think that the machine could and should also help here.

Urban (Machine) Knitting

Since my research aim for the participant observation was to evaluate the suitability of machine knitting for the purposes of urban knitting, I seized the opportunity and asked Veronika if she had ever done machine knitted graffiti. In fact, she had and told me about her experience as a participant in the *"Knit her Story"* project by the Strickistinnen[8]. *"Knit her Story"* was a large-scale urban knitting installation on the occasion of the hundredth anniversary of International Women's Day which took place in combination with a big demonstration on the Vienna Ring Road. Veronika's contribution was an elaborate piece of machine knitting which she had worked on for a week together with an assistant. Her design was a multi-coloured knitted image showing the famous portrait of the female worker of the "We can do it!"-posters (cf. figure 4.6). Unfortunately, the project took a sad ending. Even though the installation had been officially authorized by the city of Vienna and it had been agreed that the crafted artefacts should remain on display for a whole month, the municipal garbage collectors removed most of the exhibits right after the demonstration event. Veronika's piece "survived" the "cleaning" of the garbage collectors - but only to be removed by an unidentified person just 3 days later. She remembered this as a sad ending of a good cause but tried to make herself think that someone took it because he or she liked it so much and wanted to have it.

What is interesting about this anecdote, is that Veronika deliberately chose to invest a lot of time and effort in the design of her craft contribution although she was not obliged to do so.

[8] `https://knitherstory.wordpress.com/19-marz-2011-2/` (Accessed: 04.08.2015)

Figure 4.6: Veronika's contribution to *"Knit her Strory"*. Photo by Philipp Breu [9]

In fact, she easily could have created the biggest fabric to cover a whole tree, but she chose to balance her advantage instead and to set herself a task which would require to invest just as much devotion as any hand knitter for their craft. This aspect had me considering that voluntarily committed effort might be an important factor for urban knitting. In the case of hand knitting most people know that it is a slow and skilful activity and the completed artefact naturally incorporates and represents this knowledge. Giving it away by installing it in public space symbolises accordingly to give away the invested time as well. This is a powerful statement if we consider that time has become a precious resource in present-day's service economy. Of course urban knitting could also be done with the aid of machines but in order to express a statement of similar significance it would need to find a way to show that it involved effort to produce. In this respect, hand knitting has even a clear expressive advantage over machine knitting.

However, machine knitting might also facilitate novel possibilities in producing crafted artefacts for technology integration. In the course of the workshop we brainstormed briefly on how machine knitting could be used for technologically enhanced yarnbombing. Since machine-knitted fabrics have a very even loop structure, it could be used for producing visual symbols which need to be very accurate. For example it would be hard to hand knit a scannable QR-Code whereas the machine can achieve the necessary resolution and even stitch patterns. The use of conductive thread (woven into it during fabrication or subsequently embroided) could

[9] `https://www.flickr.com/photos/philippbreu/5540579540` (Accessed: 04.08.2015)

also add electronic functionality to a knitted piece (eg. in combination with an Lilypad Arduino). Veronika also showed me a project where she designed a fabric with a lot of pockets which could also contain technological devices. While listing all these different ideas, it occurs that there seem to be many different ways in which the components of craft and technology can be combined in a meaningful way.

Findings

Altogether the workshop provided some surprising insights. The simplified hypothesis that machine-aided increase of production efficiency was also desirable for urban knitting proved to be wrong. It is arguable if machine knitting is really speeding up the process. I was surprised how complex and time-consuming machine knitting can be. While beginners need to invest a considerable amount of time and effort in order to learn how to use this tool, not even experts make much use of their speed advantage when they work on a piece for urban knitting.

As I found out, machine knitting can be hardly compared with hand knitting. Both are completely different craft activities which require different sets of skills to produce a similar outcome. Knitting machines are no wonder tools and require the craftsperson to become a bit of an engineer, too. Instead of simplifying the a craft it just alters it. Even machine knitters need to be concentrated all the time and do a lot of counting. As soon as a pattern is involved the knitting process becomes a lot more complex. This is just as valid for machine knitting as it is for hand knitting. However these are rather superficial similarities considering that the underlying activities involve completely different qualities of experiencing textile production.

Constituting a distinct form of craft by itself, I argue that using a knitting machine wouldn't really exclude the craft aspect from the practice of urban knitting. But even though it could theoretically speed up the production of crafted artefacts, it has also implications when used in the context of an installation project where showing the amount of invested effort becomes an inherent socio-political statement. In fact, the lessons learnt from the machine knitting workshop pointed out an important characteristic of urban knitting in general: It is obviously not so relevant how well or quickly the components of an urban knitting installation are actually produced, but instead, the important factor is that the textile creations represent a certain amount of visible effort and that the creators clearly communicate that they tried to do them as well as they could.

4.2 Urban Knitting Workshops

Participant observation at the machine knitting workshop had allowed to explore the question what it would mean to outsource the craft production to technological means and eventually resulted in learning something about the very nature of urban knitting. Since the explicit expression of effort seemed to be an important part of the craft's statement (and hand knitting was here clearly in advantage over machine knitting), it was decided that technology would need to come into play at some other point of the design project than in relation to the very textile production. It was unclear however which other aspect would be more appropriate for technology integration. With this question in mind, I had the opportunity to organize an urban knitting workshop at a public event. While knitting with participants on a collaborative urban knitting installation, I

would be able to ask them for their opinion and collect different ideas how and where technology integration would make sense.

Workshop Description

The urban knitting workshops took place at the Christmas edition of the Urban Space Market in December 2014. The Urban Space Market is a local bazaar event making interim use of vacant buildings. Since the venues are changing it can be called a nomadic event series which is specialised on street art and fashion. It is periodically organized by the Urban Space crew, a self-proclaimed initiative for urban art and culture in Austria[10]. The market is therefore strongly associated with Vienna's street art scene. This focus is also reflected in its agenda: Besides the market stalls and catering facilities there are also DJ gigs, live performances and showcase graffiti sprayings which attract a diverse mix of people including national and international artists and designers as well as local visitors interested in their work.

The particular Urban Space Market event which was the setting for my observations in relation to this thesis took place at a untenanted house in Geigergasse 5-9 (1050 Vienna) on three consecutive weekends between December 4 and 21 2014. Even though it was mostly planned as a Christmas market, the organizers wanted to offer more diversity in their showcase of street art. Therefore, the Urban Space crew also wanted to include yarnbombing and addressed me to organize a workshop, since they knew me from a previous workshop.

As producing a critical mass of knitting which is needed for such an installation takes a considerable amount of time and I wouldn't know how many people intended to participate, I decided to offer the workshop on nine days. This resulted in a total 55 workshop hours distributed on Friday, Saturday and Sunday of three consecutive weeks. I brought a suitcase full of wool and yarn donations as well as other craft supplies (needles, scissors, measure tape, etc.), printed knitting patterns and books for inspiration. While the location changed every weekend within the venue, the organizers always made sure to provide the workshop with a table and benches in a light room. A big poster and a small chalkboard stated that this was a free urban knitting workshop and that everyone was welcome to join and knit.

The workshop was received quite well. Although only a few of the many market visitors participated, it created a lot of interest. Many people passing by commented that it looked very cosy and indeed there was a relaxed and friendly atmosphere during the workshop. In course of the 55 hours of workshop in total a number of 59 people decided to participate. Per day the total number of participants could range between 2 to 15 participants. Almost half of the time I didn't have any participants at all, but if people attended they often sat down in small groups of up to 4. Many came in company of friends, but quite often also people would be sitting together at the table who had not known each other previously. The participants started a total of 49 pieces of knitting or crochet, of which 40 were installed later on.[11] With an additional

[10] `http://www.urbanspace.at/` (Accessed: 04.08.2015)

[11] Some people who were counted as participants didn't start to knit. They had different reasons for that ranging from not being in the mood or not daring to give it a try. Some also just wanted to keep the company of their friends who were knitting. Instead of becoming active themselves, they skimmed through the books and discussed different aspects related to the phenomenon of urban knitting. In this respect they also contributed to the general findings within that time frame and are therefore counted as participants.

number of 14 knitted panels produced by me, the resulting installation comprised 54 different pieces of knitting that altogether covered parts of the metal fence in front of the event location (cf. figure 4.7).

Figure 4.7: The installation result of the workshop

Observations

Observation data was collected again by taking hand-written notes and photos. In addition to a standard digital camera an unobtrusive action cam was used to capture the chronological sequence of each day in a time-lapsed video. A voice recorder was also at hand but only rarely used due to the participants' preference to not being audio recorded. Previously prepared counting lists helped to maintain an overview on the number of participants.

Most of the participants were young women. However, apart from this clear majority there were also some children, men and people of an older age. Almost none of them had previously engaged in urban knitting and only a few were experienced crafters. Most of them were novice knitters who seized the opportunity to give it a try and to learn it. Several individuals reported that they had learned how to knit or crochet in primary or secondary school but had not engaged in it ever since. The results of the workshop must therefore be understood as a collection of external impressions of urban knitting. "External" means that the participants didn't represent insiders who regularly produce new knitted installations but rather interested outsiders who have a certain interest in textiles, handicrafts and encountering knitted street art. It is important to keep this in mind while synthesizing a portray of urban knitting based on the provided perspectives.

The most surprising insight to me was that many people apparently didn't know what I meant when I said the word "urban knitting". Also other synonyms such as "yarnbombing" or

"guerilla knitting" didn't make much sense to them. However, as soon as I showed them photos and images in books or pointed to the evolving installation outside, they all recognized it. Many would immediately report of encounters with other installations which they had previously found in Vienna or other cities during a journey. Others stated that they had only seen photos on the internet so far and were excited to see how such an installation comes into being in real life. So even though there seemed to be rather little knowledge about urban knitting, there was much interest. Even many people, who went by the workshop without taking part, stopped for a little while and had a closer look at the books which I had brought. Many were smiling when they saw the photos of cars, trees and tank covered in textile wrappings.

At the same time, while knitted graffiti often was received as something "cool", there were also still many stereotypes around regarding the handicrafts per se. These were mainly related to gender or the perception of being an old-fashioned activity. Such prejudices could be observed in several situations when I directly addressed people passing by inviting them to join us knitting. Many men immediately rejected it as "women's work"[12]. Few even tried to seize the opportunity to initiate a flirty situation by comments such as *"Why don't you knit some fancy underpants for me?"* or *"Yeah! Finally a woman who knows what is decent for her to do!"* In another particular situation I was sitting with a male and female graffiti artist and discussed if urban knitting can account for being street art or not. The argument of the young man was that it wouldn't be real graffiti in his point of view because most of it doesn't happen on the street[13] and therefore the risk of being caught in the act would be reduced. The female sprayer countered that she was not sure if the illegality is really the main point in doing graffiti. In her opinion the aesthetics of sprayed images was more important. However, no matter if such discussions were motivated by stereotypical clichés on knitting, street art and gender or not, there obviously is a lack of knowledge concerning the aims and characteristics of urban knitting as well as a certain resistance of some people who only see the craft part of it and diminish it due to stereotypical thinking.

Questionnaire

Before the workshop I had prepared a one-sheet questionnaire which asked participants a single question: *"Which place does technology take in Urban Knitting?"* I asked them to answer this question twice: once when they were beginning with the workshop and once just before they would leave. By openly putting up this question for discussion I hoped to identify current practices in the field of urban knitting and collecting ideas which could be used to inform the design. However, the workshop resulted in other outcomes and rather opened up the field of investigation. As stated before, there were no "real" urban knitters among the participants (contrary to my expectations), and therefore they couldn't inform about current practices within that field. However, these "outsiders" added a whole new perspective which I had not considered before. Moreover, they helped to filter out different types of constellations how technologies could come into the play of knitting on a more general level.

[12] One person even used the very degrading Austrian swearword "Futarbeit".

[13] I have to object here that the installation process of larger installations can also take many hours which might be even longer than sprayers need for doing a tag.

When asked for the place of technologies in urban knitting, the participants often didn't see any connection at first. Many just had never thought about a possible relation (cf. the response of a participant: *"I didn't understand the question at first. For me there was no interrelation."*), but for some it was more like a deliberate statement based on a generally critical attitude towards technology. One participant wrote for example: *"In my opinion technology (which represents soullessness) should not enter the world of knitting."* However, all participants would start thinking more about it and in most cases they eventually found a combination that made sense to them. These were the most commonly mentioned constellations:

- **Knitting *as* Technology**
  Some participants elaborated on knitting being a technology itself. For some participants it seemed that the usage of tools could qualify it as a lo-fi form of technology: *"In a sense you are operating a tool. One that doesn't need electricity, but in the broadest sense it has something to do with technology."* An interesting observation was here also how some people seem to think about a correct linguistic categorisation: *"I think that urban knitting doesn't have a lot to do with technology but with technics."* "Technologie" in German might be a bit more specific than its English translation "technology" and the more generalizing word "Technik" might be a more suitable notion to include low fidelity technology. Apart from defining knitting as a technological form another similarity was found which was related to the repetitive and logical nature of the craft process: *"First you need to learn the basic technique and from there on you can execute the desired pattern just like a program."* Another person wrote: *"Technology is for example integral in the techniques of knitting, the consistence/production of wool, the counting of stitches for certain patterns."*

- **Technology *for* Knitting**
  The comment about the production of wool leads to another common line of thought which regarded how technology facilitates and supports (urban) knitting. On the one hand, such responses often concerned the industrialized production of yarns and knitting supplies. In this practical sense technology had a major role in knitting, as we can learn from statements such as *"Highly relevant - Because there are no knitted goods without knitting needles!"* or *"For the tools required, for the material and even for the places that are about to be decorated with it are made with human technology."* On the other hand, the participants frequently mentioned the relevance of the internet for promoting projects, learning craft techniques and networking with like-minded.

- **Knitting *for* Technology**
  The thought that technology can facilitate urban knitting was sometimes reversed by stating that knitting would also have the capability of enhancing technology too - at least on an aesthetic level:*"[Technology] can be made prettier."*
  "One could certainly decorate technical devices with knitting."
  "The technology of knitting is a small part of the whole in order to embellish it."
  One participant even claimed: *"We need technology to wrap it in knitting!"* While this last comment probably was meant as a joke, all of the quotes highlight that handicrafts

has an aesthetical advantage over technology which is obviously still perceived as cold and ugly in its physical appearance. Interestingly, this can also go the other way round. Technology can also influence knitting design when it is used *as a theme for* knitting. This mostly seems to happen when technical artefacts have a certain popular cultural standing. For example one participant mentioned that she found it inspiring to see knitting patterns for a helix structure. Others loved the knitting patterns showing *Space Invaders* or other pixel images from retro-games.

It is noteworthy that the answers of the participants in most cases referred more to knitting in general than specifically to urban knitting. This might be due to their lack of specific experience. During the workshop the participants were mostly busy with the demanding task of learning the craft technique. It was therefore not surprising that they rather tended to focus on this aspect than on others (eg. street art, urban space, etc.).

Findings

To sum up my findings based on the observations, informal ad hoc conversations and questionnaire answers, there was a striking lack of information among urban knitting "outsiders". While most people seem to have seen installations, least of them knew why people would engage in urban knitting activities or even how the practice was called. The answer of one participant gets to the heart of the problem: *"I didn't know that urban knitting had any other meaning than keeping trees warm. Yes, I really thought people do it in order to keep trees warm. Actually, I didn't even know of the existence of the term 'urban knitting'."*

This understanding constituted a key transition point in my thesis thinking: At the beginning of this research and design project I had only focussed on urban knitters. Now it became apparent to me that the biggest problem which could be overcome by design was not so much related directly with its manufacturing process but rather with its communication to others. In this sense, technology could serve as a mediator explaining the artefacts and its purpose as another participant suggested: *"Since Urban Knitting is a modern and new art, technology could contribute a lot to expand it."*

Making information available is a classical topic of computer science, especially since the internet became popular. It is likely that good explanations of urban knitting are available online. In fact, there are countless Wikipedia articles, blog posts and websites dedicated to this topic. But how could the unknowing "outsiders" find out if they don't know the name of what they want to search for? And then it is also questionable if they are really that concerned about knitted graffiti that they would in fact initiate a search later on when they are at a computer. A better approach would be to provide the required information directly at the place where and when it is needed.

Having identified the need for situated information about urban knitting, the next step was to find out what kind of such information was already available online. How do people discuss issues related urban knitting? What kind of information is relevant enough in this context to explicitly share it with others online? Moreover I wondered about what kind of information real urban knitters were already sharing and if this would match the questions of their audience. I therefore decided to continue method-based exploration with a detailed online content analysis.

Figure 4.8: Some photo impression of the workshop

4.3 Online Content Analysis

After having gathered close-up views from people with little or no experience in yarnbombing, it was important to compare these with the perspectives of active urban knitters. A first approach to do so was to conduct an analysis of user-generated online content associated with the given topic. Mainstream social media services such as Facebook[14], Twitter[15] and Instagram[16] are good places to start taking such a closer look. They are used by millions of people who actively share and consume information and connect with each other on the basis of shared interest. The huge number of users and the global outreach of these services make it likely to find content related to almost any given topic. Therefore, such large scale online environments can serve as attractive sources of data for researchers to learn more about the collective social experiences of specific user groups [52].

It is to assume that social media services are just as popular among people who engage in urban knitting. Considering the fact that some collaborative installation projects largely depend on the participation of crafting peers producing a critical number of contributions, it is possible that networking tools could even play a central role in online activities related to urban knitting practices. At the same time web services based on user-generated content also seem to be powerful instruments for promoting existing installations. Images of spectacular urban knitting installations are good candidates for "going viral". For example, the American online media company BuzzFeed[17], which is known for spotting posting trends and supporting these in list form, features urban knitting in several articles. Staff member Alanna Okun lists for instance "32 Incredibly Cool Yarn-Bombings To Brighten Your Day"[18] and embeds several photos of trees, sculptures, phone booths and vehicles spectacularly covered in knit and crochet.

The primary concern for the subsequently described online content analysis was to find out which kinds of information social media users generate related to urban knitting. Even though these will comprise yarnbombers just as well as non-knitters, some of the data will provide access to first person perspectives of practitioners. The analysis should hence also shed light on the question for which purposes urban knitters tend to use social media in connection to their craft activities.

Twitter as a Data Source

For the purposes of this thesis I chose Twitter as the social media data source for further analysis. The choice was motivated by two crucial factors: On the one hand Twitter is one of the most popular networks to date. According to the company's fact sheet [1] it is used by an average 302 million monthly active users who produce 500 million postings per day (also known as "tweets"). Given this enormous scale it was likely to find a sufficient amount of data related to the special interest group of urban knitters. On the other hand, posted data is not only public

[14] `https://www.facebook.com/` (Accessed: 11.05.2015)

[15] `https://twitter.com/` (Accessed: 11.05.2015)

[16] `https://instagram.com/` (Accessed: 11.05.2015)

[17] `http://www.buzzfeed.com/` (Accessed: 23.04.2015)

[18] `http://www.buzzfeed.com/alannaokun/yarn-bombing-rocks#.odJmLEWJaJ` (Accessed: 23.04.2015)

(that is accessible without the need of having a twitter account and signing in) but also easy to retrieve for further automatic processing. In fact, Twitter offers some well-documented public APIs[19] for developers to access its global data streams. Several online tools have built on these and offer easy-to-use graphical interfaces to facilitate social media monitoring and export search results as ready-to-use spreadsheet files.

That said, conducting research based on online sources of information requires acting with certain caution. While providing new opportunities to investigate, online research and virtual ethnography also present new challenges which need to be considered. Rotman et al. [75] discuss several challenges which are specific to large scale online environments compared to traditional face-to-face ways of carrying out ethnographic methods. They describe extreme conditions for research due to the vast amount of data available, the resulting necessity to clearly scope a-priori and constant change of tools, interfaces and content. Another issue is pointed out by Lazar et al. [52] who remind that online identities might differ from the real-world beings. Hence online data should be dealt with certain critical reserve.

Besides these issues about research challenges and reliability of online content in general, the specific nature of Twitter data needs to be considered, too, since it produces slightly different data compared to other social networks. Postings consist of text limited to 140 characters and the only visual media content which can be embedded are photo files. Everything else has to be linked by inserting a URL referring to other external websites. Due to these special design characteristics Twitter produces short and mainly text-based content distinct from postings on other services.

Considering the issues above the research questions underlying the task of online content analysis were adapted to the capacities and limitations of Twitter data. In this respect the scope was defined by the following matters:

- How much is tweeted about urban knitting?
- Which terms do Twitter users employ to refer to urban knitting?
- How big is the share of tweets constituted by original content compared to retweets and pass along information?
- What kind of information is tweeted in this specific context?
- For which purposes do urban knitters post content on Twitter?

At this point it should also be mentioned what was **not** the goal of the online content analysis. Firstly, it was not supposed to be a social network analysis (SNA) in terms of describing a given network structure by identifying key users and their social roles defined by the quantities of their interactions. Such SNA results are often used to visualize specific community networks as for example in Gonzalez's [32] analysis of Twitter usage in the context of academic conferences. Even though SNA delivers interesting insights on user formation from a quantitative point of view it is not very useful for describing qualitative aspects such as the topics discussed within

[19] `https://dev.twitter.com/overview/api` (Accessed: 11.05.2015)

these constellations. Here, the online content analysis shall rather focus on the texts mentioning the given topic rather than on the users as distinct entities. Secondly, it was not aimed for a detailed text analysis based on linguistic measures as done for example in the work of Jamison-Powell et al. [43] who approached their analysis of tweets on medical disclosures of Twitter users suffering insomnia in that way. Instead, the results shall be discussed based on a generic content classification level using thematic coding where appropriate.

Data Collection and Processing

The Twitter data collection spanned over eight days between March 22 2015 and March 29 2015. A total of 279 applicable tweets were gathered which were posted within that period. Using two different online tools the postings were collected in a spreadsheet including message text, user name, time stamp and URL.

The reason for using two tools for data collection was due to experiencing different numbers of results in preceding test runs while searching for the same keywords. To be on the safe side and to ensure to assort a data set as complete as possible, I decided to use Social Searcher[20] and Topsy[21]. Both are freely available web tools and seem to deliver reasonable results when searching for custom keywords. While Social Searcher offers downloading the query results in an automatically generated spreadsheet, the Topsy results needed to be added manually into the list.

The search was conducted in English. Since the word *"urban knitting"* has several popular equivalent signifiers (such as *"yarnbombing"* and *"guerilla knitting"*), a list of suitable search terms was defined in advance. This list contained the words "yarnbombing", "yarnbomb", "yarn-storming", "urban knitting", "guerilla knitting", "kniffiti" and "knitted graffiti". Each of these terms was used to respectively run a query with both tools. In the spreadsheet it was recorded which tweet was found by which keyword as well as by which of the two search tools.

After merging 277 results from Social Searcher and 84 results from Topsy, the list needed to be scanned for duplicates. Duplicates were basically a direct result from searching with two tools and a row of possible keywords. Some of the tweets were found by both online services. Others included more than one of the signifiers. Filtering was done in two steps: First the tweets were sorted by user name and compared by their respective tweet text. After that, the URL was unified in such a way so that it was possible to compare the tweets by their unique IDs. This 2-step-filter led to a solid check that all duplicates had been removed.

Apart from duplicates there were also two thematically unrelated posts found in the data set. These just happened to contain both the words *"urban"* and *"knitting"* by coincidence but didn't have anything to do with urban knitting as such. They were not as easily identified as the duplicates and were only noticed in the process of reading through all tweets for later content analysis.

The 2-step-filter for duplicates and the content scanning reduced the data set from an initial quantity of 361 tweets down to total of 279 validated tweets in the spreadsheet. Table 4.1 lists the number of results for each search term.

[20] `http://www.social-searcher.com/` (Accessed: 11.05.2015)

[21] `http://topsy.com/` (Accessed: 11.05.2015)

Search Term	Number of Hits	Percentage
yarnbombing	213	76.3%
urban knitting	31	11.1%
guerilla knitting	13	4.7%
yarnbomb	13	4.7%
kniffiti	1	0.4%
knitted graffiti	1	0.4%
yarnstorming	1	0.4%
yarnbombing & urban knitting	5	1.8%
urban knitting & guerilla knitting	1	0.4%
Total	**279**	**100%**

Table 4.1: Validated search results sorted by keywords

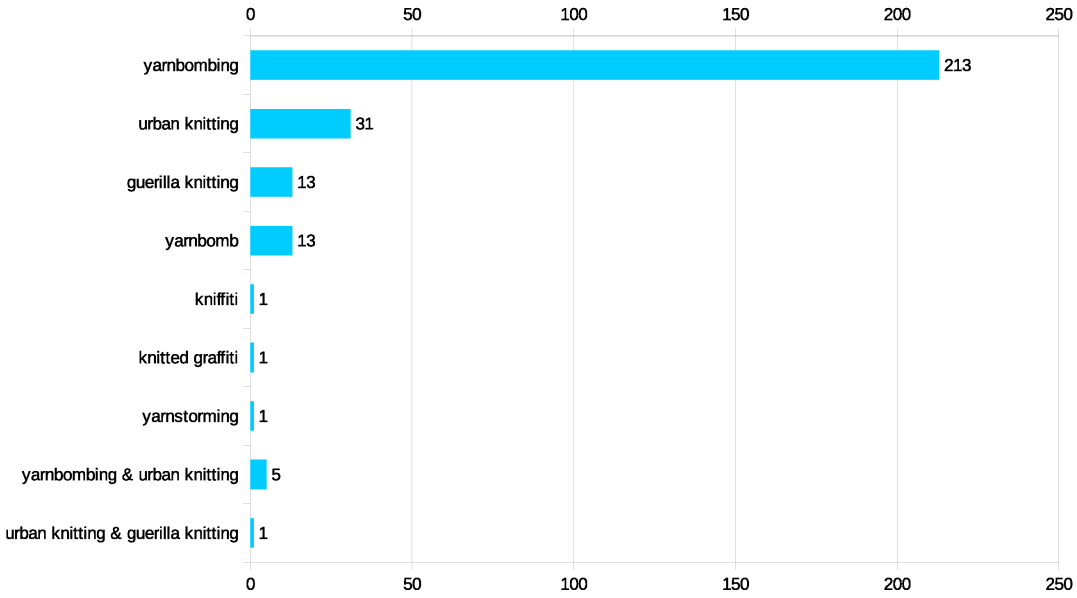


Figure 4.9: Number of tweets found per keyword

Quantitative Findings

After the preprocessing steps mentioned above the spreadsheet was ready to use for any further analysing steps. However, the present table layout was already sufficient to shed light on some quantity issues. It is problematic to generalize from such a sample of course, but it allows us at least to have an impression of the topic's presence and a rough clue about its dimension. 279 validated tweets in eight days still indicate that urban knitting is a permanent topic of conversation on Twitter. However, it certainly is a very small one compared to the amount of other non-related tweets. If we take the official estimation of 500 million tweets each day [1] and

compare it to an average of 35 urban knitting postings per day as the sample suggests, we see that it doesn't represent any more than a rough share of 0.000,007%. This lets assume that urban knitting is a very special interest yet with a perpetual presence on Twitter.

Taking a closer look at table 4.1 and its visualisation as a bar chart in figure 4.9, there is a striking dominance of tweets referring to knitted graffiti using the word *"yarnbombing"*. A majority of 76.4% employ this term whereas only 11.1% use *"urban knitting"* and 4.7% call it *"guerilla knitting"*. Even though the usage of one single term clearly prevails, the signified activity is still surrounded by a whole terminological spectrum. It is important to keep this in mind, since there might be many reasons why various synonyms are in effect. Different words emphasize different aspects. Tweeters might therefore deliberately choose to use rather *"guerilla knitting"* than *"yarnstorming"*. On the other hand, there has never been an initiative to standardize a term. Different groups of craftspeople might have introduced different names for their street art projects. Some tweeters (approximately 2% in the sample) seem to be particularly aware of the terminological spectrum and therefore include two synonyms in their posts. Figure 4.10) shows an example for such a tweet.

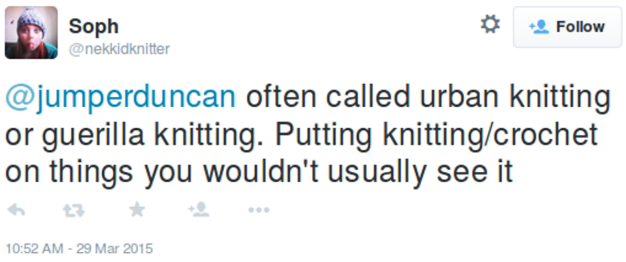


Figure 4.10: Tweet using two equivalent terms for urban knitting[22]

Content Analysis with Given Content Categories

In order to conduct an analysis on a qualitative level the data sample in the spreadsheet needed some further manual processing. The tweets were supposed to be classified by associating their content to different categories. The first approach was to use an existing categorisation framework as the one proposed by Stephen Dann [20]. In his paper Dann reviews Twitter content categories identified in prior literature research and consolidates them into six primary domains with 23 subthemes. The full classification model and all category definitions are listed in appendix chapter A.

Since the categories are all of a rather generic nature and based on formal definitions which are relatively easy to apply on any data set, the framework served as a good starting point for the analysis of the urban knitting tweet collection. However, not every category was likely to be represented in the data set. For example it would have been rather surprising if a tweet was categorised by *"News 2. Sport"*. Instead it was expected that tweet assignments would accumulate

[22] `https://twitter.com/nekkidknitter/statuses/582103140159348736` (Accessed: 11.05.2015)

on a few adequate categories, which should already give an indication on the different kinds of situations in which Twitter users are referring to the topic of urban knitting.

The given categorisation framework was applied to the data set by adding a column in the spreadsheet for assigning each tweet to one of the 23 Dann-categories. Even though it would have been possible to make use of certain automation mechanisms for a part of the classification process (eg. filtering out all tweets containing "RT" and classifying them as *"Pass along 1. RT"*), it was decided to do every assignment manually. That is, each tweet was read by the researcher before an applicable Dann-category was chosen and entered in the designated spreadsheet cell. Reading every tweet would allow to get more familiar with the content of data set and ultimately reach an assessment if the Dann-categories are sufficient for analysis or not. Table 4.2 presents the final classification results, while figure 4.11 visualises their distribution among the primary domains and figure 4.12 shows the share of tweets per subcategory.

Domain	**Category**	**Tweets**	**Percentage**	**Grouped**	**Share**
Conversational	1. Query	5	1.8%	27	9.7%
	2. Referral	10	3.6%		
	3. Action	3	1.1%		
	4. Response	9	3.2%		
Status	1. Personal	2	0.7%	17	6.1%
	2. Temporal	1	0.4%		
	3. Location	9	3.2%		
	4. Mechanical	0	0.0%		
	5. Physical	0	0.0%		
	6. Work	0	0.0%		
	7. Automated	0	0.0%		
	8. Activity	5	1.8%		
Pass along	1. RT	109	39.1%	194	69.5%
	2. UGC	74	26.5%		
	3. Endorsement	11	3.9%		
News	1. Headlines	0	0.0%	0	0.0%
	2. Sport	0	0.0%		
	3. Event	0	0.0%		
	4. Weather	0	0.0%		
Phatic	1. Greeting	2	0.7%	41	14.7%
	2. Fourth wall	0	0.0%		
	3. Broadcast	19	6.8%		
	4. Unclassifiable	20	7.2%		
Spam	Spam	0	0.0%	0	0.0%

Table 4.2: Results after Dann-categorisation

As expected some of the categories were more suitable for the given data set than others. On a domain level we could see for example that the vast majority of tweets represented pass along information while non of the postings could be classified as news. This seems plausible

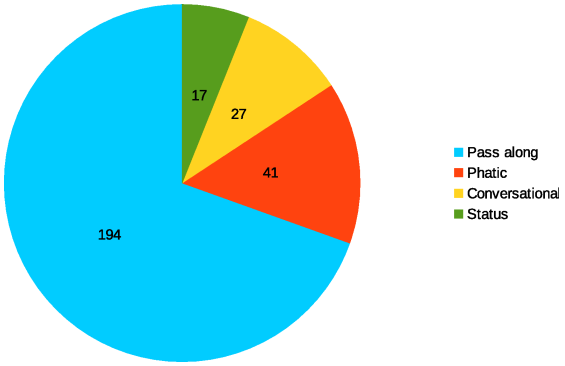


Figure 4.11: Results of Dann-Categorisation: Number of tweets per domain.

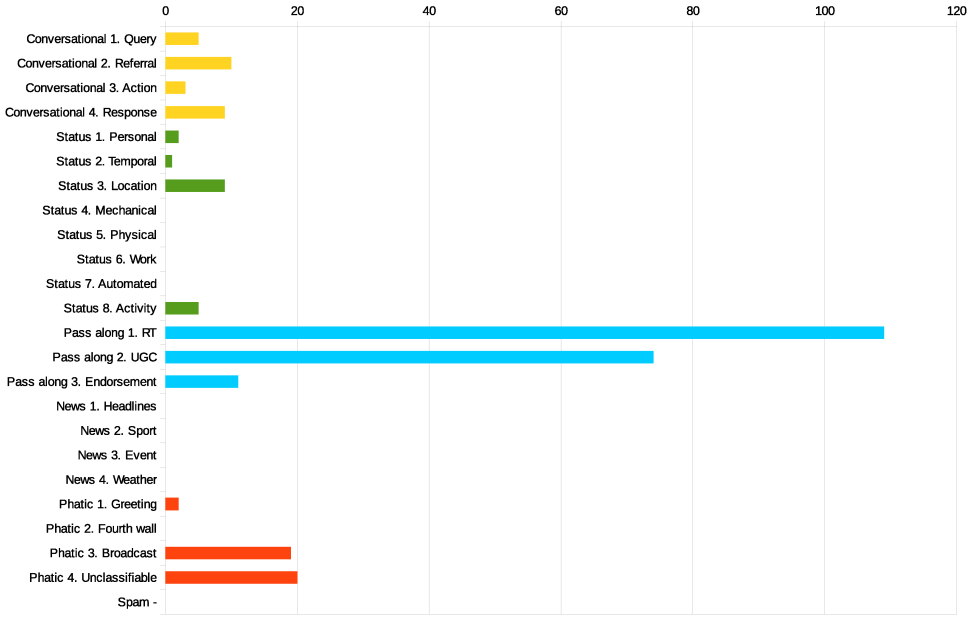


Figure 4.12: Results of Dann-Categorisation: Number of tweets per category.

considering urban knitting as a special interest topic which is not very likely to produce headlines in mainstream media[23].

According to the category distribution Twitter seems to be mostly used as a channel to collect and amplify user generated information and corresponding direct or indirect communication. Representing 69.5% of the whole data set, the Pass along type of content constitutes a clear majority. This means that most of the information collected was not original Twitter content. This can be understood in two ways: Either the shared tweet was originally composed by another

[23]There were a few links to articles in local newspapers but since these were posted by the media agencies themselves they count as *"Pass along 2. UGC"*.

user or it links to content external to Twitter.

