



**HAL**  
open science

## Designerly way of thinking in a robotics research project

Dominique Deuff, Ioana Ocnarescu, Luis Enrique Coronado, Liz Rincon-Ardila, Isabelle Milleville, Gentiane Venture

### ► To cite this version:

Dominique Deuff, Ioana Ocnarescu, Luis Enrique Coronado, Liz Rincon-Ardila, Isabelle Milleville, et al.. Designerly way of thinking in a robotics research project. Journal of the Robotics Society of Japan, 2020, 38 (8), pp.692-702. 10.7210/jrsj.38.692 . hal-03070527

**HAL Id: hal-03070527**

**<https://hal.science/hal-03070527v1>**

Submitted on 14 Nov 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Designerly Way of Thinking in a Robotics Research Project

Dominique Deuff<sup>\*1</sup>, Ioana Ocnarescu<sup>\*2</sup>, Luis Enrique Coronado<sup>\*3</sup>, Liz Rincon-Ardila<sup>\*3</sup>,  
Isabelle Milleville<sup>\*4</sup> and Gentiane Venture<sup>\*3</sup>

<sup>\*1</sup>Orange <sup>\*2</sup>Strate École de Design <sup>\*3</sup>Tokyo University of Agriculture and Technology <sup>\*4</sup>LS2N

## 1. Introduction

Originally, design is a practice that aims at improving the living environment through quality craftsmanship. It developed during the industrial revolution, combining art and industry. In the 1950s, design made a marketing transition, and its objective was geared towards commercial efficiency. For about twenty years, some designers moved in another direction [1]. For K. Krippendorff, design from the industrial revolution was considered as outdated and design take a turn for social, political and cultural preoccupations [2] (cited by Ref. [1]). It seeks to reconnect with its original humanist tradition, and aims at focusing on the meaning of produced objects and their social significance. In that respect, design becomes user-centric, it concentrates on the triad of shape/function/meaning. In summary, through its history, design has focused first on the object, then on the functions, and currently it concerns experiences as shown by the Bremen model proposed by A. Findeli and R. Bousbaci [3] (cited by Ref. [4]). Design can be defined as the practice of future-oriented creation with the intention of improving a situation, carrying the willingness to reinvent the world at the service of the human [5].

Regarding design in the context of research, according to D. Fallman's model [6], design research activity can be visualised in between three extremes: "design studies", "design practice" and "design exploration". "Design studies" involves researchers from other disciplines like philosophy, psychology, sociology, history, etc. that analyse and framework the practice of designers, the specificities of the design process and the design impact for other disciplines. This field contributes to design theory, design methodology, design history, and design philosophy.

"Design practice" regroups activities that are similar to those conducted by designers outside of academia; it is a way of doing research through the practice of design. This position involves working as a designer in a practical project while having in mind a research question to answer. A. Findeli defines this type of design research as "*a systematic search for and acquisition of knowledge related to general human ecology considered from a designerly way of thinking, i.e. a project-oriented perspective*" [4]. He explains that design research should answer two questions: a design question coming from the project, and a research question for which the designerly way of thinking is central [4].

Finally, the third extreme, "design exploratory", is close to "design practice" in the sense that the researcher applies design to bring forth a product or a service, but it differs in its purpose. This type of design research proposes a new paradigm to challenge research topics; it makes the transition from 'problem-solving' approach to 'problem-setting' perspective. It aims at experimenting, sometimes to the point of provocation, to reveal alternatives to traditional thoughts. The outcomes of this type of design research become statements or contributions to an ongoing societal discussion.

As part of robotics research, few collaborations exist between design and robotics. However, design recently contributes to robotics through the three extremes of Fallman's model. Thus, in "design study", there is some contribution like the philosophic one of L. Damiano [7]. She studies the designer's role in the cross collaboration between designers and roboticists. In "design practice", design intervenes for the design of robots both in shape and in interactions (Ref. [8]~[10]). Design engage also for studying the impact of the integration of robots in an ecosystem, as researches carried out on the Roomba vacuum cleaner (Ref. [11]~[15]). Design enables also to question the future through "design exploratory", exploring various type of robots [16], and studying reactions to these proposals.

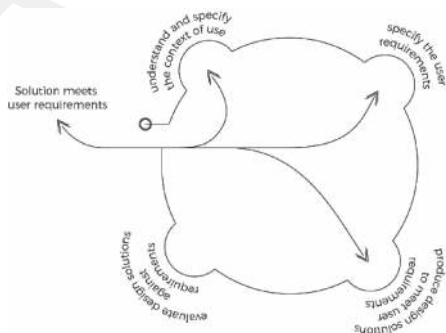
In the context of our research, our project focuses

on studying the living together with social robots, and in particular, mainly questioning the impact of social robots such as robots in the ecosystem of homes. To achieve this objective, the project aims at comparing the starting ecosystem (the current way of life at home) with the ecosystem integrating a social robot. Our approach is ecological (by definition ecology is the scientific study of organisms and their interactions with their environment) which means that studies are realised on real situations, because to understand the individual and his behaviour, it is necessary to understand his global environment [17]. Thus, users are placed at the heart of our approach and users' data are gained from the field which is the foundation of this work. The project does not aim at measuring the impact of any predefined device; rather it plans to study the impact of an object having been designed on the basis of data from the field. For this, the project follows a situated and user-centred design approach in strong connection and interaction with real users and their daily contexts.

