

# **Designing a Social Robot for a Children's Hospital. Caring Responsibilities of Technological Design in Sustainable Cities<sup>1</sup>**

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## **1. Introduction**

Since 2012 we have been collaborating on an interdisciplinary project team to develop an innovative health program to introduce social robots into the daily dynamics of a pediatric hospital for children's therapy and accompaniment. Designed to interact with people in a manner consistent with human psychology, and following the guidelines and rules of social interaction (Breazel, 2011), social robots have been developed for multiple applications, among them children's hospitals (Caci et al., 2004; Diaz et al., 2010, 2011; Michaud et al., 2007; Tanaka et al., 2007, etc., among many others).

Alongside this multidisciplinary collaboration process, the roboticists were exploring functionalities, programming and robot's appearance. In this process, we, as social scientists, had the assignment to integrate users' views and concerns in their design; identifying children's preferences regarding their affective and relational needs when hospitalized. In this context it was developed a participative process with children to design a social robot.

### **1.1. A brief revision of citizen's and children's participation in technology**

The participatory process was conceived and designed taking the STS (Science and Technology Studies) tradition of debate and study of citizen's participation in science and technology—a central issue for STS since the 1970s (Bucci and Neresini, 2008). As a general perspective, from STS it is assumed that changes that have occurred in knowledge societies are transforming the conditions of participation in the public and political life of contemporary societies (Callon et al., 2001;

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Mort et al., 2015). The enormous growth in and emphasis on innovation promise in science and technology in the last century has created contradictions for institutions of governance (Jasanoff, 2003). As technical development has become more pervasive, global and complex, demand has grown for more systematic evaluations and international rules and standards to control costs and benefits of technological and scientific progress. The 1984 chemical plant disaster in Bhopal, the nuclear accident in Chernobyl in 1986 or the controversies around Monsanto's genetically modified foods and crops are paradigmatic examples of this complex process of scientific and technological development that demand more complete and multivalent evaluations. From the '90s, partially due to these changing modes of scientific research and development, there is growing pressure for accountability. The demand for greater public involvement and participation in assessing risks and uncertainties for new technologies is perhaps the most prominent demand—the so-called “participatory turn” in science and technology (Jasanoff, 2003).

In this framework appear numerous proposals and methodologies focusing on co-production as a way of knowledge generation, claiming to diminish the dichotomy between experts and lays. This kind of initiative bets on highlighting different voices that are often invisible, introducing the discussion of laboratory research and “research in the wild”, that is, research in which laypersons work with scientists to produce and disseminate knowledge (Callon et al., 2009). Concepts such as consultation, public participation, or debate are increasingly present in the decision-making processes of issues mobilized particularly by technoscience (Callon et al., 2001; Domènech, 2017). They appear as different experiences with different citizens' participation, from punctual interventions to hybrid forums, public spaces in which diverse groups and persons discuss in a search for commonality and desired words (Callon et al., 2009).

Parallel to the debate surrounding public participation in technological development from the social sciences, from computer sciences and engineering the tradition of participatory design (PD) was developed, a methodology born at the end of the '70s and promoted by the unions of Scandinavian countries inspired by participatory action research (Clemensen et al., 2007). This trade union movement sought to increase workers' control over their own work and to democratize the technology that, since the '70s began to be established in all companies (Kensing and Blomberg, 1998). In the beginning, PD was strongly linked to political action and to an objective of social change—a methodology intensely concerned with the ethics of design and the democratization of labor, driven by pragmatic, theoretical and political motivations (Greenbaum, 1993). However, today in most PD projects, and also in the experiences in which children participate, the focus is on methodologies that facilitate the participation of users during the various phases of the design process (for a review of the approaches of analysis made from the PD, see Kensing and Blomberg, 1998; Sanders and Stappers, 2008; or Spinuzzi, 2005).

Although participatory episodes with children are not quite common in PD, since the '90s interesting experiences involving children in the processes of designing information technology have appeared. A review of the different theories

and applications developed in this field can be found in Nettet & Large (2004). These approaches understand children as an important group of users and consumers of technology (Heller, 1998), which implies the need to wonder about how to develop new technologies that respect them and respond to their needs. In this sense Druin's (Druin, 2002) proposal, which develops a model to understand the several roles that children can adopt in a participatory design process, and the ways these roles can affect the produced technologies, is very popular. Regarding children as users or consumers of technology, the more they participate, the more the development of innovations and improvements to the final design of technology is facilitated for them (Fails et al., 2013; Frauenberger et al., 2011; Good et al., 2006).

