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# Together alone, Yōkobo, a sensible presence robot for the home of newly retired couples

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## ABSTRACT

Feeling together and at the same time feeling free while sharing the same roof is a balance that newly retired couples try to reach. Indeed the beginning of retirement is complex, and sometimes, even when both spouses find themselves at home together, some spouses could experience a feeling of loneliness. To respond to this insight, we introduce the concept of “sensible presence robot” - Yokobo to fill this loneliness gap through subtle interactions. The pictorial introduces and describes the different steps of the design process of Yōkobo as a non-anthropomorphic and non-vocal robot for the entrance of dwellings. Through its expressiveness, Yokobo is

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a presence messenger for newly retired couples. On a larger scale, this research is a manifesto for the slow technology trend in which perceptions and time open a discussion on poetic sensibility.

## Authors Keywords

Design process, non-anthropomorphic robot, behavioral object, slow technology, sensible presence object.

## CSS Concepts

• Human-centered computing–Interface design prototyping

## INTRODUCTION

Even when living with a spouse, a feeling of loneliness could be experienced by some retired spouses. It is a surprising insight that we gained from an exploration study we conducted with ten families in retirement [11]. This study aimed at understanding newly retired couples living at home, both their activities and their relationship. Indeed, many studies showed that each transition in adult life generates a change in role,

expectations, and attitudes towards the spouse and thus influences the couple’s relationship [9]. Retirement is no exception. The transition to retirement often involves reorganizing the couple’s daily life. Living together every day requires establishing a “good distance” (time, space) to have personal independence while maintaining a conjugal closeness [4]. Our study highlighted the emergence of a complex and ambivalent feeling for retired couples: while expressing a relatedness need towards the partner (it is indeed pleasant to feel the presence of the other at home), spouses also point out a need for individual freedom. Feeling together and, at the same time, feeling free while sharing the same roof is a general insight for our study on newly retired couples [11]. This ambiguity can lead to dissatisfaction related to differences of opinion about the time to be shared [4].

In this context, we questioned the role of robotics as a possible link within the couple. Therefore, to further explore and understand the perception of having a robot at home for a retired couple, we conducted a two-day exploratory study with the social robot Pepper

of Softbank. The notion of social robots is diverse. Depending on the field of research, studies do not focus on the same “social” aspects of robots [7]. One of the most recent definitions is given by Graaf and al. who wrote “Social robots are machines programmed in such a way that their behavior is perceived by humans as social, which, in turn, evokes social responses from human users” (De Graaf et al., 2016). For these authors, the human user constructs the ‘sociability’ part of the robot in their mind. Therefore we needed to focus on humans and their perception to identify a possible “robot’s sociality.” In our study, we chose the Pepper robot because it is well known, and we wanted to collect the feeling of such a big robot considering a dwelling. Pepper was used as a technological probe, which means that its functions and usage were less the focus of our study than the perception of other parameters such as shape, behavior, material, control management. This study’s results highlighted the notion of presence that such an object brings [11] and the desire to engage in interaction with such an animated object. In contrast, it was considered too big, cumbersome, and noisy.

Thinking about the presence’s feelings that a robot can generate led us to question the role of a robot as an intermediary between the spouses. Regarding loneliness’s feelings, our aim was not for the robot to be a companion for the spouse who feels alone but for it to convey the presence of the other. Following our study’s result, the robot Pepper was not considered to answer this issue. Consequently, we decided to seek another way of envisioning a robot.

### RELATED WORKS

#### Robots for home

A few years ago, the media made many announcements regarding companion robots (Buddy, Zembo, Jibo, Kuri, Aido, ElliQ, Pillo, etc.) [42]. It was one of the main trends of the CES 2017 [24]. Moreover, at this time, it was forecast that sales of personal assistant robots would grow by 280% in 6 years [41]. Interestingly, recent research studies recognize that the market is the lowest in the robotics segment. This low score is due to production delays, the users’ deception (the gap between users’ expectations and the robot’s functions), and the rise of voice assistants [10, 26]. However, vacuum and lawnmowers robots are a rising market [26].