Most tweets in the pass along category belong to the first type and are so-called “retweets”. Retweeting is a Twitter functionality which allows to simply re-post a tweet by another user. It is generally used to quickly spread information without needing to add anything. In the data set at hand such retweets account for an absolute share of 39.1%. This feature might be especially useful for urban knitters who are currently organising a project and looking for participants. Other twitter users then can act as recruiting facilitators by retweeting a call for participation. Figure 4.13 shows such an example.

Figure 4.13: Example of a recruiting tweet which has been retweeted 13 times[24]

The other type of pass along information refers to specific content outside of Twitter. Either this content was composed by the Twitter user herself (category “2. UGC”) or by somebody else (category “3. Endorsement”). Representing a total share of 26.5% the second biggest category comprises tweets which actively links to user-generated content such as blog posts, photos on Instagram, videos on YouTube or events on Facebook. This is a lot compared to only 3.9% of tweets linking to web content created by others and might be an indication for Twitter being a popular tool for promoting DIY-content.

The remaining 30.5% of the tweets consist of conversational (9.7%), status (6.1%) and phatic content (14.7%) and comprise any kind of communication directed to specific other users or the global Twitter community. It seems that status tweets mainly focus on issues of location (eg. in terms of telling others where they spotted a yarnbombing installation) and activity (eg. in terms of reporting about the progress of setting up a specific knitting installation), while phatic tweets call out to a not specified audience spreading very differently kinded information. Often it seems to be about opening up new opportunities of support, may it be in the form of wool donations or participants.

[24] `https://twitter.com/gingerfig/status/581192012722003971` (Accessed: 11.05.2015)

Content Analysis with Custom Categories

The Dann-categorisation framework was a good starting point for qualitative analysis but seemed to be too generalised in the long run. All findings described above resulted from constantly comparing the generic category definitions to the specific tweet content. This process sometimes required to group very different-kinded tweets in a single category. In the end, a feeling persisted that some relevant aspects had not been revealed yet due to the static category definitions in the given framework. This apprehension was reinforced by the insight that some of the dominant categories grouped tweets with very diverse content. For instance, the formal guidelines demanded to collect all links to user generated content in category "Pass along 2. UCG" no matter if it was about an urban knitter documenting a specific project or a random person sharing a photo of an installation she spotted in the street and liked. While reading through the whole data set, it soon became clear that more concrete categories would be necessary to describe the gathered data in a more appropriate qualitative way.

It was decided to apply a thematic analysis approach as described by Braun and Clarke [12]. In their journal paper they outline the method as an accessible and flexible analysis tool for qualitative data and provide a step-by-step guideline comprising six recursive phases. While the first phase (familiarizing oneself with the data) had already been carried out during the previous processing and Dann-categorisation procedure, all remaining steps were taken in an additional analysis session. Initial codes were generated (phase 2) by adding a column with notes in the spreadsheet and writing down short descriptions summarising the purpose of each tweet and highlighting interesting characteristics. *"Link to Tumblr, documenting yarnbomb"* and *"yarnbomb photo with location"* would be examples for such initial codes. Phases 3 and 4 involved searching for common themes and reviewing them. This was undertaken by introducing 17 categories with working names and assigning each of the tweets to them. While reviewing these categories, they could be grouped into five overall themes, which were clearly named and specified in the final phase.

Table 4.3 presents the themes and their specifications. The identified custom categories are listed in table 4.4 together with their respective definitions. All of the themes and categories (apart from *"Not classifiable"* which simply contains all tweets in an unknown or not understandable language) will be briefly discussed in the following.

Theme	**Definition**
Artefact-related documentation	Information and views on accomplished installations as specific physical objects in public space
Creation process	All content focussing on activities involved in creating and installing urban knitting
Utilisation	Content by other stakeholders utilising the positive image of urban knitting for their own purposes
Topic of conversation	Conversational content featuring urban knitting as a topic
Not classifiable	Content which is not classifiable

Table 4.3: Themes resulting from thematic analysis

Theme	Category	Definition
Artefact-related documentation	Yarnbomb	Statements of encounters with specific installations
	Project details	Detailed background information and retrospective reflections on particular urban knitting installations
Creation process	Recruiting	Calls for participation in an urban knitting project
	Work in progress	Documentation of projects in the making
	Installation process	Documentation of setting up an installation
	Organising	Administrative postings with the purpose to organise the preparation or installation activities
	Inspiration	References to ideas or motivations which could possibly initiate new projects
	Material	References to the materials used or needed
Utilisation	Local news	Local news reporting on specific initiatives
	General account	Portrays of urban knitting as a "movement"
	Promotion	References to yarnbombing activities in the context of other causes such as charity or local initiatives
Topic of conversation	Humour	Jokes and other humorous statements
	Socialising	Postings resulting from social norms and friendly interactions with other users
	Support	Specific or general positive reactions
	Critical perspective	Critical expressions of negative issues
	Technology	Content discussing the involvement of technology
	Definition	Explanations what urban knitting is
Not classifiable	Not classifiable	Content which is not classifiable

Table 4.4: Custom content categories

Artefact-related documentation

The theme *"artefact-related documentation"* comprises all tweets about specific finalized urban knitting installations. That is, such tweets are posted after the preparation work of the urban knitters is done and the referred yarnbomb has been placed in a public location. They generally address the installation as a given physical object.

The theme includes two subcategories depending on the level of offered details. **"Yarnbomb"** involves tweets which represent mostly brief and random encounters with installations. They often include a photo and sometimes even mention the location where it has been spotted. Most of these tweets are posted by people who have not been involved in the documented urban knitting project, so they lack any further background information such as for example the name of the artist. This is the main difference to the other subcategory **"Project details"** which comprises all tweets offering more specific information for a particular yarnbomb. They often contain links to blog entries by the urban knitter in which they describe their motivations and ideas behind their initiative. Some even link to making-of videos published on YouTube. Given that the installation is already accomplished, the provided background information is often writ-

ten in form of retrospective reflections. Two representative tweets for these two categories can be seen in figure 4.14.

Figure 4.14: Tweet examples[25] for the categories "yarnbomb" (left) and "project details" (right)

Creation process

Tweets contained in the theme *"creation process"* focus on any kind of activities which are involved in creating and installing a yarnbomb. In contrast to the previous theme of artefact-related documentation the postings keep records of the time before the installation is accomplished and considered as a finalized physical artefact. Six categories were introduced to refine the steps and aspects which are relevant in the creation process of an urban knitting installation:

"Recruiting". Postings of this type are public invitations for interested knitters and crocheters to participate in an urban knitting project. Sometimes they are directed to specific Twitter users, but most of the time they call out to the global community hoping to reach like-minded yet unacquainted people. Figure 4.13 shows such a recruiting tweet.

"Work in progress". This category pictures the unfinished craft artefacts while they are in the making. Some of the associated tweets use text to describe the user's feelings, aspirations and experiences while crafting, but most include photos of the unfinished pieces. Their captions often express elation and anticipation.

"Installation process". Associated tweets document the moment when the knitting is installed in public space and in effect becomes urban knitting. They often contain photos showing a person attaching the textile creations to an object or portraying the happy creator next to the just accomplished yarnbomb.

[25] HeartofLiverpool: `https://twitter.com/HeartofLpool/statuses/580649874187771904` Weird: `https://twitter.com/TenzaGramorla/statuses/581466664262344704` (All links accessed: 11.05.2015)

“Organising”. Some Twitter users seem to be people in charge of organising urban knitting projects. This is indicated by administrative posts which announce upcoming meetings for preparing or installing the artefacts together.

“Inspiration”. This category captures moments of inspiration including all kind of thematic or design ideas. Such tweets express motivation to initiate a new project.

“Material”. The postings collected in this category concern the materials used or needed for creating an urban knitting installations. An example in the analysed data set is the call for wool donations.

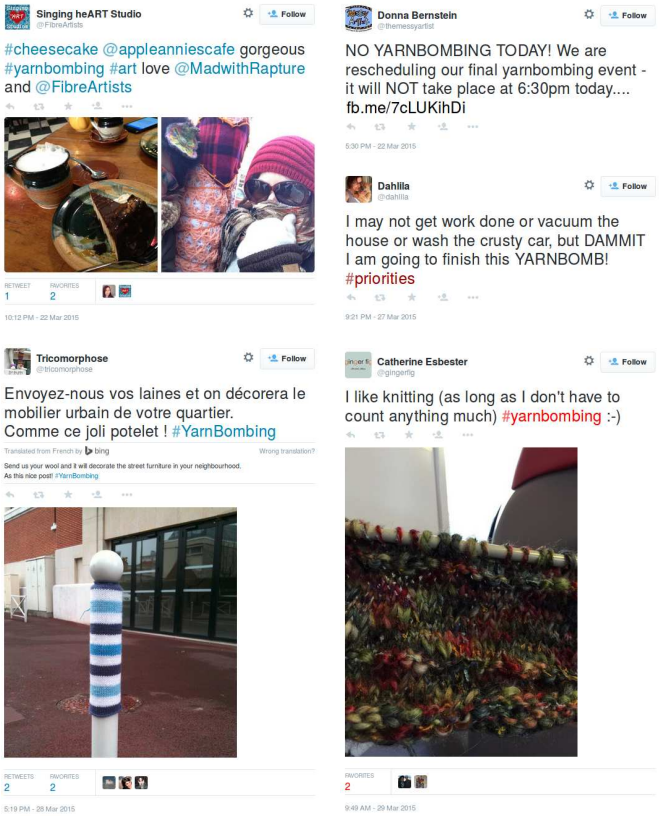


Figure 4.15: Creation process tweet examples[26]: installation process (Singing heART Studio), material (Tricomorphose), organising (Donna Bernstein) and work in progress (Dahlila, Catherine Esbester)

[26] Singing heART Studio: `http://twitter.com/FibreArtists/status/579752417270456320`
Tricomorphose: `https://twitter.com/tricomorphose/statuses/581853211637780481`
Donna Bernstein: `https://twitter.com/themessyartist/statuses/579681642798825472`
Dahlila: `https://twitter.com/dahlila/statuses/581551610368659456`
Catherine Esbester: `https://twitter.com/gingerfig/statuses/582087044358344704` (All links accessed: 11.05.2015)

Utilisation

The *"utilisation"* theme was introduced to cover all related content which is provided by stakeholders other than urban knitters and their public audience. This means that in this case the tweeters are rarely active in knitted street art themselves but they are aware of the public interest in this means of creative expression. This group mainly comprises media or charity institutions which approve and utilise the positive image of urban knitting for their own purposes. Local newspapers hope for more readers reporting about the new installation of a regional craftivist collective (subcategory **"local news"**). Blogs try to provoke more clicks by presenting urban knitting as a global subcultural movement in portray features which are illustrated with spectacular photos of many different installations (subcategory **"general account"**). Charity organisations organise yarnbombing events to raise more awareness and donations for their actual cause (subcategory **"promotion"**).

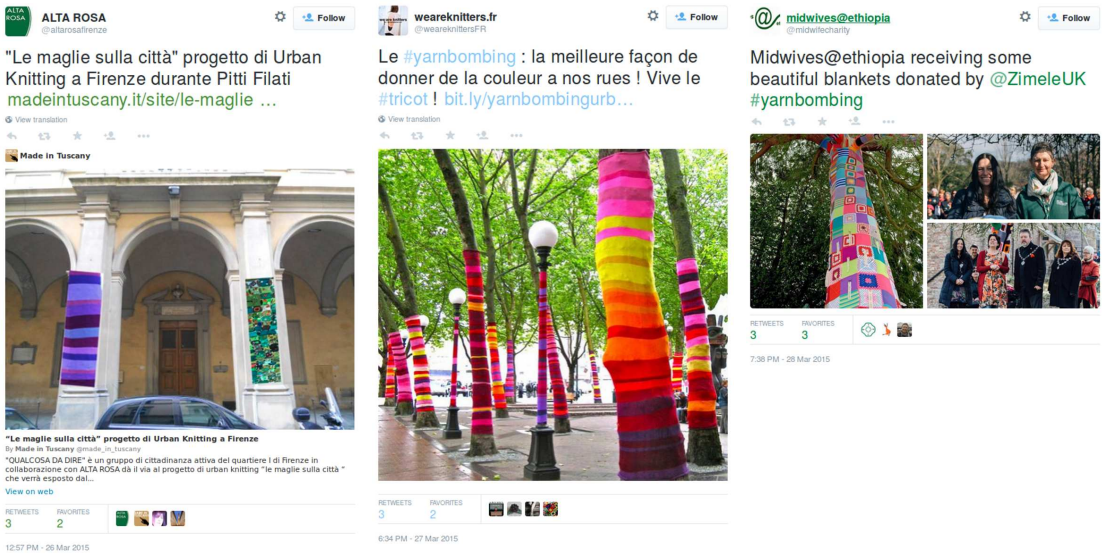


Figure 4.16: Tweet examples for the theme of utilisation[27]: local news (ALTA ROSA), general account (weareknitters.fr) and promotion (midwives@ethiopia)

Topic of conversation

Urban knitting can also be a regular topic of conversations and statements. The 140-character-limit for each message turns Twitter into a so-called micro-blogging tool inviting private person users to frequent updates which briefly describe current thoughts and concerns. Apart from direct interaction with friends and other users, some make use of Twitter as a an expansive

[27] ALTA ROSA: `https://twitter.com/altarosafirenze/statuses/581062457176752128`
weareknitters.fr: `https://twitter.com/weareknittersFR/statuses/581509518401536000`
midwives@ethiopia: `https://twitter.com/midwifecharity/statuses/581888131441541121`
(All links accessed: 11.05.2015)

communication tool and deliberately put up issues for public discussion. The six subcategories of this theme represent the different contexts in which the topic of urban knitting was mentioned. However, it is to assume that the categories are not complete since this theme apparently is the most diverse and dynamic one. Repeating the analysis with a data-set gathered in a different time frame could therefore possibly feature other topics. The most important topic categories identified in the given set of tweets are described in the following and illustrated by examples in figure 4.17.

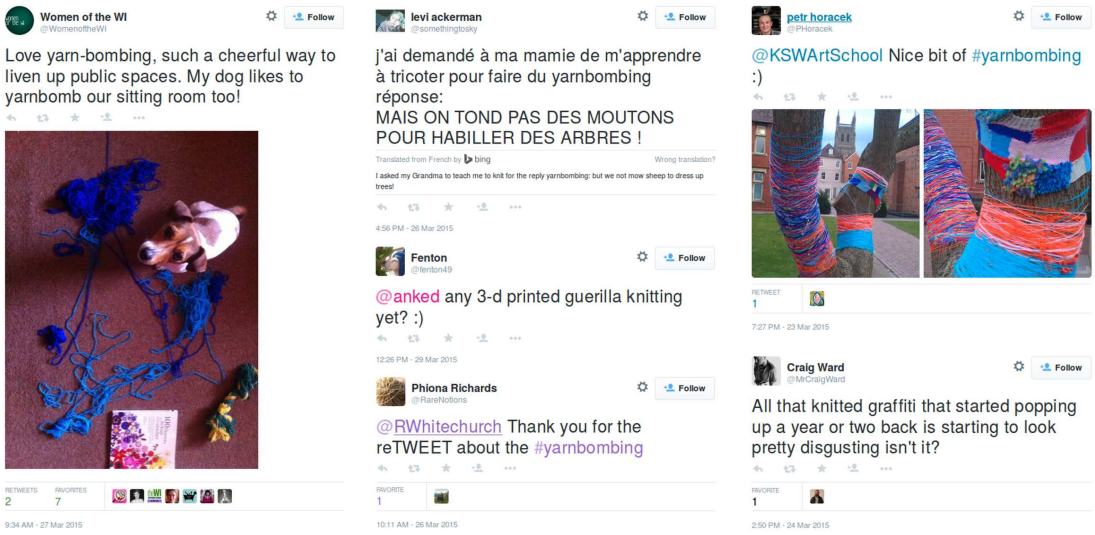


Figure 4.17: Examples of tweets categorised as topic of conversation[28]: humour (Women of the WI, levi ackerman), socialising (Phiona Richards), support (petr horacek), critical perspective (Craig Ward) and technology (fenton)

"Humour". Many craftspeople have a special kind of humour which might be connected with how they cope with experiences of doing mistakes [53]. The data set at hand contains several tweets which fit in here. They involve jokes and funny anecdotes from daily life.

"Socialising". This category holds postings which were created in miscellaneous social settings. Often they result from friendly direct communication with others and serve as polite gestures. Urban knitting is therefore often not the primary issue in this kind of tweets, instead it just happens to be part of the particular social context. A typical example for the socialising category would be a thank-you message to a follower who retweeted a yarnbomb photo.

[28] Women of the WI: `https://twitter.com/WomenoftheWI/status/581373645714489344`
levi ackerman: `https://twitter.com/somethingtosky/statuses/581122604288880640`
Phiona Richards: `https://twitter.com/RareNotions/statuses/581020627705819137`
petr horacek: `https://twitter.com/PHoracek/statuses/580073293878808576`
Craig Ward: `https://twitter.com/MrCraigWard/statuses/580366172136337410`
fenton: `https://twitter.com/fenton49/statuses/582126692937940992`
(All links accessed: 11.05.2015)

"Support". Support tweets can be described as positive reactions to specific instances. Just as socialising tweets they are often embedded in a highly social setting (being replies to other tweeters or including retweeted texts) but in contrast to the former they clearly centre urban knitting activities as the primary topic and highlight their personal appreciation of it.

"Critical perspective". Even though urban knitting is received very positively in general, some Twitter users are concerned with negative aspects and put them up for discussion. This might involve the uncertainty, if installing a yarnbomb in public space is legal or not or mentioning that woolly installations become dirty and ugly with time.

"Technology". The relevance of technology in urban knitting is not a frequent topic of discussion but still existing. In the given data set it only appeared in a single tweet. But since this category is highly related to the topic of the thesis at hand it was decided to keep it as a distinct category.

"Definition". Tweets categorised as definitions are such which try to explain urban knitting to unknowing peers on Twitter. Figure 4.10 would be an example of this type.

Findings of Thematic Analysis

Just as proceeded with the Dann-categorisation each tweet in the spreadsheet was assigned to one of the determined custom categories and its associated theme. Table 4.5 presents the final results of the categorisation with the absolute numbers and percentages grouped by the themes.

Theme	Category	Tweets	Percentage	Grouped	Share
Artefact-related documentation	Yarnbomb	68	24.4%	101	36.2%
	Project details	33	11.8%		
Creation process	Recruiting	36	12.9%	95	34.1%
	Work in progress	32	11.5%		
	Installation process	16	5.7%		
	Organising	5	1.8%		
	Inspiration	3	1.1%		
	Material	3	1.1%		
Utilisation	Local news	19	6.8%	33	11.8%
	General account	8	2.9%		
	Promotion	6	2.2%		
Topic of conversation	Humour	8	2.9%	25	9.0%
	Socialising	6	2.2%		
	Support	6	2.2%		
	Critical perspective	3	1.1%		
	Technology	1	0.4%		
	Definition	1	0.4%		
Not classifiable	Not classifiable	25	9.0%	25	9.0%

Table 4.5: Results of thematic analysis: Number of tweets per custom category and theme.

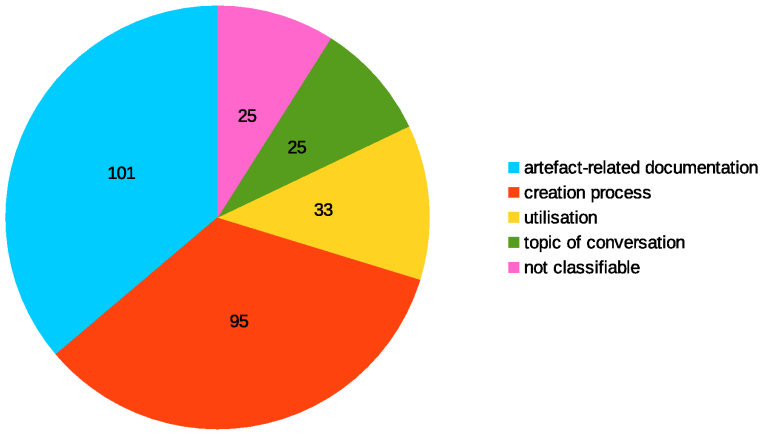


Figure 4.18: Results of thematic analysis: Number of tweets per theme

Figure 4.18 visualises the distribution of the tweets among the different themes. As shown in the diagram the artefact-related documentation and creation process themes are the most dominant classes (constituting together a share of 70.3%). The numbers of tweets categorised as utilisation, topic of conversation or not classifiable content each amount to comparable percentages (between 9 and 12%), but play a far minor role than the two big themes.

What is interesting about this distribution is that the categories which are most directly relating to specific urban knitting installations or activities are the ones appearing most frequently in the data set. Both artefact-related documentation and creation process posts can normally only be tweeted by people who have direct access to such projects in some way. This means they are most likely to be either (one of) the creating craft artists or an "eye witness" encountering the installation on-site. It is hard of course to be all sure about the specific role which the respective Twitter user is playing in the given instance, but the results are distinct enough to make two assumptions: First, some Twitter-using urban knitters like to provide additional information on their activities and projects. Since the character-limit of tweets doesn't leave much room for details they only include most basic info such as location and other people involved directly in the messages and link to other external services for further information. Second, people appear to be glad when they encounter urban knitting installations taking the situation as a special moment in daily life which they like to capture in a photo and share it with their friends on Twitter. The general positive response to knitted graffiti on Twitter is striking considering that only 1.1% of the tweets express an explicitly critical perspective.

Results of the Online Content Analysis

The analysis of publicly available online content collected on the microblogging-platform Twitter provided some very interesting insights concerning its usage in relation to urban knitting. Not only did it roughly outline the popularity as a topic but it also allowed us to get an impression of the most common situations for tweeting about particular yarnbombs or yarnbombing in general.

On a quantitative level we found out that urban knitting is a very special interest amounting to not more than maybe 7 tweets in a million. Most related tweets refer to it by the term "yarnbombing". Other synonyms are also used but are less popular.

Taking a closer look at the specific tweet content during two analysis iterations we recognised that most tweets represent information which is passed along. This means much of the content is either created by another user and retweeted or links to information external to Twitter. Another important finding which resulted from coming up with a customized categorisation framework was that most of the tweets seem to arise in direct relation to specific installations and projects. This indicates on the one hand that urban knitters might like to provide background information on their projects and on the other hand that non-involved people appreciate the experience of encountering a yarnbomb in public space.

The determined custom categories also shed light on possible purposes for which urban knitters use Twitter. Apart from spreading information about their installations, they also use it for a variety of other activities involved in urban knitting. They use it to actively recruit interested peers to participate in larger projects. For some Twitter users it can also be an administrative mean for organising the distributed work of bigger collaborating yarnbombing groups. Work in progress and the installation process are captured which turns Twitter into a social documentation tool offering an open communication space between the craftspeople and other Twitter users. While the non-involved can use it to express their appreciation and support (or critical concerns in very rare cases), such comments might serve as an additional source of motivation for the urban knitters who are happy about the positive response to their craft pieces.

In this manner, the online content analysis filtered out the adaptive multi-purpose usage of mainstream social media by people referring to urban knitting. This was also the main finding in regard to the over-all thesis work. With this in mind it is important to discuss this insight with respect to the previously identified groups of "insiders" and "outsiders". This perspective points out three interesting aspects: First, it seems to be a common practice in this setting to simply use well-known online tools for the own purposes. Secondly, the publicity of Twitter as a mainstream platform is an important factor as well if it is used to "amplify" user-generated content related to urban knitting. While it serves classic promotion, being heard by the big crowd can also be understood as a work-around for not being able to directly reach the artist or the audience of a specific installation. Third, the identified custom categories manifest a clear interest in communication across the information gap on both sides. Urban knitting artists try to make project details and documentation available at the same time while the spectators publicly express their interest in the installations by posting photos and location descriptions of their encounters.

However, the online content analysis had some shortcomings as well. On the one hand, the analysed data was often not clearly attributable to the user groups. Containing many different statements by urban knitters as well as by other people who are not active in knitted graffiti, the tweets themselves often disambiguated the role of their author. On the other hand, we have also seen that technology does not seem to be a common topic to explicitly discuss in this setting. Therefore, the next step of the exploration phase is to gather directed first-hand information by yarnbombers providing an exclusive insight into their views on the relevance of technology concerning their urban knitting practices.

4.4 Survey

The analysis of public online data had provided several interesting insights concerning what kind of content is usually posted in the context of urban knitting. However, the method also showed several weaknesses with respect to the overall research question. On the one hand, it was often not possible to determine the role of the author beyond all doubt. In many cases the content could have been provided by an urban knitter just as well as by somebody else. On the other hand, the role of technology had hardly ever been picked up as a central topic of discussion within the collected tweets. Even though the informative value of the analysed data set was high in terms of learning about the social media use and perception in regard to urban knitting, in the particular aspect of the knitters' relationship to technology the method seemed to be highly depending on a combination of several coincidences. In fact, it needed practitioners who were clearly identifiable as such (eg. by writing *"I did this"* instead of *"Here it is"*) and who by coincidence just happened to publicly express their point of view on exactly this topic. Since this did not happen, it was decided to employ another method which was capable of gathering more focussed data directly provided by urban knitters.

An online survey seemed to be a suitable option to meet these requirements. It would allow to ask specific questions and with the aid of an accurate survey design it could be made sure that the answers are provided by the envisaged group of self-proclaimed knitting street artists. The goal of such a questionnaire was to find out which kind of technologies urban knitters employ and for which purposes they use them. Furthermore, the data should shed light on how the participants perceive this involvement of technology in their craft activities. Where do they set deliberate limits for technology integration?

Survey Design

Having clarified the research focus for the survey method and thereby defined a clear envisaged aim for data collection, appropriate questions could be phrased. First, a draft was written in an informal text document which was subsequently reviewed and refined. Once the set of questions had reached a sufficient quality of language and were believed to be specific and unambiguous enough for the participants to answer, they were transferred to an online survey tool.

The chosen software for this purpose was Google Forms[29] since it is free to use, it doesn't have a limit for the number of questions and it is relatively easy to quickly set up a questionnaire. The Google service offers a number of standard question types (for example open text answers, multiple choice, scales, choosing answers from a list, etc.). Additional media content such as images and videos can be embedded, too. The tool has also some integrated features for monitoring the number of responses and summarizing the gathered data in automatically generated excerpts and charts. The "raw" version of the responses can be downloaded as an CSV-file for further processing and analysis in an external spreadsheet application.

The resulting online survey comprised thirteen questions split up in three sections following an introduction. The preface briefly introduced me as a Master's student writing a thesis and explained the role of the given questionnaire in this context. The text further promises to treat

[29] `https://www.google.com/intl/en-GB/forms/about/` (Accessed: 27.07.2015)

the provided data carefully and exclusively for the purposes of the thesis. In the end of the introduction I also gave my e-mail and Twitter contact for enquiries and comments.

The following sections were titled “Some basic demographics”, “Urban Knitting and You” and “Urban Knitting and Technology”. Each of them contained three to five questions which were mostly optional to answer. The only mandatory questions regarded the information if the participant had ever engaged in urban knitting or not and a personal assessment of the role which technology takes in urban knitting. A view of the entire survey with all questions is provided in the appendix chapter B.

Results

The survey was online for 45 days[30] and was advertised by posting the link periodically on different social media channels such as Facebook and Twitter. In total, the questionnaire gathered responses by 49 participants. However, 9 of these didn’t see themselves as urban knitters and were therefore excluded from the main statistics. The following analysis is therefore based on the answers of 40 valid participants.

Urban Knitting Demographics

The survey starts with asking some optional questions regarding the participant’s gender, age, country of residence and professional status. This helps to outline a general overview on some commonalities and variances within the group. Even though there is not a “typical” or “average” urban knitter, the data indicated some significant quantitative tendencies. Among the 40 participating urban knitters only two were male. The average as well as the median age was 45, while the youngest participant was 26 and the oldest 68. The participants were residing in 9 different countries. More than half of the participants were from Australia. Other responses came from Austria, UK, New Zealand, Germany, France, Ireland, Mexico and USA. The uneven distribution of represented countries is very likely to be connected with the way of advertising the survey. It seems that posting the link on the board of the Facebook group of a large Australian urban knitting group was especially prolific. The occupational status seems to be far more diverse. While some of the participants are retired (4), stay at home for childcare (4) or have other reasons for not being economically active (such as disability status, unemployment, sponsored studentships, etc.), most work in a diverse range of fields. The mentioned professions included for example a forester, a psychologist, a retail manager, a small business owner and an attendance officer. However, it is noteworthy that 20% of the respondents are also creative professionals (eg. fashion designer, photographer, graphic designer or artist).

Personal Urban Knitting Background

The next section of the survey referred to the participants’ personal stories with urban knitting. What was their first contact with it? What are their motivations to engage in it? And which factors would make an installation project especially significant for them?

[30] from April 11 2015 to May 25 2015

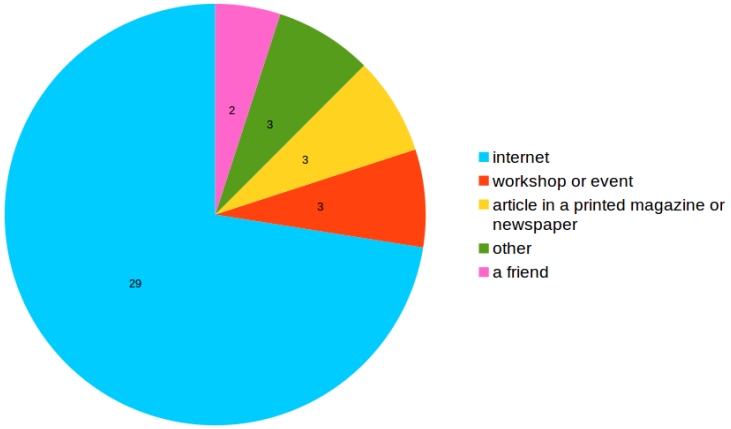


Figure 4.19: Survey results: how the participants found out about urban knitting.

Asking the participants how they had found out about urban knitting, their answers clearly highlighted the importance of media in this respect. While few had first come in contact with knitted graffiti through workshop events (3), friends (2) or installation encounters (1), most (34) saw or heard about it through mainstream media channels. With 29 mentions (which accounts for 72,5% of the valid responses) the internet seems to be clearly in the lead. However, also printed magazines, newspapers and books were named.

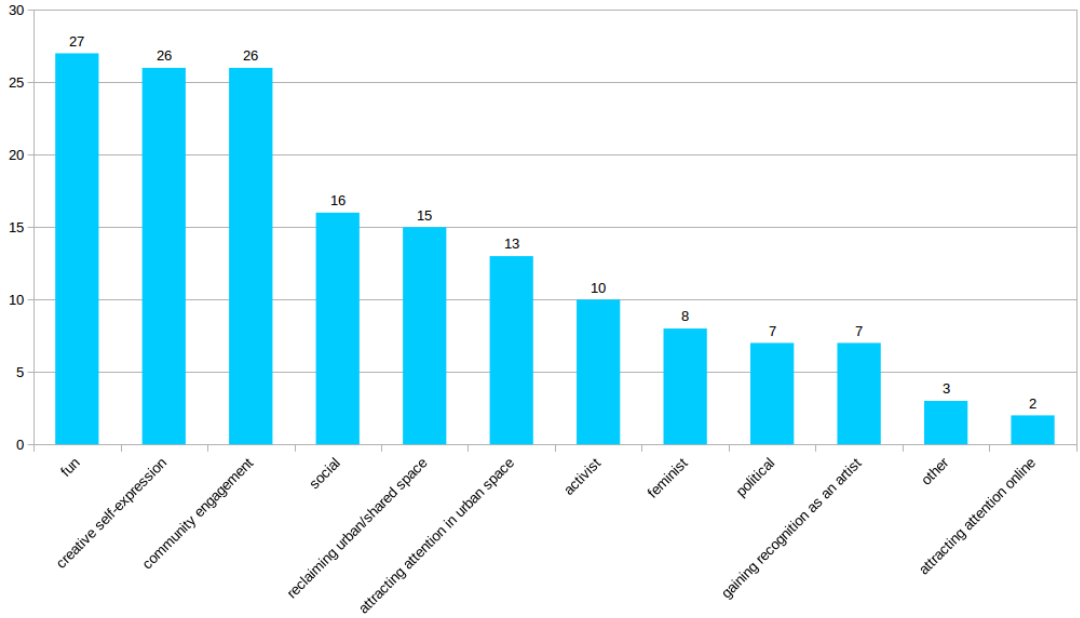


Figure 4.20: Survey results: numbers of selection per motivation

A multiple choice question asked how the participants would characterise their main motivation to engage in urban knitting. The prepared answer options seemed to be quite well chosen since all of them were ticked at least twice and only three other additional sources of motivation were named. The top three mentions were fun (67,5%), creative self-expression (65%) and community engagement (65%). Also personal utilisation of urban space as well as social reasons and activist causes seemed to be quite popular stimuli. Interestingly, while creative self-expression seems to be one of the main factors, recognition and attention seems to be far less important to the participants. Making people smile, drawing them back to nature and using it as personal form of therapy were explicitly specified as other sources of motivation.