## 2. User-centric Design, Different Approaches

Various user-centred design approaches exist. Through three different approaches, we will introduce specific characteristics of a user-centred design.

First, the *Human-Centred Design* standard (HCD) [18] is a standard process that was initially proposed in 1992 and validated in 1999, which consists in an approach to design interactive systems focusing on users. The process is composed on four phases which are repeated until an optimal solution is reached (**Fig. 1**): (1) users' observation phase to understand the context of use, (2) analysis phase to specify the users' requirements, (3) design phase to produce solutions, and (4) assessment phase to evaluate solutions with users. It is based on four principles that are at the centre of a user-centred design approach: (1) understanding users' needs, (2) making users participate actively in the process, (3) iterate on solutions, and (4) working into a multidisci-



**Fig. 1** HCD approach

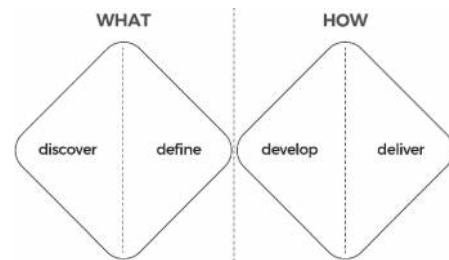
plinary design team.

The second approach is the design council's *Double-Diamond* [19]. In addition to the previous principles, this approach distinguishes two phases of the design process (**Fig. 2**): a first diamond to identify WHAT is the experience to design and a second diamond to figure out HOW to develop a solution to respond to the experience identified in the first diamond.

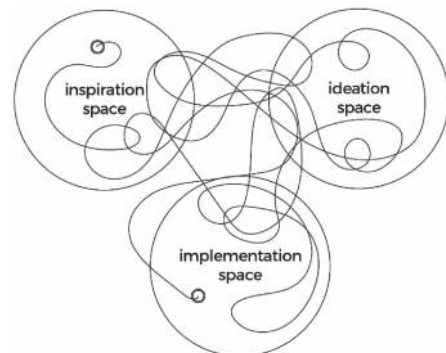
An important point of this approach is the notion of divergence-convergence which is at the heart of the creative attitudes introduced by A. Osborn for the brainstorming technique [20]. The divergence phase seeks to generate various ideas in quantity, without constraint. The convergence phase refocuses the project to make a choice among all ideas that were generated, using project's constraints as filters.

The third approach is *Design Thinking*, a process that aims at achieving innovative services or products. It existed as guidelines at the end of the 20th century and was formalised by T. Brown [21] [22]. This approach is collaborative in nature and consists of three *spaces* through which a team will pass as many times as necessary and in a varied order. (**Fig. 3**): (1) "inspiration space" to understand users, (2) "ideation space" to generate and test ideas and (3) "implementation space" to develop the product to market.

*Design Thinking* as described by T. Brown has popularised the "design culture" and the design way of thinking. D. Norman argues [23] that "[a]lthough [he] still sticks to [his] major point that design thinking is not



**Fig. 2** Double-Diamond approach



**Fig. 3** Design thinking spaces

an exclusive property of designers—all great innovators have practiced it—[he] now do[es] believe that designers have a special claim to it”. What is underlined through *Design Thinking* is the notion of empathy, continuous experimentation and regular questioning. This leads to the idea of iterating over ideas continuously in order to delay the development of a solution to seek innovation; that is to resist the temptation to take a solution directly and quickly in order to avoid being “captured by too facile a solution” [23].

This shows that underlying the processes, there is a specific designers’ way of doing and thinking. N. Cross refers to it by indicating that it is a “third culture” based on “*planning, inventing, making and doing*” [24]. H. Rittel clearly explains that design is a structured and organised work that is sometimes interrupted by ideas and intuitions [25]. S. Vial presents design as having two components “drawing” and “intent” [5]. Design is a practice which uses representation skills for the benefit of a vision or purpose. It brings both substance and form. Design practitioners follow their intuition, a certain part of subjectivity while formalising the objective data of the field. These different opposites are part of “design culture”.

While following the design process, one cannot know beforehand the outcomes of the process. But thanks to the method, the tools and the “design culture”, the result is always anchored in the project ecosystem, responding to users’ needs or improving the quality of their life. What is important to emphasise, is that the origin of the design work will always start from the humans, people, users in their environment.

### 3. Robotics for the Home—a Robotics and Design Research Project

Our project questions the impact of social robots in the ecosystem of the homes. Our goal is firstly to understand how and why this type of machines could be accepted and used in an ecosystem formed of people, contexts and products. Secondly, we ask questions in term of design and design choses: how to design strong and long-term commitment objects and services for the members of these homes?

