Pa(w)ticipatory design – Designing mediated wearable interaction between an air-scent search dog and a human

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**ABSTRACT**  
Designing for and with animals is common within Animal-Computer Interaction (ACI). However, studies involving animals within the design process has challenges due to verbal barriers, and an unclear methodology on how to both understand, and analyse animals in ACI. This paper explores how an air-scent search dog can participate in the design process from the beginning to end involved in various design methods with a Participatory design (PD) approach, to empower the relationship between human and dog with the help of wearable technology. The study explores the benefits and challenges of the involvement of other species than humans in the process of making a prototype. Furthermore, two types of tools with biting and pulling interactions attached to a vest were developed and tested on an air-scent search dog in two different environments. Due to the verbal barrier between dogs and humans, it was necessary to let the dog participate by testing physical prototypes. This study aims to empower this relationship between an air-scent search dog and its handler with the help of wearable technology. The results suggest that direct contact with the other species is crucial in the creation and iteration of prototypes regarding; weight, placement, and wearable technology. The results also showed that in the context of search training, or situated based action, it is crucial to test the prototypes in an environment that reflects a real scenario in a forest, which is a typical place for search training.

**Author Keywords**  
Participatory Design; Animal-Computer Interaction; Wearable Technology; Interaction Design; Human-Dog Interaction; Empowerment

**INTRODUCTION**  
With the help of its skilled nose, the dog can work as a valuable rescuer to search for missing persons. Therefore, the dog works alongside with a dog handler as a team to find other living species. During this collaboration under search, a mediated interaction occurs between them. This study aims to empower this relationship between an air-scent search dog and its handler with the help of wearable technology.

Because the dog will be a vital part of the search, this study focus on how the dog can be involved in the design process. In the making of designs for animals, it is central to allow the animals to participate in the process [15]. Research within Animal-Computer Interaction (ACI) need to consider some questions. Based on some of ACI’s principal statements, the design needs to be shaped according to the animals’ needs, not harm its health, and improve the life of the animal in somewhat [14]. However, regarding involving animals in the development of designs have challenges due to verbal barriers and an unclear methodology on how to both understand and analyse animals.

Initially, in this study, a pre-study was made that explored how a wearable dog vest can help the dog to interact with its owner by either biting or pulling at a tool attached to the vest. The purpose of creating and testing a dog vest as a help-tool between the handler and its dog during the search may promote cooperation as well as calm the handler when the dog is out of sight. By utilizing existing practice and materials in the form of a dog vest and bringels tool, the interaction between the handler and the dog can be more efficient by reducing the virtual distance between them.

Thus, this paper aims to explore how an air-scent search dog can participate in a design inquiry to empower the relationship between the dog and its handler with the help of mediated wearable technology. The study also explores what challenges and benefits it can give by including other species, like dogs, in the design process. Therefore, the research questions are:

*How can the relationship between an air-scent search dog and its dog handler be empowered by a dog participating in a design inquiry?*

*What challenges and benefits can it result by allowing other species, like dogs, to participate in the design process?*

An important notice is that the study has involved making prototypes for both the dog user and human user, but this paper has focused on the dogs’ involvement.

**ANIMAL - COMPUTER INTERACTION**  
If developing with interactive technologies together and for animals, the designs relate to Animal-Computer Interaction [14, 16]. For this paper, the ACI perspective has been focusing on dogs and technology for developing new tools in air-scent training and performance. Previous ACI research with dogs has been involved in several themes like monitor or tablet communication [31], dog tracking [17, 18], aiding/helping humans [25, 9, 1], and gaming design [31]. Mancini [14] has proposed three various aims when it comes to ACI, which is necessary to consider in studies of this character:
THE NEEDS OF NATURALISTIC SETTING when studying the interaction between animals and technologies.

IN THE DEVELOPING OF USER-CENTRED TECHNOLOGY for animals, it needs to a) improve the needs of the animal, b) support the animal when carrying out tasks for humans and c) foster an interspecies relationship.

EXPLORING, ADAPTING, AND EVALUATING theoretical and methodological frameworks for user-centred design, both with an HCI and animal science approach.

Further explaining, ACI’s aims were created to address animals as an accepting target group for digital systems. When developing technologies for animals, there must be a purpose, facilitating everyday life as well as improving the animals’ relationship with other species (e.g., humans) [14].

Dog-human relationship
When it comes to working with a design, it is needed to think about how we look at whom we can consider as users of the design. It may affect, among other things, whom we see as legitimate users by how we divide and name others. Animals live in one way or another in a relationship with humans. Therefore, ACI is often focused on how technology can act as a link or as a mediated interaction between animals and humans.

