

ISTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY

**HUMAN-SERVICE ROBOT INTERACTION: AN ETHNOGRAPHIC STUDY ON
ROOMBA VACUUM CLEANER IN THE DOMESTIC ENVIRONMENT IN ITALY**

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JUNE 2010

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**İNSAN VE SERVİS ROBOTLARI ETKİLEŞİMİ: ROOMBA ROBOTİK
ELEKTRİK SÜPÜRGESİ İTALYA EV ÖRNEĞİ**

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FOREWORD

I would like to dedicate my work to my lovely family who is always there with their great and unconditional support no matter where I am and what I do; to my only brother and sister who generously share their warmest love and cheers with me; to my friends whom I enjoy walking towards the common crazy dreams with; to the Italian Roomba users for their valuable contribution; to the energetic team of Design Continuum Milan who always believed in me; and to my supervisor Prof. Dr. H. Alpay Er who never stopped motivating and supporting my work and effort sincerely.

June 2010

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ABBREVIATIONS

IFR	: International Federation of Robotics
UNECE	: United Nations Economic Commission for Europe
RU	: Roomba Users
nRU	: Non-Roomba Users
RUS	: Roomba User Survey
nRUS	: Non-Roomba User Survey
HSRI	: Human Service Robot Interaction
MIT	: Massachusetts Institute of Technology
GUI	: Graphical User Interface

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HUMAN-SERVICE ROBOT INTERACTION: AN ETHNOGRAPHIC STUDY ON THE ROOMBA VACUUM CLEANER IN THE DOMESTIC ENVIRONMENT IN ITALY

SUMMARY

In recent decades, robots have appeared to be more present in our domestic lives in order to correspond to different needs and purposes of use. Some of them serve to entertain inhabitants, whereas others focus on performing specific services. The majority of studies in the literature indicate that even old, traditional tools are being replaced by these new robotic products that are used for the same or similar tasks.

Apart from product replacements, the domestic environment contains other variables and factors, which are primarily affected by these new technologies both in positive and negative ways. More importantly, these various factors tend to change dynamically in response. As a consequence, new smart technologies, which robotic products are a promising part of, become a catalyst for change considering the variety of key factors and players in the surroundings.

However, still little is known about the impact of new smart home technologies within the domestic environment. Even though researchers have already started studying service robots and human interaction mainly in laboratories, there is a big need for studies to be conducted in real domestic environments. It is a compelling necessity for both technologist and designer to develop a deeper understanding of the domestic environment before planning the future of robotics.

This thesis aims to contribute to Human-Service Robot Interaction (HSRI) literature by exploring the effects of these named technologies within the domestic environment, in particular by studying an existing product example in a specific area. Its main focus is on the interaction between Roomba, a robotic vacuum cleaner, and dynamic factors within the domestic environment in Italy. These dynamic factors are envisioned as cleaning products, people, daily activities and the environment. Finally, the study also explores the general concept of domestic robots with respect to the position of Roomba in Italian society.

The research model is mainly inspired by the “Product Ecology” approach by Jodi Forlizzi. By following product ecology guidelines, the thesis aims to approach an ethnographic design-focused research model to discuss existing literature findings through new perspectives and open new arguments to contribute to the future of robotics.

The study opens up with an overview of the literature. Then, two separate qualitative surveys are conducted among Italian people through online platforms. First survey is designed for Italian Roomba users, and contains questions about house organization, cleaning habits and routines, Roomba experience as well as user demographics. It is mainly designed to deliver first impressions and findings about the Roomba interaction and experience in the domestic environment in Italy. The other survey is specific for those who never had Roomba experience before, and it is composed of

questions related to cleaning habits and routines, domestic organization and demographics. It provides a base to compare findings of the first survey and gives a summary of Italian cleaning habits and domestic organization. In addition, both surveys investigate how Italian people would anticipate and picture the future of domestic robots. The survey phase is followed by a series of observational interviews with Italian Roomba users. Interview sessions explore same topics in details by additional support of records and photographs.

In conclusion, the cumulative analysis of both surveys and interviews reveals that Roomba causes drastic changes on cleaning activities, and it creates strong emotional bonding with its owners. On the other hand, Roomba does not bring forth long-term engagements regarding cleaning products and environmental structure. The last part of analysis points out three main topics about the overall robot concept in Italian society. Those are the importance of robots' visible movements, the references communicated with the intelligence of robots and the relationship between the generations and robots' reliability.