The project focuses on the life of young retirees in their homes. Regarding this context, retirement is a time of many upheavals due to a return home, a possible loss of social positioning, possible isolation, or difficulties to communicate within the couple, etc. [26] [27]. In this context, we hypothesise that a social robot could be a vector between the two members of the couple to help going through this milestone of life changes. To

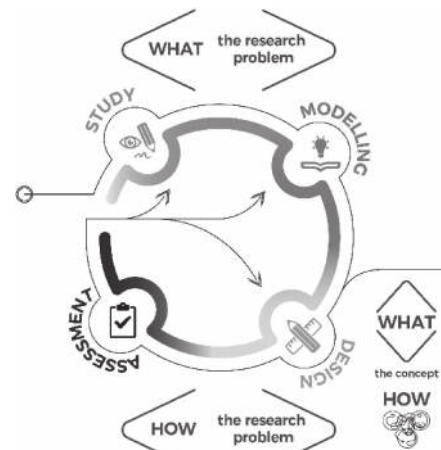


Fig. 4 Our four-phases design approach

answer the research question and to design this vector as a social object as part of the retirees ecosystem, a global process was implemented based on an original design approach.

This approach is composed on four phases clearly inspired by the *HCD* (Fig. 4) with several differences. First, the project is research-oriented and focuses on acquisition of scientific knowledge, thus the second phase consists in analysing data but also in modelling them. Second, the duration of an iteration may be longer than in a conventional design approach.

As previously defined, design focuses on people and design work is based on the understanding and feeling of these people in their context. This approach is strongly rooted in the field and the “study phase” is mainly composed of periods of empathic observation towards the retired couple and their ecosystem. This is in line with *HCD* and goes beyond. Being a divergent phase, the objective here is not only to observe an activity but a global ecosystem, with all the richness of lived experiences.

The “modelling phase” is a convergence phase to:

- analyse fragmented and unstructured data and consolidate them through a shape that allows team members to feel the atmosphere and the life of the target users,
- represent the global ecosystem (retirees, environment and interactions) to understand the dynamics of the system,
- identify a design brief for the design question, in connexion with the research question.

It is a convergent phase to precise the research problem and the system in which research occurs. To draw a parallel with the *Double Diamond*, the “study phase” and the “modelling phase” constitute the search and identification of a WHAT regarding the research ques-

tion.

The following phase is the “design phase” which uses all the previously gathered data to design and build a social robot. In this phase, design researchers are design practitioners; this phase is about developing a solution to answer a design question through the design brief identified in the previous phase. This phase is composed of two stages: the “WHAT stage” and the “HOW stage”, regarding the service and object to create to answer the research problem. The “WHAT stage” integrates several steps of convergences and divergences, and implies a collaborative team of designers. The “HOW stage” applies many iterations to search ideas and has moments of random progression between data, design and implementation. It is highly collaborative as it involves the whole project team. This whole phase fully implements the “design culture” as described in section 2. The goal of these numerous iterations is to decide the solution as late as possible in order to be well rooted in the ecosystem, and to allow questioning around the purpose (vision of the desired experience) through tangible practice (drawing, model, low-level prototyping). Once the solution is identified and designed, it is time to model, prototype and realise the social robot.

The last phase, the “assessment phase” has the purpose of preparing the protocol that will enable to answer our research question. In this phase we measure the impact and acceptability of a social robot in the homes of retirees. The objective is to deploy prototypes of the social robot in the households previously used in the “study phase”; and this, over a period of time of four weeks. Compared with the *Double Diamond*, these two last phases, “design phase” and “assessment phase” corresponds to HOW the project can answer the research question diverging with various solutions for reaching a social robot’s concept, and HOW to converge towards a concept and a measurement protocol for understanding its impact.

At the end of this fourth phase, considering the *HCD* approach, in order to address the same or a new research question, it could be necessary to iterate towards previous phases: to gain new knowledge from the field—“study phase”, to adjust the understanding of the ecosystem—“modelling phase”, or even to adjust the built solution—“design phase”.

## 4. Experience of Design Practice in the Project

### 4.1 The “Study Phase”

During the “study phase” two explorations in the field were set up. The first exploration aimed to study

life and activities of young retirees into their household. The second exploration had the objective of understanding young retirees’ perception of a robot, an object with its own behaviour, in their homes. The following sections describe these two field studies.

#### 4.1.1 Field study to understand young retirees’ ecosystem

J. Forlizzi [28] proposes a model based on the theory of social ecology which studies the relationships between humans and their environment. Any product is thus seen as part of the ecological system, and as one of the actors of complex social relations operating in this system. The aim of the model proposed by J. Forlizzi is to collect knowledge on how each individual uses a product, the problems linked to the different places and activities in which the product is used, and the more relevant characteristics of the product for its use in the product’s ecosystem. This ecological framework provides a way to understand the physical and social context of use of a product, and a way to suggest possible changes compared to an initial state of an ecosystem.

Our work is based on Forlizzi’s model to understand the ecosystem of the young retirees composed of the house, the people who live there, and the objects that make up the home. A field study was carried out with ten households in May 2018; five households in France and five households in Japan. Prepared in both languages, French and Japanese, the protocol aimed in collecting the activities, communications and moments of life of retirees in their daily lives. It is composed of:

- a first semi-directed individual interview to understand retirees’ daily life and feelings since retirement,
- a diary to fill in for two weeks to capture activities at home,
- six cultural probes—design tool created by Gaver et al. [29] —to bring subjectivity into the design process (in our case, collecting subjective data regarding their life at home, the objects in their house, and their feelings of everyday life) and provoke inspiring responses. Retirees could freely realise them during the two weeks.
- a second semi-directed individual interviews to understand retirees’ activities at home and get precision regarding data from their diary.