### **1.2. An ethics of care as way of conceptualizing children's' participation**

Participation of children as a concept and as an approach was consolidated in 1989 from the United Nation's Convention on the Rights of the Child (CRC). CRC proclaimed the right of participation as a fundamental right of children, understanding that participation is the means through which a democracy is built and it is a fundamental right of citizenship. Accordingly, the participation of children refers to their processes of participation in the public domain (schools, community associations, or other organizations) outside the family, through which decisions are shared that affect their lives and the life of the community in which they live (Hart, 1992).

Liberal theory's main concern was to create citizens of a state rather than subjects of a king. This change is crucial for children's status, because citizenship is defined by the rational capacity to consent to political authority, and this capacity makes a distinction between rational adult citizen and non-rational child. In early liberal theory, the role of children was distinguished from that of other noncitizens because they have the potential to become citizens since they will develop the necessary attributes of citizenship, such as reason, autonomy and oneself authority's capacity. In liberal theory, however, the objective is to produce rational citizens; the way of producing and caring for such creatures is irrelevant to liberal political theory (Arneil, 2002). Caring belonged to the private, as opposed to public sphere, and also belonged to the realm of natural and organic phenomenon; therefore, it was of little political interest. The liberal theory of citizenship, is based on the separation between the public world of rights-bearing citizens and a domestic sphere of non-rights-bearing caregivers and their dependents (Pateman, 1988). Although in contemporary occidental societies the traditional division of reproductive labor of women in the household and male breadwinner in the labor market is not an accurate description of the way most people live, the notion that citizenship is attached to work remains (Tronto, 2005).

Some critical perspectives from feminist political philosophy question the power of rights discourse that can have pernicious consequences for children. Children's rights theorists have very good reasons for advocating for rights for children; its ultimate goal, that we share, is to improve children's lives. Rights are

seen as the best tool to achieve this end. This is the assumption that the ethics of care wishes to challenge. Rights have been used by women, black people and other oppressed groups to improve their lives. However, as Arneil (2002) proposes, we should not assume that the same holds true for children. While the concept of rights is elastic, it cannot escape its origins based on the critical distinction between public rights and private care. *The nub of the problem is this: while rights' theorists, building upon a liberal framework, ultimately believe that the fight to improve children's lives is progressing the further we move from "nurturance" to "self-determination" [...], it is clear that if one takes children's need to care seriously, we are moving in the opposite direction, namely from a focus on the right to liberal autonomy (and the conceptualization of the individual, state, and society which accompanies it) to a reconceptualized understanding of the need for (and responsibility to) care* (Arneil, 2002:86–87).

Although not conceptualized explicitly with the concepts of citizenship and rights, the PD experiences developed with children assume this logic, according to which as much as children participates, so much they will improve their status of citizenship and technological design will be progressively democratized. Nevertheless, our aim in this text is to challenge this assumption, assuming the role of radical critic to the rights discourse, that proposes an alternative construction of citizenship based on the caring relations and the ethics of care. Since Carol Gilligan's publication *"In a Different Voice"* (1982), a vast number of pages about the ethics of care has been written. Despite its origins in feminist studies and struggles, some interpretations advocated understanding the ethics of care as a proposal to deprivatize and degenderize the notion of care, with the aim of transforming the moral boundaries that care has historically contained, feminized and privatized (Tronto, 1993).

It is understood that the ethics of care contain two basic dimensions (Sevenhuijsen, 2000, 2004): a first dimension that refers to care as a series of concrete activities, i.e. care in its most everyday sense of "caring for" and "taking care of". The second dimension refers to the set of values that guide action in various social spheres. In this sense the ethics of care has developed a series of debates about the meanings and values of care in modern societies to integrate care into political discussion. From the care approach, the concept of autonomy is critiqued, with an articulation of its reformulation around three arguments (Verkerk, 2001): 1) questions the idea of self-sufficiency and independence as the main value for human living, making other neglected values emerge, such as trust, caring and responsibility; 2) autonomy could be understood as a moral capacity that can only be developed in relation to others, not in isolation from relationships—the concept of "relational autonomy"; 3) the moral question from a care perspective is presented in terms of responsibilities, rather than of rights (to autonomy, to participation)—relationships in which responsibilities towards each other are set.

As Sevenhuijsen (2004) explains, the underlying motivation of an ethics of care approach is to focus attention on care as a political concept and to position it as a social and moral practice of the notion of citizenship. The moral subject of the lib-

eral conceptualization of the citizen is that of a free subject that has associated a series of individual rights. This subject establishes relationships based on their rights and obligations and the resolution of a series of moral dilemmas based on a hierarchy of rights, obligations and relationships. However, the ethical subject that poses the ethics of care always lives in a network of relationships in which each one has to reconcile different forms of caring responsibilities (Sevenhuijsen, 1998).

## **2. Objective and hypothesis**

The main objective of the presented research is to develop a participative process with children to design a preprototype of a social robot for a children's hospital, as a way of democratizing technology in sustainable cities through citizen's participation.