İNSAN VE SERVİS ROBOTLARI ETKİLEŞİMİ: ROOMBA ROBOTİK ELEKTRİK SÜPÜRGESİ İTALYA EV ÖRNEĞİ

ÖZET

Ev ortamında, çok çeşitli ihtiyaç ve amaçlara yönelik olarak tasarlanmış olan servis robotlarının sayısı son yıllarda giderek artmaktadır. Söz konusu bu robotlardan bazıları insanları eğlendirmeye yönelik olurken, bir kısmı da oldukça belirli ve özelleşmiş hizmetlere karşılık gelmektedirler. Günümüzdeki birçok güncel çalışma da bu söz konusu akıllı teknolojilerin aynı görevleri yerine getiren geleneksel ürün ve aletlerin yerini aldığı sonucuna varmış, ve böylece evcil ortamda kullanılan bu robotlarının sayısının artışı çarpıcı bir şekilde ortaya koymuştur.

Değişime uğrayan ürün ve aletlerin ötesinde, günümüz ev ortamı bu yeni teknolojilerden etkilenmeye müsait çok çeşitli faktörler içermektedir. Daha da önemlisi, söz konusu bu faktörler karşılıklı etkileşim sonucu hızlı değişime eğilimli olmaları ile öne çıkmaktadırlar. Bunun sonucunda da, servis robotlarını da içine alan bu yeni akıllı teknolojiler, ev ortamındaki bu değişken faktörler için katalizör görevini görmektedirler.

Tüm bunlara rağmen, akıllı teknolojiler ve ev ortamı arasındaki etkileşim konusu henüz yeterli düzeyde incelenmemiştir. Bu etkileşim her ne kadar laboratuvar ortamında araştırılıyor olsa da, halen daha gerçek ev ortamında yapılacak çalışmalara karşı ciddi bir ihtiyaç duyulmaktadır. Bu önemli ihtiyacın arkasındaki başlıca neden ise, elde edilecek tespit ve sonuçların özellikle robot sektörü içerisinde hizmet veren mühendisler ve tasarımcılar açısından sağlayacağı katkının büyüklüğüdür.

Tüm bunların bağlamında, yapılan bu tez çalışması belirli bir servis robotunu özel bir coğrafya ve kültür içerisinde inceleyerek insan robot etkileşimi bilgi dağarcığına katkıda bulunmayı amaçlamaktadır. Diğer bir deyişle, Roomba robotik elektrik süpürgesi İtalya örneği, ev ortamındaki çeşitli değişkenler göz önünde bulundurularak bu çalışmanın odak noktasında tutulacaktır. Böylece, bu bahsedilen ev ortamındaki değişken faktörler temizlik ürünleri, insanlar, günlük aktiviteler ve çevre olmak üzere dört ana sınıf nezdinde araştırılacaktır. En son olarak da İtalyan toplumu içerisindeki temel robot anlayışı ve Roomba tecrübesinin buna etkisi irdelenecektir.

Jodi Forlizzi'nin "Ürün Ekolojisi" yaklaşımından etkilenen bu çalışma söz konusu yaklaşımın prensipleri doğrultusunda tasarım odaklı etnografik bir araştırma modeli ile mevcut çalışmaları farklı açılardan sorgulamayı ve robotik teknolojilerin gelişimi adına yeni tartışmalara bir zemin hazırlamayı amaç edinmiştir.

Bu tez çalışması, konu ile ilgili daha önce yapılmış olan akademik çalışmaları inceleyerek başlayacaktır. Daha sonra, internet ortamında iki farklı nitel anket uygulanacaktır. Birinci anket Roomba kullanıcılarına yönelik olup onların ev organizasyonu, temizlik alışkanlıkları ve Roomba tecrübesini anlamaya yönelik sorular içermektedir. Böylece Roomba İtalya örneğinin ilk yansımalarının elde edilmesi amaçlanmıştır. İkinci anket ise İtalya'da yaşayan ve daha önce hiç Roomba

tecrübesi olmamış kişilere yöneliktir. Bu şekilde, Roomba etkisine maruz kalmamış geleneksel İtalyan ev organizasyonu ve temizlik alışkanlıkları hakkında bilgi toplayacak, birinci anket ile bir karşılaştırma yapma olanağı sağlayacaktır. Bu iki anket uygulaması daha sonra da gözleme dayalı kullanıcı röportajları ile pekiştirilerek, sorular ve araştırma konuları daha detaylı şekilde ele alınmaktadır.

