'A Farmer, a Place and at least 20 Members' The Development of Artifact Ecologies in Volunteer-based Communities

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ABSTRACT

In this paper, we present a case study of an urban organic food community and examine the way the community shapes its artifact ecology through a combination of appropriation of freely or cheaply available tools, and the long-term effort of building the community's own website. Based on participatory observation, content analysis of communication documents, and a series of interviews, we see how the collection of artifacts that a community uses to support their practice form what we refer to as their *community artifact ecology*. A community artifact ecology is multifaceted, dynamic and pending on what the members bring to the table, as well as on particular situations of use. The community artifact ecology concept is important for CSCW as it enables framing of the relationship between communities and technologies beyond the single artifact and beyond a static view of a dedicated technology.

Author Keywords

Community; volunteering; artifact ecology

ACM Classification Keywords

H.5.3 Group and Organization Interfaces: H.3.5 Web-based services

INTRODUCTION

In this paper, we present a case study of a local organic food community, their struggle and creativity in finding and appropriating specific computational artifacts, software applications and devices alike, to support their developing practices. Through participatory observation, content analysis of communication documents, and a series of interviews, we trace the history of the community from being a few selected people searching for a potential for action around a matter of concern, to a growing and established community with practical concerns and duties to fulfill. The entry point to this is a study of the genealogy of the community and its artifact ecology: The collection of tools that the community uses to support their core activities, which are based on voluntary work. Like many other self-organized communities, based on volunteering work, this one operates with little resources and with an open and fluent way of organizing their work. The aim of the paper is to bring forward the kind of everyday 'vernacular' design work (e.g. [26]) that volunteer-based communities engage in, to shape a working artifact ecology that supports their needs. This enables us to better pinpoint potential areas of CSCW research with volunteer-based communities, especially in the contemporary context where there is an abundance of tools available. The questions we seek to answer are the following:

- What constitutes an artifact ecology in the context of volunteer-based communities?

- How do such communities shape their artifact ecology?

- What role does the artifact ecology play in the shaping and the development of the community?

In the following, we argue that establishing a community artifact ecology is an inherent part of shaping the community and plays an important role in the formation and ongoing life of a community. It shapes the community as much as other elements, e.g. manifestos, regulation, membership terms and the community space. To understand how self-organized communities go about their work, it is necessary to consider how they establish, provision and work with their community artifact ecology.

By addressing the development of volunteer communities through the perspective of community artifact ecologies, we aim to focus on the technological mechanisms that support, develop or hinder the emergent practices and purposes of the community. In contrast to previous contributions in this area, the importance of this contribution lies in drawing attention to the multiplicity of experiences and technologies that are brought into play in such a setting.

BACKGROUND AND RELATED WORK

Whereas CSCW has always discussed work as an activity that goes beyond paid labor [11], this has not happened without discussion (see [3] and [48]). Lately, there has been a growing interest in the notion of voluntary work as a type of collaborative endeavor. These endeavors can be temporary (e.g. as responses to disasters, see [55]), they can happen through everyday help-giving (e.g. [53]), or as longer-term activities that eventually scaffold the shaping and sustaining of communities around particular concerns (e.g. [23]). Community is a wide concept, which is also applied outside work settings: In CSCW, attention has been to online communities and community networking systems (e.g. [41, 18, 45]). Preece & Maloney-Krichmar [45] summarize this research and look at how communication and interaction among members of online communities may be supported, whether at work or not.

In many parts of the world, alternative models for the production and distribution of food are being explored. In agriculture and food studies, these are referred to as civic food networks [46], or Alternative Food Networks (AFN), as a representation of the so-called "quality turn" that emerged as a reaction to disappointments in mainstream industrial food circuits [25]. In practice, this means that, triggered by concerns over food safety and health, economic strain, ecological ideals, and/or civic activism, there is a portion of the population in various locations worldwide that is putting effort in getting access to clean, local, and often organic food. This has prompted new alliances between cities and the countryside by reconfiguring the distribution chain and creating direct links between city dwellers and farmers [38], and an interest in e.g. urban gardening communities [54, 36].

The theme of sustainable food has been picked up by e.g. [20], and is situated in the wider discussion on sustainability [21]. Food distribution networks have been discussed by [23], communities of organic farmers by [35], and urban gardening communities by [2, 51, 54, 36]. In the wider field of organizing and collaboration online, recent studies of time banks [6], crowd-funding [28], online learning communities [40] and other forms of sharing communities are equally relevant [37]. However, much of the discussion remains focused either on the use of existing digital tools or online platforms to support these activities, or on the design of new ones, often from a monolithic perspective. Additionally, in the recent CSCW cases, the use of multiple technologies is studied inside a multiple user setting of relatively short-lived situations [24], or of established online enterprise communities [39].

Despite its main focus on communities of practice at work, CSCW has nonetheless provided a number of perspectives that are useful for the current case: Communities, as researched in CSCW, have often been defined with a background in Lave & Wenger's [33] definition of communities of practice, which means a focus on learning, as a journey for newcomers into central members of the community, and the roles of routines, the physical setting and artifacts, often, but not entirely, within work. Other parallel theoretical framings have included socio-cultural activity systems, or a combination of the two within work settings and beyond [16,

14], emphasizing also that communities 'work' whether this is as paid labor or not.

CSCW has been focused on how groups pick, orchestrate, use and work with multiple software systems over time, e.g. Pipek & Wulf [44], Star & Ruhleder [50], and strategies to cope with systems that do not smoothly support collaboration routines [15]. Upon these roots, several authors use Star & Ruhleder's idea of infrastructure and infrastructuring to embrace the notion, that technologies are appropriated and reappropriated into networks of technological infrastructures and use situations, not only within paid work, but in wider purposeful activities [30, 44].

THEORETICAL FRAMING: ARTIFACT ECOLOGIES

In the aftermath of ubicomp (see e.g. [9]) it has become evident that technologies do not exist in isolation from each other, and should not be understood and built as such [31, 7, 4, 43, 29, 52, 13, 49, 47]. In continuation of the work by Krippendorff [31], Jung et al. [29], and Bødker & Klokmose [13], we use the terms *artifact ecologies* to focus on the ways in which human beings, as individuals or together as groups or communities, are surrounded by multiple technologies, applications and devices alike, that they appropriate and use in different combinations for shifting purposes over time.