### **2.1. Designing a social robot with children**

During a 3-month period, a research team of engineers, medical personnel, and social scientists worked in a school with a group of 6-year-old children and 11-year-old children to design a prototype of a social robot for a children's hospital.

Two 1st-grade group classes and two 6th-grade group classes participated in the experience—a total of 120 pupils. In most of the workshops, instead of working with the whole class, subgroups of five to six students were organized to facilitate the participation of all children. With each group-class, the participative experience was conducted alongside 12 workshops, one per week for each group class (a total of 48 sessions). The analysis presented in this essay is based on the experience with 1st-grade pupils (6-year-old children). Designing a social robot was systematized into six phases, some of them conducted in one workshop and others with two or three (see Table 1). Each phase was defined in relation to the desired objective and the activities that would be done with the children. Later, all workshop activities were defined in detail with the two 1st-grade teachers of the school, in an attempt to use interesting dynamics and methodologies adapted to the age of the children. In all workshops carried out, school participation included children, two teachers, two social scientists, and one engineer.

### **2.2. Participation of children as a way of democratizing technology?**

We use the field work done during these participative projects to nurture our political reflections, using political theories and STS debates as toolbooks for articulating our suspicions and analysis for discussing critically what seems to be a desired participation of citizens in technology as a way of democratizing it. As is explained, we focus the analysis on children's "participation", as they are the main actors of our design process.

However, by its very nature, the fact that the main actors in our process are children facilitates the emergence of particularly controversial issues in participatory processes. Alongside the participatory process, there emerged lots of contro-

versies and uncertainties that put us on the spot: our inexperience in holding a participatory process with children, getting over the tensions between institutional constraints and the aim of democratizing the robot's design and adapting our methodology to school pedagogies.

Our starting point was to discuss the supposed "autonomy" of individual citizens who participate in a process of technological design. Assuming the perspective of the ethics of care that proposes a radical reconceptualization of the notion of citizen as an individual with his/her own rights, emphasizing responsibilities and caring interdependency relations, an analysis of the participative process from a different dimension is undertaken. Integrating the ethics of care into the analysis of the participatory process enabled us to consider what the caring needs were in each specific situation, as the centrality of caring includes the right to have time to care and to make a place of care for our bodies, ourselves and our environment. Opening new looks into the analysis of multiple caring interdependency relations articulated during the process is proposed as a new political dimension for the analysis of participation in technological design and for rethinking the debate surrounding the responsibilities of technological design towards society and the world.

### **3. Results**

With the intention to integrate the ethics of care into the analysis of the participative process with children for designing a social robot, we focus on two specific episodes. The first episode, "*sticking papers on the whiteboard*", allows us to unravel the network of caring relationships among the participants and the way that these relationships imply the constant adjustment and readjustment of the defined participative process. In the second episode, "*saving robot prototypes in trays*", we focus on how caring also includes technologies and objects and how caring for these things also implies caring for children.

#### **3.1. Sticking papers on the whiteboard**

In the first workshop conducted at the school (Phase 1) we wanted to share a workflow with children, engineers and social science researchers with the intention to put children in the role of roboticists, discussing with them what the engineer's work is, their daily tasks and problems, etc. Children have to write on a paper their ideas about what an engineer is or does, and then stick the paper on the whiteboard, while explaining their annotation. However, after some minutes not all six-year-old children in the classroom had completed the task, because some of them write slowly or don't know all the spellings and cannot translate what they wanted to explain into letters. Because of this the possibility of making a drawing about what particular thing an engineer is/does was introduced. It was a slightly messy situation because the children who wrote with letters and, consequently, finished before, were standing up, explaining their ideas and sticking the papers on the bottom of the circle drawn on the whiteboard, while teachers were discussing with the rest of the class, some of them were still drawing whether this was or was

not a thing that an engineer is/does. Progressively, while the other children stood up, the children who were not so fast writing letters, could not reach to stick their paper in the top of the circle, as the bottom part was full; so, it was the teacher who took the paper and stuck it on the whiteboard. Moreover, their ideas cannot be well discussed because teachers were sticking the papers on the whiteboard (backwards) instead of discussing the ideas with the whole group as the initial ideas stuck were facing forward. Hence, the messy situation was progressively growing.