Data were collected on various formats. Some elements issued from cultural probes were in digital format (sounds, images—**Fig. 5**). Some other data were realised on paper (diary—**Fig. 6**, collage—**Fig. 7**, manual writing—**Fig. 8**, and document with stickers—**Fig. 9**). And voices of participants were captured during the interviews on a voice recorder. Format of raw data



Fig. 5 Photos taken by participants regarding their home

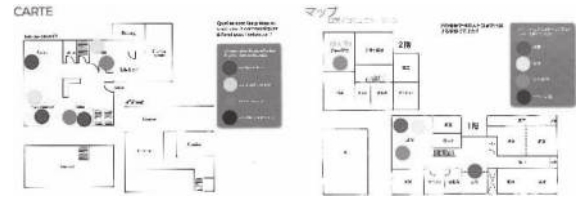


Fig. 9 Home's map with information through stickers

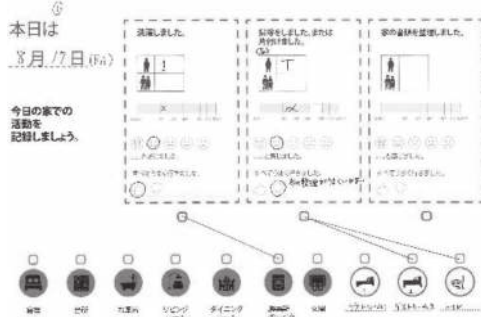


Fig. 6 A diary page



Fig. 7 Collage of magazine pictures

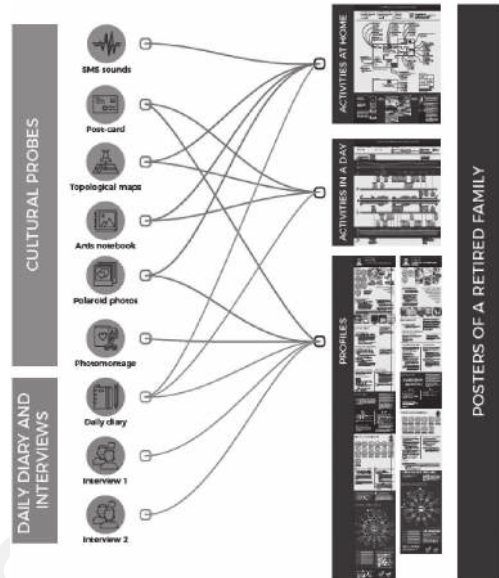


Fig. 10 Each household is depicted through four graphical posters combining the various types of raw data



Fig. 8 Postcards and personal expression

is mainly tangible and thus brings lots of sensibility through participants' writing, participants' creativity, and participants' gaze in the photos they took.

In order to deeply understand retirees' life, we created a new design tool called "empathic window". It shows in a graphical way all the data gathered on the retirees' study (Fig. 10). Each household is depicted through an "empathic window" composed of a set of

four original graphical posters: one for each member of the couple, one to show activities during a day and a last one to show activities realised in the different rooms of the house. This last poster conveys also the general atmosphere of the house through subjective data obtained by the cultural probes (images, poems, pieces of prose). These posters are valuable tools in the design phase, because they generate a strong empathy and a tangible feeling of people's lives at home.

Based on these posters, a two-day workshop was organised to clarify the design question related to social robots as vectors between the members of the couple. Insights from the field show that the selected couples had no strong pain points in terms of communication and relationship. We noticed only some feelings of loneliness expressed by a wife, or some time constraints due to the presence of their spouse in their daily activities.

The workshop led to think that the contribution the social robot could have should strengthen the bond between the two persons instead of seek to resolve a pain point in their life. Thus, the outcomes of the workshop led towards Human-Robot-Human interaction; the social robot serving as a vector between the two members of the couple.

Eleven themes were identified to design the robot. Following a team discussion, three themes were selected

to contribute to the design brief for the “design phase” (Secret garden VS. shared garden, lack of presence, aesthetic and sensory atmosphere).

#### 4.1.2 Field study to understand young retirees’ perception of a robot in their home

When thinking about a social robot integrating homes harmoniously, questions arise in terms of shape, interactions, role, characteristics, etc. E. Grimmaud proposes to consider robots as “objects with behaviours” and not copies of humans or animals. From his point of view, robots must be considered as machines that can fail and their behaviour must be understood through the experience of “behaviour signals” they have [30]. F. Kaplan [31] proposes to consider robots as objects of daily life, and to ponder their value for inhabitants as for any other object in the home (corkscrew, clothing, furniture, photo album, etc.). Thus, a robot would have a “value profile”, represented by a simple curve showing the evolution of the “experienced value of an object”. This would imply to question the “value profile” of a social robot and the interactions that the members of a household could have with it. The work on the notion of “robjects” [32], i.e. the use of an everyday object to which behaviours have been added, is interesting because this “robject” is already a used object of the ecosystem. Another inspiration for our project is Okada’s “weak robots” that focus on the notion of robots that, because of their weakness, attract humans and make them do things [33].