Studies related to people’s expectations regarding robots at home in the Human-Robot Interactions community show that the most expected role is domestic butler [6, 19, 34]. From the adults’ point of view, the robots must be helpful and capable of performing domestic daily tasks, “simplif[ing] or improv[ing] life” [5, 13], and should have limited autonomy [29]. A robot that takes the initiative or some prerogatives is often rejected [12, 34]. Regarding companion robots which are often associated with robots for the home, they seem to be mainly expected by children [5]. Some studies also evoke that participants were least willing to have a robot focused on interactive and communication services [6, 14, 34].

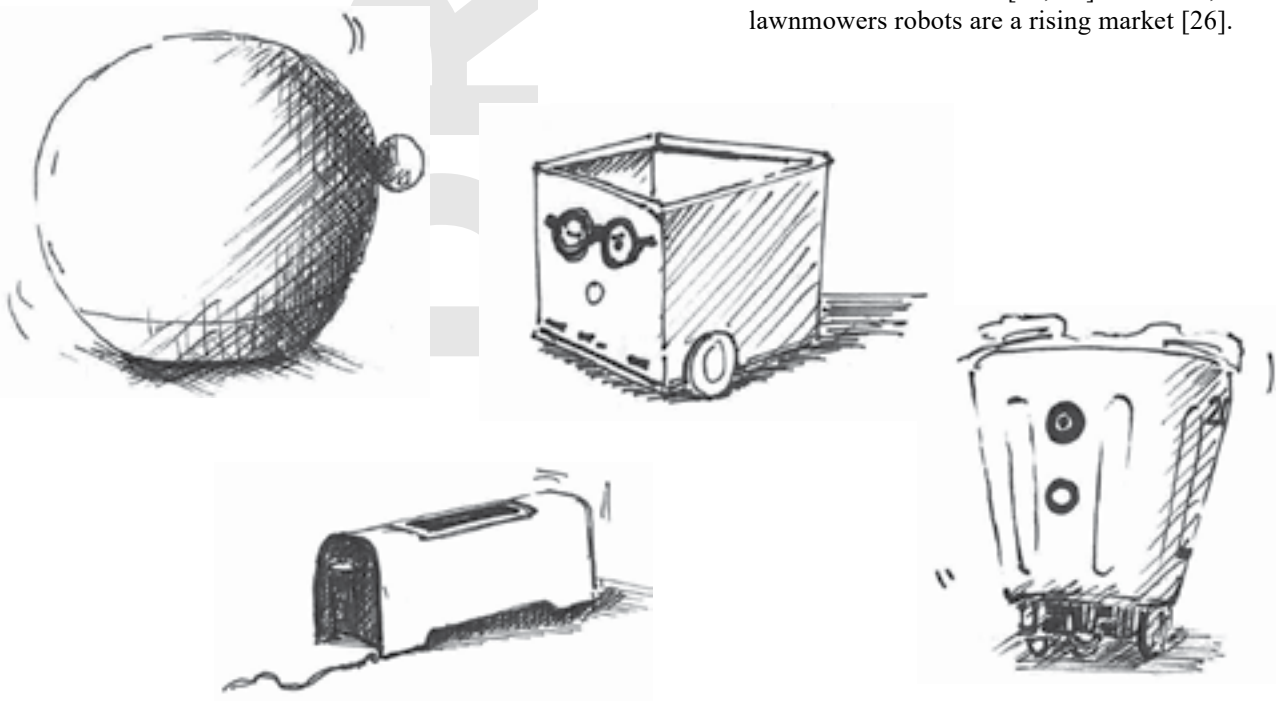
If the butler robot does not already exist as the previously cited studies expected, functional vacuum robots have entered many households. Studies of the Roomba vacuum robot have been carried out in the home [15, 16, 17, 38, 39]. These studies showed the influence of the robot on the home’s ecosystem and the impact on people’s relationships. Through a long-term study of six months, Sung and al. [39] have described a Domestic Robot Ecology system where Roomba takes three roles: a tool, an agent, and a mediator. The robot’s presence in the home had social impacts: it was a showcase for the family, it was at the origin of interactions between household members and, it impacted domestic task organization. The study also highlights that the ecosystem evolves, modifying, in consequence, the robot’s role and the interactions between family members and the robot.

#### Other concepts of everyday robots

Kaplan [28] wonders why social robots have not yet become everyday objects and how they could be valuable objects for everyday life. He concludes that “for robots to find a niche among the multitude of other everyday objects, they must offer a different added value.”