Research within the relationship between humans and non-humans, such as dogs, has been researched on several topics such as playful motivations [21, 22, 31, 32], training commitment [3] and health effects on each other [30]. The relationship between dogs and humans has both been strengthening and given positive health aspects. Research has shown that by training together, it can help humans to understand the dogs’ behaviour better, therefore perceiving improvements in their relationship together [3]. According to Väätäjä [30], the feeling of togetherness between human-dog relationships gives a positive effect on the dogs’ health as same as it does for humans between human-human relationships. Therefore, the relationship between dogs and humans does depend on how they understand each other. Research has also shown that the use of playful experience in design making for animals can be an efficient way to engage the animal participant [20, 31].

Participatory design with multispecies
Design acts like a conversation [11] and an iterative process of practice based on actions of theoretical and reflective processes [26]. One way to approach design is to involve users in the design process, which is called participatory design (PD). PD pioneered in Scandinavia during the 1970s, also called the workplace democracy movement, where an increased demand among the employees in the decision making took place [23, 24]. PD aims to be responsive to the users’ needs through a diverse collection of principles and practices, especially in the making of technologies, tools, environments, businesses, and social institutions [27].

By letting users participate in the design process, it allows the users or stakeholders to have an opinion or affect the design and, this creates mutual learning between the designers and the users [2 p. 8]. Users can create together with the designer and test ideas and solutions at an early stage. This direct contact between the user and the designer can help shape the result in an unexpectedly positive way by using tools such as brainstorming and initials prototype evaluations. Halskov and Hansen [6] have found in previous research five fundamental aspects of participatory design: politics, people, context, methods, and product. The authors further explain the people (users) are the expert of their own lives; therefore, they want to influence decisions that affect them. Users can influence or change by participating in design methods, and this can help to bring forward design alternatives. The context of where the design will be used is the fundamental starting point in the design process. The PD methodology, focusing on technologies, has also been divided into three necessary steps, according to Spinuzzi [28]:

INITIAL EXPLORATION OF WORK in which the designer gets to know the users and how they work. The designer learns about the technology the users uses today, but also their workflows.

DISCOVERY PROCESS is a stage where the designer and users work together to try and envision a potential future, on what would be a better solution for the users.

PROTOTYPING is the last step where the designer lets users test out prototypes to find the best suitable artifact to fit their future envision and goals.

Besides to let the users’ test prototypes the users can be a part of the creation of the prototype as well [23]. Users can also be a part and experiment in, for example, verbal communication, workshops, and other toolkits. The types of methods and tools depend on the users, context, and purpose of the experiments.

During participatory design, it is essential to consider which one enters the design process [15]. Depending on whom you design for determines which one should be involved in the PD process. If the project affects other species than humans, one can include non-humans as well, for example, animals. When developing technologies where animals are affected, it is vital to ensure that the designs are not making a negative impact on animals’ welfare, which is one of the aim statements for ACI [14]. According to Haraway [8 p. 71], it is not only important to minimize the risk of cruelty to the animals. The obligation to the companion species is much more challenging than the relief of suffering for the animal [7 p. 54].

One of the core aims of interaction design is to understand the user [15]. According to Lawson, Kirman, and Linehan [12], it is essential for the designer to understand to what extent a design process can reflect the needs of the animal as a user rather than useses. The designers need to question
whether the animal can benefit from the product or if it is just for the amusement of humans [12]. By letting the animals participate in design activities it can give the animal a voice in the design process, and what Lawson and colleagues call it power sharing between the designers, users, and communities. Lawson and colleagues mention potentially intractable ontological issues such as verbal communication [12]. Due to the lack of comprehensible verbal communication between non-humans and humans, one way to reflect the animals’ needs is to let the animal interact with physical prototypes [6, 17]. In other words, non-humans can participate in the process of doing or acting rather than through verbal communication [22]. Haraway [8 p. 26] is in similar thought and writes that animals express themselves with a non-linguistic language, where an embodied communication is more like a dance than a word. Haraway further explains that humans and non-humans are companion species [8], and the relationship between them is important for a contingency of subjectivity [7 p. 4]. The linguistical difficulties between humans and non-humans can also be more understandable through material semiotics of other species [8]. Mancini and colleagues [17] have explored how co-constructive meaning exchange could be understood between humans, animals, and technology through indexical signs. To understand an animal in this case, dogs, one must understand its’ indexical signs (e.g., body movements, posture, and signals). Human communication uses a combination of signs; symbols, icons, and indices [19].