These references are a source of inspiration for the project regarding a social robot. But to better understand the perception of so-called social robots in the context of the retirees’ households, an exploratory field study was set up. It was based on Softbank’s robot Pepper which was placed in households as a cultural-robot probe. Our goal was to use Pepper as a technological object to gain information about users but also their perception and response toward this probe [34]. Through this robot probe, the objective was not to determine the usefulness of this object in the household, but to study how the members apprehend this object that had its own behaviours and its own dynamics. This technical probe aimed at addressing the following questions: (1) How is the size of the robot perceived? (2) Does the material and shape of the object fit into the atmosphere of the house? (3) How people feel regarding a robot that is not controlled by them? (4) What emotions are generated during interactions?

To answer these questions, a program was specified and developed that allowed Pepper to offer activities to participants (doing gym, doing meditation, having



Fig. 11 Experiment cards filled in at each interaction with the robot



Fig. 12 Ideas box post-its



Fig. 13 Ideal robot sheet

the TV program, the weather for the week or news, having cultural information, taking photos, answering questions). Conversely, these participants could question the robot at any time of the day to interact within the framework of the proposed functionalities.

As for the first study, the same ten households were used in 2018 and 2019. The robot was placed two days in each household and to get data the following protocol was applied implementing various types of methodological tools:

- Pre-exploration phase: to know the ideal image the participants had of a robot at home, participants were invited to use collage of magazine pictures.
- Introductory exploration phase: this phase aimed at launching the exploration by introducing the robot, at knowing couple’s perception of robots in general and at describing the data collection kit.
- Exploration phase (2 days): it allowed gathering data regarding interaction with the robot (experiment cards to be filled in at each interaction with the robot—Fig. 11), regarding the way the participants interacted with the robot (logs), and regarding their vision of the ideal robot (ideas box—Fig. 12, and ideal robot sheet—Fig. 13).

- Post-exploration phase: the previously introduced questionnaire on the perception of robots was applied to measure if there was a change from their pre-exploration opinion. Perception of a robot at home was collected for each participant through an interview.

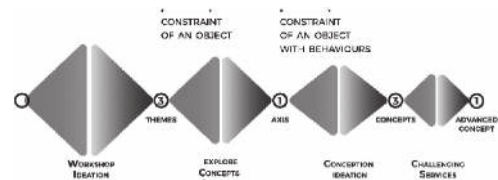
This field study is close to D. Fallman’s “design exploration” type of research in the fact that the idea was to place in homes an incomplete, imperfect in use, with sometimes strange various behaviours robot to get reactions to this out of control object. Lots of direct reactions on usefulness of the robot were obtained, but a more subtle analysis of the data revealed interesting lessons to be taken into account in the “design phase”.

As already identified in some studies [10] [35], the participants are looking for an assistant, a polite and helpful servant, with an emotional side (Japanese) or bringing a certain comfort (French). The fact that the robot is humanoid and can talk is something very appreciated and expected from the participants. But the study confirmed that if the interaction is difficult, it generates a lot of frustration and dissatisfaction due to a gap between the shape that suggests that the robot could talk like a human, and the actual capabilities of the robot. The participants would prefer the object not to be too big, but to be visible, and most of them appreciated that the robot has a reaction to touch. Expressions of affectivity towards the robot came out during the interviews, even coming from people rather opposed to the idea before the experiment. With regard to the robot’s own behaviour, most participants expressed the need to maintain total control over the robot, although they acknowledged that they were, in some cases, sensitive to the robot’s unpredictable interpellation. The study also shows that it is necessary to avoid repetitive gestures or behaviours that quickly bore participants.

Thus, thanks to the two field studies realised, the project gained a lot of knowledge and directions to orient the design towards a behavioural and non-voice-based object. It would be a non-invasive but surprising “robject” whose purpose would mainly to strengthen the bonds between the members of the retired couple and not between the persons and the robot.

## 4.2 The “design phase”

During this “design phase”, there were two periods: a first one to identify the service concept that can suit the retirees’ ecosystem (seeking to the WHAT question) and a second one which consisted in specifying the object and its behaviour (seeking to the HOW question). The following describes the two different design periods set up in order to obtain a social object.



**Fig. 14** The design process to identify a H-M-H vector concept

### 4.2.1 Social robot concept identification: question of WHAT

From end of February to end of May 2020, through a succession of divergence-convergence stages (**Fig. 14**), a concept has blossomed which answers the design brief of a vector between members of the couple, and for which a robotic solution is conceivable.

First, a two-day creative workshop was set up with designers around the three identified themes (see end of section 4.1.1. Goal of the project was to establish what type of service could be generated from data regarding the retirees’ ecosystem. Six designers were placed in a room with households’ “empathic window” to inspire them. A protocol of creative games was prepared through which designers generated ideas through the three themes. One day was focused on service of any type and the other day was focus on service integrating an object. During the two days, ideas came out, highlighted that some ideas appeared in both the two days, and some of these ideas met the selection criteria (couple centred, object oriented, innovative). So we were able to validate the fact that a service integrating an object could be a type of solution for the studied ecosystem.