Considering Mondada and al.’s point of view [33], for

ge Numbers will be added here and either centered or right-aligned



robots to become part of everyday life, one way could be to robotize objects already present in the home's ecosystem. "Robots" are tangible objects with an existing use [33, 37, 43] whose value is brought by their behaviors. There are not copies of humans or animals; they are basically objects with movement. More abstractly and broadly, this is what Bianchini and Quinz [2] called "behavioral objects." These objects realize unpredictable, spontaneous actions that lead to independent behavior, namely "meaningful indicators of an internal state and a disposition to interact with the world" [31]. Considering "behavioral objects," Grimaud thinks that robots must be considered machines that can fail, and their behavior must be understood through the experience of "behavioral signals" [22].

Anderson-Bashan and al. [1] care about the specificity of such non-anthropomorphic objects. These objects offer the advantages of avoiding people's preconceptions about the object's abilities. Moreover, Heider and Simmel's study shows that geometric shapes moving in a square framework on a video can make people project a story between individuals [23]. Reeves et Nass demonstrate through the "media equation" that individuals facing a neutral PC can be polite towards this PC [36]. These studies show that even an abstract object can provoke social cues. Some previous works on non-anthropomorphic robots validate this result: an abstract robot [1], an animated door [27], a car seat [40].

All these studies have one thing in common. They show that it is not the complexity of behavior or appearance that will make people use these objects but rather their ability to draw people's attention. As an example, Okada's "weak robots" propose an original approach. These robots have a simple function/task, and because of their weakness and inability to perform their function, they attract humans' attention and make them do the task actively [4]. And a way to achieve this goal is to focus on designing movement.

### Designing animated objects

The design of animated objects is not trivial. According to Auger [44], integrating moving objects such as robots into homes is complex. Indeed, such objects in domestic contexts must, on the one hand, confront other domestic objects and thus face the laws of cost / benefit / efficiency. On the other hand, they must resist the influence of the forms of fiction. These reasons partly explain why the available robots do not belong to the current domestic context.

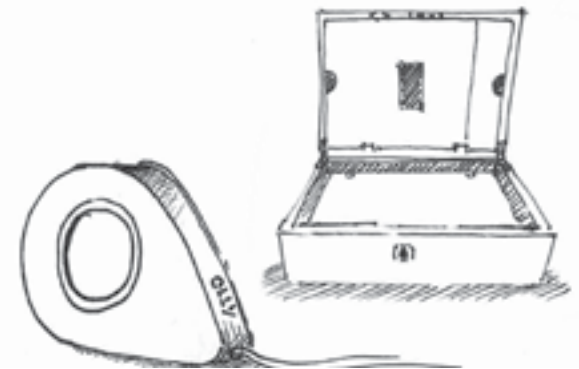
One way to approach robotics differently is to apply a design process. This approach opens up other attributes of expressiveness and considers that basic and less expensive objects could offer relevant and powerful experiences [45]. Auger proposes to center the object's function on what it excels at, namely, in this case, movement, and thus to integrate animated objects into the home beyond the forms proposed by fiction [44]. For Hoffman and Ju, the design of such an object based on designers' intuition, movement experts such as dancers, or participatory workshops involving end-users, is a way to meet the challenge of finding the proper movement for the object [45]. In the context of non-anthropomorphic objects, this is all the more important as the challenge belongs to "unexplored territories" [1]. Motion design is currently more art than science [45].

Some authors choose to prioritize the search for movement expression before form and function; the identified movements help determine the number of degrees of freedom of the robot and then decide on the motors to use [45]. Other authors start from everyday objects and apply design methods to study motions' expressiveness. The behavioral design of the Sirkin and al.'s mechanical ottoman [46] or the car seat of Tennent and al. [40] followed this approach. The work of Anderson-Bashan and al. concerning an abstract object for greetings started from abstraction and geometric objects before studying the machine's behavior [1].

Considering the ecology of newly retired couples as essential, starting from the experience to offer, through a design approach, seems key to designing a novel behavioral object in context.

### Slow technology trend

The "slow technology" philosophy belongs to the movement of "taking one's time" of the "slow attitude," such as "slow food," "slow work," "slow life." Slow technology thus goes against the use of technology to meet a need for efficiency, functionality, and usability [47, 48]. It proposes to take a different point of view on technology. The question is not to focus on how it could be useful but on the meaning of its use and how it could be expressed? Slow technology proposes a concept where time (by taking the time to understand what is going on) plays a role in the object's adoption. It is an approach that aims to offer time for reflection, contemplation, and personal interpretation. Over time, the sum of successive experiences with the product creates the object's meaning and value. The experience is continuous and progressive. The contribution of technology is not direct and perceptible but at each individual's level of feelings and sensitivity.