Some care ethics theorists' claim that good care cannot be explained by a universal title defined in general principles, in a way that is done, for example with medical ethical principles. Instead, it is something that people shape, invent and adapt in everyday practices (Hamington and Miller, 2006; Tronto, 1993). And as also has been identified by these theorists and many other feminist theorists, care is not only about bodies or things, it is also about intangibles, as is well represented by other care synonyms used sometimes for the same kind of tasks and activities, such as subjectivation or affective work. Caring for children is building communities and sustaining meanings, affective dispositions and shared forms of value, which underpin social coexistence and cooperation (Fraser, 2016). In the above explained activity, the adaptation of the activity is a way to take care into consideration in the participation process. Some 6-year-old children were writing their ideas about what an engineer is or does faster on the paper, while others were still thinking how to write what they were thinking or how to do the letter they were spelling. Although the introduction of the possibility not initially planned of making a picture, supposes changing the activity's defined methodology and supposes that the session finally was a bit more chaotic than it was originally designed, the introduced changes were done for adapting the participative process to children's practices, taking care of these intangibles.

The skills of the research team members in planning the activity for children writing their ideas, as well as the improvised adaptation to different children's literacy practices, are a way of focusing on heteronomy, instead of focusing on autonomy; it is not understanding autonomy and heteronomy as opposites, but stressing in the concept "heteronomy" the interdependence of all processes and actors and the constant adjustments among them. Human practices and relationships are not always rational or predictable, the adaptation and adjustment of the planned participative process to the practices and needs of children doing the activity must be handled together with care. This issue is well represented by the distinction developed by Mol (2008) between the logic of choice and the logic of care. The concept that Mol (2008) develops for health care is that a world infused with the idea of individual choice and the logic of choice does not offer a superior way of living to the life that may be led in a world infused by the logic of care. The logic of care concentrates on what we do in a particular situation for articulating how to live well and how to shape good care, and instead of focusing on persons as subjects of choice, it focuses on them as the subjects of all kind of activities. In the activity of defining what an engineer is or does, if children who were not writing their ideas

quickly had no other option than to write, it is quite probable that they wouldn't have felt well or comfortable. Independently of their specific idea of what they wanted to explain about an engineer, their choice of how to define him/her, children felt better if the research members were aware of what they were doing and their literacy learning, and consequently they adjusted the participative methodology to these practices.

The adjustment of the process to actor's practices reminds us to the *matters of care*. From actor-network theory (ANT) some authors such as Storni (2015) rethink participation in participative design of technology as a *matter of concern* (Latour, 1999). Contrary to the *matters of facts*, universal statements about the nature of phenomena, *matter of concerns* looks at the mediated and procedural aspect of reality with special emphasis on the relations that can be given among the actors. Feminist orientations of STS and ANT add crucial sensibilities to the conceptions of agency, emphasizing the always relational character of our capacities for action, the constructed nature of subjects and objects, resemblances and differences, and the corporeal grounds of knowing and action (Suchman, 2003). From this sense, Puig de la Bellacasa (2011) proposes to add to the *matters of concern* the *matters of care*, which means to take into account those participants who will hardly be successful in articulating their concerns and also those issues that are not part of the prevailing worldview (Papadopoulos, 2008). In the first narrated episode, it is quite evident how teachers and members of the research team directed their attention to different children and their different practices, introducing an option not previously defined to make a picture instead of writing, thereby adapting the activity to different children's literacy learning.

The notion of *matter of care* proposes to direct attention to analyze how care operates in a sociotechnical context, especially taking into account the different roles that the researchers themselves have in the research processes. The sticking episode is not finished when children write or draw their ideas. Children have to stand up and stick their papers in one of the circles of the whiteboard. The bottom part of the circles was progressively full of papers, and six-year-old children have short legs and arms, so they could not reach the empty top of the circle. Maybe an initial caring practice would have been to draw the whole circle in the bottom half of the whiteboard. However, as the actors went along, things were ordered and assembled in some ways and not another. In the sticking episode, teachers and children were sticking papers on the whiteboard because the circles were drawn too high and children could not reach the top of the circle to stick their ideas. The final composition of stuck papers organized in circles defining what an engineer is or does and what not, is the organization of the world of the assemblage of the teachers, children, circles on the whiteboard and the papers with letters and pictures. It seems obvious that not all actors involved in the participative process are the same, nor participate in the same way in the assembly. *Matters of care* take into account what makes possible the process we are analyzing, what concerns prevail and, ultimately, to which world it contributes.



In the analysis of this episode of “sticking papers on the whiteboard” from the introduction of the ethics of care possibilities emerge the relational associations between all actors involved in the participative process. While not focusing on autonomy, this approach stresses the constant adaptation and adjustment to intangible care needs of participants, in our case the children who are designing a social robot. Participation from the ethics of care approach is a needed never-ending process of adjustments and readjustments, first changing from letters to drawings, then solving the problems of children that cannot reach the bottom empty part of the circle, then assuming the chaos of children moving in the class while the teacher comments on other children’s ideas, etc.