Jung et al. refer to an artifact ecology as *"a set of all physical artifacts with some level of interactivity enabled by digital technology that a person owns, has access to, and uses.* [29, p.201]. In their work, the composition of the artifact ecology is closely tied to the personal context and purpose of use, as well as to how the artifacts are connected through functional compatibilities. Based on their study, the authors conclude that *"Ecologies evolve according to individual users' personal strategies and appropriation of artifacts."* [29, p.209]. New artifacts have the potential to both influence new use patterns and the way in which the existing artifacts are conceived.

However, an artifact is not only a physical device. Krippendorff [31] argues that we cannot distinguish between software, hardware and individual devices when it comes to computing. Bødker & Klokmose [13, 12] similarly focus on the mediation of use, by software as well as hardware. They expand Jung et al.'s definition of the artifact ecology by pinpointing its *collaborative and dynamic* nature: It unfolds around the introduction of new artifacts and moves through different states in a dynamic relationship with other artifacts, people and their activities and practices. In the *unsatisfactory state*, the ecology no longer lives up the needs or expectations of its user. When a new artifact is added to the ecology, the ecology goes through an *excited state* where the new and existing artifacts are explored and (re-) assessed. In the *stable state* the artifacts have found their role and the ecology at large functions in everyday activities. Changing configurations of people and activities are hence dynamically related to changing configurations of artifacts [8, 12]. In this dynamic whole, past artifacts as well as future ones may play a role for the shaping of human practices, and accordingly they may be usefully considered part of the artifact ecology. This historical view also fits well with Ackerman et al.'s [1] definition

of *resources*, based on a summary of analyses of a number of physical and virtual artifacts for coordination and collaboration in a variety of communities of practice: *"A resource is an entity that is used in a particular manner to address a recurring need or problem. Its manner of use is characterized by shared expectations, understandings and practices that have built up during the history of its use in a specific environment."* [1, p.310]

The work of Nardi & O'Day [42] and Bell [5] emphasize localities as an anchoring point for place-specific ecologies, such as the museum or the library. Nardi & O'Day's information ecology or Bell's cultural ecology addresses places where people take part in activities related to a specific domain and interact with the artifacts available in this local environment. Nardi & O'Day point out that a healthy ecology is always in motion, and describe how *"[P]eople's activities and tools adjust and are adjusted in relation to each other, always attempting and never quite achieving a perfect fit."* [42, p.53](p.53), while still displaying *"stable participation of an interconnecting group of people and their tools and practices."* [42, p.53]

Rossitto et al. [47] introduce the concept of *constellations of technologies* to refer to the several technological artifacts and applications that people use as part of cooperative work. Based on their study on how students negotiate and orchestrate artifacts and applications in their nomadic group work, they discuss how constellations are made in use, and the process of making the constellation work. They argue that a constellation is unique to a particular group and that individuals can use different applications within different groups. The performative process of appropriating these artifacts (*aligning constellations*), happen in the interplay between the situation at hand (place, time and activity) and in negotiation between *proposers* and potential *adopters* within the group. A particular constellation of a group emerges from the intersection of the multiple artifact ecologies of the individual group members. Rossitto et al. describe how some of the artifacts are sometimes negotiated in the beginning of a project, while emergent needs (cf. an unsatisfactory state) can result in the introduction of a new artifact. An individual might act as a proposer (the more capable peer in Bødker & Klokmose's [13] activity theoretical vocabulary) and suggest a potential artifact to the group – which then again might create tension (cf. unsatisfactory state and excited state) in the intersection between the ecologies and personal preferences of the participating members.

To summarize, we have expanded the original concept of artifact ecologies to include a community aspect and we have taken it to a new social setting, that of volunteer-based community work. We see a community artifact ecology as the particular constellation of artifacts that a community owns, has access to and uses in its activities. It is characterized by a high degree of shared understanding of the core activities and the role of the artifacts within the ecology. The community artifact ecology emerges from the combination of the different artifacts that key members introduce from their own personal ecology. It changes throughout the community lifetime

in response to community needs. This occurs both through explicit negotiation and more subtle adoption of artifacts originating from the ecology of individual members, often more capable peers. It is both dynamic, as it co-evolves with the community, and stable beyond the individual member. While particular artifacts may stem from individual members, they are often adopted by the community and become part of the community practices and shared history.

After presenting our research approach, we will look at how a particular community, based on volunteer work, shapes its artifact ecology and how this ecology co-evolves with the community itself. We examine the different stages the community and its artifact ecology go through, and the circumstances, tensions and work involved in establishing and maintaining the community artifact ecology.

RESEARCH APPROACH

In some of our previous work with volunteer-based communities [27], we began examining the different tools such communities use. In order to better understand why and how communities organize and work with multiple artifacts as part of their practices, we now sought to study in depth a local organic food community in Aarhus, Denmark. We have first approached the community when one of the authors became a member and started taking part in community activities. Based on the initial insight and a review of the community website and Facebook page, we began formulating our research goals and tentative research questions. In order to understand what were the tools used by the community and how the community actually developed the suite of digital tools and aids that support the community activities, we first started with participant observations during community activities and a series of interviews with core members. After trust was gained, we got permission to go through the recorded minutes from community meetings throughout its lifetime and reviewed them.

The interviewees were recruited based on their knowledge of the community and long-time membership in the community and the core organization. The interviewees are between the age of 25 and 45 and all have been long-time members of and/or played a vital role in the formation of the community and development of the community artifact ecology, see table 1. This include a founding members, the current developer of the website, participants from core work groups (communications, shop, products and ordering), and a board member, who is responsible for the contact with authorities. Four of the participants have been members of the board and played leading roles in core work groups.

We chose a semi-structured interview format and followed a base guide in all the interviews. The interview touched upon the respondents' introduction to the community, their characterization of the community and community space, technology and activities, and current challenges. The guide was amended between the interviews to accommodate different roles, (see the 'roles' column in table 1). Two of the interviewees were interviewed together[1], and we conducted one follow-up interview for clarification and elaboration with one participant[2]. The names of the respondents have been

changed for this publication. Inspired by Jung et al. [29] and Cabrera et al.[17], we experimented with mapped events, artifacts and people on a timeline together with two of the participants[3], in an attempt to capture the chronology and key elements to aid us in our analysis of the interview data (see figure 1). We used the mapping exercise with one of the founders to establish the overarching chronology of the community and with the current developer in an attempt to map the development of the website.