## Session Title

Following these different notions of objects associated with movement and the slow technology trend, our project focuses on designing a robject to strengthen the bond between spouses and limit the feeling of loneliness. Unlike most works regarding HRI, this research does not focus on direct interaction between an individual and a robot. It concerns the couple's interactions in the presence of a robot. Human-Human-Robot Interactions (HHRI) is an emerging field of HRI [36]. This field mainly studies human-human interactions while interacting with a robot. There are still few studies regarding the impact of robots on social relationships between people [36].

This pictorial describes the approach applied in the design phase and the design questions raised during its creation that led to the Yōkobo and the embodiment of a new concept: a sensible presence robject. This pictorial describes the approach applied in the design phase and the design questions raised during its creation that led to the Yōkobo, a sensible presence robject.

yōkobo

is the association of

yōko-so

(welcome in Japanese)

and ro-bo(t)

(pronounced in French,  
't' is silent)



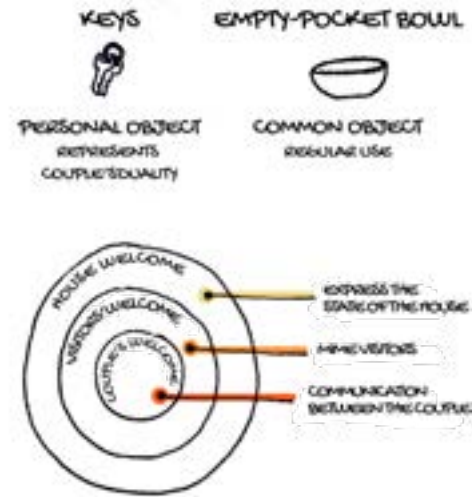
## YŌKOCO'S DESIGN PROCESS

The design process consists of three different steps: ideation, modeling, and prototyping.

The ideation step lasted for three months. This step is a sequential list of divergence-convergence moments to progressively specify a concept integrating a behavioral object for our field study. This ideation step implied various designers' workshops for generating ideas and concepts. These workshops occurred between the designers' individual works and the project group's discussions. The ideation phase led to Yokobo, a robject placed at the home entrance which can fuse effortlessly with the home. Its focus is to greet little moments of life to strengthen the links between the couple.

The modeling step progressively allowed the deepening of the concept identified in the previous step and the designing of the 1 robject. During this step, the reflections sailed between the concept, the shapes' design, and the interactions' modalities. In this step, the team shifts from a collective of designers to a multidisciplinary team, including mechanical engineers, software programmers, and control engineers.

The third and last step of the design process is the prototyping step. It aimed to develop and test the prototype through the agile Scrum method, an iterative software development method.



The following pages describe all the work done during the modeling step.

### Deepening the concept

At the end of the ideation step, the concept was created on the notion of robject. To imagine a robject, we focused on the entrance of the dwelling. We choose this specific space because the entrance hall symbolizes a place for expressing the home's welcome. In Japan, the entrance hall represents the separation between outside and inside, avoiding the dirt entering the private inside spaces. In ancient Greek and Roman houses, a vestibule is a place between the private areas of the dwelling and the street. It offers security and privacy from the outside. In current days, it refers to the space close to the outer door, which connects to the dwelling's interior. Whatever the culture,

it is a passage and transition place. It can refer to the butler symbolism.

Designers studied objects in the entrance hall and modeled the entrance with papers, seeking imaginaries and usage scenarios. Many discussions around the paper mock-up and the lab's whiteboard wall regarding the various objects in the entrance hall focused on the pin-tray often laid on a sideboard and the keys. The pin-tray can be used extensively and regularly. Keys are personal objects and can represent the couple's duality and the idea of security. Therefore, we choose to iterate on a robotic pin-tray at the home entrance. Indeed a pin-tray that has an already existing use. We studied how we could rethink this small object to propose an additional function by creating from this object. It would bring the idea of welcoming and enhancing small happy moments for spouses.