According to Mancini et al. [17], indices are readily accessible to dogs. The authors further explain that indices are grounded in contextualized associations in individual and cultural experiences.

To involve other species into the process has its advantages according to French, Mancini, and Sharp [5], which has worked with zoo elephants in making of a self-controlling shower. According to the authors, the human designer can gain awareness of the animals’ co-play with physical prototypes, and therefore get insights into the animals’ behaviour and interactions through observations [5]. In their research with elephants, they discovered that the making and sharing process goes hand in hand together. Further explaining that the designer got forced to try to use their senses in making the prototype in a way that the target species might be engaged. French et al. describes that they needed to think about the physical properties such as weight, shape, texture and smell through an elephant perspective more within prototyping.

Participation and empowerment in Participatory design
The purpose of PD is to involve participants and gain new knowledge. Lawson and colleagues [12] definition of a PD approach can compare to Kensing & Greenbaums’ [10] explanation as giving a voice to the participants by letting them be involved in the design process. Kensing & Greenbaum [10 p. 21] further explain the purpose of the PD approach is also motivated to equalizing existing power relations. Others, such as Halskov & Hansen [6], has discussed the importance of mutual learning for the designer and the participants as a collective reflection in action. Suchman [29] refers to PD to be situated action based and embedded in the context where situations are performed.

Participatory design can be used as a form of empowerment of users through equality interfere and sharing power relations [13 p.108; 10 p. 21] and driven by emancipatory and democratic values [23]. However, involving participants in the design process does not guarantee that participants have a say due to power relations or unequal access to knowledge of relevance in decision-making [13 p. 47]. The PD field is often depend on asymmetrical relations between participants, where different levels of power positions are influenced by norms and values [13 p. 49]. Lundmark [13] explains how design cannot be neutral because it is founded on the norms and values of society. When designing for a specific target group it, therefore, demands special attention on which values and norms these artifacts communicate to the users [13].

One way to highlight these power and power relations is to use the notion of interference as a norm-critical perspective [13 p. 56]. Otherwise, there is a risk of reproducing pre-existing power relations (values, norms or identity structures) [4 p.194]. The norms and values can be visualized as normative expectations to consider, such as gender, sexuality, diversity, functionality, and age when designing a system or service [13].

The notion of empowerment has been described as complex and questioned [13]. Ertner, Kragelund, and Malmborg [4] explains the term empowerment as a delegation of power, authority or giving an ability or enablement for how empowerment is enunciated in the PD field. They further describe five notions of empowerment [4]:

a) The use of tools and systems can make it possible for concrete improvement and empowerment for a specific user group which in some way enables the users to change their own lives to the better.
b) Involving participants can make collective intelligence through direct democracy which can influence potential and social matters.
c) Empowerment can help to enhance the participants level of participation and position which can involve fixing unbalanced power relations.
d) Empowerment can be used as a resource for helping the researcher/designers’ ability to engage and make a commitment to the participants.
e) To use empowerment when shaping the process for knowledge production as a social discourse and reflexive practice.

According to Lundmark [13 p.19], PD as a research domain often focuses on how the participants get empowered by being involved and contributing to the project. The author further explains on the importance on which role and position the participant has and how it develops during the
design process. By exploring the participants' perspectives, it can lead to organizational and transformative processes of new roles and new communities of practice.

**METHOD**

The study aimed to empathize with the target group, which was non-professional air-scent search dogs together with their owners and involve them in the design process through a participatory design approach.

A total of 16 participants, including eight dogs and eight humans, participated in the user study. The dogs had previous experience with air-scent search, and the humans consider themselves as the owners of the dogs. Through the design process, two participants became the main users of this study. By allowing one handler and its dog to be the main users, the design of the prototypes could be as customized and tested as possible.

The study has involved both dogs and human users through various methods. Firstly, to get to know the users, two observations at training sessions and three individual interviews with the human users were conducted. Followed by a brainstorming session together with the human users at South Stockholms’ Working Dog Club\(^1\) in Ägesta to take forward goals and envision a potential future in air-scent search training. Lastly, prototypes were developed, together with the main participants, through an experience board with playful triggers (e.g., icons) on a workshop, and user tests in two different environments to try out the prototypes.