The primary data in the study is the transcribed interview data. In addition, we have also used our observation notes from 8 hours of participant observation, conducted during packaging shifts at the community space at four occasions, as well as minutes from the community meetings (open assemblies and working group meetings) from the last four years (N=153), which are available in the members-only section of the website (we were given permission to access them and analyze them by the board members at a later stage). The two maps from the interview sessions were used as supplementing material throughout our internal analysis and to identify key artifacts in the ecology.

Our analysis has focused on three aspects in the data, namely establishing the elements of the ecology, its chronology and how it developed, and examining the interplay between the community activities and the ecology. The data was analysed in two steps. First, we coded the transcriptions individually using open codes to identify common themes, *artifact, introduction, change, collaboration, breakdown, software, challenges, activity, need, community* etc., and then consolidated these through comparison across the interviews. Second, we used the themes to further identify central statements in the interviews and compared these through meaning condensation (see [32]). The themes and focus are presented in the analysis below.

Study limitations
Acknowledging the limitations of a single case study, we find Flyvbjerg's [22] argument for the relevance of good case narratives valid in our case, which is further triangulated with

theoretical insights regarding artifact ecologies. He introduces the idea of paradigmatic cases, *"cases that highlight more general characteristics of the societies in question"* [22, p.232] and allows researchers to develop a metaphor or a new school of thought. Our study allows us to explore and examine how self-organized communities use and orchestrate multiple artifacts as part of their practice. This in turn aids us in further developing the existing theoretical conceptions of artifact ecologies. The findings presented here are particular to the specific case and cannot be generalised to any community. We use the particular findings to start theorising on the dynamics of artifact ecologies beyond the individual and how communities orchestrate their particular artifact ecology. We will return to the limitations in the study in the discussion.

CASE STUDY: THE ORGANIC FOOD COMMUNITY
The reported research is based on a case study of an organic food community in Aarhus, Denmark, a city with a population of around 300.000. The city is a university city with a large percentage of younger people. This is also reflected in the member composition of the community. The community was started in late 2010 by two women wanting to find a cheaper and more sustainable alternative way to get fresh local organic food, inspired by initiatives that were sprouting worldwide. Both had worked with organic food production and sustainability as part of their university studies. The community has grown at high rate and has now around 900 registered members (and around 3000 likes on their Facebook page). According to their own website (AOFF.dk), their mission is to offer cheap, local organic fruits and vegetables, and through that spread information and awareness on organic and sustainable food production in order to engage members and locals in sustainable initiatives. Their manifesto and founding principles reflect their core values, which relate to a strong ideological stance on local organic and sustainable food production, collaboration and community, knowledge sharing, and emphasizing a high degree of transparency within the community organization and in the distribution channel.

"Organic for all! The Aarhus Organic Food community is a member-owned and operated cooperative food community - an alternative to ordinary profit-oriented supermarket chains. We offer organic, tasty, locally produced and sustainable food in season for the lowest possible price. We offer a great selection of organic vegetables and fruits, and support sustainable farming.[...] We want to set an example by educating ourselves and

Name	Role(s)	Membership	Interview length
Laura[3]	Founder work group and board member	2010 – 2014	01:07:05
Karen[1]	Work group and board member	2012 – now	01:09:48
Nadia[1,2]	Work group and board member	2011 – now	00:48:31 (01:09:48 follow up)
Robert	Work group and board member contact to authorities	2011 – now	00:54:48
Paul[3]	Work group member web developer	2011 (active 2012) – now	01:02:19

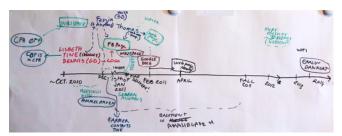**Table 1: Interviews and respondents role within the community.**

Figure 1: Overview map from interview with Laura

others about food and health, collaboration and the environment."
(Excerpt from the manifesto published on the community website, translated to English by the authors)

While the community identifies as a 'fællesskab' (literal: community), creating a 'forening' (literal: association) is the most common way to create a formal organization in the local context. An association is a particular Danish organization form and legal entity that provides some benefits, e.g. financial support and use of public facilities, while also requiring a board, by-laws and a yearly general assembly. The organic food community is highly organized with a board and seven working groups covering the tasks involved in managing the community, arranging events, coordinating with authorities (permits and hygiene inspection), buying and coordinating with the local farmers, and selling and distributing the organic food goods to the ordinary members of the community. The board and the working group represent a stable core group of members of approximately 40 volunteers. According to the website and our interviews, the community organization has a flat hierarchy and is open to all members, with weekly meetings in the working groups, monthly community meetings and an annual general assembly, where the board is elected. However, it is clear that the members involved in the board and in the working groups constitute a sub-group of particularly active individuals. Other members are nonetheless expected to participate in the Thursday afternoon activities and actively encouraged to join the monthly community meetings via the community newsletter and the Facebook page. Members pay a fee upon joining the community and they are required to volunteer with three hours of work each month, coordinated through a scheduling tool on the community website.

Community space and Thursday activities
The primary activity of the organic food community is the distribution of the weekly bags of locally grown organic food to the community members. Each Thursday, local farmers deliver the pre-ordered food goods outside the 'residents house' – a shared local community space close to the city center, after which volunteers work to pack and handout the bags to the community members stopping by to pickup their order. A typical Thursday starts around 12.30 at the community space, where the members, who signed up for the packaging shift, meet and start packaging. The first tasks are to unpack the packaging gear (bags, bowls, weights, gloves etc.), turn on the refrigerator and put out the food-handling manuals and authority reports which need to be visible to everyone as part of the requirements for food-handling (in case of unannounced inspections by the authorities). When the farmer(s) arrive, everyone helps unloading and starts weighing and packing the goods into individual bags for members to pickup. Written manuals (also available via the community website) contain detailed instructions on how to setup and do the packaging efficiently. After the packing is done, they clean the room thoroughly and setup the community laptop and credit card terminal so that it is ready for the next group. Packing usually takes three hours and around 3.45 pm, two members of the selling shift take over, handing out bags and taking orders for the following week. Around 5.15 pm the second shift starts and the two members handling the shop are replaced. The community manuals contain detailed information on how to setup the shop, keeping track on orders and payments, use the credit card terminal and spatially organize the bags, tables, order and payment area, etc. The shop is open for community members from 4 pm until 6.30 pm. When the shop closes, the late shift members pack, clean and close down the community space. A typical Thursday ends around 7 pm.