The last task in this section of personal urban knitting stories was to describe a project which the participant was particularly proud of. Although the mentioned installations were very diverse in their visual appearances and physical characteristics, there seemed to be two main factors for making them outstandingly significant:

- **Large Scale.** Many participants stated to be proud of having been part of ambitious installation projects which impress by size or mass. Here are some examples for descriptions falling into this category:

  Participant 2: *"I've knitted a car! It took me 8 months of intensive crochet, to cover a car with knitting (Inside and outside), and it looks pretty awesome! :)"*

  Participant 35: *"The Woolly Walk Along - 80 meters of knitting along the Devonport wharf in Auckland, New Zealand, 2011"*

  Participant 36: *"A world record Yarnbomb at our local children's hospice highlighting their work"*

  Participant 9: *"As a member of Yarn Corner, I have been involved in several large scale projects. Although our annual event, yarnbombing all the trees in the City Square (in Melbourne, Australia) looks spectacular, I am particularly proud of the Tractor we covered for the Royal Melbourne show in 2012, and the 'house' and car and caravan that we covered in 2013. As we were able to give classes, and teach people to knit and crochet during the Show, it was amazing to see peoples reactions to our work. The sheer enjoyment it gave them, young and old."*

- **Support of Good Cause.** Besides its quantity, the content of an installation seems to be another important issue for urban knitters. Many report of projects which allowed them to dedicate their work to good causes. However, it's up to the knitters themselves to decide what exactly might be a good initiative to campain for with their craft. The topics can be very diverse as the following examples suggest:

  Participant 30: *"Sunshine tribute tree to raise awareness of domestic violence against women. April 2015 "*

  Participant 14: *"[I] have participated in a yarn bomb in honour of a young girl who was murdered in a park. We were asked to crochet flowers and hearts in pink which was her favourite coloure. I also did a montage of hearts, flowers and butterflies in the shape of a rainbow because a poem about rainbows was read at her funeral."*

Participant 10: *"I yarn bombed a Statue In Scarborough North Yorkshire , I am so proud of the piece as I raised a lot of awareness of Anxiety disorder, I made 6 foot wings with hundreds of little watching eyes, I played with color a brightness and darkness are such a big part of the disorder, I also used free form crochet through out the project , which took me away from the common ridged lines I also suffer from it , I was able to install the whole work with out one attack on a busy Saturday morning!"*

Participant 1: *"Being part of a 'protect from fracking ' camp with several yarnbombs - the company have been stopped for now! Here is a picture of one of the yarnbombs, I put it on the fence of the heavily guarded site of the drilling company. In Northern Ireland."*

Participant 46: *"We crocheted endangered german words and installed them at places where they fitted: e.g. etepetete in front of the Ritz Carlton Hotel, Remmidemmi on a brigde where people are spontaneously gathering to drink beer and have party."*

Figure 4.21: A selection of projects which have been linked by the artists[31]

[31] Copyright by the artists (from top left to bottom right):
Veronika Persché, Yarnbomber, Kate Just, Knitty Graffiti, Woola Oops, Berlin Strickeria (All accessed: 31.7.2015)

Urban Knitting and Technology

While the previous two sections had helped to get to know the main characteristics of the paritipants' urban knitting activities, the last section of the survey picked out their individual perception and contextualized usage of technology as its central theme.

First, the respondents were asked to rate their general attitude towards technology on a scale from 1 (most negative) to 5 (most positive). This was an easy quantifiable measure to include in the questionnaire even though each of the participants probably had a different thought when confronted with the abstract term of technology. However, the general perception associated with their individual notions seemed to be rather positive. 77,5% of the responses rated it with either 4 or 5, while no one picked 1 and only one person said 2 (who however didn't sound very negative in the later technology-related questions). All in all, this resulted in a quite positive average of 4,15 out of 5.

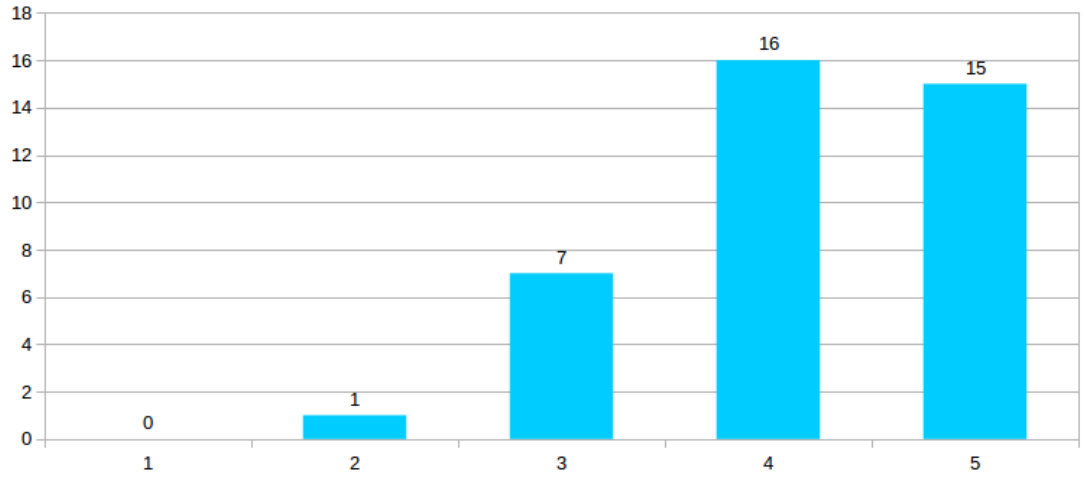


Figure 4.22: Survey results: urban knitters rating their general attitude towards technology from 1 (negative) to 5 (positive)

After the general rating two consecutive questions asked the participants about which role technology plays in urban knitting. They were requested to specify its impact first in relation to their own urban knitting practices and then think about how it affects the movement in general. While only three participants (3,5%) didn't see any connection between technology and urban knitting, all of the others regarded certain parts of the involved practices tight-knit to the internet. Their answers provided an interesting portrayal of how present-day online tools are supporting many of the craft-extrinsic aspects and the emergence of a collective identity.

Most of the answers mentioned social media or specific services which fall into this category. Participant 10 wrote for example: *"Technology in the computer sense can be a very great powerful tool if you know how to use it correctly. Social Media blows me away in the sharing of my work."*, while participant 12 was a bit more specific about it: *" I use various forms of social media including facebook, Instagram, Pinterest to show and share ideas and get inspiration. I*

occasionally read craft and art blogs and often purchase materials online." There seems to be a striking consensus on the choice of instruments[32]. Social media represents something like a central meeting place, which offers virtual infrastructure for most of the urban knitters' needs and wishes. Some participants also mentioned e-mail, blogs and online shops for craft supplies, but even these often seem to be interrelated with social media. Participant 34 put this into the following words: *"Email is a vital tool for us all to stay in contact and 'talk' about our projects, and just general chat. We all have busy lives, so cannot always be on the phone to each other or meeting up. Facebook and the wider Internet helps us to attract attention to our projects and ask others to be involved and is great for showing our completed work. We have also been able to connect to other groups and be involved with their projects, some in the UK others in America and Australia."*

The participants reported to use the internet (and especially social media) as a multifunction tool for quite a wide range of purposes. Some of them were able to list their scope of functions concisely. For example, participant 11 uses such technologies for *"information, inspiration, patterns [and] connecting with others"*, and participant 46 summarized it by *"inspiration, exchange and communication"*. Other respondents emphasized one or another function as being especially important to them and their urban knitting projects. Here are the most frequently mentioned purposes:

- **Access and Networking.** The answers often contained the word *connecting*. It seems that many urban knitters look for other like-minded people online. Sometimes this might even be the only way to get access, as in the case of participant 25: *"I live in [a] rural area and connect with others in group through face book sharing ideas photos of projects unfinished and finished."* Most of the time though, networking online is perceived as a means to integrate local action into a larger or even global framework: *"Connection and collaboration online, especially through social media, has expanded my ideas and initiatives."* (participant 15)

- **Collaboration.** Social media not only helps to *"build a community of others who share [the same] interest"* (participant 40), but also supports such groups operatively. Two participants mentioned for example Facebook events to be important for setting up gatherings. Another interesting instance of how this network can be used for efficiently organising projects, was given by participant 9: *"The group I belong to, Yarn Corner, operates via a Facebook group. Here we list all our projects, sign up for them, and discuss how to go about our installations. The internet is essential to us as we have members from all over Australia and the world!"*

- **Inspiration.** Another keyphrase in the responses was *to share ideas*. Participants referred here to their experience of frequently being inspired by like-minded peers or distributed

[32] At least among the participants of the survey. It is questionable of course, if such results can be generalized for all urban knitters. Considering that all participants were recruited online and that the survey itself was to be filled out online too, no one who absolutely avoids the internet would have had access to it. Furthermore, the prominent status of social media might also be a biased result since most of the participants had only found out about the survey by being frequent users of exactly those social media channels where the survey had been advertised.

visual media. *"Searching online for ideas"* (participant 18) and *"to grab some inspiration (colors, techniques, style)"* (participant 49) seem to be common practices before beginning a project. Participant 44 for example thinks that it is a *"great way to connect others, share photos, and find patterns to base work on. Huge portion of my research to prep a piece is done online."* At the same time, this seems to be embedded into an open sharing culture. For them it seems just natural to *"share ideas on projects on social media"* (participant 42) and to *"[check] out other works of yarn"* (participant 31). Many participants don't seem to worry about their ideas being "stolen" by others and readily share them within their smaller or larger communities. On the other hand, participant 10 also criticizes a sloppy copyright handling of others who seem to take this kind of open sharing for granted: *"What I notice is that credit to the artist is rarely given, this includes patterns too, I belong to many forums where patterns are passed of free even though the designer is selling them, It just belittles others work, Work photos are also stolen and end up in some weird places where people are making money off them!"*

- **Documentation.** A great deal of the previously mentioned inspiration seems to come from pictures and photos which other urban knitters post online in order to document their own projects. For many it's obviously an important part of every urban knitting project to *"share results, document progress"* (participant 40) and *"[show] our completed work"* (participant 34). Interestingly, the respondents rarely said why exactly they are doing so. Only participant 2 mentions that *"it's also for me a way to engage with people, making them smile... and I need photos for that and [a] computer too"*. But there are certainly other reasons involved as well.

- **Resources.** Another frequently stated function of the internet was to use it as a source for material as well as immaterial resources which are needed to pursue urban knitting activities. This can manifest by *"ordering wool, searching for patterns"*, as participant 4 stated, or by *"using youtube videos to learn how to do new stitches"* according to participant 26. What participant 45 calls *"sharing knowledge"* seems to be a very important part here and meets the wish of others to learn. Participant 9 reported for example that she managed to teach herself to crochet with the help of youTube videos.

- **Megaphone.** Comparing the answers regarding their own personal practices to those discussing the technology effects on urban knitting in general, makes it clear that the participants perceive that internet media has the potential role of a megaphone. It can spread the word and might even contribute to forming a larger movement. Participant 6 sees *"[...] technology here more in the sense of media and information technology to provide a bigger stage for knitting projects or to gather together to share same interests."*, while participant 30 thinks: *"It's highly important for media coverage, raising awareness on a broader scale. Information can be accessed globally rather than locally or democratically. Extremely relevant."* Another good example for the megaphone role of technology is provided by participant 41: *"It is very important to take on board all technology where the result is people see that there are other ways of being. That the world can be more fun and more colourful and that knitting especially doesn't belong with the aged and infirm - it is an activity which is fun, good for the soul, creative, artistic as well as plain useful."*

However, knitters also set a limit for technology integration into their urban knitting practices and express a clear preference of hand knitting over using machine produced artefacts. There are of course no global rules denying that machine knitting can be a full-fledged producing technique for urban knitting, but there is obviously a debate with quite different views in place. While participant 40 states that *"[f]or many yarnbombers, knitting machines are an essential part of the process"*, participant 48 emphasizes: *"we knit ourself, by hand"*. However, the general consensus standpoint seems to stand in line with the latter point of view due to qualities inherent to the craft practice. Participant 1 wrote for instance: *"I don't use a knitting machine, value the hands-on work, meditation in action for me!"* Participant 12 agrees: *"I prefer to handmake everything. I knit or crochet as a large part of my enjoyment is the process of making a piece."* With the majority expressing the superiority of handmade artefacts, using a machine to speed up production can induce guilty feelings: *"In the sense of production of the work, I have an icord machine that saves hours of work, though does feel a bit like cheating!"* (participant 34) And in some groups it even seems to be part of the etiquette: *"Another group I belong to has used machine knitting for several installations, although Yarn Corner is known to frown on this :)"* (participant 9)

The last survey question asked for other ideas for how technology could be integrated in urban knitting. Most of the gathered suggestions had to do with location-based services. For example some respondents wished for a map annotation tool which would mark installations and facilitate them being found by interested peers. Participant 6 put the idea in following words: *"[...] something like an app where people share urban knitting projects or pieces in a map. This would be fun. People take a picture of a piece and mark the place in a map all over the world. So other people could see what great installations are existing and also go visit them when they are around."* Other participants imagined such a service more like a geocaching equivalent. Participant 40 wrote for example *"GPS locators to help those seeking the installations to find them. Like a geocache."* Participant 34 even had a specific use case scenario in mind for an internet-of-things-based geocaching which was inspired by two other projects: *"I like the idea of getting knitting/crochet into the outdoors and have participated in #yarnifiedlovebomb, creating little hearts to leave out and about with 'You are loved ' on the label. I have just recently made some ducks for the 'Little Yellow Duck' project which is a similar concept that helps promote organ donation. The ducks are named and are logged onto a map when found. They have a QR code on the label to make life easier. I like the idea of maybe having a trail that people could follow through an app, of small installed pieces. I suppose a bit like geocaching but with woolly items."* Other kinds of ideas mainly related to a technology integration as a means of assisted production for specific complex techniques (eg. assistance with intarsia patterns or a flexible conversion tool turning online images automatically into knitting patterns) or specialized media tools which would *"allow urban knitters to explain their motivations and explain how urban knitting fits into the other things they do in their creative lives"* (quoting participant 15).

Discussion

All in all, the survey was a very insightful method to gather focussed standpoints, comments and stories by validated participants. It helped filtering out important characteristics of urban knitting practices from their creators points of view and to see how these fit into their other activities

facilitated by technologies. Even though the realisation of the method as an online survey and the recruitment using social media channels might have had a major impact on the results in terms of a higher-than-average approval of such media channels, the responses helped creating a bigger picture of urban knitting as a comprehensive collaborative craft intervention in local urban space with a global outreach. In regard to technology integration in urban knitting, the responses suggested that urban knitters have a certain affinity to technology while being critical on its limits. For them it is a deliberate choice how to use technologies and to which extent. The general attitude towards technology is put in a nutshell by participant 4: *"Everything except the knitting itself involves the internet."*

4.5 Lessons Learnt for Design

The previous sections have documented a mixed-method approach which was conducted as the initial exploration phase of a design project. After the results were discussed individually, it is now important to sum up the most relevant findings in regard to the following design stage. Eventually, not all of the insights, which were described above, directly influenced the design idea, but from each method at least one framing aspect could be derived and, therefore, all of them were valuable informants for the later design.

The most important finding was obtained during the workshops and implied that the biggest problem in the context of urban knitting didn't concern the existing practices themselves but rather its surrounding information infrastructure. While the created installations are full of inherent messages, narratives and symbols and the artists want to express these publicly, those, who are not involved in urban knitting and randomly encounter the artefacts in public space, are usually excluded from this particular information. In this respect, we can define two different user groups for the future design: urban knitters and their public audience. Design should accordingly facilitate the message transmission from the creators to random interested people who pass by the installation. A more direct situated communication between them should be envisaged.

The quality of the existing information gap will be key to discuss the success of a later design. Its basic characteristics therefore should be known in great detail. As the online content analysis and the online survey pointed out the present information situation, it is rather a problem of mediation than of availability. In some way the current situation constitutes a dilemma because the lack of information on the audience side is in mere contrast to the active media usage on the creators side. As the Twitter data confirmed, a lot of related information is de facto already available. Most of the tweets belong to the type of pass-along information and try to make specific information more visible or popular within vast social networks. The data suggests as well that many tweets are even posted in direct relation to a specific installation and project. However, these are "weak links" which might be obvious for the installation creators but usually not for outsiders. For them, it is still hard to find specific information because it is often not clear what to precisely look for and where it can be found.

The results of the different methods portrayed the given status quo quite well by providing qualitative insights from the respective point of view of the two user groups:

Both the results of the online content analysis and the online survey suggest that many urban knitters are active on social media as well. They use it as a handy multi-purpose tool for many different objectives in relation to their hobby. Both methods showed that they use it for example as a means to network with like-minded, to recruit other craft-enthusiasts for large-scale projects, to coordinate and distribute craft tasks, to document work in progress and to actively promote installations. This broad range of different activities suggest that urban knitters clearly seem to be interested in telling their audience about their creations. Their urge to communicate background information becomes most obvious in cases when they are proud of their accomplishment (eg. due to its size) or if it is dedicated to a good cause (megaphone-functionality). Even though the acceptance of technology in this sense of media is prevalent, technology itself does not seem to be a primary topic of discussion for urban knitters. Only one single tweet in the set of 279 picked it up explicitly. It seems that urban knitters rather tacitly use the tools which are available online and don't show much initiative to request more specialised software. However, when asked (as by the survey), there are indeed quite playful ideas involving technological solutions (eg. location-based services which could facilitate to find existing installations). Still, as soon as a possible technology integration in the craft process itself came up, the knitters were very critical. They value working with the own hands and tend to reject the thought of technology interfering with their craft. The handmade is also an integral part of the symbolic expressiveness of urban knitting. As learned during the observations at the machine knitting workshop, the visibility of effort embodied in the installations seems to be a major part of this statement. Even though we also have seen that machine knitting does not automatically imply a reduction of effort, many urban knitters would feel as if they were cheating to make use of such machines.

On the other side, the outside perspective of the audience was characterized by an apparent lack of specific knowledge but also by a general interest in regard to urban knitting. The observations in course of the urban knitting workshops identified an over-all positive reception of knitted graffiti installations. The positive comments of participants and passers-by in the workshop settings as well as the large number of tweets reporting of installation encounters suggest that many people seem to like what they see when they walk by a tree covered in knitting. However, the modified object itself leaves them obviously in mere wondering and doesn't give them enough clues how to find an explanation for what it is about. In most cases the spectators just don't have any chance to find out more details. In this respect, the "outsiders" would clearly benefit from being provided with a direct and specific information infrastructure in order to turn into knowing "insiders". Providing first-hand information could also help to break down stereotypes which still seem to be prevalent as it had been noticed in course of the urban knitting workshops. People, who still tend to marginalise handicrafts and handicrafters (mostly women), could be confronted with new aspects which might change their attitude. Theoretically, it would just depend on if they decide to give it a try with such an information infrastructure.

Having learned about the different viewpoints on the present information gap, we can now think of how to address this opportunity for enhancement with design. One possibility to tackle the issue would be to introduce artificial meta-information which facilitates quick identification and association such as for example a unique installation hashtag or name. But this would not solve other practical problems such as finding a way to make sure that this ID stays available. At present, some survey participants reported to use business cards for exactly this purpose. But

these could be easily torn off or be soaked by rain making them unreadable, while it would still require some search effort online on the audience side. QR codes could help to reduce this effort [7, 27, 42, 58, 59, 77] but being a visual artefact themselves they would most certainly interfere with the optical design of the craft. So-called Aestheticodes [8, 60] could maybe help to solve this aesthetic problem, but these are not so well-known yet and it is questionable if the knitted structures can fulfil the requirements to visually embody a valid code.

Another way to approach the problem would be to try it the other way around and to bring the information back directly on the site of the installation where the audience is in a current state of wondering and would most benefit from it. Instead of outsourcing the content to a given online resource, it could be directly connected to the given artefact. Design could therefore be used to augment the installation and facilitate immediate interactive exploration. This was the chosen approach of the "Tools for Wools" design idea, as will be described in the next chapter.

CHAPTER 5

First Design Iteration

The lessons learnt from the preceding phase of exploration informed the design of an interactive information layer augmenting urban knitting installations. The general idea was to provide urban knitters with a tool which should enable them to explicitly share their thoughts and intentions behind their craft pieces with interested urban peers. At the same time this information should be readily available and make it easy for the public audience to find out specific details on a given installation.

The following two chapters will document the conception, implementation and user tests of a prototype which attempts to fulfil the requirements which had been identified during exploration. This section starts by describing the basic design idea in greater detail and continues with the first of two consecutive design iterations in which two versions of a digitally augmented urban knitting installation were built. The first version was a small-scale representation of an installation which served as a proof of concept. It comprised five wool panels which were mounted on a solid board. The next chapter will describe the second design iteration which involved initiating a real urban knitting installation project. Twenty-six active urban knitters from seven different countries were recruited by posting a public call of participation on a website and mainstream social media channels. The gathered wool panels assembled a flexible portable installation. Both versions were tested with users representing the groups of artists and non-involved passers-by.

5.1 Design Idea

The results of the exploration phase suggested that people who are not involved in urban knitting often lack the information what such installations are about and that some urban knitters would like to tell their audience more about the background of their work. This deficit of knowledge on the one side and the lack of a direct audience-oriented information tool on the other side pose a communication problem. The engagements of artists and spectators with the physical installation usually take place at different times which prevents direct face-to-face-conversation and leaves the artefact's craft design as the sole unclear medium to convey its message. Viewing

the circumstances as such a temporal problem of mediated communication induced the idea to provide additional information infrastructure augmenting the physical installation object by corresponding digital data which is available at any time.

The information should be received by the installation viewers as directly as possible, relieving them from active effort to search for background information online. The most proximate human sense is touch which in the case of crafted art also suits the tactility of the medium. Therefore, it was decided to base the system's responsiveness on touch interaction. Furthermore, it was assumed that direct touch interaction with the knitted pieces might also contribute to giving the user a more personal and possibly emotional access to the installation. This assumption was encouraged by the findings of related research. Tsetserukou et al. [83, 84] for example described their design study which had explored affective haptics in terms of the system-mediated possibilities to elicit, enhance and influence the emotional state of device users by means of tactile sense. Felicia Davis's work on transforming computational textiles [21] evaluated the material expression of emotion and stated that the expressive qualities of different materials in fact triggered specific feelings in participants but highly depended on their personal contextualized readings of body, place and material.

Combining all of these considerations and thoughts with my personal implementation knowledge of prototyping technologies resulted in the concrete design idea of a touch-interactive installation controlling an info system as illustrated by the sketch in figure 5.1. By touching a part of an urban knitting installation corresponding information should be displayed on a mobile device (such as a smartphone or tablet). Technically, this would comprise components for registering and processing touch or proximity sensor inputs, a stable communication connection between the installation and the mobile device and the representation of the respective digital data.

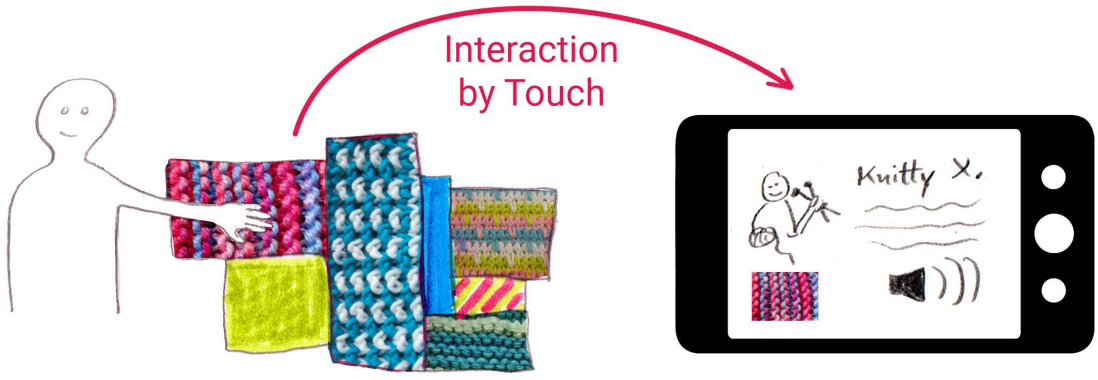


Figure 5.1: Sketch of the design idea

5.2 Course Context

The first version of the prototype was implemented as the final project in a Master's program course titled "Building Interaction Interfaces"[1]. The course was based on hands-on projects and required the students to do several smaller projects with different ubiquitous computing technologies such as Kinect, Arduino and Android programming. The final project should include a combination of technologies and solve more complex tasks. The students worked in teams of three[2] and were free to choose the topic for the last implementation assignment. Since the course task happened to coincide with my insightful observations at the urban knitting workshops (where I first had identified the information gap between urban knitters and the installation spectators) and my team-mates were interested in experimenting with sensor-facilitated touch interaction, we agreed on implementing a small-scale representation of an augmented urban knitting installation. While the development of the prototype corresponded in the first instance directly with the course requirements, I could use the immediate results in the second instance as a jumping-off point for further work as part of my Master's thesis. In this manner the prototype became a means to perform a proof-of-concept evaluation of the basic design idea.

[1] `https://tiss.tuwien.ac.at/course/courseDetails.xhtml?windowId=58c&courseNr=187A25&semester=2014W`, (Accessed: 14.7.2015)

[2] My team-mates were Farzaneh Yegan and Michael Treml.

Figure 5.2: Front view of the first version prototype

5.3 Prototype Version 1.0

The first version prototype was designed as a small-scale representation of an interactive urban knitting installation mounted on a flat surface board which provided information on each of the contained craft artefacts. Firstly, it was meant as a hands-on experiment to explore the different technological possibilities how to implement such a system. Secondly, the resulting prototype was intended to facilitate a practical proof-of-concept check based on user tests if the prototype was in fact capable of having uninvolved people deal with the messages and stories behind urban knitting.

Looking at the prototype from the front, it consisted of a plain chipboard with a small representative urban knitting installation and an information device attached next to it (cf. figure 5.2). The installation comprised five different panels created in knitting or crochet technique. All of them had a rectangular form while they varied a lot in colour, yarns and size. However, each of the crafted pieces was big enough to place a full flat hand on it. The five panels had been produced by five different hobby-crafters. Four of them were recruited within my close circle of family and friends, while I added the last piece myself in order to reach a number of five.

The interaction was based on capacitive proximity sensing. Whenever someone touched any of the pieces, the screen device displayed corresponding information on the particular piece. It showed the title and artist name as well as a description text and a photo of the knitter with her piece (cf. figure 5.3). All of this information was provided by the participating artists themselves. They had been asked to explain their contributions in their own words and present themselves to the installation spectators in any form they wanted. We had offered them to include

Figure 5.3: Android app displaying first-hand urban knitter information

also video and audio material but none of the participants were willing to do so. Instead, all of them sent in a text and a photo. All text and photo contributions are listed in appendix chapter D. To provide users with additional real-world feedback on which piece is currently described on the screen, we added a blue LED indicator below each crafted piece. As soon as a piece was selected, its indicator lit up while all others were switched off.

Apart from the information device and LED-lights most of the technological components were placed on the backside of the prototype (cf. figure 5.4). In this manner they remained largely invisible to the user who usually only sees the front side of the installation. Sheets of aluminium foil served as capacitive touch sensor electrodes. These were connected to an Arduino microcontroller board which sent signals to the Android smartphone attached on the front. The sheets of aluminium foil had the approximate size of the crafted pieces on the front side and were taped to the back side of the board in a corresponding position.

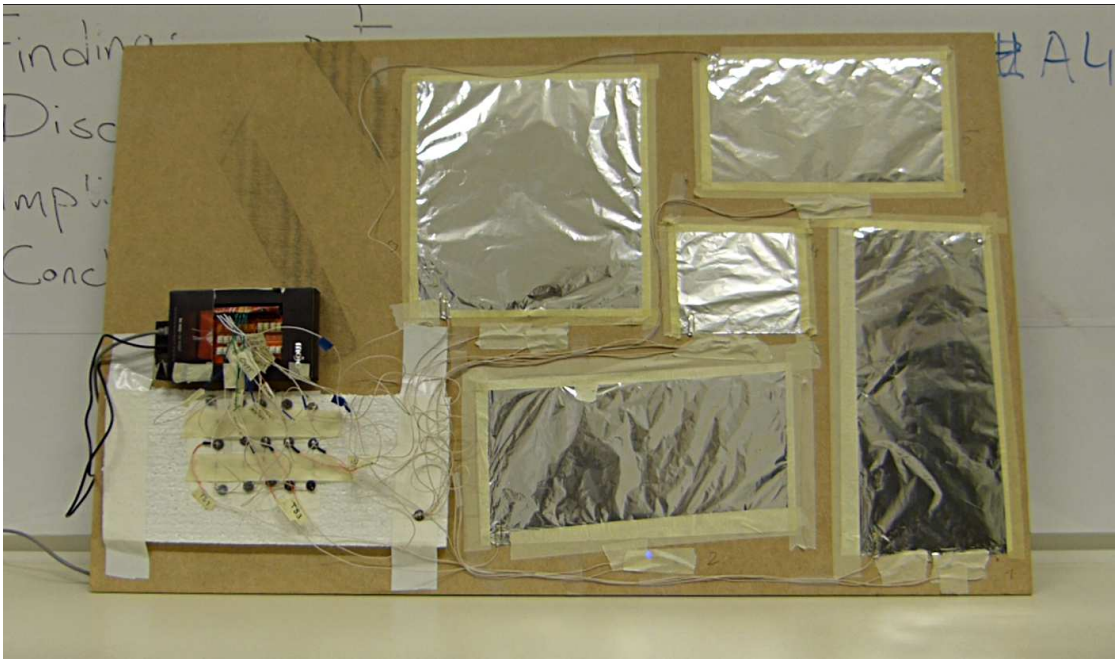


Figure 5.4: Backside view of the first version prototype

5.4 Hardware and Implementation

Technically, the prototype consisted of three main units: one for touch sensing and processing, one for displaying the respective information and one for managing the LED feedback. These three tasks were performed by two hardware components: an Android-operated smartphone[3] and an Arduino Mega microcontroller. These components were connected by a regular USB-cable enabling communication and data exchange between them.

[3]The product used in this design iteration was a Samsung Galaxy Nexus.

For the information displaying part a custom Android app was implemented. The program had a relatively easy structure consisting of an activity for each piece and a service running in the background. The service listened to signals on the smartphone's micro-USB-connection coming from the Arduino and would - in case of a sensed touch - accordingly start the activities with the respective information. The code can be viewed as part of the Appendix C.

Most of the hardware setup was part of using the Arduino microcontroller for touch sensing and LED feedback. In order to build custom capacitive touch sensors, sheets of aluminium foil were used as electrodes and connected to a circuit with resistors between two Arduino pins. This is the standard setup for Arduino's official Capacitive Sensing Library[4]. As can be seen in figure 5.5 one of the Arduino pins served as an output channel while the other one registered changes in the current as an input pin. In principle this works by using an incrementing variable inside a while loop as a time indicator how long it takes to send a sate change from the sending pin to the receiving pin. The two resistors in between were used for stabilizing the circuit behaviour on the one hand (a low-value resistor) and for adjusting the sensor sensitivity on the other hand (a high-value resistor). While the small-value resistors were rather optional in this case, it was worth experimenting with the values of the high-value resistors. For the prototype we used resistors of $10\,\mathrm{M}\Omega$ to make the sensors capable of proximity sensing. This means that sensing worked through the board and the mounted artwork. No direct touching of the aluminium foil was required anymore and touch interaction was working quite smoothly on any area of the knitting. However, it still needed to be touched with the full flat hand. Touching with the fingertips alone wasn't sufficient enough.

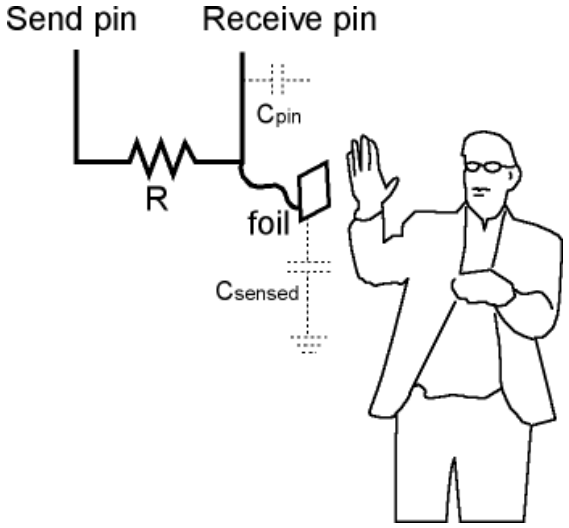


Figure 5.5: How touch sensing works with the Arduino Capacitive Sensing Library[5]

[4] `http://playground.arduino.cc/Main/CapacitiveSensor?from=Main.CapSense` (Accessed: 16.7.2015)

[5] Figure by Arduino (Accessed: 16.7.2015)

Apart from continuously comparing the capacitive sensor measurements and eventually triggering a change in piece selection, the Arduino code also took care of controlling the LED feedback. This was done straight forward by switching off all lights apart from the one associated with the currently selected knitted artefact:

```
// switch active LED
if (!pieceStatus[piece]) {
    for (int i = 0; i < PIECES; i++) {
         pieceStatus[i] = false;
        digitalWrite(pinLight[i], LOW);
    }
    pieceStatus[piece] = true;
    digitalWrite(pinLight[piece], HIGH);

    // switch Android Activity
    currentPiece = piece;
    androidSent = false;
}
```

5.5 Proof of Concept Evaluation

The subsequent user study was conducted with seven participants representing the two main stakeholder groups defined as urban knitters and uninformed passers-by. The goal of the test was neither a detailed technical examination of the performance nor a thorough efficiency check of the user interaction at runtime. Instead, it aimed for some first quick qualitative statements to find out if the prototype was going into the right direction and provoking promising reactions in consideration of the identified information gap problem. Following an iterative user-centred design approach the feedback should be used to gather and prioritize ideas for further development and improvement.

User Tests with "Passers-By"

For the user group representing uninvolved people incidentally encountering urban knitting installations, my team mates and I organized a one day user study session on the 19th of January 2015. It took place in a room of the HCI group of the Institute for Design and Assessment of Technology at the Vienna University of Technology. In this room we installed the prototype by placing it on a cupboard in front of the wall. No further mounting was applied. Power was provided by a USB-connection between the Arduino board and a laptop computer. This might have looked a bit misleading (as if the laptop was steering the board's reactions), but it was important to do so due to technical reasons. In this way the power connection served as grounding of the system to the architectural environment and we still had the possibility to access the touch sensor values in case of any technical issues. Apart for some initial setup problems and temporary reaction delays for some of the crafted pieces every now and then, the prototype was functioning as expected and the study participants could interact more or less autonomously with it.

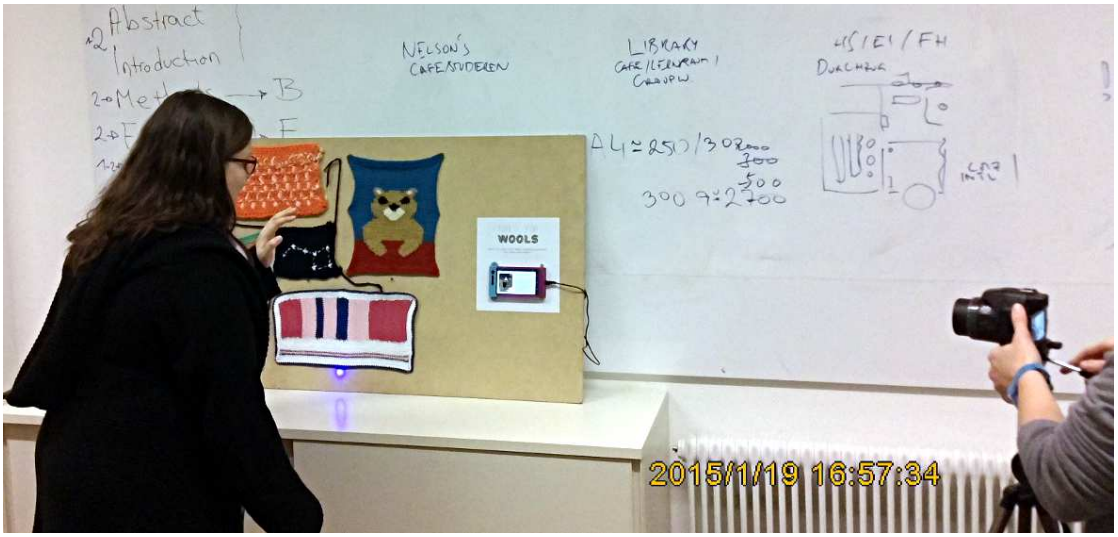


Figure 5.6: User interacting with the prototype while being video recorded

The participants were recruited within our extended circle of friends asking them to come by, as well as from students who happened to be present at the institute. All of them were at a similar age (between 25 and 30) and had a certain academic background, being bachelor, master or PhD students, but we managed to achieve a good mix of people regarding sex and previous knowledge about urban knitting. During the session we invited our participants to try out the prototype. Their interactions with the board were documented by a video recording (cf. figure 5.6). After that we conducted a semi-structured interview with them which lasted between 10 and 40 minutes and gave us insights on their individual experiences with the prototype as well as on their previous encounters with urban knitting and interactive art installations (cf. figure 5.7).