### **3.2. Saving robot prototypes in trays**

After conducting a set of activities to decide which robot each group was going to develop, and defining its appearance and main features, in Phase 5 two workshops for building prototypes were organized. Based on the pictures and the description given in previous phases, a first prototyping workshop was conducted for building robots with modelling paste. During two sessions 6-year-old-children played with modelling paste to shape a robot. After this prototyping exercise, another workshop conducted alongside two more sessions for building the same prototypes with robotic construction blocks was organized. From one session to another, the prototypes were saved in trays. For each group-class two trays were used for the modelling paste prototypes and then two more trays for saving the robotic construction blocks prototypes were added.

So, the course of the events was as follows. In the morning a group of children start an activity with their 2 robotic teachers, 2 social scientists and 1 engineer, to shape a robot (first with modelling paste and then with robotic construction blocks). After the 50-minute session, they save the robot (more or less finished) in a tray that teachers give them, together with other robots built by other groups. The trays, in the eyes of children, disappear from their classroom to nobody knows where. The next week, one day in the morning the robotic teachers, the social scientists and the engineer appear again with the trays and with the robots. Also in the sessions for prototyping with construction blocks, the earlier modelling paste robots (along with the construction blocks ones) were always taken to the classroom for children to have the reference for their designed robot. Intuitively it could seem that the event would go on following the same point where it finished the last session. However, there is a detail that points to a relevant difference: when trays left the classroom away from the eyes of children, they were saved in the robotic room of the school, a room with not so many space and lots of things. In this room the trays were stacked on top of each other, together with the trays of the other groups. The consequence was that, session after session, the modelling paste prototypes were progressively chopped, dismantled and dirtied. With the robotic construction block trays, what happened was that apart that the prototypes also being broken, the room where they were saved was the robotic room where older children went for their lessons, and when they needed some construction

piece or programming bricks, they took them from the trays. Therefore, every week, on the day on which the participative process was done, children had to dedicate time to repairing their prototypes as much as possible. Sometimes it was possible but sometimes it was not, because the modelling paste was too dirty or because a piece was missing and could not be replaced, or the brick had a different programming. Sometimes children were annoyed or very annoyed, other times they searched for an alternative or in the end, sometimes they passed without paying attention.

In the “sticking papers on the whiteboard” episode, the analytical emphasis has been done with care for the intangibles and the constant adjustment among all actors. In this episode, complementarily, the focus is on the care of things. “*Care is everything we do to maintain, continue and repair our world so that we can live in it as well as possible. This world includes our bodies, ourselves and our environment, all that we seek to interweave in a complex web of sustaining life*” (Fisher and Tronto, 1999:30). This wide definition of care implies a radical political turn because it contains the intention to deprivatize the notion of care, thus challenging one of the moral boundaries in which the origin of citizenship’s notion is sustained—that of the radical separation between the public with citizenship rights and the private with natural and organic cares.

Although not following this line of argument, the intention to question the traditional dichotomy’s categories sounds familiar to STS. From this approach, there are pioneering works analyzing and discussing the care of things (Mol, 2008; Puig de la Bellacasa, 2010, among others). Foregrounding such care of things is a way for the overlooked dimensions of caring in material ordering to emerge and to renew how maintainability has been conceptualized (Denis and Pontille, 2013). Exploring relationships between the care of things and autonomy, López Gómez (2015) foregrounded the continuous process of adjusting and stabilizing devices’ arrangements as a constitutive aspect of maintaining autonomy. From these approaches, autonomy won’t be defined by a particular arrangement but by an open range of defined small associations and adaptations along with interactions and experimentations.

In this episode, there is what a double process seems at the same time: members of the research group didn’t take care of the prototypes, and treated them in a way that was not concerned with guaranteeing their material configuration. On the contrary, children took the responsibility of maintaining, cleaning, fixing and composing the robot prototypes saved in trays. Mol (2002), in her analysis of care of patients, identifies that the logic of care is a skill partly distributed. But in the logic of care identified by her, the traditional borders between practitioners, family and lay persons are moved, and care is not just reserved for doctors and nurses. However, during the participatory process in the school, our observations are more similar to the conclusions of Denis and Pontille (2013) in their analysis of the maintenance of the Paris subway than that of Mol (2002). For them the distinction between maintenance workers and riders in relation to attention and activity for caring for signals and other things used in the subway is quite clear. In the partici-

pative process analyzed, the responsibility of maintaining the robot prototypes was tackled particularly by the children. Teachers and other members of the research group were only involved in fixing and recomposing robots when children asked them to.

In the analysis of the episode of “saving prototypes in trays”, the argument highlights the necessity of taking care of things as a way to analyze participation stemming from the ethics of care. In guaranteeing the maintenance of robot prototypes, the logic of care is not distributed at all as children are the only ones who take care of their prototypes. In this episode, it seems that taking care of things that children do as part of the participative process could be understood also as a way of taking care of them. Emphasizing the material caring relations in the process allows us to identify the distribution of caring responsibilities among the process—an inherent dimension of the ethics of care.