The purpose of the prototypes was to make the virtual distance between the dog and the human during a search training session less with the help of wearable technology. Both the dog and the human user got to test wearable prototypes. The dog user tested bringsel prototypes attached to a dog vest with two different interactions: pulling and biting. The human user tested the feedback from the dog through visual screen interaction with a mobile application and haptic feedback on a wristband.

The research performed in this study is qualitative. Each design method has been video recorded and has helped to document the results.

**DESIGN INQUIRY**

Based on the study, several findings have been collected based on the participation of animals; in this case, air-scent search dogs and the dogs’ owners, in the design process. It became apparent that it was difficult to get the dog involved in methods based on verbal communication. These results were also conducted through previous research as well because dogs tend to understand playful triggers and bodily communication more than words and semantics, as also evidenced in previous research [21, 8, 5]. During this study, it became clear that interview, group brainstorming session, and experience board workshop were not suitable for the dog users, because they base on verbal communication and abstract thinking. However, emphasizing pre-study observations, exploration of material and form in the making of low fidelity prototypes, and tests on the dog’s interaction of pulling and biting sensors were relevant for participating design with dogs.

**The human participant’s experience of training together**

During individual interviews and brainstorming session with the study’s human participants, all human users mentioned the importance that the dog needs to have fun during search training. The informants are training with their dogs to give it both physical and mental activity, and social learning. All human users mention the importance to see the dog as the active party in the team between the handler and its dog. The course instructor also mentions that the cooperation between the handler and the dog is crucial. The dog mimics the behaviour of the handler, and thus it is never the dog’s fault. The instructor tells that it is because the dog owner subconsciously manages the dog in a way that confuses the dog. Through these results, it was important to allow the dog to remain the active partner during the search, and thus the prototype needed to be a part of this. In this case, the dog that interacts with the bringsel tool to indicate to its owner of the finding of the missing person.

During a brainstorming session, the dog owners could participate in a discussion on what was fun and important, and difficult with training with their dog in a dog club.

**Emphasizing observations at training sessions**

Observations gave information about how the training sessions work today, how the dog and human communicates, and indexical signs were noticed. Every dog handler has their individual practice in how they communicate with their dogs, which makes an individual bond between them. Each dog searched after three-four figurants that were hiding around 60 meters away from the starting points. The training session for each dog was approximately 10–20 minutes. Both the human handler and the dog did not know where the figurants were before they started the training session. The instructor knows where the figurants are hiding. Therefore, he guides the dog handlers to the different starting positions on the path in the woods.

**Dog-Human bond during a training session**

Each dog in the group had previous experience of search training. One dog was a bark alert search dog, and four dogs were bringsel tool or loose roll alert search dogs. Each human handler used different types of commands to start the search. Some used hand gestures, others used the word “Search” and others let the dog decide when to start (Fig. 1).

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\(^1\) South Stockholm Working Dog Club (SSBK): [https://www.ssbk.se/](https://www.ssbk.se/)
Figure 1. The difference how the human interacts with the dog on the starting point before the search after a figurant; pointing hand gestures with verbal commands with a Labrador Retriever (left) and stroking calming behind with no verbal commands with a German Shepard (right).

Some of the dogs needed candy between every search when others did not get candy until the end. Every training session ends with a so-called Candy rain (Fig. 2), which means that the dog receives candy from everyone in the group. Through reward in both gestures, verbal communication, and sweets, it is essential to end each training session positively.

Figure 2. The image is showing the importance of Candy rain from all participants during every training session to make these occasions fun and motivating.

Compared to tracking dogs, air-scent search dogs have a distance between the handler and the dog. During the observation, it was noted that it was a stressful environment for the dog owner because of the lack of visibility of the dog. To maintain the focus and concentration of the dog, the humans needed to know what and when to do everything. The human participants are necessary to be consistent in movements, commands, and hand gestures. It was noted that the human user needed to know when, for example, to give commands, put on and disconnect leashes, and how to run with the dog. Through these results, it was important to use existing search rules and materials in the form of bringsel tools to make the transition from today's training to the new prototype that is not noticeable by the dog. By using common interactions such as biting and pulling, the dog could easily understand the study's prototypes.

Exploring materials and prototype making

Both the research methods and practical design work have been worked together in parallel. Results from the different methods have been significant for design decisions for practical work.

Through discussions with the main human user, it gave some results on what she thought was important when it comes to the prototypes: the dog vest, tools and the role of the air-scent dog in searching. During the session, the dog got to test three different materials for the bringsel tool, mostly to determine which material or texture the dog preferred. The handler had brought the dog's material (Fig. 3) used in the training so that the designer could use these for inspiration and measure in the creation of the dog vest.