Söz konusu anket ve röportajların birlikte incelenmesi sonucunda Roomba'nın temizlik alışkanlıkları üzerinde önemli etkileri olduğu ortaya çıkmış, Roomba'nın kullanıcıları ile önemli bir duygusal bağ kurduğu anlaşılmıştır. Öte yandan, Roomba'nın temizlik ürünleri ve ev organizasyonu üzerinde uzun süreli kalıcı değişikliklere sebep olduğu söylenememektedir. Araştırmanın son bölümü ise İtalyan halkı içindeki genel robot kavramının üç önemli noktasına işaret etmektedir. Bunlar robot hareketlerin görünürlülüğünün önemi, akıllı hareketlere yapılan göndermeler ve nesiller ile robotlara karşı duyulan güven ilişkisi olarak özetlenebilir.

1. INTRODUCTION

In the latest decades, robots have appeared to be more present in our domestic lives in order to correspond to the different needs and purposes of use. Some of them are served to entertain inhabitants, whereas some others focus on performing specific services. The majority of studies in the literature (Norman, 2007) indicate that even old, traditional tools are being replaced by these new robotic products that are used for same or similar tasks.

Apart from the product replacements, domestic environment contains other key variables and factors within its borders, which are primarily influenced by these new technologies both in good and bad ways (Forlizzi, 2007). As Forlizzi (2007) points out, there are few theoretical models to investigate products' social experiences and the mutual adaptation between those and the societies. These named models put the emphasis partially or fully on the main proactive players within the ecology; such as products, people, environment and the dynamics.

On the other hand, when speaking about the mutual adaptation, it is crucial to know that the idea of adapting to technology from the human perspective is a fairly new phenomenon. Norman (2007) claims in his book titled "The Design of Future Things" that the launch of each technology occurred to be an impulse for changes in the societies. According to him, in the 1800s, the introduction of cars and vehicles let people pave roads for. This drastic change is then followed by homes in the 1900s when they are added pipes after plumbing and toilets became internal elements, and also late in the 1900s when the wires and outlets for telephones, televisions and internet connections are built in.

In that sense, it is important to question how well the current set of homes is designed to host the autonomous service robots and how much they have to adapt if necessary. Di Salvo and Forlizzi (2006) assert that current houses are not designed in a way which is suitable for service robots of the near future. They foresee the potential need for fundamental changes to accommodate autonomous service robots and the ubiquitous computing within the home environment.

In addition to potential changes in the physical environment, it is also important to question how people would react and how much their daily activities and routines would be affected once these smart technologies and autonomous service robots enter to their daily life. Former researches on the integration of new smart technologies into the domestic environment show obviously that the counter-effects potentially happen in terms of the physical structure as well as the subjects, their daily activities, routines and even habits and attitudes (Forlizzi, 2007; Grinten et al., 2007; Sung et al., 2007).

On the downside, the human adaptation might not be so easy and take months, years and even ages although they are more flexible and adaptable comparing to service robots and machines (Norman, 2007). So, it would be ideal for humans to have service robots adapting themselves to the environment and people, even though these smart devices are rigid and too limited in certain capabilities. But such lack and limitation of machines' and robots' capabilities force people and environments to change in response. That eventually results in the final decision which is either to take the technology as it is or to go without (Norman, 2007).

Given the high level of the social impacts driven by the past technological milestones, designers need to understand the social impacts of new technological products and systems, since they are the interpreters between such ideas, reality and the societies (Norman, 2007). The challenge is not just composed of technical solutions to make autonomous service robots deal with a limited range of tasks, but it is also about having them participating within the entire human society as much, intuitive and natural as possible (Fong et al., 2003). Norman (2007) underlines the necessity of such adaptation: “[...] *as machines start to take over more and more, however, they need to socialize; they need to improve their limitations [...]*”. Furthermore, robots' adaptation to changing and unknown environments, and to their users are effective tools for a successful long-term integration (Grinten et al., 2007).

Due to growing presence of social robots in people's domestic life, the dynamics in the home organization should be investigated when robots are introduced into their field and activities (Fong et al., 2003). However, still little is known about the impact of new smart home technologies within the domestic environment. Even though researchers have already started studying service robots and human interaction mainly in laboratories, there is a need for the studies conducted in real domestic

environments. It is a compelling necessity for both designers and technologists to develop a deeper understanding of the home environment, before planning the future of domestic service robots.