Each week, members place orders for the following week and based on the number of orders, members of the responsible working group contact the local farmers to see what food goods are available, and order the needed amount. The incoming orders from the members and the orders that go to the farmers are currently collected and maintained in several different Google spreadsheets. The contents of the bag for the following week is the posted on the community website and Facebook page, often together with recipes collected by the recipe's group. The bag of food goods is sold at a fixed price, which has gone unchanged throughout the community lifespan. While there is a seasonal list on the website, and the contents of the weekly bag is announced as soon as possible, the members do not know exactly what is in the weekly bag until the details are announced.

From our observations and interviews we see how sharing a space on Thursday afternoons plays an important, yet subtle, role in the way the community shapes itself. Having a place to distribute the weekly bags of vegetables is a defining trait of the community and an integral part of its activities.

"So, as we grew and got a bit more established, we also needed to [move]. But we also really wanted to have own space where we could make it a little bit cozy."
(Laura)

When asked, the interviewees emphasized the face-to-face meeting, personal relationships and community activities as the situations, where the community best comes to life:

"Well, it happens on Thursdays, it happens in person. [...] We have a lot of followers on Facebook and we post various things there, but I think everything community-wise kind of happens in person, either like in the opening hours or at the meetings." (Karen)

"The community feeling is when I am actually at the shop on Thursdays and when we have a meeting. And you see people face-to-face. I dont feel that we have a very strong community on Facebook or anywhere else, virtually. It is more the personal relationship I have with other members when we see each other." (Robert)

The relationship to the community space is not only functional, even though the residents' house is a shared space. It is part of the community identity and having some say over how it is organized during the shifts on Thursdays is important to the community members. The interviewees identify the community with the activities happening every Thursday. The website plays the role of closely supporting these activities, e.g. manning shifts, information on handling food goods, and through the focus of the working groups. It is only possi-

ble to become a member by visiting the community on Thursdays. This is not by deliberate decision, but rather a result of a member registration feature never being implemented on the website.

COMMUNITY WORK AND THE ARTIFACT ECOLOGY

In the following section we analyze how the community and its artifact ecology develop hand-in-hand. By studying the practices of the community in question, its purposes, tools, and places, we have identified three main conceptual stages in the formation and establishment of the community and its artifact ecology: Becoming a community, everyday community work, and building anew. These stages are characterized by some (temporary) stability in terms of foci, concerns, artifact, and activities, which are grounded in the empirical study. The stages are used descriptively and conceptually, and should not be read as prescriptive, a point we will return to in the discussion.

Becoming a community and first steps in shaping the ecology

The two founders of the community were interested in finding cheap and responsible models for getting local and seasonal organic food. One of the women had heard of the Copenhagen organic food community while talking to people at the UN Climate Conference (COP15) that was held in Copenhagen in 2009 and subsequently invited a representative from Copenhagen over to learn more about how to start a local organic food community in their city. At that meeting he presented the basic requirements for starting a community similar to the one in Copenhagen:

"You need to have a farmer, you need to have around 20 members, so you can at least order 20 bags, because otherwise the farmer is not gonna be able to deliver for you. [...] And then we needed a place and some bags to put the vegetables in." (Laura)

They followed the advice and started a local initiative based on the model from Copenhagen, which is an association model; build around multiple working groups, volunteer work and a community wiki as the primary organizational platform. One night late in October 2010, the two founders, created a logo (with the help of a graphic designer) and a Facebook page to put, as one of interviewees said, *something into the world* and see if there were similar initiatives and/or like-minded people in their local area.

The Facebook page proved to be a very efficient way of triggering interest in the ideas of sustainability and in the ambitions to develop a local alternative to the existing ways of buying local organic food. Facebook played a vital role in the initial formation of the community. Within weeks the founders were approached by a web developer, who offered to develop a free website for the initiative, a representative from a local youth wing of a political party, who offered the community a meeting place, and a local farmer, who wanted to supply organic vegetables to the community. According to our interviews, they had all seen the initiative through the Facebook page and offered their help and services, because

they sympathized with the initiative and shared parts of the ideas related to organic food and sustainability.

"[...] there are so many different types of communities and the visual impression that you give out is quite important to the target group who can feel like, they can identify us" (Laura)

The community officially became a registered association after the first general assembly in January 2011 and active members started to take orders and distribute weekly bags of organic food to the then approximate 30 members. Initially, the community adopted the concept, organization, regulations, and the use of a community wiki (Wikispaces.com) from the initiative in Copenhagen. At the first general assembly, the founders presented the organization, comprised of a board and a series of working groups, the founding principles and manifesto, which emphasized a flat, consensus-based organizational structure aa well as the aim to provide cheap organic food. The ambition was not just to create an association that would offer cheap organic food (as a service), but as one of the founding members put it:

"The idea of the association was also to create a community, like a sense of we have something in common and share the ideas of organic production." (Laura)

While the community at first adopted the use of a wiki from the established community in Copenhagen, and found it somewhat useful in the beginning, they quickly started to see problems in using this as a community platform. The issues were both related to the functions and how the wiki reflected the community identity and values. The founders wanted a community platform that was easy identifiable, reflected the community (i.e. sustainability and being well-organized) values and incorporated a more professional image (opposed to other grassroots organizations as one interviewee put it). A more functional concern was related to the openness of the wiki format and the platform was assessed less user-friendly than other tools.