Figure 3. The image is showing four different early low fidelity prototypes for bringsel tools (top left), the participants' search vest (bottom) and an old fire hose (top right).

The dog investigated freely the tools several times and eventually liked a specific rope that was chosen (Fig. 4). The rope had more texture compared to the jeans braids and plastic tube. The dog gave interest to the plastic tube but spat it out of the mouth repeatedly. According to the human user, it may be because the tube tasted bad, but the softness and shape fit the dog. The human user also told that the dog had tested a so-called Norwegian bringsel tool earlier, but the dog did not appreciate it. As the handler interpreted it, the dog considered it to be suffocating.

Figure 4. The dog got to choose between a rope and two types of braided prototypes. The dog picked the rope.
According to the human user, the prototypes should not involve sound because some dogs find sound as stressful. In this situation, the human user worked as a type of translator for the dogs’ behaviour. Therefore, regarding ACI ethical guidelines [14] regarding not harming the dogs’ health, a Norwegian tool or sound was considered not suitable for further research. The material should be reasonably durable, preferably in a material that is water resistant and can be washed. It should not be too heavy (but not too lightweight either), in a suitable size for the dog's mouth and placed where the dog reaches it.

It was necessary to explore different types of shapes and materials when developing the dog vest, and then adapting it after the dog's liking.

![Figure 5. Two different types of bringsel tools which were tested during the design process with a soft potentiometer (left) and a pressure sensor (right).](image)

During the process, several forms, sizes, and materials were sketched, constructed, and iterated after every test with the study’s main dog (Fig. 5).

**User tests in two different environments**
New technology can affect both humans and dogs during a search training. The results of the three different user tests have resulted in two areas, the dog's interest and the biting vs. pulling interaction for the dog.

**Home environment**
Before the test, in a real searching context, the material was tested at the participants home. Both the dog vest and the different types of bringsel tools were tested. Due to the forms of the pressure sensor (biting) and the soft potentiometer (pulling), two types of prototypes worked (Fig. 6).

![Figure 6. The dog tested the vest with both pulling and biting interaction prototypes in its home environment.](image)

In the beginning, the dog did not understand what to do with the tools. The dog gave no direct interest in the tools and just let it hang on the vest without sniffing or biting them. By putting dog candy inside the pressure sensor tool and smearing liver pâté (Fig. 8) on the pulling tool gave the dog some interest in the prototypes (Fig. 7). The excitement of the dog was short-lived, but it helped the dog to see and investigate the tools more, e.g., by pressing its nose against the biting tool.

![Figure 7. The human user tries to trigger the dog by bringing the prototype close to the dogs’ nose and shaking it briefly.](image)
According to the human user, the dog was not disturbed by the dog vest. Otherwise, the dog would have scratched on the vest or stood entirely still like a ‘freezing’ position. The dog user was sitting, laying and walking freely with the dog vest without scratching or ‘freezing’ position.

The material of the dog vest could have been stiffer. The thin plastic fabric from the raincoat slipped slightly to the side where the bringsel tool was placed. The length of the tools was too long during this user test and shortened somewhat before the second user tests. This was made so the dog could not get caught in the threads.

During the user test, the dog was allowed to test the pressure sensor inside a prototype. It was to investigate if the dog was interested in the interaction to bite and verify if the technology could read the pressure of the dogs’ bite. It turned out that the connections of the pressure sensor dropped its grip when the dog bit it. Based on the result, the conductive wire was replaced by the contacts being soldered directly onto the belt using plastic discs.

**Forest environment**

To test both the dog vest, the bringsel tools with biting and pulling interaction, the technology was subjected to a scenario where the dog searched in a wooded area. The technology was tested in its design (Fig. 9).

The dog made the entrance being excited and pulled the collar at the beginning of the search, often with an expression of an open mouth, uplifting ears and being focused to start searching.

The technology of the different parts of the vest needed to be durable that made it possible for the dog to use it. The dog runs and bounces against branches, grass, and rocks when it is searching. Therefore, it was important that the environment around could not cause harm to the dog, destroy the technology, or give it false results.

During the second user test, the pressure sensor gave wrong results. It was too sensitive and got activated when the tool hit the dog when it ran. By setting a time limit that the dog must bite the prototype for about a second, this error message could be solved. The dog understood the biting interaction and chose to hold the tool in her mouth when she arrived at its handler.