This study aims to contribute to Human Service Robot Interaction (HSRI) literature by exploring the effects of the robotic technologies within the domestic environment, in particular by studying an existing product example in a specific area. It is mainly inspired by “Product Ecology” model by Jodi Forlizzi (2007) that is designed to investigate and explain the product use surrounded by various situations by addressing interaction design researchers to qualitative, ethnographic research methods. By following product ecology guidelines, this thesis aims to approach with an ethnographic design-focused research model, to explore the interaction between Roomba, a robotic vacuum cleaner, and the Italian domestic environment, to question existing literature findings through new perspectives. It eventually strives to open new arguments to contribute to the future of robotics. In addition, the main approaches, that this study is going to investigate in details, are listed as follows:

- 1) What is the impact of Roomba on cleaning products and tools?
- 2) What is the communication level between Roomba and people?
- 3) How much does Roomba influence cleaning and other daily habits?
- 4) What are the counter-effects between Roomba and the domestic environment?
- 5) Which features and attributes of Roomba shape the robot concept among Italian people?

2. STATE OF ART

2.1 Service Robots in Domestic Environment

2.1.1 Background

The word ‘robot’ is deriving from the Czech language and used for the first time by Karel Capek, the Czech playwright (Khan, 1998). Capek referred this word to ‘forced labour’ or ‘serf’ in his play R.U.R Room’s Universal Robot that was performed in Prague 1921 with a main theme about the dehumanization of man in a technological civilization. Robot is defined by the Robot Institute of America (1979) as: "A programmable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of task". Over years, this definition became more general and had broader boundaries. Today, any automatically operated machine to replace human effort in an intelligent way is named as robot, although it does not resemble human beings in appearance or perform functions in a humanlike manner (Url-11).

Considering robots to be a part of intelligent and autonomous machines, Norman (2007) takes the initial branches of robots back to the 1700s when the first effort was put on the development of the mechanical automatons. As a successful example that Norman (2007) gives, Wolfgang von Kempelen is an early adopter with his chess-playing automaton “Turk” (Figure 2.1 :) that he made public in Austria 1769. Even though “Turk” was a hoax with a mechanical arm controlled by a chess expert, the idea of having intelligent mechanical devices succeeded since the community was eager and ready to believe in the possibility of having such intelligent devices (Norman, 2007). However, after this first interaction between people and intelligent devices, the evolution of intelligent automatons did not gear up until the development of mechanical theories developed in the mid 1900s (Norman, 2007).

Following the rapid development of intelligent devices in the mid 1900s, big industries and companies began to take the advantage of intelligent devices for various tasks, especially through the full or partial robotic devices. According to the

report by Nations Economic Commission for Europe and The International Federation of Robotics (2005), the main reasons behind this growing trend were to save costs, increase productivity and quality, remain in the global competition and shift dangerous and laborious work from human to machine. To give an example, welding robots in the automotive assembly plants made drastic changes in the assembly line because they speeded up the process and made welding services more concrete and precise (Fong et al., 2003). In the late 1980s, the development of mobile robotic vacuum cleaners had already started for industrial and commercial settings (Di Salvo et al., 2006). Another example, which also points out the dangerous part of the task, could be the development of robots within the military services by the launch of devices like the unmanned aerial, ground and underwater vehicles as well as the tactical mobile robots (Url-7).



Figure 2.1 : Turk, a chess-playing automaton designed by Kempelen in 1769 (Url-8)

Today, people are becoming more aware of the potential and functional value of these intelligent devices especially when their service and the final benefit are obvious and visible (Fong et al., 2003). Majority of the users are aware of robots' capabilities of doing many of daily activities ranging from managing healthcare to giving education services at different levels. Depending on the various key elements like the subjects involved, and the environment where the activity takes place, each task obviously contains different level of complexity which is highly connected with the intelligence level driven by technology. Therefore, it is also observed that complex activities requiring more intelligence like child/animal care tasks are not preferred as much as household tasks would do where the complexity is relatively low (Dautenhahn et al., 2005). Nevertheless, reports proves this finding as daily tasks; such as, vacuum cleaning, cooking, lawn-mowing where the final results rapidly and clearly communicated to the people, are having an increasing trend in current domestic environments (UNECE/IFR, 2005). Donald Norman (2004) foresees that the benefits of the development of intelligent machines will be more close to people and their daily life through the areas like driving automobiles, piloting commercial vessels, education, medicine, and taking over dangerous and routine work.