#### **4. Conclusions**

Starting the analysis questioning the supposed "autonomy" of the citizens who participate in a process of technological design, it is integrated the theoretical debate around the critique with the notion of citizenship based on individual rights, represented by the debate in political philosophy surrounding an ethics of care. One of the most relevant contributions of the ethics of care is its focus on relationality and interdependence, emphasizing responsibilities over rights (Arneil, 2002). From the guiding thought that people need each other and that they can only exist through and via caring relationships, the notion of citizenship is widened with another one of “caring citizenship” (Sevenhuijsen, 2003). This approach is also taken from STS with the proposal of Puig de la Bellacasa (2012) of *thinking with care*, as a way to stress the relevance of care as a vital requisite for thinking and understanding worlds and as a way to reflect on the role of care in technoscientific contexts (e.g., Lopez et al., 2014; Schrader, 2015; Star, 1991; Suchman, 2003, among many others).

Analyzing the participative process with children in designing a social robot from perspective of the ethics of care gives us the opportunity to discuss critically some of the uncertainties and handicaps that appeared during the process. To understand children’s participation in technological design, conceiving it on the basis of responsibility relationships, and not on the basis of autonomous citizen’s rights, is proposed. Participation from the relational approach proposed by the ethics of care begins with the ways in which people formulate their responsibilities in a specific context and how they handle the dilemmas of responsibility between them, the others, the world around them and the conflicts that may arise between them. It implies taking care of the tangibles of intangibles. In our case, the well-being of children during the participative process is identified with a constant adaptation to ad hoc specific situations, in a never-ending process of adjustments and readjustments that configures the participative process in an open methodology. As a political positioning in which care is the focus of the participative process,

hand in hand with the responsibility to take care of children's needs during the process, is also included the need to take care of things involved in the process, thus underlining the importance of material caring relationships in designing technology.

The proposal developed in the analysis is to introduce care into the debate surrounding citizen participation as an inextricable element for the democratization of technology. Although this is understood as a general outline, in our specific experience of designing a social robot with children this approach leads us to debates linked to the introduction of ethics in the design of social robots. In line with the proposal of van Wynsberghe (2013), introducing ethics in designing a social robot implies a care-centered design approach that begins from the very beginning from the moment of the idea of generation and throughout the design of prototypes. The inclusion of care issues in the study about participation in technological design implies the integration of a perspective according to which neither policies linked to the generation of knowledge can be disjoined from the issues of care, nor ethics in technology. Opening new looks at the analysis of multiple caring interdependency relations articulated during design processes is proposed as a radical political view for the analysis of participation in technological design in general, as well as in robotics, thereby rethinking the debate surrounding the responsibilities of technological design in smart sustainable cities.

### **5.Applicability**

The results of the study offered a set of outputs that could facilitate practical applicability. This transferability could be systematized alongside two dimensions: a methodological dimension and an analytical one.

On the one side, regarding robotics as a subject of study and PD as a method to design social robots, a useful six steps method, including a set of goals and activities for each step (see Table 1) is offered. Taking the deepening of democratic mechanisms of technological development in sustainable smart cities as a goal, a participatory methodology is proposed, taking robotics in all its complexity and multidisciplinary, thanks to the potential offered by robots to discuss and link everyday life with technological solutions. From this approach, children will be more than mere receivers of technologies to interact with, and they will develop critical and creative abilities to use social robots as a way of relating to the world according to their needs and wishes.

On the other side, analyzing the participatory process with children in designing a social robot from the perspective of the ethics of care allows us to develop an analytical proposal that should be useful for other participatory processes aiming to integrate responsibility in technological design. Taking care of tangibles and intangibles could be understood as two indicators of how a participatory process introduces the concept of caring citizenship in innovation processes in smart sustainable cities.

*Table 1.*

***Participative process' phases for designing a social robot with children***

<b>Design phases of a social robot</b>	<b>Objectives to reach with children</b>	<b>Activities to do in the school</b>
1. Organize an interdisciplinary team	Sharing a workflow with engineers and social sciences researchers	What is an engineer? What does he/she do? (all group) 1 session
2. Analyse stakeholders' needs	Empathizing with sick children's needs	How I felt when I'm sick? (individual) 1 session
3. Define what we want the robot to do	Choosing what robot we want to develop	What thing I will bring with me in an hospital? (small groups) Role-playing of an hospital (small groups) 2 sessions
4. Specify the features (functional and of design)	Choosing the appearance and functionality of the robot	Defining the robot's appearance and its features (small groups) 2 sessions
5. Develop prototypes (conceptual and functional)	Building prototypes	Building prototypes with modelling paste (small groups) Building prototypes with robotics' construction blocks (small groups) 4 sessions
6. Validate the prototype (fatigue tests / robustness and users)	Testing prototypes	Playing with prototypes (small groups) Presenting prototypes (small groups) 2 sessions