In the interviews we asked the participants to describe their first impressions. Many of them seemed to like the general idea and characterised the prototype as *"nice"*, *"cute"* and *"interesting"*. Of course their positive replies might have been compelled by the social configuration of the situation. I admit that the setup of the study with us (three researchers) being in the room with one or two participants at the time might have biased their answers unintendedly due to social norms demanding to being polite to peers. Still, we don't believe that these norms were the only reason for positive feedback. The video recordings documented that comments such as *"Nice thing!"* or *"Cute!"* did not only occur in the interviews when asking them for their opinion but also during autonomous exploration of the prototype without any intervention by the researchers. The video recordings often showed the participants smiling and laughing while touching the pieces or looking at the information screen. Also the timing of smiling seemed to be interconnected directly with the participant's actions. That is, smiling was most likely to occur when they touched a piece and realized that the touch interaction had worked correctly and triggered a change on the smartphone display. This might indicate that using the hands for this kind of system is perceived as very enjoyable. In some of the situations the smiles might also

Figure 5.7: Interview with two user test participants

have been triggered by the fascinating impression that the prototype magically reacted to their touch without requiring any buttons or other well-known input technologies. And sometimes, the participants maybe just liked what they were seeing on the information screen.

The participants' statements in the interview strengthened these interpretations. They said that the installation was looking so soft and interesting that it was inviting to touch. Participant St. stated for example: *"I really like the concept of touching. Because... it's always nicer. I prefer it when I'm in a place and see something [like this], just to chhhchhhhhh [makes a noise and grabbing gesture], touch. I think that's a great idea! And then you also get to know something about the artist."* The aspect of immediate information feedback also seemed to be important to S., who had never seen or heard of urban knitting before: *"It's interesting! As you touch, you get information. OK, we all have seen a lot of sensors and electrical stuff in our daily lives, but in this [way], no I haven't seen."* Another participant, D., emphasized the direct nature of this kind of interaction compared to normal touch screens: *"Yeah, that's the thing! The experience is a whole other. Normally it's like, well, you use your smart phone. But there it's like, yeah, use the handwork. So it's much more direct. To touch and see."*

Apart from just being informative the participants also identified a new personal level of information. They stated to enjoy the background stories and seeing photos of the installation's creators. C. put this aspect into the following words: *"I think the important part is that it is on a more personal level. You know, when you see something like that and then you go on Google and just say, I don't know, 'knitting in the city' or something. Then maybe you find an article about urban knitting which is just generalized. And the artists can't tell what they thought about it. So this is much more personal."*

Even though the participants enjoyed this kind of information, they criticised the texts for

being quite long. This would tax their patience, especially when it was required to scroll down. They suggested to use a bigger screen and a larger font size. Alternatively, they could imagine the texts becoming more catchy by reducing them down to punchline style or maybe using different media forms such as audio. To put it into S.'s words: *"We are so reluctant to just start with brief information. [Long information] makes you tired. [...] I just mean brief and very simple. I think this can fascinate you at first glance."*

Besides requesting an optimized information design which is more intuitive and does not demand as much attention as for reading a long text, the participants also suggested to include some basic information about urban knitting in general. Although they enjoyed the personal background stories they still felt quite clueless regarding the "big picture". They wished for an introduction which designates the installation at hand as an example of urban knitting and an explanation what this form of street art is generally about. The participants had different opinions though on how this information would best fit into the existing prototype. While C. imagined it similar to a starting page of the information app, D. pictured it as a "crafted info button" and St. in form of a simple paper sign which excluded this particular kind of information from the screen.

Figure 5.8: Test participants interacting with the prototype

The reactions concerning the general usability of the prototype on the other hand were very consistent. All of the participants stated that it was easy to use. In the video recordings we could

see that they apparently were a bit unsure first what to do. But this initial uncertainty could be easily overcome with the help of a brief introductory advice by us to just touch any of the pieces. From this point on it did not seem hard to find out how to interact with the prototype. After the participants had successfully switched the piece selection for the first time, they didn't seem hesitant to touch anymore and were autonomously exploring other features of the prototype. Some of them claimed that the combination of LED-indicators and the knitter photos made it even intuitive to understand that the texts were connected with the knitted pieces.

However, the first touch was not as easy as we had hoped. During the construction of the prototype we had tested the functionality by touching the pieces with the full flat hand only. In the user study we quickly observed that there are also other ways of touching which should be supported. Most participants first tried to touch the pieces with the finger tips only. This is probably an intuitive way how to approach an unknown object and reflects the just mentioned uncertainty. Unfortunately, this kind of minimal contact is not sufficient for the implemented sensors and the prototype is not likely to react. In the user study we could only solve this problem by showing or telling the participants how to place the hand on the pieces, but in future versions the prototype should support different ways of touching by tuning the sensitivity of the sensors and the threshold settings in the Arduino code.

Another important insight from the user study was that a board prototype in a lab context might not be very representative for a more "natural" setting where people should interact with an urban knitting installation in public space. According to our participants the prototype was working well and was fun to use for them in this particular study setting, but they were not sure that they would use it the same way if they encountered it in a park or on the front of a building. The context seems to matter a lot. A. would maybe choose not to interact with it because it could be dirty. D. was concerned that he could look like a strange person if he would stand too long in front of the installation, to read the texts on a small screen which is not very visible for others. Context-dependent behaviour patterns are hard or even impossible to investigate in a lab. This is why, further evaluation in a more natural outdoors setting was needed. This would require some technical adjustments of the prototype. Apart from tackling practical issues such as making the technology weather-resilient for example, the next version prototype should also provide the impression of a real-world urban knitting installation. Since urban knitting is normally applied to many different surfaces and forms (eg. trees, sculptures and fences), a major task would be to find a way how to integrate the sensors in the design while also supporting the flexibility of textiles. It would therefore be important to introduce this adaptability to the prototype technology as well.

Feedback from Urban Knitters and the Informative Value of First-Hand Data

Three out of the five participating knitters agreed on being interviewed after the prototype had been built. While one of them had the opportunity to interact directly with the prototype, the other two saw a short video. This allowed all three of them to have a quite solid impression of what the prototype basically did and how the interaction looked like. The interviews focussed on two main aspects. On the one hand we were interested in their individual approaches to urban knitting. For further improvements of the prototype and finding a suitable way to present their different backgrounds in an implemented app format, it would be important to understand

the variety of underlying motivations. On the other hand we were interested in hearing their opinions on the first version of the prototype. We wanted to know to which extent it already met the urban knitter's interests and demands, and which features were still missing in their point of view. Together with the feedback of the passers-by their input was supposed to guide further development of the prototype.

While the interviews were conducted in teamwork together with my colleagues, I individually conducted an additional content analysis session after the course work had been completed. The participants had provided rich first-hand data in order to explain their crafted artefacts and their thoughts behind it. Even though they had written their description texts for non-involved installation spectators, it also seemed like an abundant data source for research. Making use of the inherent informative value of such self-made visual artefacts (and the subsequent explanation by their creators) for research purposes, corresponds to how the British sociologist and media theorist David Gauntlett has described his idea of creative research methods:

> The process of making a creative visual artefact – as well as the artefact itself (which may be, for example, a video, drawing, collage, or imagined magazine cover) – offers a reflective entry-point into an exploration of individuals' relationships with media culture. [28, p.1]

He argues that the reflection involved in a creation process and the availability of other modalities to express thoughts than spoken or written language can be very beneficial for data collection, even though it might be more complex to analyse data which is not based on text [28]. Although Gauntlett wrote this out of a media studies perspective, his approach seems also legitimate for other domains, creative materials and research questions. In his own study exploring identities [29] he had used Lego for example to let participants create metaphorical representations for their identity which were clarified in subsequent interviews. In this project knitting constitutes an equivalent creative medium and the first-hand data provided by the participants was an adequate alternative to interviews. Therefore, the prototype project seemed like a good opportunity for applying creative research methods and taking a closer look at the gathered material.

For close examination of the first-hand data I used thematic analysis as described by Braun and Clarke [12] again. This allowed me to deconstruct the content into its most relevant statements and compare them to the interview data. Naturally, the ex ante delivered texts couldn't give any feedback on the design per se (since the prototype was only presented to the participants at a later time), but the content analysis of the description texts contributed well to filtering out common characteristics and motivations. Altogether the gathered data set provided a quite consistent portray of urban knitters clearly highlighting some motives being very important to them.

Even though our study involved only four urban knitters (myself excluded), the results already pointed out several factors which seem to be important sources of motivation for them. Since we could see different facets of similar background stories it is possible to categorize the variety of individual stimuli into four basic types in relation to the following aspects:

- **Urban space.** Urban space is reclaimed as a shared place of action and intervention which is used to pursue a personal mission within a social but non-personal environment.

- **Ideals and values.** Urban knitters depict themselves as caring fellow citizens with strong believes who want to express this part of their identity. During the study we repeatedly encountered the knitters' views on personal freedom and wishes for collective happiness. As indicated above they believe that urban space should belong to everyone and that making use of it can be of benefit for the community. With a little wool they seek to democratize urban space while giving their local peers a little colourful break from "grey" everyday-life.

- **Craft.** While urban knitters produce crafted artefacts to commit to the public, they give up on any individual use of their physical creations and to some extent even a personal connection to it. Instead their main relatedness pertains to the process of its making. This shift in focus highlights the knitters common appraisal for aspects inherent to the applied crafting techniques.

- **Material.** Urban knitters often don't pay much attention on their choice of materials and in many cases they just use what they have at hand. Using left-over yarn is not perceived as a restrictive factor in their design, though. On the contrary, it is often reported to result in stimulating craft experiments.

Most participants directly referred to three out of the above mentioned motivation categories in order to explain their craft contributions: ideals and values, material inspiration and the crafting process.

For example, some knitters tried to explain the chosen motive or design of their piece which revealed also a great deal of their personal ideals and values. Carla for example embroidered the asterism of the Big Dipper on a plain dark blue crochet square and explained that she wanted to bring back the beautiful night sky into the light-polluted city. Shlomo on the other hand associated her piece consisting of white, pink and blue stripes with childhood memories of watching Boris Becker playing tennis on TV. Of course these statements are not always totally clear in expressing the creator's ideas but they definitely indicate topics which are valued by them.

Other knitter texts rather focussed on their choice of material. It was noted several times that they used wool from their stash at home or left-over yarn from former knitting projects to turn into urban knitting. Inge for example mentioned cheap *"plastic wool in glaring colours"*. She thinks that this material cannot be used for making anything to wear but appreciates it as great material to produce *"useless but pretty bits"* to look at.

The process aspect of crafting is emphasized by the texts frequently referring to the fun and joy of knitting and crocheting as an activity in itself. For one participant (Shlomo) the crafting activity eventually took over other factors and determined the final design result. She called her process intuitive and compared it to *"Écriture automatique"*, a psychoanalytic writing method of the surrealists.

The only aspect of the previously mentioned categories which did not explicitly show in the description texts was the one of urban space. However, its social dimension frequently came up in the interviews. After seeing the prototype and how it worked the knitters started to think more about how their fellow citizens would experience the interactive installation. They

suddenly seemed to perceive themselves more like co-designers of the installation experience and elaborated what they could do differently in order to optimize their contributions. They were not really sure how or if the people on the street would react to the prototype but still they worried about their texts being too long. After seeing the installation as a whole it can be assumed that they might also be more willing to try out other media formats such as audio recordings or videos.

Having identified the four basic factors underlying urban knitting activities in general, it should also be discussed at how these show through the knitters' use of the prototype. The main purpose of the prototype from their point of view is to provide background information to the public audience by presenting themselves and their craft contributions. Our participants had every freedom in doing so. We had suggested them to use text but also photo, video or audio material and emphasized that there were no constraints regarding the content either. They should choose for themselves what and how to tell their thoughts to others. Interestingly enough, all of our participants decided to use a similar strategy: They stayed with the classical static media formats (texts and images) by which they were seeking to communicate on a personal level. The knitters presented themselves as modest peers on eye-height with their audience. Their background stories often mentioned their individual approaches to urban knitting and referred to their private interests just as well as to deficits and negative associations. One of the participants for example told about her "childhood trauma" from handicrafts lessons in primary school. The texts don't seem over-polished and mostly use simple language.

At the same time, the knitters also tried to keep up a certain distance to their unknown public audience. It can be assumed that this might go in accordance with common urban cultural practices in Middle and North European countries where coexistence is often favoured over cooperation. Another interpretation is that a certain basic reservation reflects a self-security mechanism for protecting their own identities. In fact, privacy seemed to be an issue for some of our knitters since not all of them were willing to reveal as much personal information as the others. This shows both in the contributed photos as well as in the texts. Looking at the images of the knitters with their pieces some of them show their faces while others use their crafted piece to disguise fully or partly (cf. 5.9). For their artist name four of the knitters chose their real first name and only one a made-up pseudonym. None of them included their surname.

Figure 5.9: Photos provided by participants. Some show their faces while others are partly or fully disguised.

5.6 Lessons Learnt

This chapter has presented the design and evaluation of the first version prototype which explored a combination of direct touch interaction with an crafted installation and an augmenting information layer displayed on a smartphone. The results of the user study suggested that this design idea was a promising attempt to bridge the information gap between urban knitters and their uninvolved fellow citizens who were incidentally encountering the installations in public space. On the passers-by side some prototype strengths were identified such as good first user impressions as well as a straight-forward, fun and easy to learn usability. It was therefore decided to continue with this design approach and improve it according to the feedback from the test users and knitters. This would involve to adapt the prototype for real-world settings. It should become more flexible and support an installation on differently shaped objects such as trees (cylindrical) or fences (flat). An optimized presentation of the provided information would also require to redesign the app on the display device. According to the passers-by it should highlight most relevant information in a brief punchline style. However, as the content analysis of the knitter data suggested, the artists do have a lot to tell. A compromise would have to be found in order to meet the wishes of both sides. An improved information design should support quick gazing but should also be inviting to continue reading more of the text.

CHAPTER 6

Second Design Iteration

The second design iteration built directly on the results of the first iteration, which had served as a proof of concept concerning the basic design idea and which had generated constructive feedback in a test session. As described above, the test users had approved the general concept, but they had also identified several suboptimal aspects of the status quo. These results guided the redesign and improvements of the next version prototype which will be described in this chapter. This time the design involved a realistic installation project. A call for participation was posted online and twenty-six urban knitters from seven different countries were recruited. Their contributions assembled a flexible prototype in the shape of a large blanket, which was tested with some of the knitters as well as with passing-by people in several more realistic settings (eg. outdoors on a tree).

6.1 Call for Participation

The second design iteration aimed to achieve a more realistic installation result than the first one. Apart from adapting some physical characteristics of the designed object (eg. to make it flexible instead of installing it on a board), this included also to work with "real" urban knitters in a way that they were used to. According to the online content analysis and the survey results of the exploration phase (cf. sections 4.3 and 4.4) it is quite a common practice of enthusiastic urban knitters to take part in international collaborative projects, which are advertised online by an installation initiator. Therefore, it seemed like an obvious idea to initiate such an open project.

A public call for participation was written, which briefly explained the project as well as the involved tasks, to invite interested urban knitters to participate. The call officially referred to the augmented installation project as the development of the "Tools for Wools" prototype. In case of interest or participation urban knitters were asked to contact me by e-mail or messages on Twitter or Facebook. I would then provide them with more detailed information on what they should do and where to send their creations. All contacts were provided and linked in order to make it easier to get in touch. In order to illustrate the design idea, a sketched image (same as

figure 5.1) and a short video demonstrating the interaction with the first version prototype were added. The call also comprised a short introduction of myself as a student who was initiating the project in the course of her work on the Master's thesis. This disclosure of my identity and motivations for this project as well as of how I intended to use the received data, was not only required by ethical reasons to have potential project participant fully informed but also intended to create a trustworthy and inviting appearance.

The call was published in form of a static HTML-website[1], which made it easy to spread its link on the social media channels of Twitter and Facebook. Apart from that it was also converted to a PDF version which was more useful to attach in e-mails. The full PDF-version can be seen in Appendix chapter E. In addition to general postings on the social media channels (which were calling out to an unspecified general public) I also wrote direct messages to social media users who had recently shown some urban knitting activities or who were among the first hits when searching for "urban knitting" or "yarn bombing" with the search tools provided by these websites. While I wasn't acquainted to any of these directly contacted knitters, I also spread the call within my circle of friends and especially addressed contacts who I knew to have an urban knitting background (no matter if they were currently active or inactive).

In order to further elaborate how urban knitters relate to technology I chose to raise this question as the central topic of the project. In case urban knitters decided to participate they were given the following three-part task:

1. The participant was asked to think about the question "Which place does technology take in (her/his) urban knitting?".

2. Having reflected on this question, the participant should then produce a crafted piece which preferably expressed their thoughts.

3. In order to explain their created artefact to others, the participant should provide some additional material, such as a brief written statement, a photo of them with their piece, a short video or an audio message.

Again, the participants should have all freedom in designing and creating their physical and digital contributions. Any technique, any material and any colours were welcome for the crafted panel as well as different multimedia formats for the first-hand data. The only requests affecting the craft results applied to a minimum size of the panels (each one should offer enough space for a full flat hand to lie on) and to a preference of flat 2D contribtutions over 3D creations.

6.2 Participants and Contributions

The "Tools for Wools" project was initiated in the beginning of April 2015 by publishing the website and distributing the link on social media websites. Active recruiting started in the following days with most messages (approximately 50) being sent between April 11 2015 and

[1] `http://web.student.tuwien.ac.at/~e0305696/call/Call_ToolsForWools.html` (Accessed: 20.07.2015)

April 13 2015. Compared to the undirected general calls (which was answered by 7 craftspeople in total), direct contact achieved a higher response rate. Even though most of the messages remained unanswered, 12 unacquainted and 5 acquainted urban knitters replied. Another 5 knitters expressed their interest in participating in face to face situations such as during meetings of a local knitting group.

ID	Title	Artist	Country	Size [cm]	Technique
1	Untitled	Susan Campbell-Wright	Australia	13 x 14	Knitting
2	Nini & Wink	Annette Fitton	Australia	20 x 18	Knitting
3	Untitled	Liz Roycroft	Australia	18 x 23	Knitting
4	the human right to shelter	Donegal Yarnbomb	Ireland	19 x 19	Knitting
5	Tools for Wools	Catherine Rowe	Australia	37 x 36	Knitting
6	Untitled	Alejandra Carreon	Mexico	19 x 20	Crochet
7	Untitled	Lety Meza	Mexico	22 x 20	Crochet
8	Untitled	Alejandra Cisneros	Mexico	18 x 20	Crochet
9	Untitled	Angelica Reyes	Mexico	22 x 22	Crochet
10	Untitled	Daniela Montelongo	Mexico	20 x 21	Crochet
11	Untitled	Andres Bustok	Mexico	16 x 20	Weaving
12	Untitled	Olga Hernandez	Mexico	17 x 20	Crochet
13	Untitled	Mario Enriquez	Mexico	18 x 20	Crochet
14	EYE OF GOD	Gilda Dominguez	Mexico	23 x 22	Wrapping
15	Untitled	Ina Österreicher	Austria	46 x 36	Crochet
16	Rainbow	@strickgraffiti	Germany	28 x 20	Knitting
17	Untitled	extremhäklerin	Austria	30 x 27	Mixed
18	Untitled	Urban Knitting Avilés	Spain	32 x 31	Crochet
19	Hand der Fatima	Veronika Persché	Austria	39 x 65	Machine Knitting
20	technique inside	Christina Gohli	Austria	28 x 22	Mixed
21	Untitled	Sue Spencer	UK	16 x 13	Knitting
22	Untitled	Mel Senior	Australia	22 x 22	Crochet
23	Untitled	Lin Tschi	Austria	38 x 33	Mixed
24	Lauras Zeichnung	Christina Gohli	Austria	41 x 20	Knitting
25	Technisches gestrickt und gehäkelt	Christina Gohli	Austria	44 x 22	Knitting
26	Untitled	Fiona Casey	UK	40 x 39	Knitting
27	Untitled	Jasmin Sauer	Austria	10 x 14	Crochet
28	Untitled	YarnBombing For Lunches	USA	27 x 15	Crochet

Table 6.1: List of craft contributions to the “Tools for Wools” project

The actual number of contributions differed quite a bit from the responses. Not everyone who reacted to the call actually participated in the project. At the same time, some of the contacted people autonomously shared the call within their local craft group or produced more than one piece for the installation. Overall, 26 urban knitters from 7 different countries submitted a total of 28 different crafted artefacts for the installation. All contributions are listed in table 6.1[2]. The corresponding first-hand data (texts and photos) which was provided for the app can be viewed in Appendix chapter D.

The submission deadline for sending in contributions was announced for the 31.05.2015. This meant that participants had almost two months to create and mail their contributions to my postal address. In order not to seem inactive myself and to stay in touch with the participants in this period of time, I created a blog on Tumblr[3] for documenting and sharing the received contributions. As a frequently updated project log it should not only communicate my appreciation for every craft creation received but also create a certain feeling of togetherness for everyone involved in the project. The postings enabled participants, who live far away from Vienna, to see the work of others and the assembled installation result as a whole. Some of the participants seemed to be particularly proud on being part of the installation after reading the blog posts and shared them on their own social media pages. The Mexican participants were even featured in a local newspaper (cf. figure 6.1) and were glad to share this news with me and the other participants.

Figure 6.1: Left: A Mexican newspaper reporting about local knitters contributing to the "Tools for Wools" project. Right: A photo of the work in progress which was published by the newspaper[4]

[2]All artists are listed by the name which they permitted to being publicly used in this project. This could either be their real full name or an artist pseudonym.

[3]`http://toolsforwools.tumblr.com/` (Accessed: 20.07.2015)

[4]Left photo by Daniela Montelongo and right photo by NOTRE DIGITAL. The full article can be found under `http://nortedigital.mx/bombardean-juarenses-viena-con-todo-el-folclor/` (Accessed: 20.07.2015)

Figure 6.2: Front view of the second version prototype (size: 175 cm x 120 cm)

6.3 Prototype Version 2.0

The second version prototype was similar in its component structure to the preceding version. However, in order to concentrate more on the performance and experience of the touch interaction system, the LED-light-feedback was temporarily abandoned and postponed as a task for future work. The two main components of the system where therefore touch detection implemented on an Arduino Uno and information display on an Android-operated tablet computer[5]. This time, the communication between these devices was based on a wireless Bluetooth connection. Since more flexibility was a major design requirement, the concept refrained from using any cables for component communication purposes. The installation spectator should have space to move around with the information device, no matter if the prototype was attached to a fence or wrapped around a tree. This way, a possible scenario could be that passers-by come to an installation, install the app on their own personal device and use the system autonomously.

[5]The product used in this design iteration was a Samsung Galaxy Note 10.1 2014 Edition.

Just as in many real-world urban knitting projects the contributed pieces were sewn together before installing them at an envisaged spot. In this way they formed a larger textile cover similar to a blanket. The prototype therefore had a fixed size but at the same time it was also flexible. Its form of a blanket allowed it to be mounted on flat as well as on differently shaped objects. Since the area of all pieces culminated to a quite proud dimension of approximately 2,1 m^2 and would cover a decent amount of space, it was important to arrange the panels in such a way that they could be easily reached. Assuming a maximum range of 120 cm between comfortable levels to reach up and down for average sized people, the prototype was required to have a landscape format. The final prototype measured approximately 175 cm x 120 cm[6].

Before putting everything together a sheet of aluminium foil was ironed on each of the pieces using double-sided fusible web. Again, these conductive layers served as electrodes for the capacitive touch sensing. This time they were a bit smaller than the respective panels and left out a couple of centimetres around the edges in order not to cause any unwanted contacts or interferences with neighbouring electrodes. As the pieces varied a lot in size, the same applied to the electrode dimensions. Some panels required to combine two sheets to cover most of their area while others needed only a few square centimeters. The aluminium foil was placed in the middle of the wrong sides of the crafted panels. In this way the electrodes were not visible in most cases[7]. Wires connected each of the electrodes individually with the Arduino which is located in a pocket below the the panel blanket.

The Arduino pocket was part of an additional textile layer behind the assembled panels. This layer was made of common cotton and served two purposes: On the one hand it protected the electrodes, wires and connections. Tree bark, concrete and other rough surface can have sharp edges which might cut or rupture the components. On the other hand, the cotton background also provided a carrier material for the installation blanket. On the top side of the prototype a broad hem was sewn which cases a robust strap, which makes it easy to install the object around a tree and prevents it from slipping. At the same hem four hanger loops are attached which also allow the prototype to hang on hooks, nails, pipes or bars.

[6]No absolute measurements are possible due to the flexibility of the textile material. Hanging will for example stretch the fabrics slightly. Apart from that, the blanket does not describe a strict rectangular form with its uneven borders as a result of the different panel sizes.

[7]However, some crochet pieces had larger “holes” as a characteristic part of the used pattern. In such cases the aluminium foil could show through if no extra textile layer was added between the foil and the crafted panel.

6.4 Hardware and Implementation

Having described what the prototype looked like, this section shall present the hardware design and explain its mode of operation. The technical components of the prototype relied basically on the same principles as the first version but details of its implementation were significantly changed in order to improve the performance and facilitate cable-free communication with an Android device. One of the main modifications was the introduction of a custom built shield compatible with the standard Arduino Uno design. As a specialised interface, which takes on all the wiring and the electrode connections, it takes care of the capacitive touch sensing as well as sending the sensor information via a Bluetooth module. After taking a closer look at the construction and the functionality of this shield, the redesign of the Android App will be discussed.

Custom Shield for Arduino Uno

The first prototype comprised only five different pieces. However, this was already enough to make its wiring quite complicated. Each electrode required two Arduino pins, so not even an Arduino Mega board would have enough pins for operating 28 electrodes (unless all electrodes would use the same sending pin). Since it was unclear just until the deadline how many contributions I would receive to include in the prototype, I decided to play safe and find a way to operate a maximum number of electrodes with a minimum number of Arduino pins. Besides, it was desirable to handle the electronics of the next prototype in a more plug-and-play kind of way since it should become portable and installed at different locations. Transportation from one place to another would require a certain robustness and it was just a realistic forethought to consider that components could be damaged in a realistic setting.

Therefore, a custom shield was introduced which should meet these issues. Such a shield can be easily detached and used on another microcontroller (as long as it is based on the Arduino Uno design standard which it was designed for). Reattaching the microcontroller becomes significantly less complex because no additional wiring is needed anymore. The custom shield's hardware design attempted to make as many of its components unpluggable and exchangeable as possible. Hence, it was built with only a few hard-wired parts establishing the essential circuit. Instead of direct soldered connections several sockets or plugs were included for removable modules. The wire connections to the touch electrodes are soldered to headers which can be unplugged from the shield's socket and even the Bluetooth module can be easily removed from its socket.

The shield is pictured in figure 6.3 and was initially designed to comprise three logical entities:

- capacitive touch sensing and signal processing
- Bluetooth communication
- LED light feedback

As stated above, the LED feedback was postponed, however the shield dimension would allow later implementation and integration of this functionality. In fact, the sockets and resistors

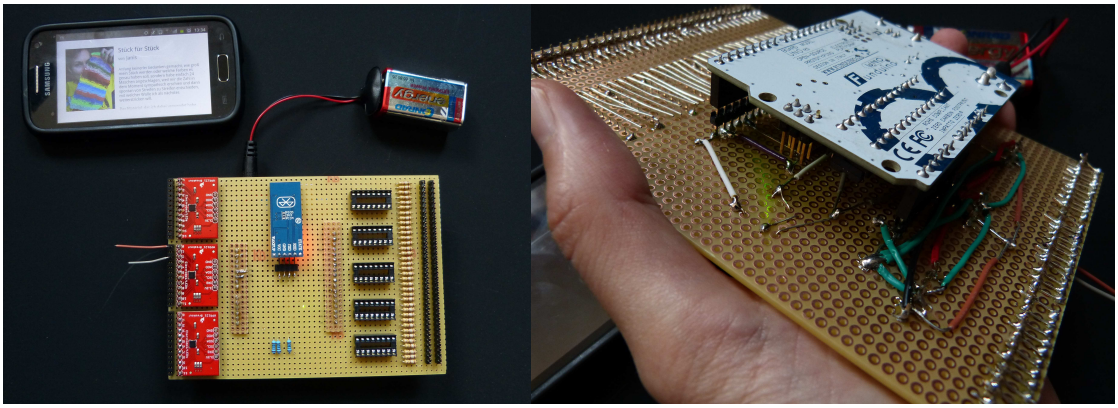


Figure 6.3: Top and bottom view of the custom shield

which can be seen on the right side of the shield (cf. top view in figure 6.3) are already integrated for this purpose. However, they are not connected to the circuit yet. Also, several 8-bit shift registers such as for example the SN74HC595 would need to be placed on the rectangular sockets and programmed to perform a multiplexed control of the LED indicators[8].

The Bluetooth communication is established by an off-shelf module. For the "Tools for Wools" prototype, I used an HC-06 Bluetooth module which was connected to the shield circuit following the instructions of an online tutorial[9]. However, since the module is running on 5V, several resistors were introduced as a potential divider in order to protect the module from damage due to overvoltage. This is a practice which was explained in another tutorial[10].

The heart of the shield is the entity for capacitive touch sensing. My first approach was to implement multiplexing with the help of daisy-chained 8 bits shift registers. Unfortunately, this didn't work out since the implementation of the Capacitive Sensing Library is not compatible with multiplexing. As an alternative I decided to use a ready-built component specialized on capacitive touch sensing, the MPR121. This off-shelf component is actually a sensor controller produced by Freescale[12], but SparkFun offers the chip on a handy breakout board[13] which is easy to connect to an Arduino. Such a breakout board can power 12 different electrodes while only occupying 3 Arduino pins. Furthermore, they can be daisy-chained without needing any additional pin connections. For the "Tools for Wools" prototype three of such SparkFun Ca-

[8] Switching on LEDs using a serial to parallel shifting-out principle is explained in this tutorial for example: `https://www.arduino.cc/en/Tutorial/ShiftOut` (Accessed: 24.7.2015)

[9] http://www.instructables.com/id/Add-bluetooth-to-your-Arduino-project-ArduinoHC-06/?ALLSTEPS (Accessed: 24.7.2015)

[10] https://www.squirrel-labs.net/blog/basic-android-app-bluetooth-arduino-remote-control-car/#page=1 (Accessed: 24.7.2015)

[11] The image sources are as follows:
Product image by SparkFun (CC BY-NC-SA 3.0)
Diagram from the datasheet, page 6 (both accessed: 24.7.2015)

[12] `http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MPR121`(Accessed: 22.7.2015)

[13] `https://www.sparkfun.com/products/9695` (Accessed: 22.7.2015)

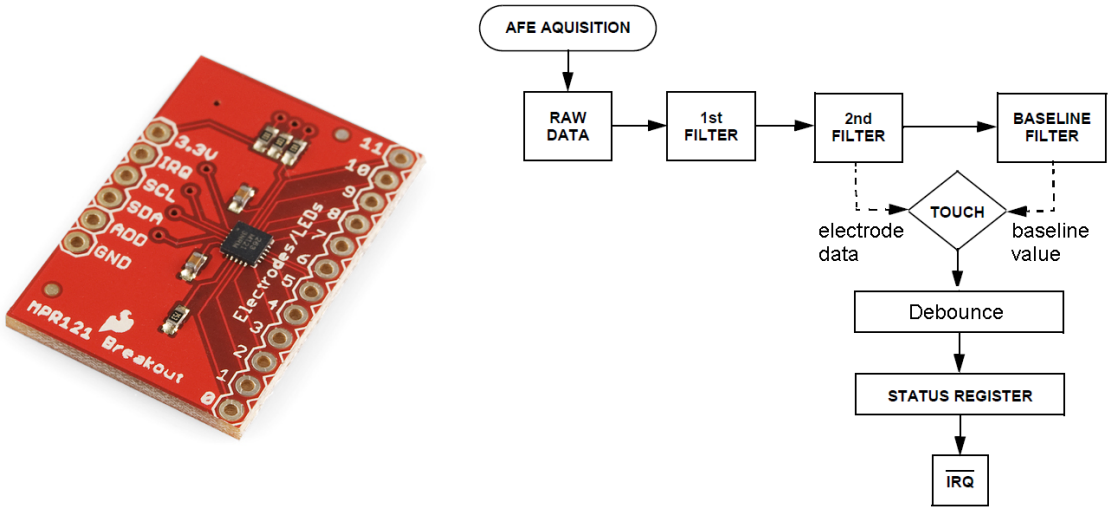


Figure 6.4: SparkFun product close-up of the MPR121 breakout board (left) and diagram of the process for capacitance measurement (right)[11]

pacitive Touch Sensor Breakout boards were used. This would allow a maximum number of 36 pieces being touch sensitive.

The use of MPR121 brings a couple of advantages. For example, it can automatically adjust to changes in the environment such as air humidity and temperature. According to the datasheet[14] it is possible to power the system by a battery, since capacitance can be measured referring to the device ground instead of a common ground. MPR121 is highly configurable by manipulation of its writeable registers. So even though the sensor is primarily designed for direct touch detection, it can be set up for proximity detection, too. Configuration can be done manually for each electrode (hard-coded) or automatically by an according auto-configuration setting. Apart from the electrode calibration and their respective touch and release threshold settings MPR121's touch detection relies on the results of several underlying signal filters (cf. figure 6.4) which can be configured as well. This wide range of adjustable settings make it relatively hard for beginners to find the optimal setup for a prototype system with differently sized electrodes where the recommended standard settings[15] only generate poorly performing results. Very good knowledge of MPR121's mode of operation is needed in order to understand the impact of different register settings. Basically, MPR121 detects touch by comparing filtered sensor data values to a baseline as illustrated in figure 6.5. In case of touch the data values drop significantly and as soon as the difference *Delta* between data and baseline values exceed a predefined threshold it is recognized as a touch. This procedure shall prevent jitter and signal noise to be falsely detected as touches.