Currently, many of the recent studies and reports highlight a growing interest in domestic personal and service robots that particularly arose in the beginning of millennium years. For instance, in 2005, the International Federation of Robotics (IFR) in cooperation with the United Nations Economic Commission for Europe (UNECE) released a study called "World Robotics 2005" (UNECE/IFR, 2005), which included global statistics about the service and industrial robots in 40 countries. As one of the remarkable outcomes, this study pointed out that more than 1,000,000 household robots were in use and there were some other several millions on the way in the upcoming few years. As another proof of this incline, U.N.'s annual World Robotics report declared also that almost more than half of the domestic robots, that were currently in use, were bought in 2003 (Url-5). According to Bill Gates (2006), who is one of the founders of the famous software company 'Microsoft', the International Federation of Robotics claimed the number of personal robots in use to be about two million by 2004. Furthermore, he added that the East Asian countries like South Korea even was planning to place domestic robots in

everyday life by 2013. Finally, the Japanese Robot Association remarkably envisioned the growth and value of the personal robot industry to be more than \$50 billion a year worldwide by 2025, which is currently about \$5 billion today.

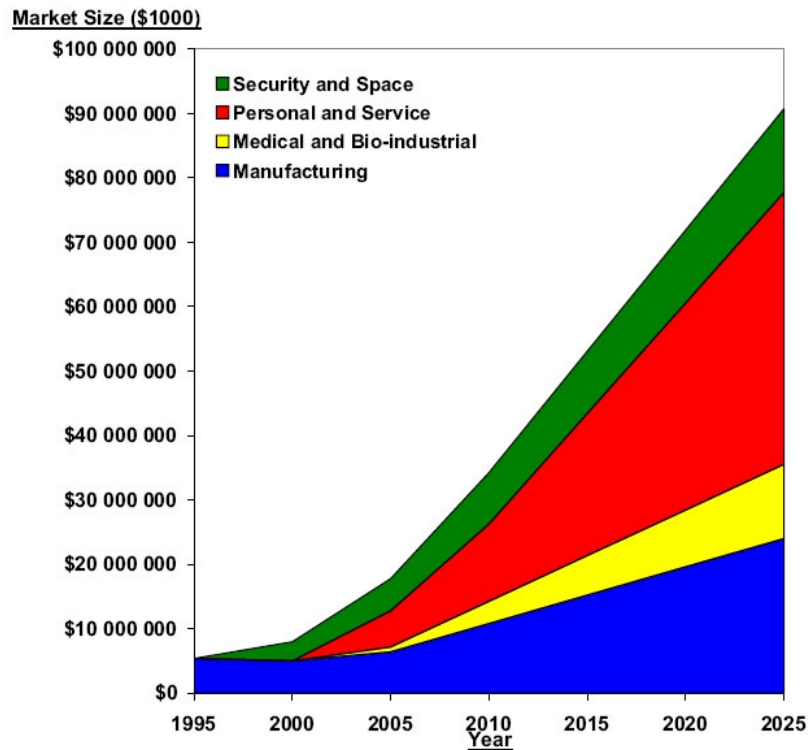


Figure 2.2 : Envisioned growth of the personal robot industry (Gates, 2006)

Beside the numeric values picturing the growth of the future robotics, the contemporary trends and growing expectations within different communities expands the feeling of being in the beginning of the next era of personal and service robots, as Bill Gates (2006) declares. In spite of the technical and technological difficulties faced within the robotic industry, Gates (2006) compares this period closely to the one when he and Paul Allen, with whom he found one of the world's biggest software companies 'Microsoft', were imagining of having computers present on one desk in each home. This declaration is very exciting in the way that the rapid developments of personal and service robots are soon to happen with respect to how drastically computer technologies shifted from being very complex devices to daily portable objects. Moreover, Bill Gates clearly assumes robots to be a ubiquitous part of the daily life by the development of technologies like distributed computing, voice

and visual recognition, and wireless broadband connectivity which will eventually allow robots to perform tasks in the physical world on people's behalf.