"We also initiated a Wikispace, but we saw that the problem with Wikispaces was that everything is public. They [the Copenhagen community] would put their schemes for when people are working and have [their] emails and contact information [public]. We saw that was a problem and this is why we wanted to create our own homepage, where you login and then you can see the shifts. Yes, and I also wanted to make it more user-friendly, because I didnt think Wikispaces was so user-friendly." (Laura)

The issues with the wiki and the opportunity to have a custom-made website motivated the community founders to develop a wish list for the new website, e.g. a members' section, shift management, working group section, repository for community documents, dedicated emails aliases, newsletters and later online ordering and payment, essentially creating an informal requirement list for the web developer, who volunteered to develop a new website for the community. As a way of handling part of the transition to the new website, a founding members introduced the use of Google Drive to handle

Artifact	Origin / Inspiration	Primary Role
Facebook page	Founding members	External and internal communication Visibility and recruitment
Wikispaces	Copenhagen community	Internal and public information Internal organization and management Initial community platform
Website (v.1)	Founding member and volunteering web developer	Substitute Wikispaces as the primary community platform
Google Drive	Founding members	Substitute the collaborative and elements in Wikispaces and supplement the website
Community mail (aliases)	Founding member, managed by web developer	Substitute Facebook for internal communication and contact

Table 2: The community artifact ecology in the first stage.

some of the tasks like managing lists in spreadsheets for ordering bags and deciding on the content of the bags based on available food goods from the farmer. Google Drive was introduced mainly as a collaborative tool to coordinate internally among the working groups, and was based on previous experiences by the founding members:

"That was me who brought the idea about Google Drive [...] because I had used it for something else. Then I saw the potential of, it's a good... because it was better than Dropbox, because Dropbox has some problems when you, when there are several users working on the same document. Whereas Google Drive is working better in that sense. And we needed something that was more user-friendly. It synchronizes all the time, even though there are several users editing the same document at the same time." (Laura)

At first, the community artifact ecology was strongly influenced by the model adopted from Copenhagen and included elements introduced by the founding members. However, the emergent functional and stated preference for a site that reflected the community values in a more consistent and professional way, and the opportunity to get a community website (for free) resulted in an early abandonment of the wiki as the primary community platform. The community website was launched in the spring of 2011. The community manifesto was published there along with other practical information regarding the community.

The core 'trinity' comprising of a Facebook page, various Google Drive applications, and the community website, was established very early in the community lifespan (around October 2010 to February 2011), in relatively short time, with few resources and by a very selected group of people. We have summarized the collection of artifacts in the table 2, as it looked in the formative stage of the community.

Everyday community work, needs and workarounds

From early 2011 and onward, the core of the community work took place around managing the community and the weekly work of ordering, packing and selling the vegetables. The process of getting volunteers for the individual working groups, manning the shifts, composing the weekly bag and introducing new organic products was the main focus.

Although the website was launched in the spring of 2011, many features were not implemented yet. This created frustrations as well as gaps that had to be filled, in order to keep up the community and management work. Some of these frustrations were due to the slow pace of the website development or the way the website was designed. The slow pace, in turn, was also due to the volunteer developer's choice to no longer be active in the community. For instance, communication among the working groups, which had been set up through a mailing system associated with the website, had to be bypassed eventually and some of the working groups resorted to a workaround:

"[...] through the website, we have some [the organization domain name] emails, and we can't get access those unless we get the code from him [the web developer/volunteer], and he is impossible to reach [...] I ended up making a Gmail account for [one of the work groups], because I simply couldn't get the account transferred." (Karen)

Thus, some of the groups deviated from the initial ambition to have specific community email addresses for the core members. Later, the group responsible for communication would formulate a communication strategy in order to separate the communication to the public from information suitable only to members. They adopted an external email service to handle newsletters and information for the members, while keeping the Facebook page for more open and external communication. The communications group added a Twitter and Instagram account to supplement Facebook.

There are also other examples of the creative ways in which the community dealt with the difficulty of accessing the community website. The volunteer developer had chosen a CMS that he was familiar with, and this created problems with access to maintenance of website, once he withdrew. Another community member volunteered to take over, but without proper access to the original website back-end, he had to resort to a technical workaround in order to get e.g. a basic community calendar working:

"On the front [of the website], there's a [Google] calendar. That is made through a hack, because I've got access to the database, so I made a hack, where I went into the database and put in an iframe as a content element [...] so that's not done through the CMS at all [...] [I] injected some SQL into the database, which [enables] the calendar feature." (Paul)

As the community grew, it needed better facilities for packaging and distributing, as well as a more established community space that would support the Thursday activities and a stronger sense of community. To help the increasingly

complex task of taking orders, handling payment and managing the distribution of the organic food each Thursday, the community members discussed getting a community laptop that could be used to keep track of the orders in the multiple Google spreadsheets. This was discussed at meetings throughout 2012 and around December 2012 a community member (Nadia) donated an old laptop. Besides being used to manage the orders to some extent, the laptop is mainly used to lookup member information and connecting a credit-card terminal to the Internet via the community WiFi hotspot. The introduction of the credit card terminal stems from early discussions at community meetings on having an online ordering and payment system, something that were on the wish list for the first website, as far back as early 2011. The credit-card terminal was originally envisioned to be a backup for the online payment system and was acquired together with license for having an online payment system. This was initiated around July 2011 and the credit-card terminal was finally functional around June 2014, and, as the online payment system has not yet been implemented on the website, the credit-card terminal is for now at least a stable artifact in the community space (it might be abandoned if the online system is eventually realised).

Through participatory observations one Thursday we saw examples of situated workarounds: The WiFi provided by the residents' house was down. There, spontaneously, one of the community members, responsible for payments, shared his own mobile Internet connection and connected the shared credit card terminal to his own laptop, so that people could pay by card. Similar acts of sharing one's mobile Internet connection and/or sharing one's laptop were also reported in the interviews.

While many of the artifacts introduced early in the community lifespan still remain a part of the community artifact ecology, they have undergone changes in the roles they played, as new artifacts were introduced. The changes and introduction of new artifacts appear to be a response to the change in focus of the community activities as well as a means to overcome frustration with existing tools. While the establishment of the community, their practices and initial ecology was the focus in the beginning, the growth of the community and stronger focus on supporting the Thursday activities, is reflected in the community artifact ecology. In table 3, we have summaries the community artifact ecology as it is in the stage focusing on the core community activities.