[14] `http://www.sparkfun.com/datasheets/Components/MPR121.pdf` (Accessed: 24.7.2015)

[15] A "Quick Start Guide" in Application Note AN3944 recommends default settings for 38 configuration registers. `http://cache.freescale.com/files/sensors/doc/app_note/AN3944.pdf` (Accessed: 24.7.2015)

[16] Diagram from the datasheet, page 7 (Accessed: 24.7.2015)

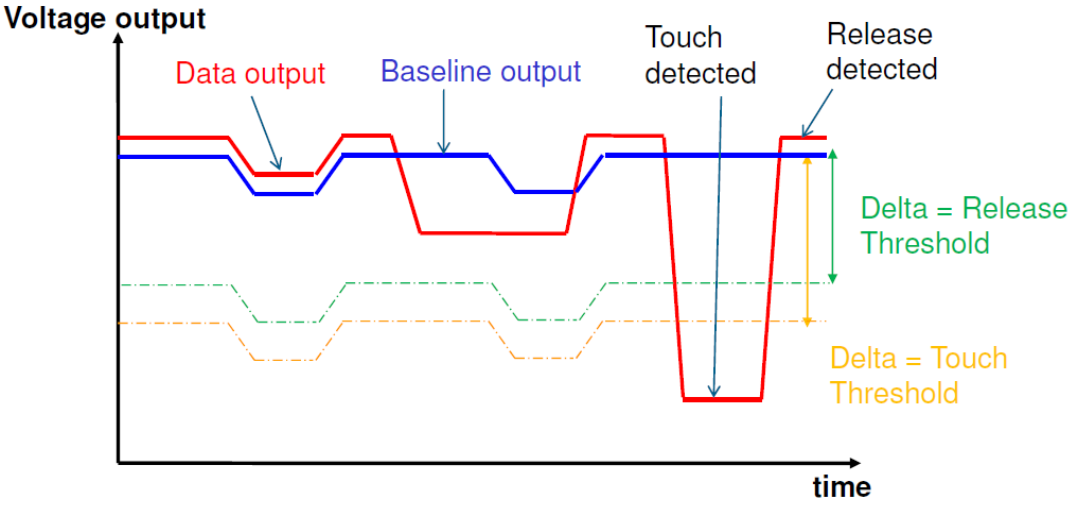


Figure 6.5: MPR121 Touch and Release Detection. Diagram from the datasheet[16]

The custom settings are entered progammatically in course of the setup routine in the Arduino code. The modified values improved the performance of the touch detection compared to earlier experiments. However, it shall be pointed out that they are still not optimal. During the tests glitches occasionally occurred which can be best described as some knitted panels behaving dominantly and overwriting the selection of another piece. Several conditions in the Arduino code improved the results:

- Only the first detected touch per loop will be reported. Others will be ignored.
- Only positive numbers smaller than the number of electrodes are accepted as valid IDs.
- A new selection is compared to the last two selections in order to counteract dominant panel behaviour.
- After each reported touch a delay of two seconds occurs.

However, more optimized settings could probably eliminate false detections completely. The whole code and settings can be found in the appendix section C.2.

Android App Implementation

There were also several challenges on the app side. It needed to handle more data than in the previous version and the design should not only attract the viewer's attention but also keep it. Since the app should receive messages from the Arduino setup via Bluetooth, it also needed to create and handle such a connection.

These three main tasks were distributed on two activities and a service in an Android application project. `MainActivity.java` displays a start screen with the project logo, checks if Bluetooth is available and activated and starts in this case the service. `ArduinoService.java` establishes the Bluetooth connection and listens for messages which represent installation panel selections. Valid messages are positive integers in the range of the number of pieces. If such a message is received, the incoming number is parsed as a panel ID and starts the other activity. `PieceActivity.java` is a template activity which structures the screen by a unified over-all design and loads the respective piece information dynamically using the associated ID. This requires a predefined application structure that holds all the information at certain predefined locations following a strict ID-scheme. For example, all photos of the installation artists are contained in the `drawable-hdpi` folder and have unified names such as `knitter_p12.jpg`. The texts are contained in `strings.xml` and are identified by their tag-IDs (cf. figure 6.6).

```
<string name="p5_title">Tools for Wools</string>
<string name="p5_artist">Catherine Rowe</string>
<string name="p5_country">Australia</string>
<string name="p5_description">My knitted square is all about colour and contrast, if you hadn't already guessed.
<string name="p5_link"><a href="http://www.yarncorner.com.au/">Visit Website!</a></string>
```

Figure 6.6: Example for tag-IDs in the XML-file

An exemplary knitter information view can be seen in figure 6.7. The over-all design prescribes that 60% of the screen is filled with a large-scale photo and an integrated label telling the artist's name and country of residence. The remaining 40% contains the contribution's title and a scrollable description which can be individually layouted in an external XML-file. This way, the app can offer a universal look and feel while providing opportunities for meeting the knitters' respective wishes how to present their data. In answer to the test users' feedback the image data was emphasized, font size was increased and most important data was highlighted as catchwords. Apart from this, an additional "sharing button" was integrated which facilitates quick and easy reporting of an installation encounter on social media. The default text tells the project title and links to the previously mentioned Tumblr blog.

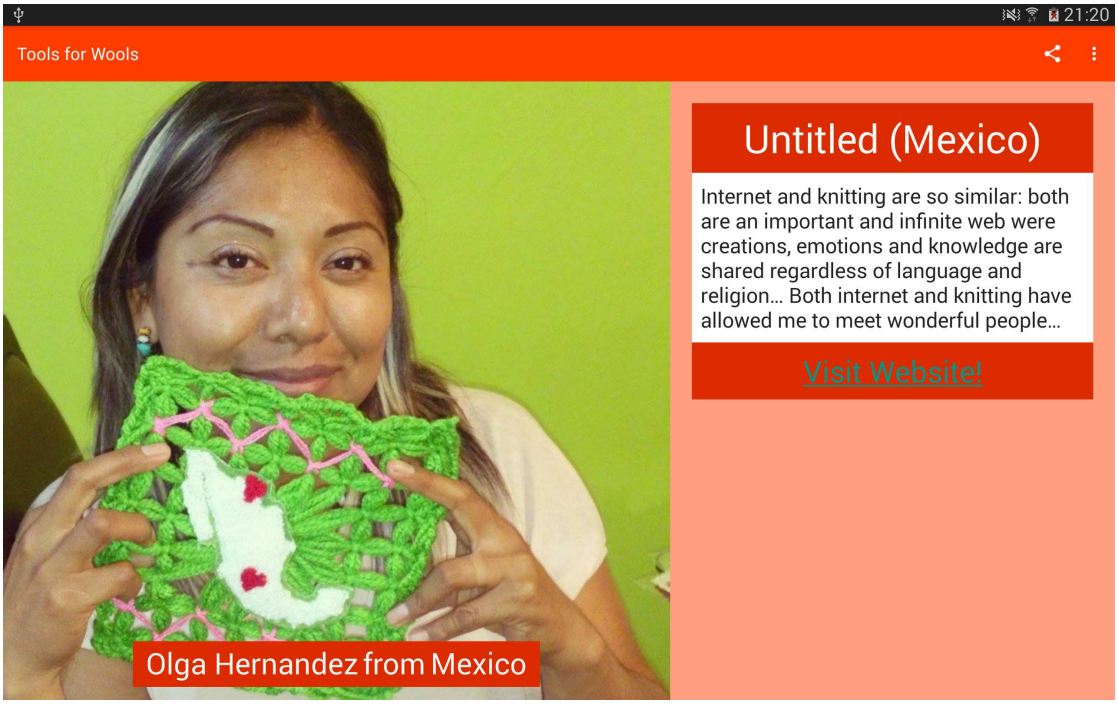


Figure 6.7: Knitter information as displayed by the app

6.5 User Tests

The second version of the prototype was tested at two locations in Vienna. While the first installation took place outdoors at the summer party at a neighbourhood center, the second test was conducted at a local maker space. Each test situation represented a different real world setting which required the installation to be transported and installed in different ways. Every person who happened to be present was invited to try out the prototype.

Setting 1: Tree Installation at the Summer Party of a Neighbourhood Center

The first user test took place at a public summer party event on the July 3 2015. At that time the installation was still a work in progress. This means the technical functionality was already implemented, but not all of the contributed wool panels had been integrated. Eleven pieces (approximately 40% of the total number of contributions) were not yet assembled and sewn to the installation. However, it was already big enough to be representative for the envisaged outcome and the occasion of a summer party at a neighbourhood center was the perfect opportunity to show the prototype to many uninvolved people that could be part of the passing-by user group.

The transportation didn't require a lot of equipment or organisation. The blanket was simply folded and put in a big bag in order to carry to the event location. This went well and no real damage occurred to the prototype during the journey. Only a few paper clips slipped from the aluminium foil sheets. These were used to connect the electrodes and could be easily be

attached again. However, the connections to the electrodes still seemed to be the most fragile part. Besides slipping clips, soldered patches could break in case the wires were pulled or torn too much. Therefore, it was planned to strengthen the connections prior to the next test.

A tree was used for the installation (cf. figure 6.8). Since its circumference matched almost exactly the width of the "blanket", the prototype object was wrapped around the trunk and was mounted using the integrated strap. The installation process was quite easy, but it was good to be assisted by a helping hand who could hold the textile up while I took care of the fastening. Since the strap first seemed a bit loose, an additional string was attached which should help preventing the installation from unwanted slipping. After that no movement was noticed. Some safety pins were used to stitch up open and flapping parts below the strap. In future some ribbons could be added to the seams and used for this sealing task. The pocket for the Arduino had not been added yet. Therefore, it was mounted below the knitting by big safety pins which were led through the holes of the shield board. The technological part was therefore visible. The compact design of the prototype and the use of safety pins also made it easy to uninstall later. In total the installation was exhibited for an approximate duration of 3 hours.

Figure 6.8: Tree installation and test setting at the summer party of a neighbourhood center in Vienna

During the test session around 15 to 20 people directly interacted with the prototype. I was located close by and came over with the tablet computer as soon as someone seemed to wonder what the installation was about. After telling them some explaining details about the project, I encouraged them to try out the touch interaction with the app. During such hands-on demo conversations some interesting observations could be made. Two particular situations shall be reported here:

Two young boys (pictured on the left in figure 6.8) became only fascinated of the installation object when noticing the electronics. They didn't approach the installation for the colourful knitting but they were interested in the cables and the shield. They were obviously wondering about the purpose of the electronics. However, when I came closer and asked them if they wanted to try out the prototype, they shook their head and left. Some minutes later they took courage and approached me to ask if they still could try it out. I explained briefly what it was and let them switch activities in the app. They were mostly into the touch interaction. It seemed fun for them to see how that changed the view on the tablet and due to the tech issues they tried out different pressures and touching techniques. The app content itself did not seem too interesting to them. They took a brief look at the photos but didn't bother to read or scroll the description part. The whole time the boys hardly spoke a word to me. Probably they were shy but nonetheless they spent some minutes trying out the installation with me. Their main reason to stay with me was probably curiosity. They seemed most interested in interacting with the system and figuring out how it worked by getting their hands on it. When I had to restart the Arduino due to a glitch, they seemed very pleased to hold the tablet for me and they were excited when I let them plug in the battery again. In this observed situation, the visible presence of technical components served not only as an eye-catcher but also as a motivator for hands-on interaction. This might be an important insight in order to engage people who are more interested in electronics than in handicrafts.

The other situation is captured in figure 6.9. Some elderly women seemed to approach the installation mainly because of their personal interest in handicraft. They intuitively started to touch the installation because it helped them to examine the patterns. Touching in order to understand how it was done seemed natural for them. From their perspective the installation was first perceived like any other urban knitting installation. This was expressed either by happy surprise reactions if they had never seen something like it before, or by proud insider comments such as *"Oh, I have seen something like that"*. When I came to them and explained what it was, they were very interested. In contrast to other elderly summer party guests who had talked to me that day and who blamed computers for alienating youngsters from a good local neighbourhood community, this group didn't react sceptically at all about the general idea to integrate technology into the knitting. This could be due to politeness of course or because I told them that it was about the stories behind the pieces which they all seemed to be able to relate to. They enjoyed seeing the photos and started to try out changing the activity. However, while touching the knitting seemed natural for them, they reacted very cautiously and uncomfortably when they touched the tablet. I doubt that they would interact with it directly even though they all seemed to like what it did and what they saw at display.

Figure 6.9: Showing the app information to a group of elderly people

In addition to the two exemplary situations described above, some general impressions of other groups of people were gathered:

- Some elderly men also seemed interested in the prototype but preferred to remain in the background. It seemed that they accepted it as a women's domain of expertise or as something which was not primarily made for them.
- Some young girls were rather interested in starting to knit themselves than in interacting with the prototype.
- The event organizers of the neighbourhood center were very interested in the prototype and liked to see it as a curious unusual part of the happy atmosphere at the event. One of them came by twice to take photos. Another one took some elderly women with her to show the installation to them.

To summarize the observations from the first user test session, the second version prototype successfully managed to create interest in a very diverse group of people. Admittedly, the setting was quite a special one. Even though the event took place in public space, it felt like a rather protected gathering (most people seemed to know each other) which was highly affected by a cheerful festive atmosphere. This was most certainly very beneficial for my evaluation work, since most people who were present had time and were open to explore new unknown objects

such as the prototype. Although all the test persons seemed interested and attentive, they seemed to have quite different reasons to engage with the installation. Just as some persons were hobby-crafters themselves and were paying most attention to the pattern details of the panels, others perceived it primarily as a technological system and tried to find out how it worked. Nonetheless, the implications were relatively similar. Both attitudes had the individuals hands-on exploring the physical object and the app response for several minutes. However, none of the test persons took the time to read the texts in the app. Since this was before the information redesign, most people also said that the font was too small or that the texts just looked too long to read. Besides, many of the elder people mentioned that they wouldn't want to read English texts. The feedback therefore served as guiding reference for the next steps to finalize the implementation of the prototype.

Setting 2: Wall Installation at a Local Maker Space

The next installation location was indoors at the facilities of "Maker Austria / selberMACHEREI"[17], a local maker space where hobby crafters and tinkerers meet to create and build all different kinds of things. The location can be described as an open workshop equipped with a wide range of tools for working with wood, stone, textiles, paint and other materials. Cooking, sewing and knitting are just as common activities there as tinkering with electronics. Since I have been organizing a frequently meeting knitting circle there, which is very active in urban knitting, it was an obvious location choice.

Installing the prototype was combined with a regular get-together of the knitting circle on the July 17 2015. This time, the work on the prototype had been practically finished. The physical installation object already comprised all contributions apart from one artefact, which was hard to integrate since it was designed to be freely hanging and did not offer any wrong side surface to attach an electrode to. A pocket had been sewn to the bottom side of the carrier material which was supposed to carry the shield with the the microcontroller and hide long wires. The app had been redesigned in order to improve the information design according to the previously gathered feedback. The only open issue at that time was performance-related. Checks during implementation observed glitches occurring after a while with some "dominant" panel electrodes reporting false signals. It was assumed that fine-tuning the electrode calibration or baseline filter settings could solve the issue, but no suitable values could be found until the given meeting date. However, since the installation would behave as intended right after a restart and allow test users to have a good impression of its functionality for a few minutes, it was considered to be presentable.

This time the installation was mounted flat on the wall of a workshop room (cf. figure 6.10). The installation process was very easy and just made use of the given infrastructure, namely some salient heating pipes which the prototype straps could be bound to and hung up on. First, the system was connected to a 9V-battery, but since it seemed to run out of power after a short while, it was plugged to a nearby electrical socket.

The "Tools for Wools" installation was exhibited at the maker space for a total duration of five hours. Apart from the knitting group members and other makers who happened to be

[17] `http://selbermacherei.at/` (Accessed: 27.07.2015)

Figure 6.10: Knitting group member and participating artist exploring the prototype together

present, all Vienna-located urban knitters who had contributed to the project were invited to come and have a look. In the end, this summed up to a test participant number of five people[18] who engaged with the prototype on that day. Each of them spent a fair amount of time (between 20 and 50 minutes) to inspect the panels and try out the touch interaction with the app. Most of them tested it together in a group. Many of the positive reactions resembled the other user tests (interest in craft details, staying attentive for quite a long time, smiling when touching, etc.). However, also some new observations could be made.

For example, in this setting the prototype sparked many project-related conversations. Sometimes this was related to the presence of the participating artists. Uninvolved installation spectators would recognize them with the aid of the app or find out which of the panels was created by them. Often they would comment then on these to be polite and to express appraisal for the artefacts. But sometimes more specific craft details were discussed such as how a particular pattern was done or what the idea behind the design was. Spectators seized the opportunity

[18]Three of them were knitters who had contributed and two of them represented non-involved spectators.

Figure 6.11: Knitting group member exploring the prototype by her own

to get into direct contact with the present artists. Reading the description texts in the app was then obsolete. But even non-present artists and their contributions were discussed extensively. Sometimes these articulated elaborations were triggered by noticing a certain craft detail. Other times the test users expressed their surprise when they found out that some of the artists looked completely different than what they would have imagined. An example for such a situation was when they saw that one of the crocheted skulls with large colourful pompoms was created by a male participant from Mexico.

An interesting insight was that system glitches due to false touch detection can also have an inspirational effect. In some situations the display of another seemingly randomly chosen piece on the screen would make the test person search for its real-world equivalent. In many of these cases they stated that they had not noticed the panel before and actually approved that the software (and its error) had pointed it out for them. This is an interesting shift that could be further explored in future work by deliberately re-introducing ambiguity as a resource for design. So far, the "Tools for Wools" prototype was supposed to favour direct touch interaction over indirect interaction restricted to the device. Still, in some cases a mix of these could be beneficial in order to facilitate different ways of exploring the installation. Besides direct touch selection an "Inspire me!"-button could be introduced to randomly display any of the pieces which the user could then look for among the real-world panels.

The redesign of the information layout was approved by all the participants. They all liked that the artist image was filling most of the screen and that a label was placed on it providing the most relevant information. The photo and the country of origin seemed to be most interesting

to them. In fact, only one out of the five test persons really started to read the description texts. Most of the time it was more like skimming and quickly scrolling down longer descriptions for more images. Some of the project contributors started to brainstorm once again how their presentation could be improved. One participant asked me for example to swap her photos (turning a smaller photo from her description into her main image). She seemed to worry that she wasn't really recognizable on the other photo. She also wished to attach her paper business card to her piece after she had seen that some other participants had done so too. Another participant started to worry if the information which she had submitted was sufficient to understand the meaning of her pieces. She almost regretted to have written very short description texts which hardly gave any indications for further interpretation. While seeing her contributions as part of the installation, she also started to think more about other multimedia ways to express this kind of information. For example, she had the idea that a song could be played when her piece in the shape of a music cassette was selected.

To sum up the user tests in the maker space setting, the finalization and technical improvements of the prototype resulted in a generally positive experience of the installation. Uninvolved but handicraft interested spectators reported to have an interesting and often surprising time while exploring the installation with the guidance of the app. Contributing artists stated to be proud to be part of such a special installation. They enjoyed the comments of the other spectators, but also seemed to become more critical about their own presentation in the app. Just as the prototype development had been a learning process for me as the system designer, it also seemed to be one to them as content contributors. If there was another installation project of this kind, they would probably think more about their specific selection of digital media types and start to experiment more on that level. So far, the design work rather focussed on the wishes of the kitting artists and user test sessions provided only brief statements by the non-involved. However, their feedback suggests that the prototype has reached a sufficient construction maturity for conducting future work in assessing the reception as well as in exploring further design possibilities on the spectator side (eg. through ambiguity or gamification).

CHAPTER 7

Discussion

The aim of this work was to explore how interaction design can enhance urban knitting by technology integration. Eventually, the project resulted in a prototype of an augmented installation in order to extend the craft's symbolism by additional communication capabilities. While the intention of the design was to support the expressiveness of the knitted pieces of art, it also gives access to even more perspectives on urban knitting. In this chapter it will be revisited how this thesis project made contributions on a technological, content-related and methodological level. Besides validating urban knitters as a relevant usergroup to design for and depicting the technical novelty achieved by the resulting design, it will be discussed how the prototype facilitates knowledge creation in a research through design tradition. By using the four lenses proposed by Zimmerman et al. [91] for critical evaluation, the process and its results will be reviewed in terms of their relevance and extensibility. Moreover, the quality and depth of the added knowledge through RtD will be analysed. The prototype development involved urban knitters as contributing co-designers, which therefore qualifies it as a novel instance of creative research methods [28, 29]. Ultimately, we will see how the gathered knowledge compares to theoretical literature on the political capacities of knitting and eventually how the design results suggest that urban knitting still fits into the historical model of the Arts and Crafts Movement.

7.1 Contributions

In course of this Master's thesis several contributions could be made on different levels. This section revisits them by elaborating once more retrospectively on the research questions of the three project phases.

RQ 1: How can information technology be integrated in urban knitting?

The thesis work started out with an exploratory study of urban knitting which evaluated it as a design space in the sense of HCI research. This means, a variety of different user research methods were applied to investigate the chosen context in a mixed methods tradition. Since this

has not been done before in connection with urban knitting, this is novel work contributing **new knowledge about urban knitters as a user group** to design for:

- *Homogenous demographics*: Urban knitting seems to be practiced by quite a specific group of citizens. The gathered data indicates that many urban knitters are white middle-aged women with a privileged educational and economical background. This contradicts to a certain degree the democratic claim for diversity of urban knitting as a form of DIY protest and intervention movement and the public media image of urban knitters pictured as trendy young women.

- *IT perception*: Current practices of urban knitting can already be described as a particular form of hybrid craft.

  - *Multi-purpose use of existing internet services*: Urban knitters use mainstream social media tools for a variety of purposes such as for example active networking, constructive collaboration, creative inspiration, acquisition of resources and skills and project-related documentation.

  - *Deliberate boundaries to IT integration*: While many urban knitters are very positive about IT (especially in terms of social media), they also tend to set deliberate boundaries to technology integration. In their current practices *"[e]verything except the knitting itself involves the internet"*[1]. The physical installations however are often characterised by the visibility of manual effort. Handwork is used as a pronounced statement and adds symbolic value to the artefact.

Besides this novel knowledge about urban knitters, another important finding could be made in direct connection with the task of finding novel ways of technology integration: The public audience of urban knitting installations was recognised as a second stakeholder, which went hand in hand with the **identification of a prevalent information gap** between them and the urban knitting artists. Even though installation-related information is often available online it generally lacks the direct association to the physical artefacts. Current identification and recognition mechanisms (eg. business cards and active promotion directed at the general public) tend to be rather workaround solutions which use given mainstream online tools for user-generated documentation.

These insights had a key influence on the further course of the design project. As it was learned, technology was already a well-integrated part on the administrative and networking levels of urban knitting. Designing another system for these purposes would hardly be very novel. Therefore design needed to happen at another place. While the initial approach considered to integrate technology directly in the craft practice itself, a new design opportunity arose from the identified information gap for far less obtrusive design interventions. It was therefore decided to work on this particular aspect. In this respect, the evolving design idea of an interactive augmented installation can be understood as a concrete suggestion to a possible answer on RQ 1.

[1] quote by a survey participant

RQ 2: How can interaction design enhance the expressiveness of urban knitting?

This research question was guiding the design work on the prototype. In this project design was primarily used to **externalise implicit content** of creative artefacts. Inherent narratives and underlying motivations were revealed by providing a tool which creates a connection between the final object and first-hand information by the creator. In the long run, it is believed that such a system also can make the implicit political capacities of urban knitting more explicit.

The prototypes **translated identified exploration findings** into a concrete design solution and incorporated several concerns of both user groups. While it built on existing practices of urban knitters to document, explain and promote their work, it also corresponded to the audience wish to find out more information directly in the moment of encounter. An object-based information infrastructure can create a link between the two sides.

Technically, the design can be seen as the **sum of individual parts**. The design was characterised by two levels of separation. Concerning the creation process it was careful not to interfere with given craft practices. The materials needed to augment the installation were therefore attached subsequently. Moreover, the physical object is not necessarily dependent on the added information infrastructure. Even without the app the installation is still a regular instance of urban knitting.

Another important aspect of the final prototype is that its implementation of touch interaction emphasises **directness**. It facilitates a more sensual experience of the installation by adding tactility to visual appearance as well as intuitive usage and system navigation. Observations during the user tests suggest that the functionality invites the audience to a more detailed exploration of the artefact.

In summary, this Master's thesis came up with the implementation of an augmented interactive installation as an answer suggestion to RQ 2. The technical contributions of the implemented prototype comprise:

- an innovative concept of an **object-based information infrastructure**, which is novel in relation to exhibits and which can connect urban knitters with audience. At the same time directness is emphasised through haptic experience which might intensify the perception on the audience side.

- an **non-obtrusive implementation strategy**. Subsequent attaching of flexible capacitive touch sensors to non-smooth fabrics doesn't interfere with craft practices. Technical design interfering is exclusively concerned with adding the information layer to the finished artefact.

RQ 3: What can be learned about urban knitting through (co-)design?

Urban knitters had been carefully examined as a user group during exploration. However, additional knowledge could be gathered later during design simply due to their content- and object-related participation in the prototype implementation. Involving urban knitters as co-designers of an installation provided **rich first-hand data** which could be used for further analysis. The gathered qualitative insights were in fact comparable to the results of other more traditional research methods (such as surveys and interviews) but sometimes even richer in content and detail.

This finding also made contributions on a methodological level by relating the design phase to the research through design concept and by discussing participatory design as a creative research method. Both perspectives will be argued in more detail in the following two sections (cf. 7.2 and 7.3). In response to RQ 3 it shall be stated here that the knowledge about urban knitting gathered during prototyping provided a rich portrayal of the artists' relationship towards technology as well as their personal reasons and motivations to engage in this specific form of craft. Since the former was the explicit topic of the interactive installation, the latter represented previously implicit information which just happened to be expressed by providing an appropriate platform for exposition.

Summary

Table 7.1 lists all contributions described above on the respective conceptional level.

Level	**Contributions**
Content-related	• Study of urban knitting as a design space for HCI research – new knowledge about urban knitters as a user group – identified information gap between artists and audience
Technological	• Prototype of an augmented interactive installation • Object-based information infrastructure – Functionality can connect urban knitters with audience – Interaction emphasised directness through haptic experience – System reveals implicit content of creative artefacts • Non-obtrusive implementation strategy – Attaching flexible capacitive touch sensors to non-smooth fabrics – Technical design does not interfere with craft practices
Methodological	• Application of Research through Design • Participatory Design as a Creative Research Method

Table 7.1: Contributions made on different conceptional levels

7.2 General Results of Research through Design

Empirical exploration of the problem space had created initial knowledge about the setting, the activities and groups of people involved in urban knitting. This information was used to inform the ideation, planning and development of an interactive prototype within two successional design iteration. However, the design followed not only a user-centred approach but also a participatory strategy which actively invited urban knitters from Vienna and worldwide to become a part of the design project. This procedure allowed to conduct research through design and collect additional first-hand data during prototyping.

On the one hand I asked the participants for contributions which they were used to: fabric panels made in knitting or crochet. These were needed for the physical prototype, but they were not expected to add much to the research since the external qualitative analysis of visual artefacts by others is a difficult if not impossible task [28]. Also objective measures such as the dimensions or the counting of the occurrences of certain physical characteristics (used colour, material or handicraft technique) were not offering relevant insights.

However, on the other hand I requested some digital material from the participants which was very valuable qualitative data for the research but which they might not be used to provide: a written text and a photo. Even though these are data formats which everyone with a computer, a camera or a mobile device should be able to provide, it could have been unusual for some of the participants to put their implicit thoughts into words and externalise them. In fact, the user tests with participating artists have shown that they often were quite critical about their own digital contributions and immediately started to think about how they could improve it. Some other participants also reported that they felt a bit unsure what to write when they first read the task description. In many cases I even received the knitted panels before the digital data, which is remarkable considering that writing a text and taking a photo takes far less time than knitting or crochet. Given these indications it is likely that the uncommon task had the participants going beyond routine and initiated a reflection process. It is remarkable that obviously all the participants took the task seriously and tried to do their best, even though it might not have been the most fun thing for them to do. This process of externalisation must also be considered as experimental for both sides. For me as a researcher I didn't know what I could expect to receive since the question was very open-ended and I did not want to unnecessarily constrain the participants. It was also an experiment for the participants since they couldn't really imagine how the final product would look like. Seeing it first (or at least the app design) would probably have changed the submitted data a bit. However, in some cases during the user tests participants also seemed to start brainstorming and be inspired to try different types of media.

The digital data which was collected by means of the research through design procedure was significantly different to the kind of data which was gathered during mixed methods exploration. Storni reports a similar experience from his research:

> *"We asked participants to use our prototype for a few weeks and to keep diaries. We then conducted follow-up interviews and further probed them about their self-care practices. Interestingly, the knowledge produced at this stage of the research project was different from the knowledge produced at the beginning of the project obtained by attending a support group and interviewing affected individuals."* [80, p.75]

While his case involved active usage of the design by the participants, the design of the "Tools for Wools" prototype constituted a common conceptual framing and motivation for its participants. They were active designers of its physical components and were excited to see what happens if an installation becomes reactive. Together we could make a design fiction real and explore what could happen if knitting was augmented by first-hand background information. This required a far more active and critical participant engagement than a 10 minute questionnaire or ad hoc conversations at a workshop setting. Accordingly, the texts which they provided were much more reflected, detailed and personal than for example compared to the survey answers or Twitter postings. This high quality of data suggests that the research through design approach had eventually taken a form of a creative research method.

7.3 Prototyping as a Creative Research Method

As argued in chapter 5.5, the active collaboration with urban knitters in order to develop an interactive prototype can be considered as an instance of creative research methods in the sense of Gauntlett [28,29]. In Gauntlett's original study, which used Lego to explore identity, participants were asked to perform three working steps in a workshop setting:

1. Getting used to using Lego.
2. Thinking and building in metaphors.
3. Building identities in metaphors.

The first two tasks served as initial facilitators which didn't contribute to the research finding per se but prepared the participants for the "real" task. However, it is important to understand the role of metaphors as expressive visual means which serve as symbols for the participants to externalise their thoughts and feelings. They are highly subjective but also very concrete for the creator since she/he will immediately feel if the created artefact is representative or not.

The setup of "Tools for Wools" was different to Gauntlett's Lego identities study in that it omitted the first two working steps. On the one hand this seemed legitimate since all participants were experienced crafters who knew how to use their craft as an expressive material. On the other hand it would have been impossible to organize physical meetings for the international participants in order to make sure that everyone went through the same learning process. In this project everyone started right away with the "real" task of expressing which place technology has in their urban knitting. The remaining process however was quite similar to Gauntlett's study: The participants engaged in a creative practice in order to answer a given open-ended question. They had enough time to reflect on the question and to build a metaphoric artefact which is expressing their thoughts. And they were asked to explain the visual result. While Gauntlett used interviews, I asked for written statements.

Having invested all the effort to recruit participants, design an appropriate task and process all this data, the reasonable question arises: So what exactly could be learnt about urban knitters by using this method that could not be learnt by the other methodical means? Since I have asked the same question both in the online survey during and in the task description of the "Tools for Wools" call, we can compare the quality of the answers.

An interesting insight was that participants of the "Tools for Wools" project tended to automatically switch between perspectives and elaborate both on the role of technology in urban knitting in general and in their specific practices. The survey answers by comparison were far more focussed on personal usage patterns and seldom provided longer thoughts on the general scale. There could be two reasons for it: First, participants of the creative research method had more time to reflect on this question and used this time to compare their own practices with their experiences with the global urban knitting community. Since it was quite an unusual topic it had them automatically thinking "out of the box" and on different levels. Secondly, it could be related with the structure of the survey. The two questions were subsequent and therefore survey participants could have felt bored to answer two similar seeming questions. Another formal and stylistic difference between the answer qualities was that the survey answers tended to be far shorter than the prototype texts and that they were often written in note form.

A big advantage of creative research methods is that they provide very personal accounts and statements. It is far more likely to be told about feelings and autobiographical anecdotes than for example in a survey. The answers also give a better feeling for the relevance of different identified themes, as I found out during the design phase of this study. Thematic analysis of the first-hand data which had been gathered during the first design iteration suggested four different sources of motivation for engaging in urban knitting: urban space, ideals/values, craft and material. Even though the participants were given a different task for the second prototype, all these inciting factors appeared again in their description texts. This emphasizes their relevance and it is to be assumed that the participating individuals felt quite strongly about these stimuli if they picked them up in their texts. Figure 7.1 provides two exemplary quotes for each of the four categories.

ideals and values	**urban space**
„My crafted piece here is a rainbow. Not only a natural phenomenon between rain and sun but also a political symbol for diversity which is in my eyes an important principle for every team, organization, art and society.“ - @strickgraffiti	*"Yarnbombing is like a gift to many, since it is delightful to see, surprising, and on a public area so all can enjoy it."* - YarnBombing for Lunches
"Internet and knitting are so similar: both are an important and infinite web where creations, emotions and knowledge are shared regardless of language and religion…" - Olga Hernandez	*"And of course I love to see my knitted and crocheted pieces bringing more color into the urban landscape."* - Ina
craft process	**material**
"I hope we can keep technology dedicated to medical and science improvements in order for technology to allow us to keep our knitting world as simple and wonderful as it is today: yarn, hook, mind and soul with the sole purpose of enjoying life while knitting." - Lety Meza	*"I have used hand dyed, handspun merino wool that I bought when on holiday in Tasmania which is very novel for yarnbombing. I usually use cheap acrylic yarn!"* - Liz Roycroft
"Urban knitting gives me a chance to try out new things without being afraid of making mistakes. For example, the hippo that you see was my first go at knitting with two colors. The social media icons (Facebook, Pinterest, YouTube, Ravelry) were my first shots at crocheting with two and three colors." - Ina	*"often my small yarn bombpieces are left in the public spaces i hang them in till someone 'liberates' them & takes them home (the bigger pieces I do take home or are gifts to people and projects) I do not ever sell them or make money from them in any way and use my own money to buy wool, often scouting second hand shops for bits & bobs & unravelling old handmade pieces i find."* - Donegal Yarnbomb

Figure 7.1: Quotes from the first-hand data illustrating the identified motivation categories

Naturally, almost all[2] of the collected texts from the second design iteration elaborated on the relevance of technology in regard to urban knitting. All the mentioned purposes had also been stated in the survey. From this perspective, both methods seem to be equal in their informative value. However, the first-hand texts often described the instances in greater detail and gave specific examples. While a survey participant for example wrote *"inspiration, exchange and communication"*, "Tools for Wools" participant Annette Fitton basically put the same aspects into following lines:

> *I network with makers far and wide via Facebook, Instagram, Pinterest and email. These contacts have led to associations with fibre growers, processors, retailers and publishers, local artists, crafters and the wider community including hospitals and schools. I've been both challenged and inspired by all the magical creativity to be seen in pictures on the net. I continue to be fascinated by people making all sorts of things in the world. Getting out and meeting people is a large and important part of my yarn bombing life.*

I would therefore argue that researchers, who don't have a lot of personal experience with a certain creative group, could benefit far more from conducting creative research methods than from surveys. Especially if it is an open-ended data quality which they are interested in.