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## **6. Bibliography**

- Albo-Canals, J., Fernández-Baena, A., Boldu, R., Barco, A., Navarro, J., Miralles, D., Raya, C., Angulo, C.: Enhancing long-term children to robot interaction engagement through cloud connectivity. In: *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction Extended Abstracts, HRI'15*, pp. 105–106. ACM, New York, NY, USA (2015)
- Arneil, B. (2002). Becoming Versus Being: A Critical Analysis of the Child in Liberal Theory. In D. Archard (Ed.), *The moral and political status of children* (pp. 70–94). Oxford: Oxford University Press.

- Breazeal, C. (2011). Social robots for health applications. *2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 5368–5371.
- Bucci, M. & Neresini, F. (2008): Science and Public Participation. In E. Hackett, O. Amsterdamska, M. Lynch & J. Wajcman, J (Eds.), *The Handbook of Science and Technology Studies* (pp. 449-473). Cambridge, Massachusetts: MIT Press.
- Caci, B. D'amico, A. & Cardaci, M. (2004). New Frontiers for Psychology and Education: Robotics, *Psychological Reports*, 94, 1372-1374.
- Callon, M., Lascoumes, P., Barthe, Y. (2001). *Agir dans un monde incertain: essai sur la démocratie technique*. Couleur des idées. Editions du Seuil.
- Clemensen, J., Larsen, S. B., Kyng, M., & Kirkevold, M. (2007). Participatory Design in Health Sciences: Using Cooperative Experimental Methods in Developing Health Services and Computer Technology. *Qualitative Health Research*, 17(1), 122–130.
- de la Bellacasa, M. P. (2012). Nothing comes without its world: Thinking with care. *Sociological Review*, 60(2), 197–216.
- Denis, J., & Pontille, D. (2013). Material Ordering and the Care of Things. CSI WORKING PAPER, 34.
- Díaz, M. et al. (2011). Building up child-robot relationship: from initial attraction towards long-term social engagement. *A:HRI 2011. Human Robot Interaction. Workshop on Expectations in intuitive human-robot interaction*. Lausanne, 17-22.
- Díaz, M. Sàez, J.; Pardo, D. & Angulo, C. (2010). Pet robots with social skills for satisfactory interaction with hospitalized children. *Proceedings of RSS 2010 Workshop Learning for Human-Robot Interaction Modeling in Robotics: Science and Systems Conference*.
- Díaz, M., Angulo, C., Domènech, M., Albo-Canals, J., Serrallonga, N., Raya, C., Barco, A. (2016). Assessing pediatrics patients psychological states from biomedical signals in a cloud of social robots. In: *Mediterranean Conference on Medical and Biological Engineering and Computing*, pp. 1179–1184.
- Domènech, M. (2017). Democratizar la ciencia. un reto todavía pendiente. *Revue d'Anthropologie des Connaissances* (In press).
- Druin, A. (2002). The role of children in the design of new technology. *Behaviour and Information Technology* 21(1), 1–25.
- Fails, J.A., Guha, M.L., Druin, A. (2013). *Methods and Techniques for Involving Children in the Design of New Technology for Children*. Hanover: Now Publishers Inc.
- Fisher, B., & Tronto, J. (1990). *Toward a feminist theory of caring. Circles of care: Work and identity in women's lives*, 35-62.
- Fraser, N. (2016). Contradictions of capital and care. *New Left Review*, 100, 99-117.