Growing pains and building anew

The design and development of the first community website had begun in late 2010 and an initial version was up during Spring 2011. In June 2011 the member section with login was introduced and in November of the same year the component to handle shift reservations. However, the website and its functionality continued to be a recurring topic at community meetings. Needs for new functionalities kept arising (e.g. a possible online payment system and an online signing up possibility for new members), and frustrations with existing ones were expressed (e.g. the inability to establish both an easy way of communicating to all members via email and as-

Artifact	Origin / Inspiration	Primary Role
Facebook page	Founding members	External communication
Twitter	Communications group	External communication
Instagram	Communications group	External communication
Wikispace	Copenhagen community	Used by a few work groups for minutes and information up until September 2014
Website (v.2)	Founding member and volunteering web developer	Primary community platform, news and events, managing shifts, community documents
Google Drive	Founding members	Supporting the work related to Thursday activities
Google Mail	Communications group	Substitute the community email alias'
MailChimp	Communications group	Newsletter service for internal communication to all members
Community Laptop	Donated by member	Used to access Google documents and community information each Thursday
Community WiFi	Bought November 2015	Used to access online services with laptop and credit-card terminal
Credit-card terminal	Communications group	Credit card payment in the community space
Ad-hoc artifacts used by members	Members	Supplement community laptop Alternative WiFi when community WiFi is down

Table 3: The community artifact ecology in the second stage.

sign email addresses to the work groups). As the community grew, the burden of management increased and at the end of 2013 the situation with the website and the general management of the community had resulted in frustrations within the community work groups:

"Well, every week there are some practical problems that we have to solve. Its just, its not fun. And this is supposed to be fun, this is supposed to be something [where] you put in your work because you want to do it and you feel like you get something back. And for a long time people have just been tired from doing all the various tasks." (Robert)

Getting the new website became an important priority for the community throughout 2013 and 2014 and the decision to build a new website was discussed and agreed upon at an open community meeting late 2013. A decision was taken that the community, as a legal association, would pay for one of their members to develop the new website. Despite this being against their principles, this was decided. The new developer (Paul) was a long time member of the community; an IT professional who had regularly stepped in to solve technical

Artifact	Origin / Inspiration	Primary Role
Facebook page	Founding members	External communication
Twitter	Communications group	External communication
Instagram	Communications group	External communication
Website (v.3)	Community work groups, board and volunteering web developer	Primary community platform, news and events, newsletter and member communication (substitute Google mail and MailChimp), managing shifts, community documents, statistics, member overview, online web shop (Substitute payment and ordering at the community space), supporting the work related to Thursday activities (substitute Google Drive)
Community Laptop	Donated by member	Used to access community website each Thursday
Community WiFi	Bought November 2015	Used to access community website each Thursday

Table 4: The community artifact ecology as it is envisioned in the third stage.

issues. Shortly after discontinuing the collaboration with the first web developer, the new developer prioritized the features for the new website and started developing it using a new CMS, which he was accustomed to use in his professional work. To the new web developer, the task seems straightforward and as a community member, he gave the impression that he knew what is needed and what was most important. He had also invited other members to take part in the work by using an online project management system, first as a more participatory endeavor, and later as a way to assign tasks:

"It's gonna be a waterfall model running because, there's no time for [...] you know the agile stage is over." (Paul)

All our interviewees regard the new future website as the long-awaited solution to many of their current problems. For example, it would solve one of main struggles of the community, namely to get enough volunteers to take part in the Thursday shifts.

"[...] the hope is, that when we get the new website, that we'll be able to, like nudge people to actually fill in the shifts." (Robert)

It will also take out the frustrations of the working group by introducing the possibility to automate the tedious and 'unfun' task:

"The more you can get those tasks done automatically, then you don't need to have a member to do this. Because people are working voluntarily and that is the hardest thing to get volunteers for. So the more you can clean away of that, just run automatically, the better." (Laura)

At this stage, there was a certain fatigue among the members, and the concern was very much with the 'drill' or the running of the activities. In this current stage, the members are starting to focus on making the existing management more efficient and easier, and on consolidating many of the small practices and systems that were developed within the work groups and across the community artifact ecology. The current focus is on a vision that should make a lot of the existing tools obsolete and/or an integrated part of the new website. In table 4, we have summarized how the interviewees envision how the community artifact ecology will look like once the new website is operational.

FINDINGS: COMMUNITY ARTIFACT ECOLOGY – MULTIPLE, DYNAMIC, AND NECESSARY

In order to further explore how artifact ecologies support the community in question, this section looks in further detail at some of the particularities of the community artifact ecology through the theoretical framing outlined above. In particular, the focus will be on the three research questions outlined in the introduction: What is a community artifact ecology? How is it shaped? And what role does it play in the development of the community?

Multiple overlapping ecologies

As we have seen in our analysis, the community artifact ecology of the particular community initially took shape from the personal artifact ecologies of the founding members and the elements 'imported' from the community in Copenhagen. Later, as the community website was developed, this soon became a central element of the community artifact ecology. As the website caused both technical and practical challenges, members of the working groups introduced new tools and adapted elements of the existing in order to continue working. All of this has lead to the community artifact ecology consisting of several overlapping ecologies, with different historical trajectories.

First, parts of the community artifact ecology were associated with the different activities within the community, e.g., in the very beginning, communication was handled via Facebook, while later being separated to handle the need for internal communication, both among the community members and to the member base at large. Currently, external communication is done via a subset of the artifact ecology, in particular social media and the front-page of the website, while internal communication is handled via emails and newsletters to the members. These groupings of artifacts, defined partly by their purpose, resemble what Jung et al. [29] found in relation to personal ecologies. Grouping artifacts based on their purpose and actively substituting or supplementing particular artifacts as issues emerge, we see in multiple instances. Similarly, subsets of the ecology are activated around particular activities. The most obvious example is how the community members setup the laptop, credit-card terminal, WiFi and spreadsheets each Thursday to support the core community activity. This resembles what Rositto et al. [47] refer to as aligned constellations, i.e. a potential subset of the community artifact ecology that is active depending upon the time, place and activity. So while the community has a community artifact ecology, it

is not active at all the time for all members, yet there are acknowledged and decided ways of setting up and doing certain tasks, from publishing minutes in the members only section, over handling the orders that go to the farmer, to setting up the workspace each Thursday.