7.4 Four Critical Lenses

Having discussed the results in regard to creative research methods, we shall also discuss the results from the perspective of conducting research through design. As part of the paper in which Zimmerman et al. introduced RtD as an knowledge acquisition model for HCI [91], they also suggested four critical lenses which could be used in order to evaluate the design and research results: process, invention, relevance and extensibility. While the **process** has already been reviewed and discussed in the previous sections, this section shall deal with the other three lenses.

The notion of **invention** requires us to ask for the explicitly novel in the resulting design. Even though the "Tools for Wools" prototype was built mainly using off shelf components and serves the performative purpose of a regular urban knitting installation, it embodies several particular aspects of contextualised innovation:

- **Addressing urban knitting in research.** As the literature review pointed out there has been hardly any scientific knowledge on urban knitting.
- **Touch interaction for art**. While most museums and galleries usually don't allow spectators to touch the exhibits, it is a requirement for this piece of art in order to experience it entirely. The design decision to implement touch interaction emphasized usage as direct and close as possible. It also suits the tactility of the expressive medium and therefore has the audience engaged in more ways than usual.

[2] In some cases the connection might be not really clear or the statement was that there is or should not be an interrelation.

- **Situated information.** The prototype deals with a problem which has been identified in the field. Usually people who don't know knitted graffiti are left in wondering and don't have a chance to find the needed data. Although some urban knitters like this mysterious effect of their installations, others would like to have a communication tool to reach their audience and tell them more about their work. The current use of blogs and social media are rather workarounds which in many cases are insufficient to satisfy this wish. The design of the "Tools for Wools" prototype is the first attempt to address this particular problem - at least to my knowledge.

The design concept of "Tools for Wools" is **extensible** in several ways:

- The thesis work had a clear focus on co-designing with urban knitters. However, much more work could be done in including more views on the public spectator side. So far, the prototype user evaluation is based on the feedback by few people. Future work should therefore not only extend user testing but also review and explore new ideas of interaction. In this sense, the public audience could be involved as co-designers as well.

- **Alternative media formats** could be explored for presenting the background information. The integration of loudspeakers that play recorded audio messages from the knitters could for example replace the use of a smartphone or tablet. Videos on the other side might be able to have more spectators deal with the details which are provided by the crafters.

- The **mode of interaction** could be made more fun by using other concepts than direct input/output. For instance, gamification or inspiring surprise could open up new interesting possibilities.

- Changing the **craft task** for the contributing knitters would not only lead to a different visual result, it could also offer new insights and findings. For example, it would be interesting to initiate two distinct installations whereof one is for self-proclaimed activist urban knitters and the other one for knitters who don't consider themselves as political. Giving them the same question to reflect on could lead to interesting outcomes and facilitate comparison and further analysis.

- There could also be further evaluation on the **shifted roles** within the design: The participants became co-designers and the researcher also had to act as programmer, tinkerer, project manager, maintenance staff and even curator. These different roles can all lead to different views and insights concerning designing as a complex process. Especially the responsibility as a curator could be worth to explore in further detail since it involves much responsibility how to assemble the individual craft panels in form of a pleasing and practicable installation object.

The last critical aspect which shall be discussed is the **relevance** of the design. It is relatively hard to measure since it always depends on who is concerned. However, the results of this design project are relevant for several groups:

- The thesis has explored urban knitting as an previously unaddressed intersection of several relevant topics for HCI research such as urban space and crafts. Researchers could therefore use and build on findings obtained during this study.

- The intention of the design is that passing-by people, who wonder and previously didn't have access to specific information, can now find out details about the installation at hand and knitted graffiti in general. However, this has not been sufficiently tested yet and still needs to be confirmed by extended in-situ user evaluations.

- Urban knitters get a tool which helps them to describe their hobby as a meaningful pastime. Good causes can be promoted and stereotypes in regard to handicraft can be possibly reduced. However, the prototype has also the capability to make the implicit a bit more explicit. This implication will be discussed later on in this chapter.

Having looked through the four critical lenses as suggested by Zimmerman et al., the design of the "Tools for Wools" prototype has satisfied several demands of research through design. Even though there is still much space for further elaboration and future work, it is considered a successful instance of applying this methodological model.

7.5 An Assistive Tool for Political Explicitness

Mixed methods exploration and research through design have provided a rich portray of present-day urban knitters: They are passionate about their craft, enjoy being part of an international community and often dedicate their work to good causes. But are they also activists in a political sense, as it was motivated in the introduction of this thesis? Based on the findings made during the thesis work, we are now able to further reflect on this question.

As we have seen in the literature review, several scholars from different disciplines have already identified the micro-political capacity of urban knitting. This was also supported by the online survey results which showed that community engagement, social reasons and reclaiming of urban space were commonly stated motivations for urban knitting. To some extent, it could be even argued if the act of urban knitting is intrinsically activist due to its multi-layered subversive nature. While it requires autonomous acting in shared space and leaving a visible personal mark without asking for permission [39], it is also a form of whimsy intervention: *"By making city dwellers take notice of the spaces they inhabit, whimsy can restimulate the senses and instil a mood of possibility by inviting inhabitants to think differently."* [55, p.69] And since producing the handicrafted panels for an installation takes time and effort, which will be ultimately given away to the public free of charge, it can even be seen as a deliberately anti-capitalistic act. All these layers of subversiveness converge to a political core of urban knitting no matter if it is explicitly intended by the creators or not. Or as Haveri stated: *"Knit graffiti and urban knitting are not always political in content, but they are politicising space by their exciting shape and location. Knit graffiti challenges us to ask what our rights are in public spaces, and who should decide for us what we see in the city."* [39, p.12]

It is interesting to compare this hypothesis with the academic discourse on the political capacities of regular handicraft. Groeneveld for example has analysed the public image of knitting

as mediated by magazines associated with third-wave feminism: *"Despite the political ambiguity associated with third-wave crafting, readers seem to understand their own craft-making practices not as inherently political but as pleasurable pursuits that enable connections between themselves and others, including older women. [...] What remains to be seen is whether these individual and mainly familial cross-generational connections can translate into broader and more collective forms of alliance."* [34, p.274-275]

Groeneveld also points out another issue about this superficial extrinsic level of political power: These magazines have been infiltrated by business, which lives of crafty trends selling DIY kits or handmade products, and they therefore focus exclusively on a target group that is young, white, urban and middle-class. While knitting has become quite a luxury pasttime (expensive yarn, time-consuming), this image also ironically excludes elder women. Ele Carpenter also criticised the commercial undermining of real activist knitting which she spotted in the particular trend of knitted cakes: *"Instead of acknowledging the feminist politics of knitting to reclaim public space, knitted cakes attempt to re-value domestic skills and re-glamourise motherhood, snapped up by the 'yummy mummy' phenomena of older mothers with disposable incomes. In other words, knitted cakes symbolise capitalist recuperation of feminist critique."* [15, p.3] She therefore claims that real political knitting needs to do more than the media image suggests: *"The work is too often promoted as cool, daydreaming, 'stupendous feats' (Moore & Prain, 2009, p205) but we urgently need a more critical vocabulary for unraveling the relentless media support of war and its 'heroic' deaths, and an intellectual feminist critique of engendered militarism (Cockburn, 2007)."* [15, p.5]

So as these sources suggest, knitting is not automatically political unless the knitter intends it to be and uses the craft to engage in cultural transformation. Urban knitting, however, is a literal act of performative transformation. As I previously pointed out, it implicates subversiveness on several levels and provokes location-based thinking. Yet, while it sets the necessary political action, it seems not to be explicit enough about it. A good example for this issue is Carpenter's doubt in yarnbombing based on her impressions of a single popular book by Leanne Prain which was rather written for the purpose of trendiness than critical discourse. However, Prain's presentation of yarnbombing as a knitting trend is in clear contrast to the texts provided by the "Tools for Wools" participants. These are infused with confident and reflective accounts on their practices and suddenly, unnoticed political symbols hidden in the visual knitting design become very clear. Therefore I see the most important political implication of the prototype in its articulated directness. It omits any additional commercial media companies which could bias or hijack the message. Every knitter's voice is treated equally and the over-all impression for the audience will emerge from browsing through a multitude of different perspectives. So eventually it will be up to them to decide if this particular augmented installation is political or not - just as it is up to the knitters to decide how explicitly they want to present themselves as activists.

7.6 Relating Augmented Urban Knitting to the Arts and Crafts Movement

Having identified the political dimension of urban knitting, it could seem at first that its activist core of handicraft has only evolved within the past few years. However, this is not true. In fact, the debate on the political implications of craft is quite historical if we refer here to pioneers who not only argued for the rehabilitation of craft to become equally approved to the fine arts, but who also built an utopian model of society on the basis of craft. The most important initiative of this kind was the Arts and Crafts movement which was an industrialisation-critical movement that emerged in the United Kingdom during the late Victorian period [13, 22, 30, 85]. It was formed around a loose group of idealistic thinkers (writers, scholars, artists and designers) who most notably built on the ideas of John Ruskin and William Morris. The main idea was the valorisation of human hand work embodied by craft on a social and economical scale. As a romanticist movement it idealised the natural imperfection of human manufacturing compared to the flawless and "soulless" products of industrial machinery. Creative engagement in craft was accordingly perceived as the most humane form of work which was endangered by the society-transforming effects of industrialisation. Paul Greenhalgh highlights the relevance of the Arts and Crafts movement in his chapter in Peter Dormer's essay collection "The Culture of Craft":

> *"The Arts and Crafts movement, in retrospect, can be seen to be the most successful construction of a theory and practice of ethical art. The crafts were to be a politicised form of work which produced art objects to decorate society. The vernacular was the model, unalienated work was the means and art was the goal. The larger ideal pulled the three elements into proximity. It was a brilliant formulation: humankind would be liberated through communal creativity. Ultimately, for craft pioneers, the movement was centred on physical and mental freedom. By uniting the work process directly to the demand for a higher quality of life, they had regenerated the idea that craft was synonymous with power."* [22, p.35]

Greenhalgh points out three important intellectual components of this craft theory: decorative art, the vernacular and the politics of work. Altogether they determine the role of craft within a culture and guide discourse about potentials on an aesthetic, social and economical level. In principle, if all three elements are implemented in a suitable way, craft can be powerful. Even though theories of the Arts and Crafts movement were published in late 19th century, they can still serve as a framework for examining the significance of current craft practices in the digital age, where computing has become ubiquitous and the implications of technology invading every aspect of modern life still needs to be discussed. In fact, the results of the "Tools for Wools" design project suggest that present-day urban knitting incorporates all three traditions of the decorative art, the vernacular and the politics of work:

- Paul Greenalgh describes **decorative art** as a practice which has existed in all cultures. It relates to the evident human manner to decorate his surrounding and leave visual traces. As part of human nature, decorative art has always been and it will always be. However, modern civilisation has found mechanisms to marginalise everyone's need for creative

expression. Scientific research about creativity for example opposes the "big C" of the high-end creative genius of renowned individuals to "little C" inherent in average people's everyday creativity [19, 30, 46]. In the same manner the Fine Arts has excluded crafts from its establishment as being the "arts not fine" [22, p.26]. In contrast to the exclusive claims of the fine arts commerce, crafts expresses a certain openness to everyone which is also embodied by the inclusive image of urban knitting. Everyone can (learn to) knit. Everyone can become a yarnbomber. And therefore everyone can become a decorative artist enjoying freedom in design and satisfying the intrinsic need of self-expressiveness.

- Romanticism idealised the rural life of past times as being the authentic voice of society. This essence is also called the **vernacular** which Greenhalgh defined as the "cultural produce of a community" [22, p.31] which is made, spoken or performed. It can also be understood as the popular culture of ethnic groups. However, this is just as much a retrospective construction [22, 85] of an ideal culture that never has existed in that way as it is to claim that knitting is re-invented or suddenly trendy after it has almost died out [34, 85]. Present-day popular culture has certainly changed in course of time but it still forms communities and produces expressive evidence. Urban knitting integrates the vernacular in two particular ways. On the one hand it operates with a focus on local urban space which is emphasised by placing a visual intervention in it. Public space is where the present-day vernacular takes place from the knitter's point of view. On the other hand it adapts to the new virtual spheres of networking. Urban knitters don't only form local knitting groups but establish a global community of like-minded. As the exploration phase and the first-hand "Tools for Wools" data have shown, they build their own conventions, etiquettes, symbols and practices and in this sense they collectively define the vernacular of urban knitting.

- The **politics of work** is the most transformative aspect of the three elements. As stated above, it builds on the Marxist view that the one who is in control of the work is also in the control of the world [22]. The goal of the Arts and Crafts movement was therefore to liberate the workers from financial dependence on industry by making them craftspeople who have full control over their own working power and skills. Since they criticised the power structures of industrialized economy, Western society has shifted away from good production towards the service sector. Time has therefore become another important (limited) resource of economical value. In this tradition, the self-empowered decision of urban knitters to invest both their work power and precious time on producing objectively non-functional knitted decoration of urban infrastructure, is a highly political statement and supports the hypothesis from the previous section. Even when urban knitters do not explicitly address political issues in the symbolic content of their knitting, their practice is politicised. The prototype helps to express both: Explicit causes are given an information channel, and the craftspeople are presented as the skillful emancipated artists who they act as.

Discussing urban knitting on the basis of the three traditions enables us to relate it directly to the theoretical foundations of the Arts and Crafts movement. Greenhalgh's statement that *"[t]he*

vernacular was the model, unalienated work was the means and art was the goal" [22, p.35] is a valid claim in respect to knitted graffiti. However, as the results of research through design suggest this interrelation should be understood as a rather flexible constellation which can be adjusted by the individual artist on her/his own authority. Either creative self-expression, activist interest and the social capacities and connecting powers of the modern vernacular can serve nowadays as model, means and goal. Whatever aspect they choose to emphasize, the "Tools for Wools" prototype can help them to express it and communicate their explicit as well as implicit messages to their public audience. In this manner, the augmented installation is an instance of enabling pervasive computing which puts the object's messages in the foreground while the technological details stay discreetly in the background. It is a literal step towards Mark Weiser's ubiquitous computing vision where these *"weave themselves into the fabric of everyday life until they are indistinguishable from it"* [89, p.3].

CHAPTER 8

Conclusion

The study at hand has presented an inductive and iterative design attempt to support the expressiveness of urban knitting. While handicrafted graffiti has rarely been addressed directly by existing research, it can be understood as the vibrant intersection of craft, street art and citizen intervention which are all relevant topics in the present work of HCI and design research. As suggested by literature review, urban knitting can be significant on various levels. It is accordingly likely to embody a rich set of characteristics including self-dependant well-being, skill development and improvement of dexterity through the making process (personal level), highly productive communication and collaboration processes amplified by a goal-oriented natural usage of media and mobile devices (social level) and active participation in public space by instrumentalising urban infrastructure in a creative and devoted way (political level). Based on these identified potentials the design project progressively sought to find a suitable modality for a coherent symbiosis of craft and technology in the direct context of urban knitting. Following a research through design approach, which is understood as a critical and holistic way to create new knowledge by generating artefacts of transformative capacities, the project went through three intertwined phases of exploration, design and reflective evaluation.

This thesis described how the endeavour had started by investigating the problem space in form of conducting several traditional research methods. Many lessons could be learned in this phase of exploration: Self-experimentation had highlighted the value of explicit effort for the expressive power of crafts. Observations had identified an information gap between urban knitters and their public audience which could not be overcome by available mainstream media tools. An analysis of such a commonly used social media channel had pointed out the general interest of both active and passive actors to tell or hear about specific installation projects and to discuss urban knitting in general. Finally, the results of an online survey had portrayed the relationship between urban knitting and technology as it is perceived from the point of view from practitioners. The responses consolidated the insight that urban knitters were highly critical about integrating any technological means into the craft process itself, while they were rather enthusiastic about social media's applicability for communication, collaboration and promotion purposes. All in all, these insights provided a sound empirical ground to come up with a concrete

design idea. It also helped setting up a conceptual framework to make sense of the gathered data which would also influence subsequent design decisions during the generative implementation phase thereafter.

Accordingly, two successive prototypes emerged which incorporated many of the lessons learnt during the exploration phase. Instead of interfering with the craft process itself or developing yet another social network tool or specialised tool supporting the practices surrounding urban knitting, technology became a discreet but internal part of the physical installation object. Both designs rest upon an initiative to bring urban knitters and their public audience closer together. The system design should facilitate object-related information exchange without constraining the artists' craft design. By making its provenance and history of origins explicit that previously had been implicit, previously non-involved people were offered a change to become involved on a more direct and emotional level. This was also reflected by the interaction concept which demanded spectators to come close and touch the physical artefact. Even though user evaluation still needs to be extended, preliminary test results indicate that the general concept is approved by both knitters and viewers. So far their responses suggested that interaction with the prototypes could be pleasant and intriguing. However, their feedback also contained constructive criticism pointing out particular details that could or should be revised. So while the first prototype was rather a small-scale installation dummy for indoor use only, the second design iteration resulted in a mobile large-scale exhibit adaptable for real world indoor and outdoor settings.

Conceived as provocative objects themselves, the prototypes were able to uncover further implicit characteristics, values, motivations and narratives of the craft contributors. Accordingly, research through design facilitated a deeper understanding of urban knitters as an autonomously acting (user) group of creative citizens who take their say in public discourse back out to urban space. With the open craft task and data collection being an integral part of the prototyping process, the design process can also be discussed as an instance of creative research methods. The provided texts and photos explain how the contributed craft panels represent their creators' ideals and values and embody their thoughts about urban space, craft and material. These findings ultimately invite us to think of urban knitting in the tradition of the historical Arts and Crafts Movement and allow to reflect on its political capacities while the practitioners can stay true to their aesthetic and vernacular identity.

However, the developed prototypes do not claim to be complete or perfect. In fact, they only offer a starting point for further examination of the problem space around urban knitting. Potential future work could go in many directions. It could involve exploring alternative ideas of smart craft installations (eg. geocaching for yarnbombing) just as well as refining and improving the approach presented here (eg. with a focus on the installation audience this time). For instance, some details of the technical implementation could still benefit from revision in terms of performance and solidity. Also as I have pointed out above, it might be worth experimenting with additional stimuli coming from the app for an even more sustained spectator engagement. New functionalities could be introduced such as an "Inspire me!" button. Even the eventual choice of media for the content presentation could be radically reworked. For instance, using loudspeakers and interview snippets instead of smart phone apps, text and photos could turn the installation into an even more direct audio-visual-haptic interface for independent "contemplation".

To conclude, this Master's thesis depicted urban knitting as an exciting playground for research, design and even research *through* design. The presented prototype design evolved from an extensive inductive critical process which was instructive as well as inspiring. Moreover, the thesis wishes to be understood as a particular design statement, and it can serve as a case study for design research which attempts to make the *right thing* [91]. In this specific case it can contribute to transform the current state of commercially dominated public space regulation and stereotypical design and craft marginalisation into a preferred state of authentic civic engagement and respected creative expression.

APPENDIX A

Twitter Content Categories by Dann

Stephen Dann proposed six primary catgories for the classification of Twitter content [20], which he defines as listed in table A.1.

Category	Definition
Conversational	Uses an @statement to address another user
Status	An answer to "What are you doing now?"
Pass along	Tweets of endorsement of content
News	Identifiable news content which is not UGC
Phatic	Content independent connected presence
Spam	Junk traffic, unsolicited automated posts, and other tweets generated without user consent due to malware

Table A.1: Primary domains for Twitter content categorisation defined by Dann [20]

Dann further refines each of these primary domains in a series of distinct subcategories based on his prior literature research as well as on results of conducting an in-depth analysis of his own Twitter timeline. A grounded theory approach allowed him to combine the very broad existing research categories with 23 guidelines for distinguishing tweet content on a more detailed thematic level.

Table A.2 lists the primary domains together with the suggested subcategories and their respective definitions.

Domain	Subcategory	Definition
Conversational	1. Query	Questions, question marks or polls
	2. Referral	An @response which contains URLs or recommendation of other Twitter users. (Excludes RT @user)
To be continued on the next page ...		

Domain	Subcategory	Definition
	3. Action	Activities involving other Twitter users
	4. Response	Catch-all classification for conversation @tweets
Status	1. Personal	Positive or negative sentiment in the form of personal opinion or emotional status
	2. Temporal	Content referencing specific dates, times, statements of temporal nature (waiting) and temporal action ("Time to")
	3. Location	Geographic references and location statements, including statements of traveling, location change
	4. Mechanical	Statements relating to any form of technology or mechanical systems (cars, phones, printers and photocopiers)
	5. Physical	Sensory experiences of a physical nature
	6. Work	Reference to work related activity
	7. Automated	Status announcements triggered by third party applications such as media players, games or software
	8. Activity	Activity statements answering "What are you doing now?"
Pass along	1. RT	Any statement reproducing another Twitter status using the via @ or RT protocol
	2. UGC	Links to content created by the user (blog/video/picture)
	3. Endorsement	Links to Web content not created by the sender
News	1. Headlines	Coverage of breaking news and personal eyewitness accounts of news events
	2. Sport	Identifiable results of sporting events
	3. Event	Any tweet which represents the live discussion of an identified or identifiable event
	4. Weather	Report of weather conditions without commentary

To be continued on the next page ...

Domain	Subcategory	Definition
Phatic	1. Greeting	Statements of greetings to the broader Twitter community
	2. Fourth wall	Textual equivalent of comments made directly to camera in television or cinema
	3. Broadcast	Textual soliloquy, monologue and undirected statements of opinion
	4. Unclassifiable	*`saf^12 ^H^H.* errors, cat-on-keyboard input and unclassifiable strings of text
Spam	Spam	Junk traffic, unsolicited automated posts, and other tweets generated without user consent due to malware

Table A.2: Twitter content categories defined by Dann [20]

APPENDIX B

Survey Transcript

The following pages show a full transcript of the survey as it was online from April 11th 2015 until May 25th 2015.

Survey on Urban Knitting and Technology

Thank you very much for taking part in this survey!

My name is Janis Lena Meissner and the questionnaire at hand is part of my Master's thesis research in Media Informatics at the Vienna University of Technology. My thesis discusses urban knitting as a particular form of creative intervention in urban space and analyses the use of digital technologies (web, social media, smart phones, etc.) in this context.

By using the term "urban knitting" I don't mean to diminish neither any other synonyms for the same craft movement (such as yarnbombing, yarnstorming, guerilla knitting or knitted graffiti), nor any other craft techniques used to produce such installations. All yarnbombers and guerrilla crocheters are just as welcome here as any urban knitters!

All data you provide here will be treated very carefully and will only be used for the purposes of my Master's thesis. By taking part in this survey you agree that I can use your answers for quantitative and qualitative analysis and that I am allowed to quote you as an anonymous participant.

If you have any questions or comments, please feel free to contact me by…
… e-mail: janis.meissner@tuwien.ac.at
… Twitter: @janislena

* Required

1. **Have you ever engaged in urban knitting?** *
   eg. installed a piece of knitting, crochet or embroidery in public place, contributed to a collaborative installation or initiated a yarnbombing project
   Mark only one oval.

   - ◯ yes
   - ◯ no

Some basic demographics

These questions are helping me to get a feeling for average characteristics of urban knitters and the international dimension of the movement. But of course you are not required to answer these questions if you prefer not to.

2. **Gender**

   .....

3. **Age**

   .....

4. **Country of residence**

   .....

5. **Professional or employment status**

.....

Urban Knitting and You

6. **How did you find out about urban knitting?**
   The first time you heard about it was because of ...
   Mark only one oval.

   - ◯ internet (eg. images shared in social media, reading about it in blogs)
   - ◯ article in a printed magazine or newspaper
   - ◯ feature on TV or radio
   - ◯ a friend
   - ◯ workshop or event
   - ◯ Other: .....

7. **How would you characterise your main motivation for engaging in urban knitting?**
   Multiple answers possible.
   Check all that apply.

   - ☐ fun
   - ☐ feminist
   - ☐ activist
   - ☐ political
   - ☐ creative self-expression
   - ☐ social
   - ☐ community engagement
   - ☐ reclaiming urban/shared space
   - ☐ attracting attention in urban space
   - ☐ attracting attention online
   - ☐ gaining recognition as an artist
   - ☐ Other: .....

8. **Please describe an urban knitting project which you are particularly proud of.**
   If you have documented it online, please share the link.

.....

.....

.....

.....

.....

Urban Knitting and Technology

9. **How would you describe your general attitude towards technology?**
   Mark only one oval.

	1	2	3	4	5	
negative	◯	◯	◯	◯	◯	positive

10. **Which place does technology take in your urban knitting projects? (if any)** *
    Technology is meant here in the broadest sense. For example: using knitting machines to produce the knitting, sharing photos of your installations, documenting projects in a blog, connecting with other urban knitters in social media, searching for patterns online, etc.

    .....

    .....

    .....

    .....

    .....

11. **Which place does technology take in the urban knitting movement in general? (if any)** *
    Again technology is meant here in the broadest sense. According to your personal experiences and observations how would you judge its relevance in regard to this particular craft trend?

    .....

    .....

    .....

    .....

    .....

Your Opinion on a Prototype

http://youtube.com/watch?v=3x46EnJh7Y4

Please have a look at the video. It shows an interactive prototype which combines urban knitting with touch sensors and a smartphone information app. The idea was to provide background information on each piece of an exemplary installation.

12. **What do you think of this prototype?**
    Do you like the idea? Would it be useful for your installations?

    .....

    .....

    .....

    .....

    .....

13. **Do you have any other ideas, how (digital) technologies could assist or enhance urban knitting?**
    eg. ideas for smartphone apps, web services or tools

    .....

    .....

    .....

    .....

    .....

APPENDIX C

Code

C.1 Prototype Version 1.0

Android app

Please refer to the code of following files:

- `MainActivity.java`
- `ArduinoService.java`
- `Piece1Activity.java`

Arduino code

Please refer to the code of `capacitive.ino`.

MainActivity.java
Seite 1 von 3

```java
package com.bii.urbanknitting;

import java.io.FileOutputStream;

import com.android.future.usb.UsbAccessory;
import com.android.future.usb.UsbManager;
import android.app.Activity;
import android.content.BroadcastReceiver;
import android.content.ComponentName;
import android.content.Context;
import android.content.Intent;
import android.content.IntentFilter;
import android.content.ServiceConnection;
import android.os.Bundle;
import android.os.Handler;
import android.os.IBinder;
import android.os.ParcelFileDescriptor;
import android.util.Log;
import android.widget.Toast;


public class MainActivity extends Activity {
    UsbAccessory mAccessory;
    ParcelFileDescriptor mFileDescriptor;
    FileOutputStream mOutputStream;

    private final BroadcastReceiver mUsbReceiver = new BroadcastReceiver() {

        @Override
        public void onReceive(Context context, Intent intent) {
            String action = intent.getAction();
            if (UsbManager.ACTION_USB_ACCESSORY_DETACHED.equals(action)) {
                Toast.makeText(getApplicationContext(), "unbind ArduinoService",
                Toast.LENGTH_SHORT).show();
                unbindService(arduinoConnection);
                Log.d("MainActivity","Service unbound");
                finish();
            }
        }
    };


    private Handler messageHandler = new Handler();

    class RunnableForArduinoService implements Runnable {
        public long msg; //
        public int piece;

        @Override
        public void run() {
            if (msg==1) {
                Toast.makeText(getApplicationContext(), "No Button ID", Toast.
                LENGTH_SHORT).show();
            }
            if (msg==2) {
                Intent myIntent = null;
                switch(piece) {
                case 1:
```

MainActivity.java
Seite 2 von 3

```java
                    myIntent = new Intent(getApplicationContext(), Piece1Activity.
                    class);
                    break;
                case 2:
                    myIntent = new Intent(getApplicationContext(), Piece2Activity.
                    class);
                    break;
                case 3:
                    myIntent = new Intent(getApplicationContext(), Piece3Activity.
                    class);
                    break;
                case 4:
                    myIntent = new Intent(getApplicationContext(), Piece4Activity.
                    class);
                    break;
                case 5:
                    myIntent = new Intent(getApplicationContext(), Piece5Activity.
                    class);
                    break;
                }
                if(myIntent != null) {
                    startActivity(myIntent);
                }

            }

        }
    }

     private ArduinoService.MyServiceBinder arduinoBinder = null;
     private ServiceConnection arduinoConnection = new ServiceConnection() {

         @Override
         public void onServiceConnected(ComponentName arg0, IBinder arg1) {
             arduinoBinder = (ArduinoService.MyServiceBinder) arg1;
             arduinoBinder.setRunnable(new RunnableForArduinoService());
             arduinoBinder.setActivityCallbackHandler(messageHandler);
             Log.d("MainActivity","Arduino Service is connected!");
         }

         @Override
         public void onServiceDisconnected(ComponentName arg0) {
             Log.d("MainActivity","Arduino Service is disconnected!");
         }

     };


    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        IntentFilter filter = new IntentFilter(
        "com.google.android.BeyondTheDesktop.action.USB_PERMISSION");
        filter.addAction(UsbManager.ACTION_USB_ACCESSORY_DETACHED);
        registerReceiver(mUsbReceiver, filter);
    }
```

MainActivity.java
Seite 3 von 3

```java

    @Override
    protected void onResume() {
        super.onResume();
        final Intent netzwerkIntent = new Intent(getApplicationContext(),
        ArduinoService.class);
        bindService(netzwerkIntent,arduinoConnection,Context.BIND_AUTO_CREATE);
    }

}
```

ArduinoService.java
Seite 1 von 4

```
1   package com.bii.urbanknitting;
2
3   import java.io.FileDescriptor;
4   import java.io.FileInputStream;
5   import java.io.FileOutputStream;
6   import java.io.IOException;
7
8   import com.android.future.usb.UsbAccessory;
9   import com.android.future.usb.UsbManager;
10  import android.app.Service;
11  import android.content.Intent;
12  import android.os.Binder;
13  import android.os.Handler;
14  import android.os.IBinder;
15  import android.os.Message;
16  import android.os.ParcelFileDescriptor;
17  import android.util.Log;
18  import android.widget.Toast;
19
20  public class ArduinoService extends Service implements Runnable {
21
22      private static final String TAG = "ArduinoService";
23      private UsbManager mUsbManager;
24      private UsbAccessory mAccessory;
25
26      private MyServiceBinder myServiceBinder = new MyServiceBinder();
27      private static MainActivity.RunnableForArduinoService arduinoRunnable;
28
29      ParcelFileDescriptor mFileDescriptor;
30      FileInputStream mInputStream;
31      static FileOutputStream mOutputStream;
32
33      private static final int MESSAGE_BUTTON_PRESSED = 1;
34      protected static final int DISPLAY_BUFFER = 2;
35
36      @Override
37      public IBinder onBind(Intent intent) {
38          Log.e(TAG,"ArduinoService is bound!");
39          Toast.makeText(getApplicationContext(),"ArduinoService is bound and
            running",Toast.LENGTH_SHORT).show();
40          return myServiceBinder;
41      }
42
43      @Override
44      public boolean onUnbind(Intent intent) {
45          Log.i(TAG,"ArduinoService unbound!!!");
46          return true;
47      }
48
49      @Override
50      public void onCreate() {
51          Log.d("ArduinoService","onCreate");
52          super.onCreate();
53          mUsbManager = UsbManager.getInstance(this);
54          Log.d(TAG,"Usbmanager: "+mUsbManager.toString());
55          UsbAccessory[] accessories = mUsbManager.getAccessoryList();
56          if(accessories == null) {
57          } else {
```

ArduinoService.java
Seite 2 von 4

```
58              mAccessory = accessories[0];
59              openAccessory(mAccessory);
60          }
61      }
62
63      @Override
64      public void onDestroy() {
65          super.onDestroy();
66          closeAccessory();
67      }
68
69
70      private void openAccessory(UsbAccessory accessory) {
71          mFileDescriptor = mUsbManager.openAccessory(accessory);
72          if (mFileDescriptor != null) {
73              FileDescriptor fd = mFileDescriptor.getFileDescriptor();
74              mInputStream = new FileInputStream(fd);
75              mOutputStream = new FileOutputStream(fd);
76              Thread thread = new Thread(null,this,"BeyondTheDesktop");
77              thread.start();
78              Toast.makeText(this,"Accessory opened!",Toast.LENGTH_LONG).show();
79              Log.d(TAG,"accessory opened");
80          } else {
81              Log.d(TAG,"accessory open fail");
82          }
83      }
84
85      @Override
86      public void run() {
87          int ret = 0;
88          byte[] buffer = new byte[16384];
89          int i;
90
91          while(ret >= 0) {
92              try {
93                  ret = mInputStream.read(buffer);
94              } catch (IOException e) {
95                  break;
96              }
97              i = 0;
98              Log.d("BUFFER", "buffer: "+new String(buffer));
99
100             while (i < ret) {
101                 Message m = Message.obtain(messageHandler,MESSAGE_BUTTON_PRESSED);
102                 m.obj = buffer[i];
103                 messageHandler.sendMessage(m);
104                 i++;
105             }
106         }
107     }
108
109
110     private void closeAccessory() {
111         try {
112             if (mFileDescriptor != null) {
113                 mFileDescriptor.close();
114             }
115         } catch(IOException e) {
```