Thus, having analysed ideas and grouped them, three axes of inspiration were selected (“Bring nature into the house”, “I am connected to my spouse” and “The house expresses the state of the household”). Based on these axes, object-oriented concepts were generated. In this stage, four designers individually made sixteen divergent propositions which were shared with project members (**Fig. 15**). It was necessary to choose on which axis to focus. We noticed that one axis was sparsely exploited (“Bring nature into the house”). Therefore, a choice needed to be done between two most exploited axes which headed in two different directions (“I am connected to my spouse” or “The house expresses the state of the home”). Introducing criteria related to robotics constraints and research project time, means and objective has been necessary to be able to decide which direction to take. After many discussions, with regard to the subject of the project, we chose to mainly focus on the “expression of the state of the household”,



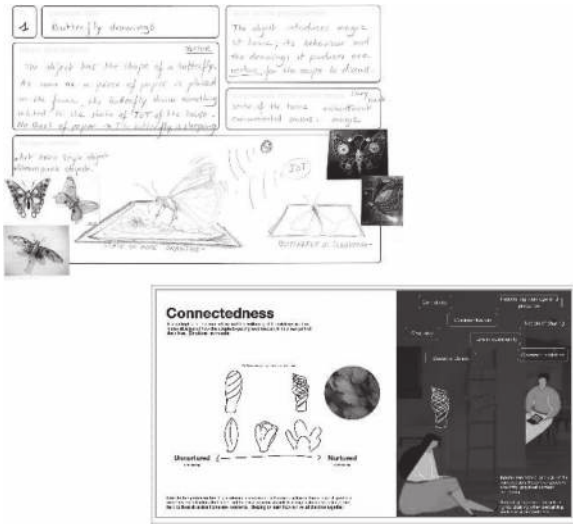


Fig. 15 Two examples of first stage's concept

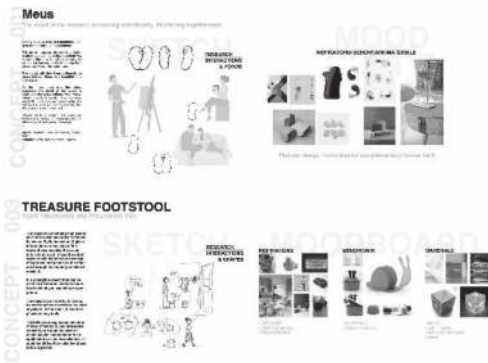


Fig. 16 Two examples of second stage's concept

while stressing the importance of the link that must be able to be established between the couple.

Once the direction established, the four designers generated individually a new series of eight concepts more precisely defined (Fig. 16). When put together during four little workshops of discussion, these concepts converged to three generic concepts. Criteria related to robotics constraints and to research project objective have been introduced to be able to decide which concept to implement.

Finally, the selected concept concerns a “object” in the entrance of the house which enables to improve “little happiness of daily life” and to enhance reception in the house. As it is a “robject”, it is by default a real well known and already used object. By its position in the house, it can be used every day, but not necessarily at all time. It brings the notion of butler in the sense of welcoming at the entrance of the home.

These four divergence-convergence stages, applying “design culture”, enabled to reach to a strong concept anchored in the studied ecosystem also integrating the notion of “robject” and object with behaviours (section 4.1.2), source of inspiration for the research

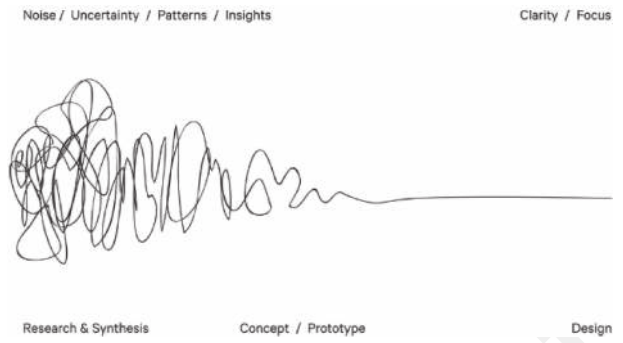


Fig. 17 The Process of Design Squiggle by Damien Newman, thedesignsquiggle.com

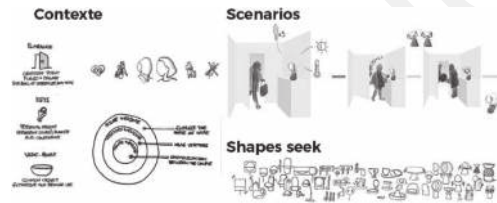


Fig. 18 Our concept board

project. The concept identification period was followed by a less directed and freer design period.

#### 4.2.2 Towards a technical prototype: question of HOW

The reflections regarding the concept juggled between the characteristics of the identified concept, the modelling of possible situations, the inspiration of existing objects, the search for shapes and modalities of interactions. This period of design which aims to describe more precisely the identified concept before prototyping it, is close to D. Newman's schema (Fig. 17). It enables to specify functions, shape and interactions, integrating step by step technical aspects.

At the time of writing this article, the concept story and functions of the service are clearly defined (Fig. 18). Currently technical constraints are being taken into account (type and size of sensors, type and size of actuators, existing APIs, materials) to converge towards a shape and interactions for the object to build. The team shifts from a collective of designers towards a multidisciplinary team including mechanical engineers, CS programmers, and control engineers.