Final design iterations sharpened the concept focused on building functions of the "pin-tray robject" around the notion of proximity. This work led to the statement that the closer a person is to Yōkobo, the more intimacy the function expresses (opposite sketch of proximity circle).

The discussions around the whiteboard gradually led to work on Yōkobo's form.



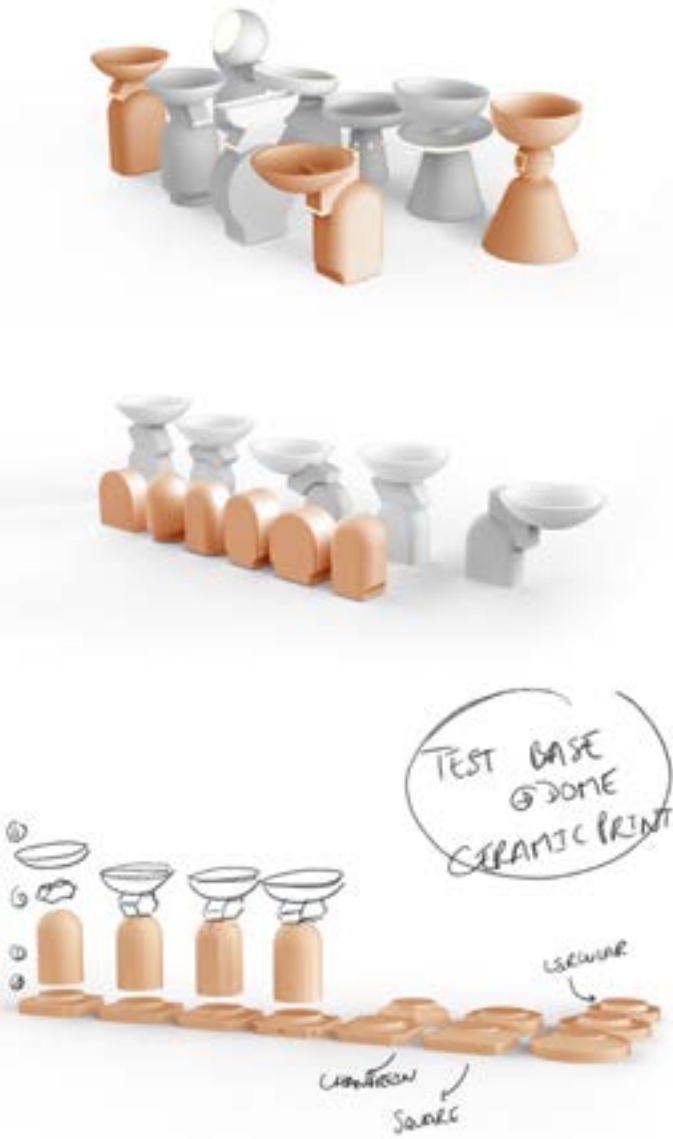


**Sketches to make the shape appears**

Talking about the concept led us to think about the shape of Yōkobo. First sketches showed that Yōkobo could lay on the floor, lay on the sideboard, or hang on the wall. This last idea was charming but faced the robotic goal of the research project. Laying the robot on the floor would have led to a robot moving on the ground, far from the image of a pin-tray bowl. The idea of laying Yōkobo on the sideboard was then judged appropriate.

Progressively, Yōkobo's external shape evolved. However, the structure of three parts, including a bowl depicting the pin-tray on a base, was rapidly adopted, looking for basic shapes.





### Refining shape through the 3D model

Yōkobo is composed of three parts laid on a base:

- The bowl: its shape has varied from a tray to a bowl and has been flared or closed.
- The central part: its shape changed several times, and it has taken time to fix it. It evolved from a sphere shape to a somewhat angular form until a pot shape.
- The “dome”: is the part that supports the other two components. Having the top of the piece rounded was rapidly fixed. The question then arose regarding a shape that has rotational symmetry. Step by step, form balance led to keeping symmetry shape.
- The base: it appeared later as a necessity for integrating sensors. It evolved from a small platform to a more oversized tray shape. This last shape integrates most electronic components while offering a related function (for example, a space for pencils and post-its).



The 3D modeling has been essential to visualize the progression of the four pieces.







### Facing reality with cardboard mock-up and bowl testing

Besides 3D modeling, other types of testing enabled specifying the robot's size and the bowl's shape.