ArduinoService.java
Seite 3 von 4

```
116         } finally {
117             mFileDescriptor = null;
118             mAccessory = null;
119         }
120
121     }
122
123
124     public Handler messageHandler = new Handler() {
125         @Override
126         public void handleMessage(Message msg) {
127             Log.d(TAG,"message to be handled");
128             switch(msg.what) {
129             case MESSAGE_BUTTON_PRESSED:
130                 String str = String.valueOf(msg.obj);
131                 int pieceID = 0;
132                 // Receiving button values from Arduino
133                 if(str.equalsIgnoreCase("61")) {
134                     pieceID = 1;
135                 }
136                 if(str.equalsIgnoreCase("62")) {
137                     pieceID = 2;
138                 }
139                 if(str.equalsIgnoreCase("63")) {
140                     pieceID = 3;
141                 }
142                 if(str.equalsIgnoreCase("64")) {
143                     pieceID = 4;
144                 }
145                 if(str.equalsIgnoreCase("65")) {
146                     pieceID = 5;
147                 }
148                 if(pieceID > 0) {
149                     MyServiceBinder.buttonPressed(pieceID);
150                 }
151                 break;
152             }
153         }
154     };
155
156
157
158     public static class MyServiceBinder extends Binder {
159         private static Handler arduinoCallbackHandler;
160
161         public void setRunnable (final MainActivity.RunnableForArduinoService
            runnable){
162             arduinoRunnable = runnable;
163         }
164         public void setActivityCallbackHandler(final Handler callback) {
165             arduinoCallbackHandler = callback;
166         }
167         public static void buttonPressed() {
168             arduinoRunnable.msg = 1;
169             arduinoCallbackHandler.post(arduinoRunnable);
170         }
171         public static void buttonPressed(int pieceID) {
172             arduinoRunnable.msg = 2;
```

ArduinoService.java
Seite 4 von 4

```
173             arduinoRunnable.piece = pieceID;
174             arduinoCallbackHandler.post(arduinoRunnable);
175         }
176     } // end binder
177
178     public static void sendCommand(byte message) {
179         if (message > 255)
180             message = (byte) 255;
181         if (mOutputStream != null && message != 0) {
182             try {
183                 mOutputStream.write(message);
184             } catch (IOException e) {
185                 Log.e("MainActivity","write failed",e);
186             }
187         }
188     }
189
190
191 }
192
```

```java
package com.bii.urbanknitting;

import android.app.Activity;
import android.os.Bundle;

public class Piece1Activity extends Activity {

    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_piece1);
    }

}
```

capacitive.ino
Seite 1 von 4

```
#include <CapacitiveSensor.h>
#include <Max3421e.h>
#include <Usb.h>
#include <AndroidAccessory.h>

AndroidAccessory acc("Google, Inc.",
                     "BeyondTheDesktop",
                     "BeyondTheDesktop",
                     "1.0",
                     "http://www.android.com",
                     "0000000012345678");

/* Used library and tutorial for this file:
 *   Capacitive Sensing Library, Paul Badger 2008
 *   http://playground.arduino.cc/Main/CapacitiveSensor
 */

const boolean DEBUGMODE = true;

const int PIECES = 5; // how many pieces of art there are, ossible values: 1-5
int pinPower[]  = { 2,  3,  4,  5,  6}; // The pins on the Arduino board to power the sensors
int pinSensor[] = {A0, A1, A2, A3, A4}; // The pins on the Arduino board where the sensor data are measured
//int pinLight[]  = { 8,  9, 10, 11, 12}; // The pins on the Arduino board for the LEDs
int pinLight[]  = { 9, 10, 11, 12, 13}; // The pins on the Arduino board for the LEDs
int threshold[] = {100000, 30000, 12000, 1000, 1000};

boolean pieceStatus[PIECES]; // if a piece is currently selected
long values[PIECES]; // current sensor values

const int SAMPLESIZE = 40;
long lastValues[PIECES][SAMPLESIZE];
int lastIndex;
long average[PIECES];

int currentPiece = 0;
boolean androidSent = false;

// Sensor objects
CapacitiveSensor cs0 = CapacitiveSensor(pinPower[0], pinSensor[0]);
CapacitiveSensor cs1 = CapacitiveSensor(pinPower[1], pinSensor[1]);
CapacitiveSensor cs2 = CapacitiveSensor(pinPower[2], pinSensor[2]);
CapacitiveSensor cs3 = CapacitiveSensor(pinPower[3], pinSensor[3]);
CapacitiveSensor cs4 = CapacitiveSensor(pinPower[4], pinSensor[4]);

/*
 * Initializing
 */
void setup()
{
   Serial.begin(9600);

   for (int i = 0; i < PIECES; i++) {
     pinMode(pinLight[i], OUTPUT);
     digitalWrite(pinLight[i], LOW);
     pieceStatus[i] = false;
```

capacitive.ino
Seite 2 von 4

```
     values[i] = 0;

     for (int j = 0; j < SAMPLESIZE; j++) {
        lastValues[i][j] = 0;
     }
     average[i] = 0;

   }

   lastIndex = 0;

   delay(1000);
   acc.powerOn();

}

/*
 * Loop
 */
void loop()
{
    // switch Android Activity
    if (!androidSent) {
      //Serial.print("Sendeversuch");
      //Serial.print(60 + currentPiece + 1);
      byte msg[1];
      if (acc.isConnected()) {
        msg[0] = (byte) 60 + currentPiece + 1; // 61 for piece 1, 62 for piece 2, etc.
        acc.write(msg, 1); // sending 6X to Android
        androidSent = true;
      }
    }

    // get sensor data
    switch(PIECES) {
      case 5: values[4] = cs4.capacitiveSensor(300);
      case 4: values[3] = cs3.capacitiveSensor(300);
      case 3: values[2] = cs2.capacitiveSensor(300);
      case 2: values[1] = cs1.capacitiveSensor(300);
      case 1: values[0] = cs0.capacitiveSensor(300);
    }

    // print sensor data for debugging
    if (DEBUGMODE) {
      for (int i = 0; i < PIECES; i++) {
        Serial.print("\t");
        Serial.print(values[i]);
      }
      Serial.print("\t");
      Serial.print("I");
      for (int i = 0; i < PIECES; i++) {
        Serial.print("\t");
        Serial.print(average[i]);
      }
      Serial.println();
    }
```

capacitive.ino
Seite 3 von 4

```
    // find out if a piece is currently touched
    for (int i = 0; i < PIECES; i++) {
      if (values[i] > average[i] * 13) {
        switchToPiece(i);
        break;
      }
    }

    for (int i = 0; i < PIECES; i++) {

      // calculate median
      sort(lastValues[i], SAMPLESIZE);
      average[i] = lastValues[i][SAMPLESIZE/3*2];

      lastValues[i][lastIndex] = values[i];
    }

    lastIndex = (lastIndex + 1) % SAMPLESIZE;

    delay(10); // arbitrary delay to limit data to serial port
}

/*
 * Reaction to when a piece is touched
 */
void switchToPiece(int piece) {

  // switch active LED
  if (!pieceStatus[piece]) {

      for (int i = 0; i < PIECES; i++) {
        pieceStatus[i] = false;
        digitalWrite(pinLight[i], LOW);
      }
      pieceStatus[piece] = true;
      digitalWrite(pinLight[piece], HIGH);

      // switch Android Activity
      currentPiece = piece;
      androidSent = false;
  }

}

/*
 * Sort an array
 * taken from
 http://www.hacksched.co.uk/arduino-sorting-array-integers-with-a-bubble-sort-algorithm/
 */
void sort(long a[], int size) {
    for(int i=0; i<(size-1); i++) {
        for(int o=0; o<(size-(i+1)); o++) {
                if(a[o] > a[o+1]) {
                    int t = a[o];
                    a[o] = a[o+1];
                    a[o+1] = t;
                }
```

capacitive.ino
Seite 4 von 4

```
        }
    }
}
```

C.2 Prototype Version 2.0

Android app

Please refer to the code of following files:

- `MainActivity.java`
- `ArduinoService.java`
- `PieceActivity.java`

Arduino code

Please refer to the code of following files:

- `ToolsForWools.ino`
- `mpr121.h`

MainActivity.java
Seite 1 von 4

```java
package com.bii.urbanknitting;

import android.bluetooth.BluetoothAdapter;
import android.content.ComponentName;
import android.content.Context;
import android.content.Intent;
import android.content.ServiceConnection;
import android.net.Uri;
import android.os.Bundle;
import android.os.Handler;
import android.os.IBinder;
import android.os.Message;
import android.os.Messenger;
import android.os.RemoteException;
import android.support.v7.app.ActionBarActivity;
import android.support.v7.widget.Toolbar;
import android.util.Log;
import android.view.Menu;
import android.view.MenuItem;
import android.widget.TextView;
import android.widget.Toast;

import com.urbanknitting.ToolsForWools.R;


public class MainActivity extends ActionBarActivity {
    private static final String TAG = "Activity";
    BluetoothAdapter btAdapter;
    TextView tvStatus;
    private Toolbar mToolbar;
    boolean BTplay;

    private Handler messageHandler = new Handler();

    class RunnableForArduinoService implements Runnable {
        public long msg; //
        public int piece;

        @Override
        public void run() {
            if (msg==1) {
                Toast.makeText(getApplicationContext(), "No Button ID", Toast.
                LENGTH_SHORT).show();
            }
            if (msg==2) {
                Intent myIntent = null;
                myIntent = new Intent(getApplicationContext(), PieceActivity.class);
                if (piece > 0 && piece < 37) {
                    String strPieceID = Integer.toString(piece);
                    myIntent.putExtra("pieceID", strPieceID);
                    myIntent.putExtra("boolBound", mBound);
                    myIntent.putExtra("boolBTplay", BTplay);
                    myIntent.addFlags(Intent.FLAG_ACTIVITY_NO_HISTORY);
                }

                if(myIntent != null) {
                    startActivity(myIntent);
                }
```

MainActivity.java
Seite 2 von 4

```java
            }
            if (msg==3) {
                tvStatus.setText(R.string.interaction_hint);
                BTplay = true;
            }

        }
    }


    private Messenger mServiceMessenger = null;
    private boolean mBound = false;

     private ArduinoService.MyServiceBinder arduinoBinder = null;
     private ServiceConnection arduinoConnection = new ServiceConnection() {

         @Override
         public void onServiceConnected(ComponentName arg0, IBinder arg1) {
             arduinoBinder = (ArduinoService.MyServiceBinder) arg1;
             arduinoBinder.setRunnable(new RunnableForArduinoService());
             arduinoBinder.setActivityCallbackHandler(messageHandler);
             mBound = true;
             Log.d("MainActivity","Arduino Service is connected!");
         }

         @Override
         public void onServiceDisconnected(ComponentName arg0) {
             Log.d("MainActivity","Arduino Service is disconnected!");
             mBound = false;
         }
     };


    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        // Setting up Toolbar
        mToolbar = (Toolbar) findViewById(R.id.toolbar);
        setSupportActionBar(mToolbar);
        getSupportActionBar().setTitle(R.string.project_title);

        BTplay = false;

        tvStatus = (TextView) findViewById(R.id.textViewInteractionHint);

        btAdapter = BluetoothAdapter.getDefaultAdapter();
        btCheck();
    }


    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        // Inflate the menu; this adds items to the action bar if it is present.
        getMenuInflater().inflate(R.menu.main, menu);
        return true;
```

MainActivity.java
Seite 3 von 4

```java
    }

    @Override
    public boolean onOptionsItemSelected(MenuItem item) {
        int id = item.getItemId();

        // Settings
        if (id == R.id.action_settings) {
            if(mBound) {
                // force Bluetooth Reconnect
                Message msg = Message.obtain(null, ArduinoService.FORCE_RECONNECT,
                0, 0);
                try {
                    mServiceMessenger.send(msg);
                } catch (RemoteException e) {
                    Log.i(TAG,"No communication between activity and service");
                }
            } else {
                // start and bind new service
                Intent intent = new Intent(this, ArduinoService.class);
                bindService(intent, arduinoConnection, Context.BIND_AUTO_CREATE);
            }

            return true;
        }

        // share on social media
        if (id == R.id.action_share) {
            Intent share = new Intent(Intent.ACTION_SEND);
            share.setType("image/jpeg"); // might be text, sound, whatever
            share.putExtra(Intent.EXTRA_STREAM, Uri.parse(
            "android.resource://com.bii.urbanknitting/" + R.drawable.toolsforwools
            ));
            startActivity(Intent.createChooser(share, "share"));
        }

        return super.onOptionsItemSelected(item);
    }

    private void btCheck() {
        if (btAdapter != null) {
            Log.i(TAG,"Got Default Adapter.");
            // Continue with Bluetooth setup.
            if (!btAdapter.isEnabled()) {
                // BT disabled. Ask to turn it on.
                Log.i(TAG,"BT disabled.");
                tvStatus.append("\nNeed to turn on Bluetooth...");
                turnOnBT();
            }
            // BT enabled.
            Log.i(TAG,"BT enabled.");
            tvStatus.append("\nBluetooth is enabled.");
            tvStatus.append("\nLooking for installation radio...");
            // start bound Bluetooth listening service in background
            Intent intent = new Intent(this, ArduinoService.class);
            startService(intent);
            getApplicationContext().bindService(intent,arduinoConnection, Context.
            BIND_AUTO_CREATE);
```

MainActivity.java
Seite 4 von 4

```java
            mServiceMessenger = new Messenger(arduinoBinder);
        } else {
            // no Bluetooth detected on this device
            Log.i(TAG,"No Default Adapter.");
            tvStatus.append("\nSorry! No Bluetooth detected on this device.");
            tvStatus.append("\nClosing App...");
            Toast.makeText(getApplicationContext(), "Sorry! This app needs
            Bluetooth and you don't have it...", Toast.LENGTH_LONG).show();
            finish();
        }

    }

    private void turnOnBT() {
        Intent enableBT = new Intent(BluetoothAdapter.ACTION_REQUEST_ENABLE);
        startActivityForResult(enableBT, 1);
    }

    @Override
    protected void onStop() {
        super.onStop();
        // Unbind from the service
        if (mBound) {
            unbindService(arduinoConnection);
            mBound = false;
        }
    }


    protected void onPause() {
        super.onPause();
        if (mBound) {
            unbindService(arduinoConnection);
            mBound = false;
        }
    }

    @Override
    protected void onResume() {
        super.onResume();
        if (!mBound) {
            Intent intent = new Intent(this, ArduinoService.class);
            bindService(intent, arduinoConnection, Context.BIND_AUTO_CREATE);
        }

    }
}
```

ArduinoService.java
Seite 1 von 8

```
1   package com.bii.urbanknitting;
2
3   import java.io.FileInputStream;
4   import java.io.FileOutputStream;
5   import java.io.IOException;
6   import java.io.InputStream;
7   import java.io.OutputStream;
8   import java.util.Set;
9   import java.util.UUID;
10
11  import android.app.Service;
12  import android.bluetooth.BluetoothAdapter;
13  import android.bluetooth.BluetoothDevice;
14  import android.bluetooth.BluetoothSocket;
15  import android.content.Intent;
16  import android.os.Binder;
17  import android.os.Handler;
18  import android.os.IBinder;
19  import android.os.Message;
20  import android.os.Messenger;
21  import android.os.ParcelFileDescriptor;
22  import android.util.Log;
23  import android.widget.Toast;
24
25  public class ArduinoService extends Service  {
26
27      private static final String TAG = "ArduinoService";
28
29      static final int NR_PIECES = 28;
30
31      BluetoothAdapter btAdapter;
32      BluetoothDevice btDevice;
33      BluetoothSocket btSocket;
34      OutputStream btOutputStream;
35      InputStream btInputStream;
36
37      ConnectThread connect;
38      ConnectedThread connectedThread;
39
40      String knitAddress = "20:13:12:03:21:04";
41      static final UUID MY_UUID = UUID.fromString(
        "00001101-0000-1000-8000-00805F9B34FB");
42
43      private MyServiceBinder myServiceBinder = new MyServiceBinder();
44      private MainActivity.RunnableForArduinoService arduinoRunnable;
45      public Handler messageHandler = new Handler() {
46          @Override
47          public void handleMessage(Message msg) {
48              Log.d(TAG,"message to be handled");
49              int pieceID = 100;
50              switch(msg.what) {
51              case MESSAGE_BUTTON_PRESSED:
52                  String str = String.valueOf(msg.obj);
53                  pieceID = 0;
54                  // Receiving ID values from Arduino
55                  if(str.equalsIgnoreCase("61")) {
56                      pieceID = 1;
57                  }
```

ArduinoService.java
Seite 2 von 8

```
58                  if(str.equalsIgnoreCase("62")) {
59                      pieceID = 2;
60                  }
61                  if(str.equalsIgnoreCase("63")) {
62                      pieceID = 3;
63                  }
64                  if(str.equalsIgnoreCase("64")) {
65                      pieceID = 4;
66                  }
67                  if(str.equalsIgnoreCase("65")) {
68                      pieceID = 5;
69                  }
70                  //Toast.makeText(getApplicationContext(), "Piece " + pieceID + "
                    touched!", Toast.LENGTH_SHORT).show();
71                  if(pieceID > 0) {
72                      myServiceBinder.buttonPressed(pieceID);
73                  }
74                  break;
75              case SUCCESS_CONNECT:
76                  connectedThread = new ConnectedThread((BluetoothSocket) msg.obj);
77                  Toast.makeText(getApplicationContext(), "CONNECTED", Toast.
                    LENGTH_SHORT).show();
78                  String s = "successfully connected";
79                  connectedThread.start();
80                  connectedThread.write(s.getBytes());
81                  myServiceBinder.btIsConnected();
82                  Log.i(TAG,"handler - connected");
83                  break;
84              case MESSAGE_READ:
85                  byte[] readBuf = (byte[]) msg.obj;          // Bluetooth-Message
                    is received in Bytes
86                  // Receiving ID values from Arduino
87                  pieceID = convertByteToInt(readBuf);        // Retrieve original
                    Arduino-Message as Int
88                  pieceID++;
89                  Log.i(TAG,"PieceID: " + pieceID + " - bt_listen: " + bt_listen);
90
91                  if(bt_listen && pieceID <= NR_PIECES) {
92                      myServiceBinder.pieceTouched(pieceID);
93                  }
94                  break;
95              case DISCONNECTED:
96                  reconnectBT();
97                  break;
98              case FORCE_RECONNECT:
99                  reconnectBT();
100                 break;
101             case BT_PAUSE:
102                 //connectedThread.btPause();
103                 bt_listen = false;
104                 Log.i(TAG,"Message received! bt_listen: " + bt_listen);
105                 break;
106             case BT_PLAY:
107                 //connectedThread.btResume();
108                 bt_listen = true;
109                 Log.i(TAG,"bt_listen: " + bt_listen);
110                 break;
111             }
```

ArduinoService.java
Seite 3 von 8

```
112
113         }
114     };
115     final Messenger mMessenger = new Messenger(messageHandler);
116
117     ParcelFileDescriptor mFileDescriptor;
118     FileInputStream mInputStream;
119     FileOutputStream mOutputStream;
120
121     private static final int MESSAGE_BUTTON_PRESSED = 1;
122     protected static final int DISPLAY_BUFFER = 2;
123     protected static final int SUCCESS_CONNECT = 3;
124     protected static final int MESSAGE_READ = 4;
125     protected static final int DISCONNECTED = 5;
126     protected static final int FORCE_RECONNECT = 6;
127     protected static final int BT_PAUSE = 7;
128     protected static final int BT_PLAY = 8;
129
130     public boolean bt_listen = false;
131
132     @Override
133     public IBinder onBind(Intent intent) {
134         Log.e(TAG,"ArduinoService is bound!");
135         return myServiceBinder;
136     }
137
138     @Override
139     public boolean onUnbind(Intent intent) {
140         Log.i(TAG,"ArduinoService unbound!!!");
141         connectedThread.cancel();
142         connect.cancel();
143         return true;
144     }
145
146     @Override
147     public void onCreate() {
148         Log.d("ArduinoService","onCreate");
149         super.onCreate();
150
151         btAdapter = BluetoothAdapter.getDefaultAdapter();
152         getBTDevice();
153         Log.i(TAG,"About to connect...");
154         if (btDevice != null) {
155             connect = new ConnectThread(btDevice);
156             connect.start();
157             bt_listen = true;
158         }
159
160     }
161
162     private void getBTDevice() {
163         Set<BluetoothDevice> pairedDevices = btAdapter.getBondedDevices();
164         if(pairedDevices.size() > 0) {
165             for(BluetoothDevice d : pairedDevices) {
166                 if(d.getAddress().equals(knitAddress)) {
167                     btDevice = d;
168                     Log.i(TAG,"Found Device.");
169                     break;
```

ArduinoService.java
Seite 4 von 8

```
170                 }
171             }
172         }
173
174     }
175
176     @Override
177     public void onDestroy() {
178         connectedThread.cancel();
179         connect.cancel();
180         super.onDestroy();
181     }
182
183     public void onResume() {
184         if(!connectedThread.getConnectionState()) {
185
186         }
187     }
188
189
190     public void reconnectBT() {
191         if (connectedThread != null) {
192             connectedThread.cancel();
193             connectedThread = null;
194         }
195
196         if (connect != null) {
197             connect.cancel();
198             connect = null;
199         }
200
201         connect = new ConnectThread(btDevice);
202         connect.start();
203     }
204
205
206
207     // convert the Byte[] received via Bluetooth into an Integer
208     public int convertByteToInt(byte[] b)
209     {
210         int value= 0;
211         for(int i=0; i<b.length; i++)
212            value = (value << 8) | b[i];
213         return value;
214     }
215
216
217     public class MyServiceBinder extends Binder {
218         private Handler arduinoCallbackHandler;
219
220         ArduinoService getService() {
221             // Return this instance of LocalService so clients can call public
                methods
222             return ArduinoService.this;
223         }
224
225         public void setRunnable (final MainActivity.RunnableForArduinoService
            runnable){
```

PieceActivity.java
Seite 1 von 3

```java
package com.bii.urbanknitting;

import com.urbanknitting.ToolsForWools.R;

import android.content.ComponentName;
import android.content.Context;
import android.content.Intent;
import android.content.ServiceConnection;
import android.graphics.BitmapFactory;
import android.graphics.drawable.BitmapDrawable;
import android.graphics.drawable.Drawable;
import android.os.Bundle;
import android.os.Handler;
import android.os.IBinder;
import android.os.Message;
import android.os.Messenger;
import android.support.v7.app.ActionBarActivity;
import android.support.v7.widget.Toolbar;
import android.text.method.LinkMovementMethod;
import android.util.Log;
import android.view.Menu;
import android.view.MenuItem;
import android.view.ViewStub;
import android.widget.ImageView;
import android.widget.TextView;

public class PieceActivity extends ActionBarActivity {
    private static final String TAG = "PieceActivity";
    private Toolbar mToolbar;
    private String participant;
    private Handler mHandler = new Handler();

    boolean BTplay;
    boolean mBound;
    private Messenger mServiceMessenger;
    private ArduinoService.MyServiceBinder arduinoBinder = null;
    private ImageView iv = null;
    private BitmapFactory bitmap;

    ArduinoService arduinoService;
    private ServiceConnection mConnection = new ServiceConnection() {
        // Called when the connection with the service is established
        public void onServiceConnected(ComponentName className, IBinder service) {
            // Because we have bound to an explicit
            // service that is running in our own process, we can
            // cast its IBinder to a concrete class and directly access it.
            arduinoBinder = (ArduinoService.MyServiceBinder) service;
            //arduinoService = arduinoBinder.getService();
            arduinoBinder.setActivityCallbackHandler(mHandler);
            Log.i(TAG,"ServiceConnection successful");
            mBound = true;
        }

        // Called when the connection with the service disconnects unexpectedly
        public void onServiceDisconnected(ComponentName className) {
            Log.e(TAG, "onServiceDisconnected");
            mBound = false;
        }
```

PieceActivity.java
Seite 2 von 3

```java
    };


    /** Called when the activity is first created. */
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        Intent intent = getIntent();
        setContentView(R.layout.activity_piece);

        mToolbar = (Toolbar) findViewById(R.id.toolbar);
        setSupportActionBar(mToolbar);
        getSupportActionBar().setTitle(R.string.project_title);

        participant = "p"+intent.getStringExtra("pieceID");
        setContent(participant);
    }

    private void setContent(String participant) {
        int tmpID = 0;

        // set name
        tmpID = getResources().getIdentifier(participant+"_artist", "string", getPackageName());
        TextView tv = (TextView) findViewById(R.id.textViewKnitter);
        if (tv != null) {
            tv.setText(tmpID);
        }

        // set country
        tmpID = getResources().getIdentifier(participant+"_country", "string", getPackageName());
        tv = (TextView) findViewById(R.id.textViewCountry);
        if (tv != null) {
            tv.setText(tmpID);
        }

        // set image
        iv = (ImageView) findViewById(R.id.imageViewKnitter);
        tmpID = getResources().getIdentifier("knitter_"+participant, "drawable", getPackageName());
        iv.setImageResource(tmpID);

        // set description
        tmpID = getResources().getIdentifier("desc_"+participant, "layout", getPackageName());
        ViewStub importDesc = (ViewStub) findViewById(R.id.stubKnitterDesc);
        importDesc.setLayoutResource(tmpID);
        importDesc.inflate();

        // set website
        tv = (TextView) findViewById(R.id.textViewWeb);
        if (tv != null) {
            tmpID = getResources().getIdentifier(participant+"_link", "string", getPackageName());
            //tmpID = getResources().getIdentifier("p13_link", "string", getPackageName());
            tv.setText(tmpID);
```

PieceActivity.java
Seite 3 von 3

```java
            tv.setMovementMethod(LinkMovementMethod.getInstance());
        }
    }

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        // Inflate the menu; this adds items to the action bar if it is present.
        getMenuInflater().inflate(R.menu.piece, menu);
        return true;
    }

    @Override
    public boolean onOptionsItemSelected(MenuItem item) {
        int id = item.getItemId();

        // Settings
        if (id == R.id.action_settings) {
            if(mBound) {
                // force Bluetooth Reconnect
                Message msg = Message.obtain(mHandler, ArduinoService.FORCE_RECONNECT, 0, 0);
                try {
                    mHandler.sendMessage(msg);
                } catch (Exception e) {
                    Log.i(TAG,"No communication between activity and service");
                }
            }
            return true;
        }

        // SHARE on social media
        if (id == R.id.action_share) {
            Intent share = new Intent(Intent.ACTION_SEND);
            share.putExtra(Intent.EXTRA_TEXT, "I just saw the #toolsforwools installation! http://toolsforwools.tumblr.com/");
            share.setType("text/plain");
            startActivity(Intent.createChooser(share, "share"));
        }

        return super.onOptionsItemSelected(item);
    }

}
```

```
/* based on following tutorials:
** - MPR121 bildr sketch (2010): http://bildr.org/2011/05/mpr121_arduino/
** - Bluetooth:
http://www.martyncurrey.com/arduino-with-hc-05-bluetooth-module-in-slave-mode/
*/

#include "mpr121.h"
#include <Wire.h>

#define MPR_1 0x5D // Address MPR121-1
#define MPR_2 0x5C // Address MPR121-2
#define MPR_3 0x5A // Address MPR121-3

// MPR121 PINS
const int irqpin = 4;

#define numPieces 36

boolean touchStates[numPieces]; //to keep track of the previous touch states
int lastTouchedPiece = numPieces + 1;
int lastButOnePiece = numPieces + 1;
int piece = numPieces + 1;

boolean got_one;
int count;

void setup(){
    pinMode(irqpin, INPUT);
    digitalWrite(irqpin, HIGH); //enable pullup resistor

    Serial.begin(9600);    // Default connection rate for my BT module

    Wire.begin();
    mpr121_setup(MPR_1);
    mpr121_setup(MPR_2);
    mpr121_setup(MPR_3);

    got_one = false;
    count = 0;
}

void loop(){
    readTouchInputs(MPR_1, 0);
    readTouchInputs(MPR_2, 1);
    readTouchInputs(MPR_3, 2);

    // send touch signal
    if(got_one) {
        if (piece > -1 && piece < (numPieces + 1)) {
            Serial.write(piece);
            lastButOnePiece = lastTouchedPiece;
            lastTouchedPiece = piece;
            delay(2000);
        }
        got_one = false;
        piece = numPieces + 1;
    }
```



```
    if (count > 100000) {
        mprSetup();
        count = 0;
    }
    count++;
}

void mprSetup() {
    mpr121_setup(MPR_1);
    mpr121_setup(MPR_2);
    mpr121_setup(MPR_3);
}


void readTouchInputs(int breakboard, int num){
    if(!checkInterrupt() && !got_one){
        //read the touch state from the MPR121
        Wire.requestFrom(breakboard,2);

        byte LSB = Wire.read();
        byte MSB = Wire.read();

        uint16_t touched = ((MSB << 8) | LSB); //16bits that make up the touch states

        int touchedPiece;

        for (int i=0; i < 12; i++){  // Check what electrodes were pressed
            if(touched & (1<<i)){
                if(touchStates[i] == 0){
                    //pin i was just touched
                    touchedPiece = i + num*12;
                } else if(touchStates[i] == 1){
                    //pin i is still being touched
                    //touchedPiece = i + num*12;
                }
                //only send signal if a new piece is touched
                if (touchedPiece != lastTouchedPiece && touchedPiece !=
                lastButOnePiece) {
                    //only send signal if a new piece is touched
                    piece = touchedPiece;
                    got_one = true;
                }
                touchStates[i+ num*12] = 1;
            } else {
                if(touchStates[i + num*12] == 1){
                    // pin i is no longer being touched
                }
                touchStates[i+ num*12] = 0;
            }
        }
    }
}

void mpr121_setup(int breakboard){
    // Set ELE_CFG to 0x00 to return to standby mode
    set_register(breakboard, ELE_CFG, 0x00);   // all elecrodes disabled

    // Section A - Controls filtering when data is > baseline.
```



```
    set_register(breakboard, MHD_R, 0x01);
    set_register(breakboard, NHD_R, 0x01);
    set_register(breakboard, NCL_R, 0x00);
    set_register(breakboard, FDL_R, 0x00);

    // Section B - Controls filtering when data is < baseline.
    set_register(breakboard, MHD_F, 0x01);
    set_register(breakboard, NHD_F, 0x01);
    set_register(breakboard, NCL_F, 0xFF);
    set_register(breakboard, FDL_F, 0x05);

    // Section C - Sets touch and release thresholds for each electrode
    if(breakboard==MPR_1) {
        set_register(breakboard, ELE0_T, TOU_THRESH_M);
        set_register(breakboard, ELE0_R, REL_THRESH_M);
    } else if(breakboard==MPR_3) {
        set_register(breakboard, ELE0_T, TOU_THRESH_M);
        set_register(breakboard, ELE0_R, REL_THRESH_M);
    } else {
        set_register(breakboard, ELE0_T, TOU_THRESH_L);
        set_register(breakboard, ELE0_R, REL_THRESH_L);
    }

    if(breakboard==MPR_1) {
        set_register(breakboard, ELE1_T, TOU_THRESH_M);
        set_register(breakboard, ELE1_R, REL_THRESH_M);
    } else {
        set_register(breakboard, ELE1_T, TOU_THRESH_L);
        set_register(breakboard, ELE1_R, REL_THRESH_L);
    }

    if(breakboard==MPR_1) {
        set_register(breakboard, ELE2_T, TOU_THRESH_M);
        set_register(breakboard, ELE2_R, REL_THRESH_M);
    } else if(breakboard==MPR_3) {
        set_register(breakboard, ELE2_T, TOU_THRESH_M);
        set_register(breakboard, ELE2_R, REL_THRESH_M);
    } else {
        set_register(breakboard, ELE2_T, TOU_THRESH_L);
        set_register(breakboard, ELE2_R, REL_THRESH_L);
    }

    if(breakboard==MPR_1) {
        set_register(breakboard, ELE3_T, TOU_THRESH_L);
        set_register(breakboard, ELE3_R, REL_THRESH_L);
    } else if(breakboard==MPR_3) {
        set_register(breakboard, ELE3_T, TOU_THRESH_S);
        set_register(breakboard, ELE3_R, REL_THRESH_S);
    } else {
        set_register(breakboard, ELE3_T, TOU_THRESH_L);
        set_register(breakboard, ELE3_R, REL_THRESH_L);
    }

    if(breakboard==MPR_2) {
        set_register(breakboard, ELE4_T, TOU_THRESH_M);
        set_register(breakboard, ELE4_R, REL_THRESH_M);
    } else {
        set_register(breakboard, ELE4_T, TOU_THRESH_L);
```



```
        set_register(breakboard, ELE4_R, REL_THRESH_L);
    }

    if(breakboard==MPR_1) {
        set_register(breakboard, ELE5_T, TOU_THRESH_S);
        set_register(breakboard, ELE5_R, REL_THRESH_S);
    } else {
        set_register(breakboard, ELE5_T, TOU_THRESH_L);
        set_register(breakboard, ELE5_R, REL_THRESH_L);
    }

    set_register(breakboard, ELE6_T, TOU_THRESH_L);
    set_register(breakboard, ELE6_R, REL_THRESH_L);

    if(breakboard==MPR_2) {
        set_register(breakboard, ELE7_T, TOU_THRESH_M);
        set_register(breakboard, ELE7_R, REL_THRESH_M);
    } else {
        set_register(breakboard, ELE7_T, TOU_THRESH_L);
        set_register(breakboard, ELE7_R, REL_THRESH_L);
    }

    set_register(breakboard, ELE8_T, TOU_THRESH_L);
    set_register(breakboard, ELE8_R, REL_THRESH_L);

    if(breakboard==MPR_1) {
        set_register(breakboard, ELE9_T, TOU_THRESH_M);
        set_register(breakboard, ELE9_R, REL_THRESH_M);
    } else if(breakboard==MPR_2) {
        set_register(breakboard, ELE9_T, TOU_THRESH_L);
        set_register(breakboard, ELE9_R, REL_THRESH_L);
    } else {
        set_register(breakboard, ELE9_T, TOU_THRESH_L);
        set_register(breakboard, ELE9_R, REL_THRESH_L);
    }

    if(breakboard==MPR_1) {
        set_register(breakboard, ELE10_T, TOU_THRESH_M);
        set_register(breakboard, ELE10_R, REL_THRESH_M);
    } else {
        set_register(breakboard, ELE10_T, TOU_THRESH_L);
        set_register(breakboard, ELE10_R, REL_THRESH_L);
    }

    set_register(breakboard, ELE11_T, TOU_THRESH_L);
    set_register(breakboard, ELE11_R, REL_THRESH_L);

    // Section D - Set the Filter Configuration
    // Set ESI2
    set_register(breakboard, FIL_CFG, 0x04);    // 4ms
    // Debounce Settings
    set_register(breakboard, CONF_DTDR, 0x77);  // highest possibly: DT 7, DR 7

    // Section F
    // Enable Auto Config and auto Reconfig
    set_register(breakboard, ATO_CFG0, 0x33);    // RETRY 11, BVA 00, ARE 1, ACE 1
    set_register(breakboard, ATO_CFGU, 0xCA);  // USL@3.3V = (VDD-0.7)/VDD*256 =
    201,7 -> 0xCA
```

```
/*
    MPR121.h
    April 8, 2010
    by: Jim Lindblom
*/

// MPR121 Register Defines
#define MHD_R   0x2B
#define NHD_R   0x2C
#define NCL_R   0x2D
#define FDL_R   0x2E
#define MHD_F   0x2F
#define NHD_F   0x30
#define NCL_F   0x31
#define FDL_F   0x32
#define ELE0_T  0x41
#define ELE0_R  0x42
#define ELE1_T  0x43
#define ELE1_R  0x44
#define ELE2_T  0x45
#define ELE2_R  0x46
#define ELE3_T  0x47
#define ELE3_R  0x48
#define ELE4_T  0x49
#define ELE4_R  0x4A
#define ELE5_T  0x4B
#define ELE5_R  0x4C
#define ELE6_T  0x4D
#define ELE6_R  0x4E
#define ELE7_T  0x4F
#define ELE7_R  0x50
#define ELE8_T  0x51
#define ELE8_R  0x52
#define ELE9_T  0x53
#define ELE9_R  0x54
#define ELE10_T 0x55
#define ELE10_R 0x56
#define ELE11_T 0x57
#define ELE11_R 0x58
#define FIL_CFG 0x5D
#define ELE_CFG 0x5E
#define GPIO_CTRL0  0x73
#define GPIO_CTRL1  0x74
#define GPIO_DATA   0x75
#define GPIO_DIR    0x76
#define GPIO_EN     0x77
#define GPIO_SET    0x78
#define GPIO_CLEAR  0x79
#define GPIO_TOGGLE 0x7A
#define ATO_CFG0    0x7B
#define ATO_CFGU    0x7D
#define ATO_CFGL    0x7E
#define ATO_CFGT    0x7F

// Configuration
#define CONF_DTDR  0x5B    // Debounce Settings for Touch (DT) and Release (DR)
#define CONF_AFE1  0x5C    // Analog Front End: FFI, CDC (1st filter samples,
current)
```



```
#define CONF_AFE2  0x5D    // Analog Front End: CDT, SFI, ESI (1st filter time,
2nd filter iterations, electrode sample interval)
// 0x5F - 0x6B Individual CDC Charge/Discharge Current, 0 -> global CDC
// 0x6C - 0x72 Individual CDT Charge/Discharge Time, 0 -> global CDT
#define CONF_AUTO0 0x7B    // AUTO: AFES, RETRY, BVA, ARE, ACE
#define CONF_AUTO1 0x7C    // AUTO: SCTS, OORIE, ARFIE, ACFIE
#define CONF_USL   0x7D    // AUTO: Upper Side Limit Register
#define CONF_LSL   0x7E    // AUTO: Lower Side Limit Register
#define CONF_TL    0x7F    // AUTO: Target Level Register

// Global Constants
#define TOU_THRESH_S    0x0F   //15
#define REL_THRESH_S    0x0A   //10

#define TOU_THRESH_M    0x46   //70
#define REL_THRESH_M    0x40   //64

#define TOU_THRESH_L    0x5f   //95
#define REL_THRESH_L    0x5a   //90
```

APPENDIX D

App Content

D.1 Content Contributions to Prototype Version 1.0

“Der Große Wagen” by Carla
Seit ich in der Volksschule war, hab ich stricken gehasst. Ich war feinmotorisch nicht sonderlich begabt und sehr ungeduldig. Erst nach der Schulzeit habe ich wieder gefallen daran gefunden, etwas mit meinen Händen zu schaffen und konnte den meditativen Aspekt dieser Arbeit genießen. Trotzdem bin ich noch immer sehr ungeduldig, da kommen mir die Urban Knitting Projekte sehr gelegen, nichts muss Form- oder Formatvorgaben entsprechen. Mit ein paar Minuten Aufwand und einem kleinen Rest Wolle kann man das Stadtbild ein bisschen erheitern. Das sehe ich auch als die Hauptaufgabe des Urban Knittings: Wir wollen die Stadt ein bisschen bunter machen und unsere Mitmenschen für ein paar Sekunden aus ihrem grauen Alltagstrott reißen. Vielleicht sind deshalb die meisten Strickgraffitis so farbenfroh... Trotzdem habe ich mich diesmal für ein dunkelblau entschieden. Der Nachthimmel fehlt mir manchmal in der Stadt. So plastisch und klar wie am Land wird er irgendwie nie. Also hab ich mich für die vermutlich bekannteste Sternenkonstellation, den großen Wagen entschieden. Selbstverständlich gibt es viele Gründe, für das Guerillaknitting. Manche_r möchte die meist weiblich und unsichtbare Handarbeit sichtbar machen, einen urbanen Raum zurück erobern oder eine Message verbreiten. Für mich steht momentan die einfache Freude an Farbe und Form im Vordergrund.