As soon as the prototype will be stable, the “assessment phase” will start, and the prototype will be used to answer our research questions regarding impact and acceptability of such object with behaviours in retirees' households.

### 5. Discussion Regarding the Use of the Approach in a Technological Research Framework

Through this article and the example of our project,

we wanted to raise awareness of what a design approach can be in a technical field such as robotics.

First, we highlight the importance of being user-centric, and in some cases beyond, focusing on social ecosystems. In this project, both the research object and the design object are constructed from data from the field. It is important to offer an experience that is centred in the ecosystem being studied. It implies that robotics is not the first object of reflexion and it intervenes later in the project. It appears gently, in small strokes, during the first stage of the “design phase”, and become the heart of the project from the second stage of the “design phase”.

This goes hand in hand with the notion of multidisciplinary, characteristic of a design approach and essential in this type of project. In the described approach, there are two periods where multidisciplinary appears: in the “study phase” to set up a technical probe, and in the “design phase” to create the prototype of the “robot” which is in the centre of the research. In this “design phase”, as the same way that reflexion of robotics intervenes step by step in the process, the robotic engineers take full part in the project once the concept of the object has been sufficiently described from the users’ point of view.

As the project is committed to a user-centred approach, it always refers to users’ data and questions the relevance of each solution, and thus question if a robotic solution is a conceivable solution for the studied context. Being part of a robotic project implies that we know that we will finally choose a robotic solution and we are aware that this is a bias in the methodology. Delaying the choice of solution and questioning the relevant moment to shift towards and focus on the robotic solution is therefore all the more important.

Having confidence in the process and the creative tools to achieve a solution, while not knowing exactly where the project is going to land, is a specificity of a design approach. It involves moving through the fog in the design process while having a clear research objective to reach. From the problem identification period to the conceived concept, this project has left room to subjectivity and creativity; research objectives being as a framework for design. And these subjectivity and intuition which are part of design is an opportunity for bringing another dimension for research work in robotics.

## 6. Conclusion and Perspective

Research through design is always on a tightrope between practicing design to propose a solution and prac-

ticing design in order to question and enable the search for knowledge [36]. Taking care to remain focused on the contribution of knowledge to a community could be a permanent work. Thanks to the described approach which is a mix of various approaches, a main layer based on the *HCD approach* provides the path to the research question. Through this circle base appears a “double diamond” which answers the research question focusing first on questioning what is a problem and second on how answering the problem. The “design culture” is present in all phases of the process, moving between “design studies” and “design exploratory”, but it deploys all its capacities in the “design phase”. This organisation facilitates the separation between the research question and the design question.

In this project, the design approach anchors in the ecosystem of the retired couple and allows empathising with the participants of the study. This approach questions this ecosystem and proposes an adapted solution taking into account the specificity of the research domain which concerns social robots.

The design approach in the field of robotics allows a robot to be modelled from field data by gradually moulding shape, interaction and function best suited to the ecosystem, just as a sculptor works the clay and makes his work appears. Thus, the design approach, by its characteristics of objectivity (based on field data) sprinkled with subjectivity (that of the users and the intuition of the designer) offers the possibility to propose new experiences around differentiating robotic solutions.

Regarding the state of the project, we are currently starting the prototype that should be consolidated during autumn, and experiments in households should take place in early 2021.

**Acknowledgements** GVLab team members for their support in the field study. This research is partially supported by the Tateishi foundation grant for research.

## References

- [ 1 ] S. Vial: *Le design*. Presses universitaires de France, 2017.
- [ 2 ] K. Krippendorff: *The Semantic Turn—A New Foundation for Design*. Taylor & Francis, 2005.
- [ 3 ] A. Findeli and R. Bousbaci: “L’éclipse de l’objet dans les théories du projet en design,” *The Design J.*, vol.8, no.3, pp.35–49, 2005. (With a long English abstract).
- [ 4 ] A. Findeli: “Searching for design research questions—Some conceptual clarifications,” book *Questions, Hypotheses & Conjectures*, iUniverse, Chow, Rosan and Jonas, Wolfgang and Joost, Gesche, pp.278–293, 2010.
- [ 5 ] S. Vial: *Court traité du design*. Que sais-je, Presses universitaires de France, 2010.
- [ 6 ] D. Fallman: “The Interaction Design Research Triangle of Design Practice, Design Studies, and Design Exploration,” MIT