Second, the community artifact ecology is comprised of multiple overlapping ecologies, stemming both from individual members, related communities and groups within the community. Key-individuals influence the community artifact ecology by introducing artifacts from their personal ecology, artifacts they have some familiarity and experience with from elsewhere. As seen above, parts of the particular community artifact ecology originate from a similar community in Copenhagen, and table 3 indicates that the communication group played an important role in influencing the community ecology. This happened through the introduction of a communication strategy, newsletter service, various social media and the credit-card terminal. So, the idea of more capable peers, introduced by Bødker & Klokmose [13], or Rositto et al.s' [47] proposers, *can be expanded beyond individuals to include more capable (or experienced) and related communities and active groups within the community itself.* The most prominent example is that of the founders and their influence in shaping the ecology, while they established the community. Other examples include deciding the underlying CMS system for the website, based on personal, professional preferences, or fixing an unsatisfactory situation by introducing a different email service. Artifacts from other ecologies got introduced from other communities, here exemplified by the initial adoption of the Copenhagen Wikispace and specific parts of the organization introducing new tools to handle payment or communication. This happened both *slowly, with artifacts being imported and adopted more permanently*, through conscious introduction from within the community, as well as through *on-the-spot quick reactions*, such as when community members invested their personal devices as a WiFi hotspot.

Third, bits and pieces of the artifact ecologies of other communities or key-members got included into the artifact ecology of the community. These would linger on, even after the members became inactive or left the community. For example, the Wikispace stayed in the ecology for as long as until mid 2014 for a particular working group. Also, Facebook and Google Drive, which were part of the personal ecology of the founding members, are still part of the community ecology, although these members have resigned from their position in the board and working groups. Substitution has happened when the different artifacts slowly transitioned and changed role as other artifacts replaced part of their functionality, see e.g. table 2 and 3. The artifact ecology thus has become stable and established in the community practices and the community space, in the same way as both Nardi & O'Day [42] and Bell [5] talk about information ecologies, namely as places and particular local cultures developed through participation in and around practices. *While individual members move on, the artifacts become part of the community, as a shared understanding of the community and their practices.* Nardi & O'Day go as far as saying that an information ecology has a

place – it is a particular habitat identifiable by the inhabitants, here the community members.

Shaping and changing a particular ecology
In our case study we have identified multiple examples of different ways in which community members engage in shaping the community artifact ecology, in relation to or as part of the core community activities. Shaping the ecology has taken place through a combination of on-the-spot reactions and workarounds and longer-term strategies, depending on the situation at hand and the members involved. From the empirical data we learned that despite being a very open community, it has nonetheless been a small percentage of members who are and were actively involved. This also translates into their involvement in shaping the artifact ecology. Some of the more casual members, whose involvement extended to taking part in the Thursday shifts, have resorted to tactic-like workarounds, such as connecting the credit card terminal to their own laptops and mobile Internet connections. However, it is the smaller percentage of members, active in working groups and organizational boards that were more strongly influencing the community artifact ecology. They were directly influencing what tools were adopted in the working groups, and they usually participated in the community meetings, where bigger IT-related decisions were taken (e.g. regarding the new website).

Other influential members were naturally the founders who got a big say over the initial constituents of the artifact ecology, as with the design of the first website and the introduction of Google Drive, where personal preferences such as ease of use played an important role. These personal preferences went beyond functional ones, to include more reflective values, such as being more user-friendly or giving a more professional and coherent image, as also noted by Jung et al. [29]. Second, the skilled 'IT guys' played a defining role with regard to the website. While the founders had a privileged position, the web developers each had a privileged position in shaping the ecology through their proficiency and ability to develop a tailor-made solution. Personal preferences still played an important role for that, albeit on a different level. While the rest of the core members knew the applications quite well in terms of general role and functionality, the IT-guys knew the software and applications on a more technical level, as software components, application interfaces and code. Here, the personal preferences were present as favoring one CMS system over another, based on familiarity with one system over the other. The founders stood out as very capable of assessing and working with a variety of online tools, whereas the two IT-guys additionally introduced a finer-grained level of operating technology, at the level of software code, as one additional way of shaping the ecology.

'A farmer, a place and at least 20 members' *and* a working artifact ecology
The advice given by the Copenhagen organic food community representative, to find a farmer, a place, and at least 20 members, made it possible to start an organic food community. The two women who wanted to found a similar community in their city followed this advice, and it worked for them

too. However, from the very beginning, they also worked on establishing a working artifact ecology. It was by establishing this initial ecology (a Facebook page, Google Drive, a wiki, and their own website) that they got in contact with a farmer, started organizing the orders, and got a place to distribute the food, as well as interested members to join.

The artifact ecology then went into a continuous process of evolution, and it still is, today; a defining trait of a healthy ecology as Nardi & O'Day argue. The road has been filled with many frustrations, related to things not working or features not being implemented. By resorting to new additions and workarounds, the artifact ecology eventually reached stable situations where it supported the various activities of the community; maybe not in an ideal ways, but as getting things going and enabling the community to continue what it does and what it needs to do to get fresh local organic food at a cheap price, through collaborative volunteer work.

At the same time, the vision of a new website has always been there, even acting as a pacifying filter to existing tensions and frustrations. When the concrete development work started with the second volunteering web developer, it also pulled the community together in the joint effort of deciding on features and specifications. The second volunteering web developer, who is now developing the new website, has been a member of the community for several years and has been doing patching-up work to the artifact ecology. With this rooting, the shared vision of the new website became an instrument of the process of shaping the community itself. This is parallel to the way the community comes together on Thursday afternoons to make the space at the residents' house look like the organic food community space: Members, volunteering for shifts, try to make the space feel cozy, clean and inviting; the recipe working groups sometimes brings in goods that they have prepared, etc.

The process of envisioning, designing, and developing the new website thus became an important element in shaping the community, just as the process of creating the initial logo, a Facebook page and the first website was an important part of creating the community in the first place. The fact that it could be tailor-made, made the vision reflect the way at least key community members viewed their community, and it provided a vision for where they wanted the community to be (easy to order, user-friendly interfaces, efficient to manage and even make community management 'fun' again), and how ultimately they would get rid of some of the mess of the current more ad-hoc artifact ecology. However, the vision of the new website is not the 'holy grail'. The process of the community coming together around the vision of the shared website was made possible by the stabilized working artifact ecology. Things neither needed to come to a hold because everything was not working perfectly, nor because a new website was being developed, yet the vision of the new, more perfect solution made the current situation endurable somehow. The artifact ecology was and is patched together, and the temporary aspect, and the temporality as such, of the patching up, are accepted, *because* a new solution is being worked on. Just as Nardi & O'Day [42] note that there is never a per-

fect fit, Bødker & Klokmose [13] outline never ending movements between the unsatisfactory, exited and stable state, and Rositto et al.s' point to the performative nature of making constellations work, so does our study indicate, that *the community artifact ecology is in equilibrium, yet dynamic and always the object of some community work*. It may even be a *fundamental condition of collaborating* in a self-organized community that is based on volunteer work and scarce resources.