Testing of bowls of various sizes and shapes was set up (images at the bottom of the page) and enabled the definition of the appropriate size and depth of the bowl.

Realizing the mock-up in actual size with cardboard has informed the size of Yōkobo. It emphasized the necessity of always having the bowl horizontal to keep the keys inside the bowl. It was also a great source of information for identifying the appropriate weight that motors can support.

The cardboard mock-up enabled us first to see Yōkobo moving for the first time (the five images below) and second to deepen the work on interactions and movement the designers' team was doing in parallel.

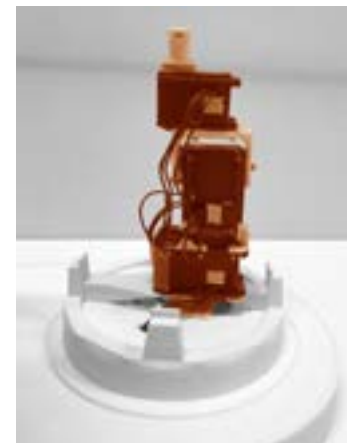


**Towards the setting up of a prototype**

The engineers' team progressively took part in the project. At first, they informed designers about sensors and motors and the constraints they imply. Then their participation was more active, starting to realize electronic elements and prepare software developments.

Yōkobo's form implied a combination of three degrees of freedom (DoFs). Therefore, Yōkobo is composed of three motors: one to make the whole structure rotate on a vertical axis, one to enable the bowl to bow on a groove, and the last one to make the bowl turn on itself. The bowl is freely moving by gravity to stay in a horizontal position. The three motors are hidden in the "dome" of Yōkobo.

The other components of Yōkobo are LEDs to support Yōkobo's four levels, an RFID sensor to detect keys, a camera to follow a person's skeleton, an ultrasonic sensor to manage proximity, and two Raspberry PIs and a PCB to control the whole behavior.



**Designing interactions**

Yōkobo is a composition of four functions: the delivery of messages between the couple, a pin-tray, the expression of the state of the house, and the greeting of visitors.

*Human's engagement means interacting with Yōkobo*

To interact with Yōkobo, a person needs to get closer to Yōkobo. When Yōkobo detects someone without being closer to it, it shows the home's mood. Namely, it expresses the atmospheric state of the household using the various sensors of the smart home context, such as temperature or air quality sensors. If the person gets closer, Yōkobo follows the person's movements to mime him/her within the limit of its ability. The gesture is the only way to engage in interaction with Yōkobo.

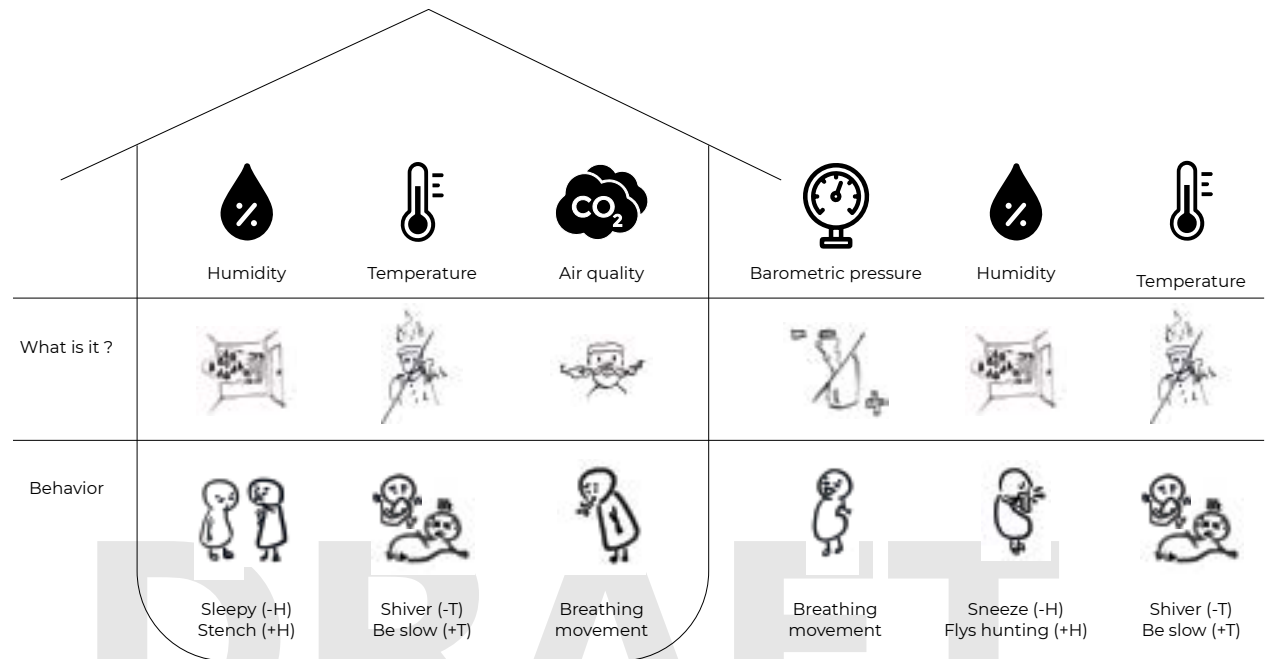
The messages' function of Yōkobo is intended only for the two individuals of the couple. To interact with his/her spouse through Yōkobo, the individual needs to have his/her keys. Taking from or putting the keys in the pin-tray bowl triggers the spouse's message and launches a message record for the spouse. In this case, engaging in interaction with Yōkobo needs a specific accessory.