- Design Issues, vol.24, no.3, pp.4–18, 2008.
- [7] P. Dumouchel and L. Damiano: *Living with Robots*. Harvard University Press, 2017.
- [8] G. Hoffman and W. Ju: “Designing Robots With Movement in Mind,” *J. of Human-Robot Interaction*, vol.3, pp.89–122, 2014.
- [9] I. Ocnareescu and I. Cossin: “The Contribution of Art and Design to Robotics,” *Proc. of ICSR*, pp.278–287, 2019.
- [10] J.-Y. Sung, H.I. Christensen and R.E. Grinter: “Sketching the Future: Assessing User Needs for Domestic Robots,” *Proc. of the 18th IEEE Int. Symp. on Robot and Human Interactive Communication*, pp.153–158, 2009.
- [11] J. Forlizzi and C. DiSalvo: “Service robots in the domestic environment: a study of the roomba vacuum in the home,” *Proc. of the 1st ACM SIGCHI/SIGART conference on Human-robot interaction*, pp.258–265, 2006.
- [12] J. Forlizzi: “How robotic products become social products: an ethnographic study of cleaning in the home,” *Proc. of the 2nd ACM/IEEE Int. Conf. on Human-Robot Interaction*, pp.129–136, 2007.
- [13] J. Fink, V. Bauwens, F. Kaplan and P. Dillenbourg: “Living with a Vacuum Cleaning Robot,” *Int. J. of Social Robotics*, vol.5, no.3, pp.389–408, 2013.
- [14] J.-Y. Sung, L. Guo, R.E. Grinter and H.I. Christensen: “My Roomba Is Rambo”: Intimate Home Appliances,” *Proc. of the 9th Int. Conf. on Ubiquitous Computing*, Springer Berlin Heidelberg, vol.4717, pp.145–162, 2007.
- [15] J.-Y. Sung, R.E. Grinter and H.I. Christensen: “Domestic robot ecology,” *Int. J. of Social Robotics*, vol.2, no.4, pp.417–429, 2010.
- [16] J. Auger: “Living with Robots: A Speculative Design Approach,” *J. of Human-Robot Interaction*, vol.3, no.1, pp.20–42, 2014.
- [17] U. Bronfenbrenner: *The Ecology of Human Development, Experiments by Nature and Design*. Harvard University Press, 1979.
- [18] ISO 9241-210: “Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems,” 2019.
- [19] Design Council: “What is the framework for innovation? Design Council’s evolved Double Diamond,” 2015. Available in June 2020 at <https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond>
- [20] A.F. Osborn: *Applied Imagination—Principles and Procedures of Creative Thinking* (3rd ed.). Charles Scribner’s Sons, 1963.
- [21] T. Brown: “Design Thinking,” *Harvard Business Review*, 2008.
- [22] T. Brown: *Change by Design—How Design Thinking Transforms Organizations and Inspires Innovation*. HarperBusiness, 2009.
- [23] H.D. Norman: “Rethinking Design Thinking,” 2013. Available in June 2020 at <https://jnd.org/rehtinking-design-thnking/>
- [24] N. Cross: “*Designerly Ways of Knowing*,” Basel-Boston- Berlin, Birkhäuser, 2007.
- [25] H. Rittel: “Some principles for the design of an educational system for design,” *J. of Architectural Education*, vol.26, no.1/2, pp.16–27, 1971.
- [26] A. Davey and M. E. Szinovacz: “Dimensions of Marital Quality and Retirement,” *J. of Family Issues*, vol.25, no.4, pp.431–464, 2004.
- [27] J.W. Osborne: “Psychological Effects of the Transition to Retirement—Effets psychologiques de la transition vers la retraite,” *Canadian J. of Counselling and Psychotherapy*, vol.46, no.1, pp.45–58, 2012.
- [28] J. Forlizzi: “The Product Ecology: Understanding Social Product Use and Supporting Design,” *Int. J. of Design*, vol.2, no.1, pp.11–20, 2008.
- [29] B. Gaver, T. Dunne and E. Pacenti: “Cultural Probes,” *Interactions Magazine*, pp.21–29, 1999.
- [30] E. Grimaud: “Les robots oscillent entre vivant et inerte,” *Multitudes*, vol.58, no.1, pp.45–58, 2015.
- [31] F. Kaplan: “Everyday Robotics: Robots As Everyday Objects,” *Proc. of the 2005 Joint Conference on Smart Objects and Ambient Intelligence*, ACM, New York, pp.59–64, 2005.
- [32] F. Mondada, J. Fink, S. Lemaignan, D. Mansolino, F. Wille and K. Franinovic: “Ranger, an Example of Integration of Robotics into the Home Ecosystem,” *New Trends in Medical and Service Robots*, pp.181–189, 2016.
- [33] T. Mori, S. Sawada, P.R. S De Silva and M. Okada: “Social Trash Box Robot: Behavior Parsing and Goal Inferences in Dynamic Interactions,” *Proc. of the First Int. Conf. on Human-Agent Interaction*, II-2-3, 2013.
- [34] H. Hutchinson, W. Mackay, B. Westerlund, B. Bederson, A. Druin, C. Plaisant, M. Beaudouin-Lafon, S. Conversy, H. Evans, H. Hansen, N. Roussel and B. Eiderbäck: “Technology probes: inspiring design for and with families,” *Proc. of CHI ’03*, pp.17–24, 2003.
- [35] K. Dautenhahn, S. Woods, C. Kaouri, M.L. Walters, K.L. Koay and I. Werry: “What is a robot companion-friend, assistant or butler?,” *Int. Conf. on Intelligent Robots and Systems*, pp.1192–1197, 2005.
- [36] I. Koskinen and P. Gall Krogh: “Design Accountability—When Design Research Entangles Theory and Practice,” *Int. J. of design*, vol.9, no.1, pp.121–127, 2015.