The technology of the pulling interaction also gave wrong results. During the second user test, a ‘run-test’ (Fig. 10) was performed with the dog. The dog ran with the prototype to determine if the weight of the tool gave result without the dog pulling in it. It turned out that the weight and speed of the dog caused the metal ring to move quite a bit, therefore it triggered a false result.
From the results of the ‘run-test’, the prototype got replaced with a lighter tool. The interaction with the pulling tool still proved difficult for the dog, since the tool needs to be grabbable by the dog; it did not always encourage pulling interaction. Therefore, the results varied, and the vest did not activate on several occasions. When the dog was pulling the tool, the dog chooses to hold the tool in the mouth as the dog did with the pressure tool. Holding the tool in the dog’s mouth is a common and used movement for both types of interactions.

**DISCUSSION**

Results from the design inquiry discuss both challenges and benefits in terms of the involvement with other species, like dogs, in a PD approach. The results from interviews, observation, and user tests helped the developing process of the prototypes and investigated power relations between the dog and its handler. The design inquiry also aims to empower the relationship between the dog and its human during the process with the help of wearable technology.

The involvement of both the handler and the dog has not only been an important part of the process, but the environment has also been valuable. The importance of a contingency of subjectivity of the relationship [7 p.4] depends on the participation of both human and dogs. To test in a real context where both handler and dogs are used to search is valuable for the study. When allowing users in the design, it is important to involve commonly occurring contexts where the environment, weather, and movements determine how it works to prototype with and for a dog. Compared to previous studies [25, 31, 9] in a controlled work or test room, this study has a test subject that moves in a large environment. The wearable technology did not always work. An air-scent search dog works in an environment where the prototype needs to hold together to be tested. Sometimes it is cold, rainy, or dark when the dogs are searching, which is things worth mentioning.

The dog also linked activities with the choice of situation and places. The environment was not only a valuable part of the test but also a part of the engagement for the dog. When the dog got to be in an environment near a forest, the dog understood what to do and when due to the connection of previous search training in a forest. This resulted in how the dog interacted with the tool without any guidance from the human user. Materials like a search vest, a bringsel tool, and candy were other important parts of the dogs’ previous experiences.

To involve users in studies has been a way to explore, create, and test ideas or solutions at an early stage. By having direct contact and inviting users in the design creation, it can give unexpected results. To involve users in the design process is a design technique that can help to both brainstorm and evaluate ideas early.

**Power relations between the dog and the human**

During the process, it appeared that in a mediated interaction between humans and animals, which concerned situations such as search training, there was an explicit interaction between them. This interaction was visualized by how they communicated and understood each other, but also how they interact with the prototypes of the study. The bonding communication between the human and dog is also unique for each couple (e.g., hand gestures, physical contact such as stroking or verbal commands).

It became clear that both dog and human users have significant roles in different ways when communicating. These roles and normative expectations [13] as participants during a search training session can be visualized of the various gestures, rules, and teamwork with other pair of human and dogs together in the dog club. Not only the individual communication language between the human and the dog but also the rules of the dog club. A mediated interaction between two species, in this case, a search dog and a human handler, requires participating from both perspectives. The user's relationship and bond to each other, regardless of the type of nature or species, is reflected in how they work and communicate with each other. Search training provides both a sense of togetherness and team spirit [30], which was both verbally expressed during interviews, brainstorming sessions and observed under the indexical signs [5, 8] that occurred during direct interaction with each other at the user tests. The indexical signs were visible through, for example, gestures, body language, movements, and sound. The involvement of both human and dog in the design process made it possible for a more collective intelligence [4] or, as Halskov and Hansen describe it, mutual learning between the designer and the participants as a collective reflection in action [6]. The collective reflection was visible through the user tests where both human and dog could test the prototype together. The different levels of power relations were shown during several times, especially when the dog did not understand what to do (user test in the home environment) and were seeking attention from its human. The dog is used to listening to its owner and seeks both security, approval, and guidance when it does not understand what to do. This security is important for the companion cooperation between the dog and the human. The guidance from the human participant was helpful to maintain the motivation of the dog participant, for example, when the human smeared liver pâté on the prototype to help the dog to shift focus on to the bringsel tool. It became apparent that the dog wanted to please the human by doing good and search right. On the other hand, the human wanted to maintain the motivation and make the search training as fun as possible for the dog.