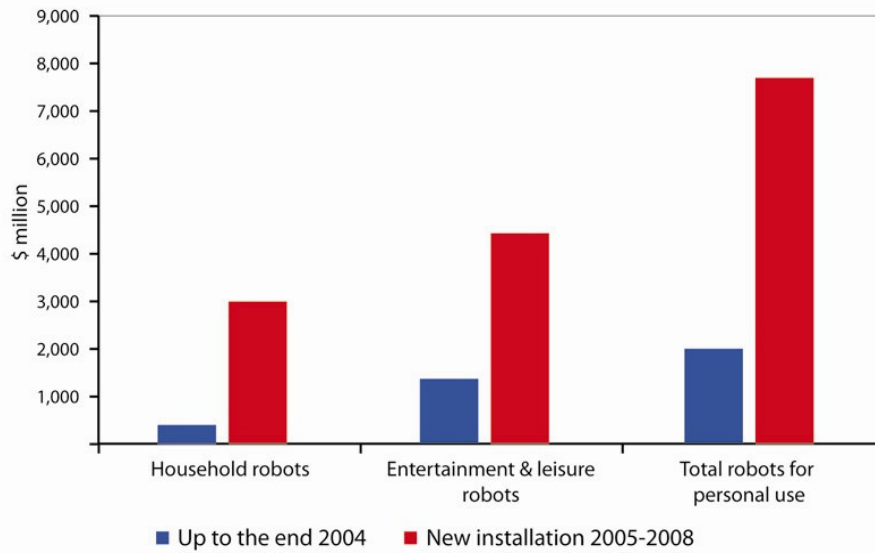


Figure 2.3 : Value of service robots for personal/domestic use at the end of 2004 and the projected installations in 2005-2008, adapted from UNECE/IFR (2005)

In the essence of all robotic systems, regardless of the given task, they all must solve a number of shared design problems, which include perception (navigation, environment), cognition (planning, decision making), action (mobility, manipulation), human-robot interaction (user interface, input devices, feedback display) and architecture (control, electromechanical, system) (Fong et al., 2003). However, the current environments are changing very quickly and becoming more complex by means of various dynamics. Therefore, it is very difficult with the current technology to give robots the ability of sensing the surrounding environment in order them to react precisely and rapidly (Gates, 2006). Gates underlines this complexity of such attributes as: “... *even something as simple as telling the difference between an open door and a window can be devilishly tricky for a robot*”. This expression clearly points out that robots need the assistance of people in unpredictable environments, even though they are supposed to be working autonomously. For instance, many of the mobile service robots need people's hand to work properly again when they bump into heavy obstacles or are trapped within a domestic area (Grinten et al., 2007). This example reinforces the idea of the

collaboration between people and robots where the high level of adaptation, communication and socialization is necessary. Furthermore, the literature indicates that human and machine, both having their limitations, have to cooperate to get the jobs done (Di Salvo et al., 2006; Grinten et al., 2007). In other words, the robots should adapt to the ever changing physical surroundings and user demands and basically understand the situation, whereas people have to understand what the robot is doing and thinking, what it should do and what it can do. At that point, studies point out that physical appearance, behaviors and verbal communication are key elements which are useful for robots to make themselves clear to their surroundings and people in the periphery (Grinten et al., 2007). Today, humans and robots do not just coexist within the same environment, but they also cooperate towards the shared tasks and goals.

Given the high level of the interaction between people and domestic service robots as described above, the static look and physical structure of a robot is a tool that biases the entire interaction and experience since it sets the majority of people's initial expectations (Fong et al., 2003). For example, a robot with human mimics, gaze and form will create expectations as if it can communicate with people like a human (Grinten et al., 2007). The Japanese researcher Masahiro Mori did an interesting study on how life-like robots should be produced (Dautenhahn, 2002). Mori basically benefited from various robot designs with a vast level of human similarities and characteristics to investigate how the human-likeness would affect people's psychological perception and emotional reaction. According to his study, human-likeness, which is grouped in two main aspects as movement and appearance, increased the overall perceptions and reactions generally in a positive way. As a result of that, Mori claims that the more human-like robots become, the more believable they are perceived as he shows on his famous 'uncanny valley' diagram (Figure 2.4 :). On the downside, he also noticed that there was a certain point where such human-like attributes and characteristics were anticipated to be strongly repulsive when they were installed onto a robot. However, he figured out that shortly after this reference point, the tendency of human perceptions came to change once again in a positive direction as the human similarity of robot designs increased, and it reached to an acceptable level of empathy in the end. This area on Mori's diagram,

where such a drastic change happens, is named as the ‘uncanny valley’ (Dautenhahn, 2002).