DISCUSSION

As the community grew, so did the effort that had to be put into managing and supporting the weekly activities. The work of maintaining the community artifact ecology grew as the community grew. This is not unlike the work that goes into maintaining any organizational infrastructure [44], and table 3 and 4 indicate some division between external communication, community management and the artifacts used each Thursday. While we do not see community artifact ecologies as infrastructure per se, they do contain elements of infrastructure (e.g. WiFi) and artifacts that exhibit infrastructure characteristics, e.g. by being standardized and multi-sited, such as email and calendars. Community artifact ecologies are dynamic and very particular to a specific community, in contrast to how infrastructure is viewed. They spring out of a complex historical mix of influences from multiple other ecologies, co-evolved with the practices of the community, bound by both culture and place. Still, the *work that goes into making the ecology work* (cf. [15, 47]) could be described as *infrastructuring*, with local adaptations of familiar artifacts, introduction of new, inertia and tensions as fundamental conditions for community work. Issues may rise between the primary activities and managing the community artifact ecology, as we have seen with the fatigue reported above. Whether this is a consequence of having multiple artifacts in play or the issues are introduced by the dynamic trait of ecologies (cf. [42, 13]) is an open question.

In our presentation of the case we outlined three stages in the formation of the community and its artifact ecology: Becoming a community, everyday community work, and building anew. These stages are meant to be use descriptively, not prescriptively, and they cover the time from the initiation of the community until writing this publication. However, our studies indicate that a large part of community artifact ecology is established in the initial stage of the community, and often co-created with the community, by the few founding members. Accordingly, paying attention to what and how the initial ecology is negotiated and decided upon when the community is formed, is important if one wants to understand how the community artifact ecology and the community co-evolves as well as some of the implications introduced in this early stage. The initial creation of the community artifact ecology by the founding members, resemble the performative act of aligning a particular groups constellation as described by Rossitti et al. [47]. Once the community is established and the primary activities are stabilized (in our case ordering and distributing organic food), the states presented by Bødker & Klokmose [13] may be more descriptive of what happens around particular activities and situations, and the subset of

artifacts involved. The different states become more visible in and around well-established activities. The unsatisfactory state of internal communication is one example, and the stable state of artifacts that make up the workspace each Thursday is another. The states do not cover the whole of the community artifact ecology, rather, they emerge around specific activates and artifacts within the ecology. This may create tensions that, over time, propagate to involve the entire community artifact ecology, as members become frustrated with a larger and larger subset of the community artifact ecology, as we have seen in our study. The frustration with multiple artifacts and an increasing prevalent idea, that a new consolidated community platform would mitigate the frustrations and overhead involved in managing the community, created a tension that resulted in paying a community member to develop a new website (and challenging the volunteering characteristic of community). Understanding the dynamics and states introduced by Bødker & Klomose, on a community level is an important part of understanding how such a community artifact ecology evolve.

The setting we present here is that of 'CSCW in the wild.' [19]. We are well aware that studying CSCW in the wild and in particular when studying a single community, results in a similar particular and partial picture of the community artifact ecology, it's genealogy and role within the community. The findings outlined above, the particular constellation of artifacts and 'stages' of the ecology, pertain to this particular community and can not be generalised to all communities. We do try to argue for a more abstracted contribution in theorizing on the concept of community artifact ecologies and the intersections between the personal artifact ecology and the share and more common artifact ecology. Whereas much focus is usually placed on understanding the way CSCW takes place through the use of particular technologies, or how technologies should be set up to support collaborative communities, our analysis and findings show that much can be learned from observing communities shaping themselves their own collaborative environment – here with the emphasis on shaping rather that just using: Communities with little resources are creative in shaping their artifact ecology, making use of existing mundane tools, but also creating specifications for software they need and finding ways to finance their development. However, our example also shows that these solutions can strain communities, as they require their own share of volunteer work. This places this kind of research in a somewhat challenging position, especially concerning our role as CSCW researchers and designers. We have chosen to undertake our research using the concept of artifact ecology because it provides a solid framing for exploring the interaction that a community has with and through a multitude of tools. Many of our findings, however, also echo the current discussion on infrastructuring, as it is taking place e.g. in the field of CSCW and participatory design (PD). Whereas the more recent discussions within PD tend to place the role of (professional) designers in prime position, so as to discuss their action possibilities, methods and responsibilities (e.g. [34]) older work such as that of Karasti & Syrjnen [30] has emphasized the design work of communities themselves, pointing more directly to the appropriation of artifacts and the development of resources *by* the community. This points to a different role for the researcher (who is engaging with a community through action research and participatory design) rather than the moral commitment to 'fix' community problems (see [10]).

CONCLUSION

Our case study shows an example of how a self-organizing volunteer-based community uses a collection of tools to both manage the community and their primary activities related to ordering and selling local organic food to the community members.

Our findings have shown that the artifact ecology of a volunteer-based community is multifaceted, consisting of overlapping ecologies, and is shaped by key members, related communities and internal work groups throughout the community lifespan. The community artifact ecology co-evolves with the community and is shaped by changing needs, while also creating tensions within and straining the community. In this specific case the community artifact ecology did support the community in their work, while also being the source of both frustrations and requiring work to make the community artifact ecology work. Work we hypnotize is a fundamental condition of collaborating in this type of communities. Based on the case study and existing research on artifact ecologies, we propose the theoretical concept of community artifact ecologies as the particular constellation of artifacts that a community owns, has access to and uses in its activities. It is characterized by a high degree of shared understanding of the core activities and the role of the artifacts within the ecology. It changes throughout the community lifetime in response to community needs. This occurs both through explicit negotiation and more subtle adoption of artifacts originating from the ecology of individual members, often more capable peers. It is both dynamic, as it co-evolves with the community, and stable beyond the individual member. While particular artifacts may stem from individual members, they are often adopted by the community and become part of the community practices and shared history.

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