*Yōkobo's interactions*

Previous research regarding minimal movements of a robot showed that a human perceives social cues even in little gestures of a non-anthropomorphic robot [1, 30, 31]. From a human's viewpoint, "these objects appear to have intentions, emotions, beliefs, and even personality traits" [31].

Levillain and Zibetti point out that surprise and ambiguity are essential in designing a behavioral object to engage with it [20, 31]; these attributes allow each person to interpret motions in his or her way to supplement the lack of information or context [20].

Considering these results (minimal movements and



surprise), the designers worked on Yōkobo's behaviors based on welcoming and expressing the state of the house.

To express the state of the house and obtain unpredictable attributes, Yōkobo is associated with a weather station. This station has sensors that get data on inside and outside temperature, inside humidity, air quality, and atmospheric pressure. To create the animations expressing the state of the house, designers choose to base the design on the human body reaction while facing extreme weather and air conditions. For defining the body's behavior in such situations, designers watched videos of those specific situations.

Therefore, the robot's body's chosen reactions were:

- in reaction to inside humidity: to be sleepy or to smell the environment foul scent due to humidity,

- in reaction to outside humidity: to sneeze or to hunt mosquitoes that appeared due to humidity,
- in reaction to the temperature: to shiver or to do everything slowly,
- in reaction to the air quality: to breathe more or less quickly,
- in reaction to barometric pressure: to breath more or less intensely.

Then they were translated into Yōkobo's movements through the three motors. Behaviors due to humidity are animations that appear discretely depending on the humidity level. When Yōkobo is "waking up" or is "going to sleep," its behavior is based on temperature data. The speed and amplitude of movements respectively depend on air quality and barometric pressure data. As weather

sensors can change anytime, Yōkobo would not have predictable behavior.

When someone is close to Yōkobo, Yōkobo starts to mime the human's gesture to greet him/her. Regarding "greetings," designers analyzed characters' animation, images, and videos of greetings, a method previously done by researchers [1, 40, 45]. Analysis of these materials led to creating pictures and videos mood boards for inspiration. In close salutation, when people enter someone else's home, they can bow as in Japan, handshake or kiss as in France, or use waving to say hello or goodbye. Based on these results, designers composed two animations for the welcome behavior of Yōkobo, a gesture where Yōkobo bows on the groove facing the visitor and the same motion rotated by 90 degrees to express a hand waving.

In addition to recognizing a human's greetings, Yōkobo mimes the human's body gestures to create a link with the visitors. Its motion follows the whole body gestures' amplitude and speed and reacts in the same way with its two top motors. When a person moves inside the room, Yōkobo follows him/her with its lower motor. These mimic motions are the base for messages between the couple, as a track of the last spouse passing in the entrance, reflecting his/her presence.

#### *Enhancing the Yōkobo's states using light*

Yōkobo interacts with movement, but it communicates its states by the lights placed on the middle piece (LED strips). When Yōkobo is "sleeping", the lights' color expresses the day's hour (white during the day and orange during the night). The lights go on and off like

a breathing rhythm. While expressing the state of the household or mimicking visitors, the lights' color continuously represents the hour of the day. When a spouse moves his/her keys, one side of the lights has an orange color during the delivery of a message (each side corresponds to the spouse's keys). When Yōkobo records the message, the lights are orange and are flashing.