Apart from the physical design, structure and attributes of robots to shape the majority of first expectations, science-fiction movies become also very effective references underlining how people’s perceptions are shaped by their past experiences, like it was pointed out by a survey conducted by Zayera Khan in 1998. Khan’s survey was done mainly to get a more thorough assessment of attitudes towards the intelligent service robots. Participants encountered a vast group of questions that aim to explore different aspects of robots including the general image of robots as well. As a consequence, the survey pointed out that the majority of robots, whose appearance the participants liked at most, were highly impressed by the Science Fiction genre originally either in literature, movies or television. As another remarkable outcome, participants distinguished two different tendencies when they were prompted to draw a robot whose appearance contained either strongly anthropomorphic or mechanistic references. Firstly, they preferred robots having a machine-like look. Secondly, they intended to like robots with verbal communication skills; such as the voice recognition and synthesized speech, which should vary naturally based on the gender and age.

As the survey of Fong, Nourbakhsh and Dautenhahn made it clearer, people today have the potential to mention about details, even like the age and gender when they are asked about the interaction level of intelligent robots. This, at the end, brings the matter of how sensitive they are to the anticipated level of interaction when thinking of such technological objects in a bigger and wider perspective. Therefore, Orlikowski (2000) asserts that people do not simply pass through the shelves in a technology market picking their desired intelligent products, but they also observe through several resources and make the final decision based on how intuitively they could interact and communicate with such intelligent devices. In a broader range of the entire world of these smart and autonomous devices, Norman (2007) expects the interest in intuitive and natural interaction to grow as these devices become more intelligent, emotional, and as they are added more personalities as well as their increasing initiatives in people’s daily lives.

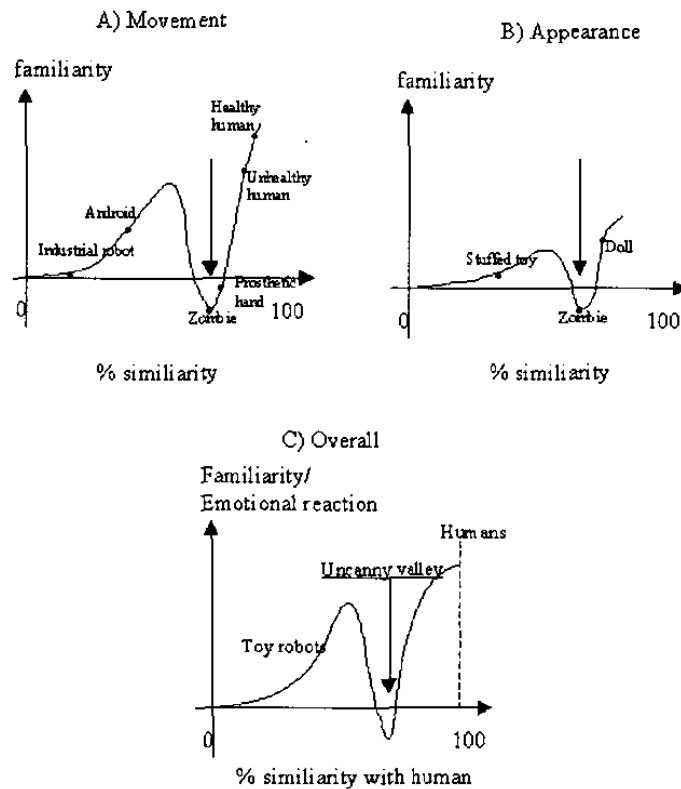


Figure 2.4 : Massimo Mori's Uncanny Valley (Dautenhahn, 2002)

Speaking of the interaction, the important facts, like how well and correct the signals between robots and humans are understood and how appropriate the communication level is chosen, are strongly driven by physical appearance, structure and dialogue type as being main references to the anticipated level of interaction (Grinten et al., 2007). For example, robots resembling human through the human look, mimics and speech capability would spread the expectation of communicating like a human and lead the user naturally to increase the complexity level of communication as if he is talking to another person. However, if the named intelligent device can not correspond to the complexity level of the chosen communication and give feedback that does not match with users' expectations, then the users might be disappointed and disengage with the intelligent device, which potentially results in the failure of the human-robot interaction (Dautenhahn et al., 2005). On the other hand, studies also show that robots with less humanlike appearance, like the dog-like ones trying to communicate with simple signals and lights, cause people to decrease the complexity level of communication and lead them to address robots more comprehensibly and interpret their signals more flexibly (Grinten et al., 2007). In that

sense, there have been many robotic project examples with various robot designs (meaning appearance, dialogue etc.) for various tasks as yet, but iCAT and AIBO could be considered to be two remarkable cases with negative and positive results, which in the essence highlight the important connection between robots' embodiment, attributes and users' first expectations which guides the rest of the interaction.