One challenge with the verbal barrier or ontological issues [12] in an interspecies design process is how to analyse the dogs’ behaviour. In situations where the designer does not know how the dog is behaving the human user can, in this case, the owner, translate the dogs’ typical behaviours with
words. For example, the designer let the human user explain that the dog did not like the Norwegian bringsel tools, and sound was not suitable for the prototype due to the source of irritation for the dog. This type of translation comes from a human perspective, even though the owner knows its dog, it does not necessarily have to be what the dogs think or feel. This type of design decisions has been modified because of the dog handler’s opinion and not through the dog user. Therefore, it is hard to know if it could have been better to test the solutions, for example, before excluding the use of sound and Norwegian bringsel tool as a prototype alternative. The crash between getting approval from the dog owner and testing potential design options in the making of the prototype has reduced the dog’s ability to choose for itself. In the case of companion species when there is an owner, it starts with an asymmetrical relation between the human and the dog where the dog is owned. The unequal power relations between the owner and the dog reflects in some of the designer’s decision-making during the process. In this case, the main dog user and the human user had different levels and positions of power depended on both the status of the species and the verbal barriers. Although the dog can show typical facial expressions or body movements such as placement of head or ears, or waving the tail, it can be difficult to determine what these bodily expressions mean in their entirety as well as in detail.

Another challenge is what it means if the dog is not aware of its involvement and influence during the process?

Situation-based activity in an environmental context

The knowledge of practical methods that concern both the involving and documenting indexical signs [8, 17] like indices [19] with other species is still somewhat fuzzy within ACI. It showed during the exploration of materials with the main dog user. The maintaining attention and understanding for the dog were situated action based [29] where the environment was useful. The dog acts after what situation it gets, and if the purpose of the methods was perceived as unclear for the dog, it seeks the attention of its owner. The attention seeking from its owner was also shown in the user tests with the dog in the home environment when the tool did not have any purpose for the dog more than to be attached to the dogs’ vest.

The use of playful materials [21, 22, 31, 32] and physical prototypes [5, 17] was useful and worked as indexical signs [14] for the dog’s understanding. The non-linguistic language approach [8 p.26] helped the process and investigation of what the dog preferred. The use of physical prototypes, such as the dog vest, the bringsel tools, and choice of interaction (pulling and biting) have resulted in some ways what the dog liked in the situation it got. If the dog had not played its part in the creation of the prototypes, the results would have been different (the customization of the dog vest and bringsel tools). By allowing the dog to participate in the making process, forcing the designer to think of a dog’s perspective and testing both technology and the construction of prototypes facilitated the iterative process. From the size, forms, placement, and material (texture and taste) of the bringsel tool and dog vest, to the type of interaction such as biting and pulling also affects the dog’s understanding of the prototype.

One example that showed the importance to have the dog to participate in the design process was the measurements of the wearable technology. To set up the pulling and biting interactions, it was needed to let the dog use the prototype in the right environment, or natural setting as Mancini [14] refers. When the dog tested to bite the prototype in its home environment, the dog did not use the same pressure because of the lack of interest in biting. In a forest environment, the dog showed its excitement by biting the pressure sensor in the prototype much harder. The bite sensor parameters depended on how hard and how long the dog bit the prototype on the situation-based activity (e.g., environment or contextual material such as a dog vest or bringsel tool). These technology parameters and levels could indicate how the dog’s interest was expelled. The technique could thus function as a measuring instrument of the dogs’ indexical signs.

Another distinguishing feature that can affect, among other things, the animal’s interaction with wearable technology is the constant moving participation. Because wearables were placed on the animal’s body, in this case on a vest, makes the construction and the placement of the bringsel tool significant, so it does not damage the animal or break. The use of soft material for the dog vest and the technique on the bringsel tools were conscious choices in the design making. The soft material also proved to be positive when the dog interacted actively with the bringel tool and when the dog rolled around with the technique on the ground.

Pa(w)ticipatory design for Empowerment?

One of the aims of the study was to investigate if the involvement of dogs during the design process changed the power relations and relationship between the dog and the human participants.

The indices that were conducted through both interviews, brainstorming sessions, observations, and user tests led to an emphasizing knowledge about how the dog and human work and bodily communicate with each other. This knowledge led to an experimental journey with material and the making of prototypes for both the dog and the human participants. Because the dogs can participate more through doing or acting [22, 8 p.26] rather than through verbal communication, user tests, and exploring with the material were methods that worked better.

Wearable technology has been used as a tool to empowering the dog’s ability to connect and communicate with the dog handler. The physical prototypes made it possible for the dog to choose and test, such as forms and material of the bringsel
tool. However, the invitation to let other species in a PD process does not require or guarantee the participant to have the ability to have a say due to unequal access to knowledge in decision making [13 p. 47]. The variation of bringsel tool alternatives could have been extended to several rounds and with more options to be able to check that material selection and shape were right for the dog’s liking. The dog user got new knowledge about the wearable vest and chose some of the design decisions (material, forms, and, sizes of the bringsel tool).