- Frauenberger, C., Good, J., Keay-Bright, W. (2011). Designing technology for children with special needs: bridging perspectives through participatory design. *CoDesign* 7(1),
- García, P. (2011). Revisión crítica de la política ontológica latouriana. *Athenea Digital*, 11(1), 155–170.
- Gilligan, C. (1982). *In a different voice*. Cambridge: Harvard University Press.
- Good, J., Robertson, J., Carss (2006). A framework for learner centred design with children. *International Journal of Artificial Intelligence in Education*, 16(4), 381–413.
- Hamington, M. & D. Miller eds (2006) *Socializing Care*, Oxford: Rowman & Littlefield
- Hart, R. A. (1992). *Children's Participation: from Tokenism to Citizenship. Unicef: Innocenti Essays*. Florence: UNICEF International Child Development Centre
- Heller, S. (1998). The meaning of children in culture becomes a focal point for scholars. *The Chronicle of Higher Education* pp. 14–16.
- Jasanoff, S. (2003). Technologies of humiliation: Citizen participation in governing science. *Minerva*, 41(3), 223–244.
- Kensing, F., & Blomberg, J. (1998). Participatory Design : Issues and Concerns. *Computer Supported Cooperative Work*, 7(1993), 167–185.
- Latour, B. (1999). *Pandora's Hope. Essays on the Reality of Science Studies*. Cambridge: Harvard University Press.
- López Gómez, D. (2015). Little arrangements that matter. Rethinking autonomy-enabling innovations for later life. *Technological Forecasting and Social Change*, 93, 91–101.
- Marres, N. (2007). The issues deserve more credit pragmatist contributions to the study of public involvement in controversy. *Social Studies of Science*, 37(5), 759–780 (2007)
- Michaud, F. et al. (2007). Perspectives on Mobile Robots as Tools for Child Development and Pediatric Rehabilitation, Assistive Technology. *The Official Journal of RESNA*, 19 (1), 21-36
- Mol, A. (2002). *The Body Multiple: ontology in medical practice*. Durham, NC: Duke University Press.
- Mol, A. (2008). *The logic of care. Health and the problem of Patient Choice*. London and New York: Routledge.
- Nesset, V., Large, A. (2004). Children in the information technology design process: A review of theories and their applications. *Library & Information Science Research*, 26(2), 140–161 (2004).
- Papadopoulos, D. (2011). Alter-ontologies: Towards a constituent politics in technoscience. *Social Studies of Science*, 41(2), 177-201.
- Pateman, C. (1988). *The Sexual Contract*. Stanford: Stanford University Press.
- Pestre, D. (2008). Challenges for the democratic management of technoscience: governance, participation and the political today. *Science as Culture*, 17(2), 101-119.

- Puig De La Bellacasa, M. (2010). Ethical doings in naturecultures. *Ethics, Place & Environment: A Journal of Philosophy & Geography*, 13(2), 151–169.
- Puig de la Bellacasa, M. (2011). Matters of care in technoscience: assembling neglected things. *Social Studies of Science*, 41(1), 85–106.
- Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*, 4(1), 5–18.
- Scaife, M., & Rogers, Y. (1999). Kids as informants: telling us what we didn't know or confirming what we knew already?. In A. Druin (Ed.), *The Design of Children's Technology* (pp. 1–26). Morgan Kaufmann Publishers. 9.
- Schrader A (2015) Abyssal intimacies and temporalities of care: How (not) to care about deformed leaf bugs in the aftermath of Chernobyl. *Social Studies of Science* 45(5): 665–690
- Sevenhuijsen, S. (1999). *Citizenship and the Ethics of Care: Feminist Considerations on Justice, Morality, and Politics*. New York: Routledge.
- Sevenhuijsen, S. (2000). Caring in the third way: the relation between obligation, responsibility and care in Third Way discourse. *Critical Social Policy*, 20(1), 5–37.
- Sevenhuijsen, S. (2004). *Trace: A Method for Normative Policy Analysis from the Ethic of Care*. In S. Sevenhuijsen & A. Svab (Eds.), *The Heart of the Matter. The Contribution of the Ethic of Care to Social Policy in some New WU Member States* (pp. 13–47). Ljubljana: Peace Institute.
- Spinuzzi, C. (2005). The Methodology of Participatory Design. *Technical Communication*, 52(2), 163–174.
- Star, S. L. (1999). The Ethnography of Infrastructure. *American Behavioral Scientist*, 43(3), 377–391. <https://doi.org/10.1177/1056492611432802>
- Storni, C. (2015). Notes on ANT for designers: ontological, methodological and epistemological turn in collaborative design. *CoDesign*, 11(3–4), 166–178.
- Suchman, L. (2007). Agencies in technology design: Feminist reconfigurations. *Unpublished manuscript*.
- Tanaka, F. Cicourel, A., Movellan, R. (2007). Socialization between toddlers and robots at an early childhood education center. *In Proc. The National Academy of Sciences PNAS*, 104 (46), 17954-17958.
- Tronto, J. (2005). Care as the work of citizens: A modest proposal. In M. Friedman, M. (Eds) *Women and Citizenship*. Oxford Scholarship Online.
- Tronto, J. C. (1993). *Moral Boundaries. A political Argument for an Ethic of Care*. New York City: Routledge.
- Tronto, J. C. (2005). Gendering Ethics and Political Theory. In *Handbook Of Gender and Women's Studies*, 417-436. Sage Publications.
- van Wynsberghe, A. (2013). Designing Robots for Care: Care Centered Value-Sensitive Design. *Science and Engineering Ethics*, 19(2), 407–433.
- Verkerk, M. a. (2001). The care perspective and autonomy. *Medicine, Health Care, and Philosophy*, 4(3), 289–294.



Walker, M. U. (1998). *Moral Understandings: A Feminist Study of Ethics*. New York: Routledge.