The design of Yōkobo's interactions took place mainly before the team developed the prototype. Nevertheless, some adjustments were needed to clarify the whole interaction system during the prototype's development.

During the process, Yōkobo was part of two two-week experiments at a university's lab entrance in Japan. Testing the technical stability and performance of Yōkobo was the primary goal of these experiments. Results enabled consolidating the technical part and adjusting the animations. Encouraging feedback came from most students and visitors of the lab that interacted with Yōkobo and described their interactions as welcoming. We detail the results in another paper, which is under submission.

#### **CONTRIBUTION**

In different ways from the ones used by [30, 45, 46], we designed a robot by initially building on a service concept and then gradually discovering its form and interaction. Thanks to the design process where the technical solution is decided as late as possible, we had the opportunity to create an object out of phase with the robots that are usually part of the domestic sphere or imagined to belong to. Following the research direction proposed by [1, 31], Yōkobo offers an opportunity to contribute to how to design robots. Yōkobo is innovative and disruptive. It distinguishes itself from the generally shared vision of robots by:



- Yōkobo is a concept that puts the humans (the spouses' couple) at the center of the design process. It is an intermediary presence created to strengthen the relationship between spouses at home. In this sense, Yōkobo supports Human-Object-Human interactions in the home context.
- To move away from home's companion robots and the biases they can generate by the presence of a face representation, Yōkobo is neither anthropomorphic nor can talk.
- Yōkobo is an object intended to be unobtrusive, stemming from ambient computing while having a persistent presence.
- It is an object in the “slow technology” trend. It means that understanding and integrating Yōkobo into one's life takes time and requires accepting not to have a clear, repetitive, and instantaneous response to an action. Learning Yōkobo's expressive motions is a continuous and progressive process. It is designed to propose a different kind of perception. This implies that the receiver should be in a specific mindset able to perceive the presence of his/her partner in a sensible and poetic manner. This contribution is not directly measured in terms of efficiency and utility.

Finally, Yōkobo is a technology proposing a new concept that we call “sensible presence robject.” It is a robject that records a symbolic trace a spouse left to his/her partner. The latter receives the trace through motion and light in a poetic way.

### CONCLUSION

Yōkobo is a non-anthropomorphic robject playing an intermediary role between newly retired couples. Yōkobo is designed to be discreet and fuse into the spouses' home and their ecosystem. It interacts with people while fading away to enhance human relationships. It transmits messages from one spouse to another in a sensible way by conveying the spouse's presence. It contributes to research in the new field of Human-Object-Human interaction, a more significant instance of Human-Robot-Human interaction proposed by [36].

We described the design process of a robject embedding such philosophy through this pictorial. But beyond a robject, the design approach led to creating a new concept, the “sensible presence robject,” for newly retired couples suffering from loneliness. It gave the possibility to take a step aside and propose an object which questions both the link between two people through their poetic sensitivity and, the impact of a slow technology as an animated object in a household.

### FUTURE WORKS

On the methodological part, the next goal of this project is to place Yōkobo in eight newly retired couples' dwellings for a five-week study. This experiment aims to assess the impact of Yōkobo's presence on each partner, the couple, and the whole household system. For that, we will use a protocol inspired by different longitudinal studies with a Roomba vacuum cleaner [15, 39]. A week before introducing Yokobo in the dwellings, participants will answer questionnaires, fill out creative cards and cultural probes on their subjective experience of their entrance. Then Yōkobo will be placed at the participants' entrance for four weeks. Each couple involved in the study will fill in questionnaires, interviews, creative cards, and cultural probes.

Regarding its design, in this pictorial, we do not describe the final material of Yōkobo because it is still under development. However, our goal is to explore different materials for its shape using ceramics to give a personal and unique aspect to Yōkobo. Indeed as it is dedicated to private home usage, it should fuse in the context of each household. Enabling the couple to choose between ceramic bowls could carry out this objective. Moreover, Yōkobo could react to sounds related to the house, some greetings words, and interact through touch. These other interactions are also future explorations that could personalize even more and enrich the sensible presence and messages between spouses.



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