The main dog participant got a new skill through the prototype, ranged communication with its handler through a technological artifact. The dog learned a new way to interact with the bringsel tool, from a loose roll to a bringsel tool attached to the vest. The new skill could be seen as empowering, referred to Ertner, Kragelund, and Malmborg’s notion of empowerment according to the use of tools or systems to gain new knowledge for the participant [4]. The new knowledge can be seen as that the dog has changed its role as a search dog to also communicating with the human through distance with the help of wearable technology. The use of wearables can also be seen as a useful tool that can allow the dog to improve its searching by allowing to choose from new bringsel tool alternatives.

The lack of verbal communication, though it makes it difficult to evaluate if the dog truly felt empowered. The making and sharing [5] process, including the participating dog, has resulted in new knowledge and a new way to think like a designer. The lack of verbal communication forced the designer to think more like a dog through the observation and user tests with the dog. The sharing process did make some collective intelligence [4] for the designer (how to involve and facilitate methods for dogs), the human user (how to involve and motivate the dog) and the dog user (new skill and test the prototypes).

Ertner, Kragelund, and Malmborg [4] notions of empowerment can be discussed through the results of the design inquiry. As discussed before, the power relations between the dog and the human, and the conflict for the designer to get an approval and listening more to the dog (not listen to the dog owner’s opinion or speculations on what the dog think or feel) has reproduced some pre-existing power relations. To enhance the dogs’ level of power position, the modification of the prototype could have been an opportunity to equalizing more the role of the dog user as a legitim and understandable participant. The exclusion of certain tools and materials based on the handlers demand, also reduced the dog’s ability to choose, consequently reducing its voice in the discussion, during certain parts of the design process. This is a difficult subject since one of the key points in ACI is not to put the animal in any harm, and a designer often has to trust the owner in what could harm the animal. Especially when certain tools such as a bringsel tool may not be harmful on the ground but can cause damage when mounted to a wearable. During the forest environment test, the dog was the acting participant, leading the human, this could be seen as empowering for the dog. Testing prototypes that hinder the dog’s movement could perhaps even lower the dog’s empowerment in those situations. The relationship between the dog and the human was key, making sure that the dog’s well-being was maintained. The human participant had to think through the dog on what could harm and lower the dog’s self-esteem.

CONCLUSION

This study aimed to empower the relationship with the help of mediated wearable interaction between the dog and the human when searching. With the help of a dog vest with tools could the air-scent search dog send messages to its handler when the dog has found a missing person. During this research, two types of tools with bite and pulling interactions has been developed and tested on an air-scent search dog in two different environments. The technology between animals and humans needs to allow both perspectives in order to work together. Both the dog and human need a purpose to the technology, and function of the prototypes need to work as a helper for their relationship.

When creating prototypes for both dogs and humans, there is a need to understand their relationship together. Through understanding dog-human relation comes challenges due to verbal communication barriers. It is essential to create and use design methods that fit the specific species. For dogs, it can explore and test physical prototypes, while humans could participate in both verbal communication and user test work.

By using two common interactions such as bite and pull, as well as adapting the shape and position of the tool similar to the dog users’ material from the search training could the main dog user understand the meaning of the prototype. By observing how the dog interacted with physical prototypes gave results about what worked or not. It became clear that the dog’s understanding of how to use the prototype was based on where and in what context it was tested. The results from user tests in the dog’s home compared to outside in a forest showed that the dog’s activities are linked to the environment.

Benefits from the design inquiry helped the designer to think more like a dog when developing a prototype or material for a dog. With the participating dog, both the designer and the human user could gain more knowledge about how to involve and communicate with the dog in an environment during searching.

Challenges from the design inquiry showed the difficulties with the understanding of the dog, and if the dog's indexical signs were analysed right. The conflict between the approval from the owner and the designers' ability to listen to the dog was confirmed. Due to verbal barriers and user tests in an uncontextualized environment, the dog could not understand what it was supposed to do with the vest and the bringsel tool.
FUTURE WORK
This study has discussed the relationship between a human and a search dog and found that their relationship and understanding of each other was of great importance to the design and implementation of the dog vest. Future work should probably involve collaboration with an animal behaviour expert, to make sure that the animals' voice is more clearly understood, and not only heard from the owner.

REFERENCES