“Hommage an Boris Becker” by Shlomo

Ein Farbmuster, das einen an klassische Tennissocken à la Wimbledon erinnert und fast vergessene Heroen der Kindheit wie Boris Becker - doch was steckt wirklich dahinter?

Mein Häkelstück mit dem Titel „Hommage an Boris Becker“ ist intuitiv entstanden. Ich habe im Vorfeld nicht geplant, wie das fertige Stück aussehen oder wie groß es werden soll. Vor mir lagen einige Wollknäuel unterschiedlichster Farben, die Auswahl erfolgte ohne großes Nachdenken. Meine Vorgehensweise ist inspiriert von der literarisch-psychoanalytischen Methode der „Écriture automatique“, die etwa die Surrealisten in der ersten Hälfte des 20. Jahrhunderts angewandt haben. Bilder und Gefühle werden dabei möglichst unzensiert und unkritisch aus den Tiefen des Unterbewusstseins ans Tageslicht befördert. In diesem Fall sollte die Methode allerdings umbenannt werden in „Crochet automatique“. Warum mein Unterbewusstsein gerade ein Boris-Becker-Tennissocken-Muster produziert hat, mag wohl daran liegen, dass das Stück in meinem Elternhaus entstanden ist.

“Bjørn Bär” by Inge

Als jemand, die gerne strickt, habe ich viele Wollreste herumliegen, und es macht einfach Spaß, aus diesen Resten sinnlose aber dekorative Kleinigkeiten wie dieses Bild herzustellen. Ähnlich verhält es sich mit billiger “Plastikwolle” in grellen Farben: Daraus kann man nichts zum Anziehen machen, aber zum Anschauen durchaus!

“Yay Crochet” by Lena
Ich weiß nicht wirklich viel über Urban Knitting, außer dass es mir Freude bereitet, wenn ich etwas davon zu Gesicht bekomme. Ich hab mir, um ehrlich zu sein, nicht viel bei meinem Teil gedacht, sondern einfach die Wolle, die bei mir daheim zu finden war, benützt und häkeln geübt.

“Stück für Stück” by Janis
Ich finde es toll, dass man beim Urban Knitting wirklich frei von der Leber stricken kann und nicht an Abzählmuster oder absolute Größenmaße gebunden ist. Das lädt zum Experimentieren ein. Und genau so würde ich auch den Entstehungsprozess meines Stückes beschreiben. Ich habe mir am Anfang keinerlei Gedanken gemacht, wie groß mein Stück werden oder welche Farben es genau haben soll, sondern habe einfach 24 Maschen angeschlagen, weil mir die Zahl in dem Moment sympathisch erschien und dann spontan von Streifen zu Streifen entschieden, mit welcher Wolle ich als nächstes weiterstricken will.
Das Material, das ich dabei verwendet habe, stammt übrigens zum Großteil aus einer Wollspende von einer älteren Dame, als diese ihren Hobbyraum und ihre Strickmaschine aufgegeben hat. Darunter sind auch echte “Perlen”, also original 80er-Jahre-Effektgarnen mit viel Glitzer und Fluff. Daraus würde ich nie Kleidung machen (Fühl doch nur, wie kratzig!), aber für Urban Knitting ist sowas natürlich perfekt! Ich hoffe, die Spenderin weiß, welche große Freude sie damit mir und auch den Teilnehmerinnen bei den Urban-Knitting-Workshops, die ich ab und zu veranstalte, bereitet hat.

D.2 Content Contributions to Prototype Version 2.0

Untitled (Icons) by Susan Campbell-Wright
Technology is a crucial element in my urban knitting. Firstly I would never have embarked on such a creative activity if it weren't for the contacts and inspirations I found online. Also, while working on a project I'm continually sharing ideas and possibilities with collaborators, some of whom are much too far away from where I live and work to ever have met. Technology enables me to participate in projects all around the world and to share in the final product.

"Nini & Wink" by Annette Fitton
This face is my Facebook profile picture. It's double knitted.
I was introduced to yarn bombing by the book, Yarn Bombing: The Art of Crochet & Knit Graffiti written by Mandy Moore and Leanne Prain, before being invited to contribute some crocheted food to a local community arts initiative where I attended a talk by Yarn Corner, a Facebook community based here in Melbourne, which I joined as a member.
Now I network with makers far and wide via Facebook, Instagram, Pinterest and email. These contacts have led to associations with fibre growers, processors, retailers and publishers, local artists, crafters and the wider community including hospitals and schools.
I've been both challenged and inspired by all the magical creativity to be seen in pictures on the net. I continue to be fascinated by people making all sorts of things in the world.
Getting out and meeting people is a large and important part of my yarn bombing life.

Untitled (Signature) by LIZ ROYCROFT

Technology has introduced the concept of yarn bombing to me and enabled me to take part in shared works initially through Yarn Corner. Yarn Corner is a closed Facebook group through which members are notified of events and projects and are able to communicate. There are over 900 members worldwide. I watched the activities of Yarn Corner for a couple of years before taking part!
My knitting piece has at the moment almost become my signature piece. I have used it for tree branches and street poles and am loving the colour clash.
I love doing fair isle patterns as I find it rewarding to see the pattern taking shape and I love using bright colours when yarn bombing more so than in everyday life!
I have also chosen to use this design for this project because I found the pattern on an English knitting website's blog as a 'something for the weekend' series. The internet is thus providing inspiration.
I have used hand dyed, handspun merino wool that I bought when on holiday in Tasmania which is very novel for yarnbombing. I usually use cheap acrylic yarn!
If it wasn't for Facebook and Internet Technology this Mum from Australia would not have the opportunity to take part in this exciting project
Cheers

Untitled by YarnBombing For Lunches

My knitting & crochet work is my art. It's the way I express my creativity. My medium for my creative expression.
Yarnbombing is like a gift to many, since it is delightful to see, surprising, and on a public area so all can enjoy it.
The piece I made for your project is crocheted out of acrylic yarn in white and yellow. The colors say "Peace & Harmony" to me and the design makes me feel like it has a message of "different but the same". In America, race relations are strained and the sad fact is that people are missing the fact that we are all the same despite our differences. I think creativity and art can profoundly change a generation and create positive change in communities.

“the human right to shelter” by Donegal Yarnbomb

For me, the technology is a way to connect with people everywhere, spreading awareness about the issues I feel passionate about. Its not about me, but about using the yarnbombs as a tool, a strategy to raise awareness & inspire action,art activism.

The little house piece I had already, it had been part of a bigger piece of work to highlight homelessness & raise money for a local project I am involved with as a volunteer,and i found it back at the bottom of my big box! often my small yarn bombpieces are left in the public spaces i hang them in till someone Íliberatesťhem & takes them home (the bigger pieces i do take home or are gifts to people and projects) I do not ever sell them or make money from them in any way and use my own money to buy wool, often scouting second hand shops for bits & bobs & unravelling old handmade pieces i find. this little house was not taken so i took it back a few days later & forgot all about it!with little time for making another piece i decided it would be an apppropiate piece in size and topic, an authentic,already used yarnbomb. as i thought a bit more on the issues of homelessness, and the human right to shelter, to safety i found myself making connections to lots of issues that have engaged me and still do, so its like a multilayered piece,evoking all these elements potentially-and who knows others for other people too. a bit like a poem, where every one who reads it can find their own layer of meaning, beyond any conscious intent of the author!

So the layers are:

* the basic human right to a home, to shelter.
* the scandal of homelessness, in ireland and globally
* the boat migrants, in the mediterreanean & further afield,leaving their homes behind in a desperate search for a new home with some hope for a better life
* the Palestinian people still living in refugeecamps since the forced evictions from their homes& land, the Nakba in 1948 and their descendants still carrying the longing to return to their homes one day
* the refugees fleeing from war & conflict at present,in Syria,Afghanistan,Iraq,Burundi, &so many places not even mentioned in mainstream news reports.
* the victims of the earthquakes in Nepal whose homes got destroyed
* victims of natural disasters anywhere, hurricanes, floods,etc losing their homes, and the increasing effect that climate change has on those,always affecting pooere people first&worst.
* women who are having to flee their homes due to domestic violence and their lack of rights & support in so many places.
* the injustice of the utter poverty of shantytowns

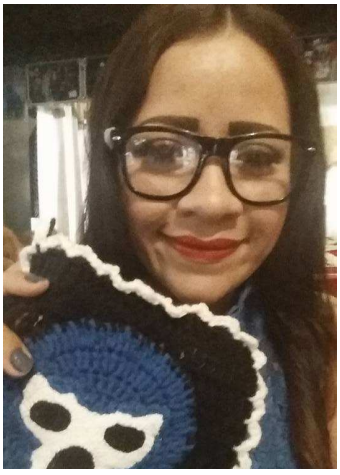
“Tools for Wools” by Catherine Rowe

My knitted square is all about colour and contrast, if you hadn’t already guessed.

I love bright and bold colours that “POP” and make a statement. I also love creating something from my own hands, something that didn’t exist before.

I came up with the idea for my tools for wools piece is that I feel like knitting and other craft work is something that connects people from all over the world, bringing people together to inspire and learn from each other. So whilst our tastes and ideals may be different, together it makes up an interesting and eclectic tapestry of beauty and imagination.

I enjoy various knitting and craft websites such as Ravelry where people and communicate and share their craft. I’m also a part of a wonderful yarn bombing community through Facebook called Yarn Corner. We support each other and charities through our craft whilst doing other larger scale yarn bombs promoting this new art form.



Untitled (Mexican Wrestler) by Alejandra Carreon

I believe that internet is one of the most powerful tools right now, people nowadays learn how to do a lot of things by simple searching through the internet, thatś how I learned how to crochet... using youtube tutorials. Today the fabric manufacturing uses machines that make textil materials through knitting, technology has made an easiest and faster way to create knitting stuff, but there is one thing for sure, those will never have... the handmade touch.

Untitled by Lety Meza

As all it touches… technology has come to improve the way we communicate, learn and share… which for most I can think of as positive impact on society… still… if I have to answer your question of "Which place does technology take in (my) urban knitting (if any)"" I sure hope the answer to be no…

You see… I have learned so much of knitting and crocheting in the net… I have been able to learn and see other peoples' techniques and wonderful pieces… but I would not trade all these tech bytes for the wonderful learning and sharing that I have in my #yarnbombingjrz knitting community… the way we share our time, yarn, knowledge and experience cannot be replaced with images and patterns and iPads and smartphones…

I hope we can keep technology dedicated to medical and science improvements in order for technology to allow us to keep our knitting world as simple and wonderful as it is today: yarn, hook, mind and soul with the sole purpose of enjoying life while knitting…

Sincerely…

Ms. Lety Meza

Ciudad Juárez, Chihuahua, México

Untitled (Frida Kahlo) by Alejandra Cisneros

Thanks to the internet there's been a resurgence of knitting. Sharing in social media has helped to popularized it. Technology is really useful for the yarn bombing community, you can share photos of installations, invite people to new events, meet other yarn bombers and learn from each other's. You can also use it to grab some inspiration like patterns, colors, new techniques and style.

I choose Frida Kahlo because I think she is an amazing talented inspiration and an important feminist icon of Mexico.

Untitled (Catrina) by Angelica Reyes
I honestly never thought knitting with technology in the same sentence, but of course they can work together. Through the internet we know that there are activities around the world with the yarn bombing and being able to know a little bit of the person that produced the piece because of technology, it's very nice. In addition we can grab inspiration and ideas seeing the work of other yarn bombers and learning more and more, because itś the beauty of the knitting, there are no limits and you can always learn something new.
I chose the granny square stitch, it was the first stitch I learn and a "Catrina", because it is an important icon in Mexico on November 2, which personally is my favorite holiday, where we celebrate the dead, with lots of colors and humor.

Untitled (Papel Picado & Catrina) by Daniela Montelongo
I think that both technology and knitting are connected by the fact of working on a net. The knitting interweaves thin cords and ideas, and technology interweaves information and people. As an artisan, I don't think that I could share my work with the world nowadays without technology. It is an implement that has become my best friend.
My work is a piece of knitting in a butterfly loom that simulates a piece of representative Mexican "Papel Picado" (perforate paper) of our festivities. it also has a "Catrina" (sugar skull) very typical of my country as a detail . The union of death and party that characterize us.
Daniela Montelongo
Architect, Textile Crafter in POMPONSPARTY and director of YARNBOMBING JRZ

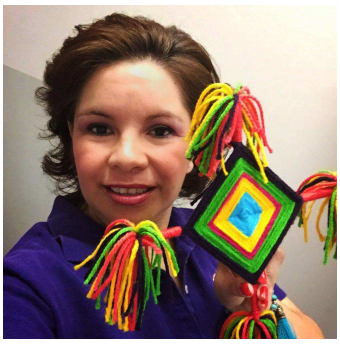
Untitled (NI UNA MAS) by Andres Bustok

When you get to Ciudad de Juarez, there are two things you cannot avoid to notice: the first one is the sun and the second one is a set of black crosses, painted on a pink background, which are distributed everywhere representing a symbolic phrase "IT IS FORBIDDEN TO FORGET" dedicated to more than 700 women of an average of 15 and 25 years old, who have been disappeared, raped or murdered since 1993 until now, in this city and for whom justice does not exist yet. This was a great deal for me by the time I arrived here from Santiago de Chile in 2011. I was so overwhelmed not only by thinking about these murdered women, but also by the stories of more than 700 families who all of a sudden stopped living and had to get used to the image of these black crosses painted all around Ciudad de Juarez. My knitting pays tribute to women's spirit, to the strength of their families and to the phrase "NI UNA MAS", which we all want to believe in. I think that knitting and technology were born without any connection to each other, nevertheless, these days both have a very strong relation since thanking to technology, knitting has run through those barriers that repressed it years later in a rudimentary environment. The knitters meet each other from all over the world, and share different techniques through the social networks. They also buy materials in different online shops, develop friendship and exchange ideas from one hemisphere to another.

Untitled (Mexico) by Olga Hernandez

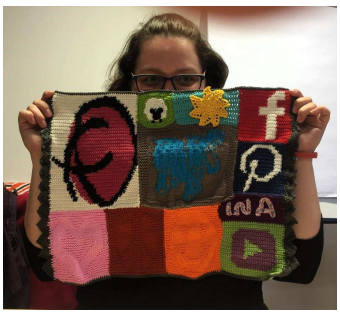
Internet and knitting are so similar: both are an important and infinite web were creations, emotions and knowledge are shared regardless of language and religion... Both internet and knitting have allowed me to meet wonderful people...

Untitled (Skull) by Mario Enriquez
Technology has alwast being so helpful with me learning how to knit, I can't think of knitting with out the help the internet. Thanks to the power social media, pdf patterns, online classes and the free tutorials of youtube i know how to knit and crochet. Technology through smartphones and computers helps us be connected with other knitters around the globe. I don't think knitting or crocheting will had the same impact if technology wasn't so advanced as it is.



"EYE OF GOD" by GILDA DOMINGUEZ
I think there is a link between technology and knitting for the way that allows us to connect our ideas. the piece I made is called "EYE OF GOD" and is a weaving technique that weaves threads with wooden sticks . It represents the link between technology and knitting from my point of view.

"Rainbow" by strickgraffiti
For me urban knitting is closely connected to social media. My twitter stream was the place where I was first inspired by some yarnbombing projects. Also via twitter I gathered some people to join me for some yarnbombing projects in Berlin. My crafted piece here is a rainbow. Not only a natural phenomenon between rain and sun but also a political symbol for diversity which is in my eyes an important principle for every team, organization, art and society.



Untitled (Ideas) by Ina

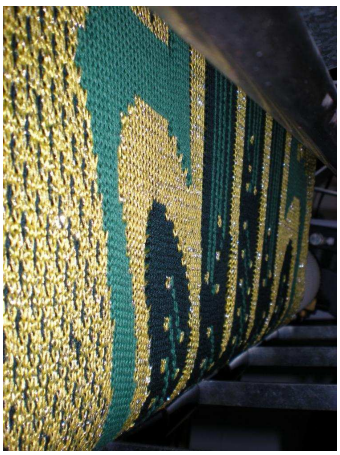
When I was in school, I loved to knit and crochet. These were one of my favorite classes. After sixth grade, those classes were not offered anymore and so I didn't take the time to knit and crochet anymore. Many, many years later, I thought it would be nice to pick up these crafts again. I just didn't know anymore how to begin. So I started googling it and soon discovered Elizzza's YouTube-Channel with very easy step-by-step instructions. I guess that was the time when I got addicted to needles and yarn. Ever since, my yarn stash keeps growing, my unfinished projects keep adding up. And there's so much to learn, so many different techniques. Thanks to technology like YouTube, Pinterest, Facebook it's very easy to find tutorials and instructions for virtually anything I'm interested in. I also took a few online classes on Craftsy and Makerist to dig deeper into some techniques. Whenever I'm looking for a specific pattern or just some inspiration, I consult Ravelry and spend hours there just admiring all those wonderful projects and wishing I had more time to knit and crochet.

I just recently discovered urban knitting thanks to Janis and all the fun hours we spend at the maker space in Vienna. Urban knitting gives me a chance to try out new things without being afraid of making mistakes. For example, the hippo that you see was my first go at knitting with two colors. The social media icons (Facebook, Pinterest, YouTube, Ravelry) were my first shots at crocheting with two and three colors. Moreover, those projects are mostly done within a reasonable time frame and thus giving me time to work on more different projects. And of course I love to see my knitted and crocheted pieces bringing more color into the urban landscape.

To sum it up, thanks to (new) technology I never run out of ideas on what to knit and crochet next.

Ohne Titel (Yarnbombing und Technik) by extremhäklerin
Vor bereits 8 Jahren sah ich ein Foto eines yarnbombings im Internet, sofort war ich infiziert. Bis heute habe ich 106 yarnbombings verteilt, die meisten in Österreich, einige aber auch in Italien, Slovenien, Kroatien, Deutschland, Kanada, USA und New Zealand. Diese intensive Häkelei brachte mir meinen Namen ein: extremhäklerin
Die Technik unterstützt mich dabei. Facebook, ravelry und verschiedenste Plattformen ermöglichen erst den Kontakt und Austausch unter den yarnbomerInnen auf der ganzen Welt.
Per email kommen Presseanfragen zu Artikeln und TV Beiträgen (ORF, LT1, die Presse, Kurier, Kronen Zeitung, Standard, Time Magazin, :-) und Einladungen zur Beteiligung an Kunstaktionen (Wien, New Zealand und Kanada) und Einladungen zur Teilnahme an Ausstellungen (Manchester UK) und Wettbewerben. (Köln)
Inzwischen halte ich yarnbombing-workshops in Schulen, Ateliers, bei Vereinen und am liebsten im öffentlichen Raum!
Mehr grün in die Stadt, der Titel meines yarnbombings Nr 86, zugleich Platz Nr 10 beim Internationalen Yarnbombing Award in Köln 1012.
Ein Jahr darauf war dann meine Ausstellung zum Thema yarnbombing ein großer Erfolg.
Am Titelfoto ein yarnbombing in QR Code, der sogar funktioniert! Mein Beispiel zum yarnbombing und Technik.
Liebe Grüße, Claudia

Untitled (4 pieces) by Urban knitting Avilés
-



“Hand der Fatima” by Veronika Persché
die Hand - weil Handarbeit zentral wichtig ist für meine Arbeit und mein Leben - ohne Handwerk keine Kunst
das Motiv - aus dem nahen Osten, der Wiege der Kultur, die unschätzbare Werte birgt, von denen großteils immer noch zuwenig bekannt ist in der westlichen Welt - das Stricken kam durch die Araber nach Europa!
die Farbe - Grün umgibt mich täglich und ist nicht wegzudenken
die Elektronik - steuert die Nadeln der Strickmaschine und auch sonst Vieles

Untitled (across the ocean) by Fiona
How has technology influenced my knitting?
I live in Northern Ireland, a small country off the coast of Europe. Ireland is surrounded by sea, with the vast Atlantic Ocean to the west. The sea is both a barrier, and a conduit for travel, and crossing the sea to emigrate has long been part of our tradition.
Back in the 1800s, it would have taken at least six weeks for a letter, as well as humans making a new life in the New World, to be carried across the Atlantic on sailing ships. At the start of my knitting life in the 1980s, the post still carried letters with news of family and friends further afield. My knitting sphere was close to home - local yarn shops, monthly magazines and our local library.
In contrast, communication is instant now, and no longer tied to people and places within my existing circles. Technology has opened the door to a world of informal cross-continent communication and projects. Wherever we live in the world, the use of knitting via technology confirms that we have much in common.

Untitled (Binary Codes) by Sue Spencer

I have knitted my rectangle, following a simple pattern. The result reminded me of a simple binary code used by computers, with the alternating of colours and repetitive pattern. Visually I find it quite pleasing, and the texture is good, too.

When I had completed the piece, I noticed that I had made a mistake, I think I must have missed one of the 'yarn forwards' instructions. I thought about it for a while, contemplating undoing it, or starting again, then realised that I actually quite liked the piece with an error. We are not perfect, we cannot easily complete repetitive tasks without mistakes creeping in. I was then reminded of a piece of information I had heard about Persian carpets. Apparently, the makers always include a deliberate slight mistake in their work, to show that they are human. Perfection is reserved for the divine.

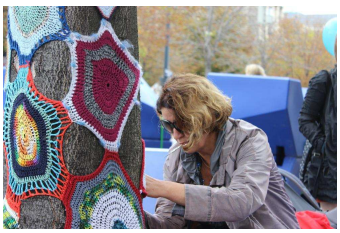
The pattern, should you wish to have a go is as follows:

You needs an odd number of stitches, and two colours. (C1,C2) Cast on in C1 Row 1(wrong side) :Knit Row 2: in C2, K1,*Sl1 wyib, K1; repeat from *. Row 3: in C2, *K1, Sl1 wyif ; repeat from *,end K1. Row 4: In C1, knit. Row 5: In C1, knit. row 6: In C2, K1,*K1, Sl1 wyib; repeat from *, end K2. Row 7:In C2, K2, *Sl1 wyif, K1; repeat from *, end K1. Row 8: In C1, knit.

About me

I live in Malvern, Worcestershire in the UK. I have been knitting since I was around 8 years old, taught by my mother. I have recently taught myself to crochet, inspired by my fellow Yarnbombing friends. My grandmother was a great crocheter, and sadly is no longer with us, but somehow my mother did not learn that skill from her. We are now learning together. Making things with wool is very therapeutic and thinking about yarnbombs and our next project is what keeps me going at times. It fills in the thinking space that I would use to endlessly re and over think various other aspect of my life. Finding friends that share that love has been wonderful. The craft is now only a part of our relationship, as we get to know each other better. Sharing the love of craft with the world in the shape of yarnbombs has been exciting.

I have four children ranging in age from 14 - 3, so life is busy. They are currently at four different places during the day. My eldest has cerebral palsy after a difficult birth meant that he was deprived of oxygen. We have had a long, difficult struggle to get compensation for him. Craft is my sanctuary away from all this.



Ohne Titel (Blumenwiese) by Lin Tschi

Was bedeutet das Blumen-Design, das du für dein Strick-Stück gewählt hast?

Für mich ist bei urban knitting der baum an erster stelle - zum Baum gehöen für mich viele bunten Blumen, Blüten

Inwiefern sieht dein Beitrag für das “Tools for Wools”-Projekt anders aus als deine anderen Projekte? Warum?

Ich denke jede Urban knitting woman entdeckt für sich ihre eigene Technik, für die sind es bunte runde und auch viereckige Stücke, die ich dann am Baum verbinde. und das ist ja das schöne, dass nicht jeder dasselbe macht

Benutzt du Technologien, um deine Installationen zu planen oder zu erzeugen? Welche? Warum?

Wenn du damit meinst, die Häkelkunst und die Strickkunst, dann ist es Technologie, mehr weiß ich dazu nicht.

und natürlich kann man sich aufgrund von internet, facebook diesbezüglich inspieren und weiterentwickeln

Benutzt du Technologien, um deine Installationen zu dokumentieren? Welche? Warum?

hier wieder, facebook, website, videos ..... vielleicht gehört auch eine erstellung einer website zu technologie

Ein Szenario: Wenn eine Maschine dir das Stricken/Häkeln komplett abnehmen würde, was würde das für dich und deine Urban Knitting Projekte bedeuten?

Dieses Szenario wird hoffentlich nie eintreten, da der trend sich ja zum teil wieder rückentwickelt und die Menschen wieder zu einfachen, selbstgemachten produkten greifen, da sie bei diesen arbeiten ja auch kommunizieren können

Untitled by Melanie Senior

I am heavily reliant on technology in relation to my crochet. I belong to a very large-scale international yarn-bombing group (based in Melbourne) and connect with and find inspiration through this group on Facebook. I find many patterns, stitches, ideas and even colour schemes from various blogs and groups that I follow. Sometimes, when I have quiet time at work, I undertake random searches to find stimulus for future projects…

“technique inside” by Christina Gohli
technique inside
www.gohli.at

“Lauras Zeichnung” by Christina Gohli
Ursprüngliche Technik: Schere Buntstifte - Laura 4 Jahre
Nachbildung gestrickt und gehäkelt - Christina Gohli
www.gohli.at

“Technisches gestrickt und gehäkelt” by Christina Gohli
Technisches gestrickt und gehäkelt
mehr dazu auf FB: Gohli oder www.gohli.at</string>

APPENDIX E

Call for Participation

The next pages contain copies of the PDF-files created for the public call for participation in the "Tools for Wools" urban knitting project:

- the general call (one page)
- detailed information which was provided in case of interest (two pages)

The HTML-version of the call can be seen online at the adress: `http://web.student.tuwien.ac.at/~e0305696/call/Call_ToolsForWools.html` (Accessed: 20.07.2015)

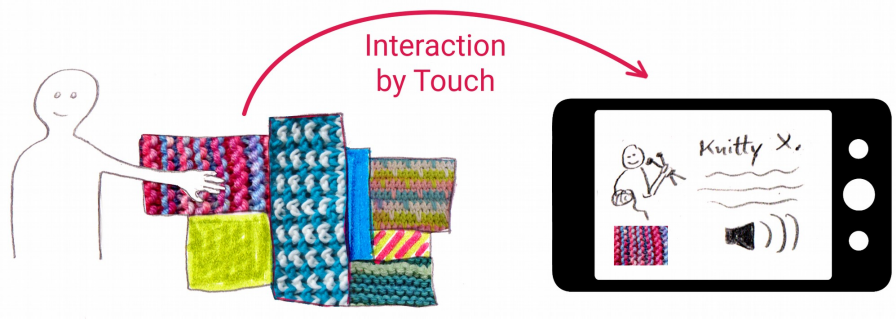
TOOLS FOR WOOLS

WANTS YOU FOR YARNBOMBING!

Calling all yarnbombers, urban knitters and guerrilla crocheters: I need your help! You are invited to join the "Tools for Wools" research project and art installation.

My name is Janis and I'm a Master student in Media Informatics at the Vienna University of Technology. My thesis discusses urban knitting as a particular form of creative intervention in urban space and analyses the use of digital technologies (web, social media, smart phones, etc.) in this context.

It also involves building a prototype in form of an interactive yarnbombing installation where the audience can learn about the background stories, thoughts and motivations of the collaborating artists. Touching any of the pieces will display corresponding information on a smart phone or tablet. The final installation will be exhibited at different locations in Vienna such as a maker space, a public park and the university.



In case of your participation I would ask you for a crafted piece and for some words explaining your thoughts on the relationship between your craft and the technologies you use. The deadline for sending these things to me would be **31st May 2015**.

If you like to participate, please send me a short message.

You can contact me by …
… **e-mail**: janis.meissner@tuwien.ac.at
… **Twitter**: @janislena
… **facebook**: Janis Lenin Meißner

I will provide you then with more detailed information on what, when and how ;)

TOOLS FOR WOOLS

Dear participant,

Thank you very much for joining the Tools for Wools research project and art installation! I'm very excited to see what the resulting installation will look like and how the project will evolve. Hooray! :)

As promised here are some more details on the involved project tasks.

What do I need from you as a participant?

1. Think about the following question:
   Which place does technology take in (your) urban knitting?

   Maybe you elaborate on technology in the broadest philosophical sense or you have a specific blog, app or social network in mind. Maybe the internet has made it possible for you to participate in a large-scale international yarnbombing project, or maybe you tend to switch off all electronic devices around you when working on a yarnbomb. There are of course no right or wrong answers. I'm just interested in your point of view.

2. Produce a crafted piece.

   You have full freedom in design but it would be great if it reflects your thoughts on the question above. Any technique, any material and any colours are fine. You can also decide about the size of your piece. It doesn't need to be large, but it would be good if it offered enough space for a full flat hand to lie on.

3. Provide some material explaining your piece and the thoughts behind it:
   - a brief written statement which puts your thoughts into words
   - a photo of you with your piece
   - any additional digital material to illustrate your thoughts. For example you could record a short video or audio message.

   Please note: This data will be used for the Android app on the information device. So please consider that it will be accessible to a public audience. If you have any privacy concerns, maybe you prefer to use a pseudonym. In the photo you can also hide your face if you wish. You only need to to share as much information as you feel comfortable with.

How should you send me your contributions?

Please send your finished crafted piece to following postal address:

Janis Lena Meißner
Schönbrunner Straße 187/15
A-1120 Vienna
Austria

For the digital material I have created a shared public folder on Dropbox:
https://www.dropbox.com/sh/h52iu4g42rd0zqb/AAApUOpEHy6TsS3BcVXRLXkVa?dl=0
If you are a Dropbox user, please let me know your e-mail address so I can send you an invitation.

Alternatively, you can also send the files to me by e-mail (janis.meissner@tuwien.ac.at).

Until when do I need your contributions?

The deadline for sending the knitted pieces and uploading the data on Dropbox is scheduled for **31st May 2015**. Please inform me if you need more time or in case of a delay.

Is there anything else you would like to know?

If you have any questions or comments, you can always contact me by …
… e-mail: janis.meissner@tuwien.ac.at
… Twitter: @janislena (https://twitter.com/janislena)
… facebook: Janis Lenin Meißner (https://www.facebook.com/janis.meissner)

THANK YOU

FOR PARTICIPATING!

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