In 2005, Philips launched the iCat robotic research platform as the world's first available plug-and-play desktop user-interface robot with mechanically rendered facial expressions with the aim of exploring the human-robot interaction in order to apply the findings in smart home environments (Poel et al., 2009). Conceptually, the iCat was designed for two main reasons; first to assist elderly people with their domestic appliances (e.g. video-recorder) and monitor their health condition, and secondly to contribute to the development of the 'Ambient Intelligence', which is a ubiquitous computing system combining all home electronics and controlling it intelligently, foreseeing the user's needs (Grinten et al., 2007).

Since the focus was mainly on facial expressions, iCat's face included a combination of high level actuators and facial organs, which eventually gave it the individual control of each eyelid, eyebrow, eye, and mouth to do as many different expressions as possible (Poel et al., 2009). Additionally, iCat had a real female voice transmitted through a speaker embedded on its body. In conflict with its human-like embodiment and features, iCat had multicolour LEDs in its ears as well as its paws. Besides, iCat did not have any other organs like arms and legs which resulted in the lack of mobility (Poel et al., 2009). Moreover, "playing" animations, that were predefined sequences based on actuator values, were controlling iCat's movements.

Following the launch, Philips started series of observational studies to see the level of interaction between iCat and especially the elderly people. As the most significant finding, it is distinguished that iCat's human-like attributes and attitudes misled the conversations in many cases mostly because of generating wrong expectations (Grinten et al., 2007). For example, although iCat's capabilities and services were clearly defined in the beginning, observed subjects wanted to have other services that are way different than what iCat was capable of. Subjects expected iCat to understand their jokes, which in the end resulted in miscommunication and disengagement due to the strict borders of its programming and predefined

animations (Grinten et al., 2007). In other words, iCat was not flexible enough to perceive the improvised conversation and react spontaneously in appropriate way once the conversation was biased in a direction that did not fit in with iCat's predefined scenarios. Furthermore, as one repeatedly kept trying to make himself clear to the other, the conversation became eventually a dead-end. This picture, on the other hand, reminds of the point where Norman (2007) refers to Socrates when talking about the mutual adaptation about human beings and technologies: a technology without a space for explanation, debate or discussion might be supposed to be a poor technology.



Figure 2.5 : The iCat by Philips, adapted from Grinten et al. (2007)

As another example, Sony introduced AIBO in 1999 which is an artificial intelligence robotic pet that is inspired by the nature of human-dog relation (Url-8). AIBO is considered to be the first commercially available companion robot with the most advanced technology (Fong et al., 2003). Over time, Sony released different models with different looks and features which initial designs are taken care of by Hajime Sorayama, a Japanese illustrator famous with women and feminine robots, and Katsura Moshino, a Japanese visual artist; whereas, the futuristic sounds, which are far from the real dog noises, are programmed by Nobukazu Takemura, a Japanese DJ/avant-garde composer (Url-8). Nonetheless, AIBO is meant to be an enjoyable entertaining source through the spontaneous features like exploring autonomously and adjusting itself rigorously. For instance, people encounter first that AIBO learns how to stumble and walk, and then they watch AIBO playing with its special red ball, which in the end constitutes a good and popular companionship (Fong et al., 2003). Today, Sony sold so far more than about 692,000 AIBO units since its release

(Url-7). Moreover, enthusiasts are even organizing events like AIBO football tournaments and dance contests (Sung et al., 2007).



Figure 2.6 : Sony AIBO Entertainment Robot Dog Family (Url-1)

Contrary to iCat case that is already described above, recent researches pointed out that AIBO with its dog-like form and artificial intelligence-based software enhanced intimacy among people which eventually leads to the acceptance of perceived usability within the given technology (Sung et al., 2007). Additionally, some studies focusing particularly on children and elderly people, and several analyses on online discussion forums highlighted AIBO's psychologically engaging aspects on both adults and children on the basis of the life-like essences, mental states and social rapports (Dautenhahn et al., 2005). For example, a group of researchers from Saint Louis University recently studied how pets would influence loneliness and create emotional bonding among elderly people. The study, where the residents got visits from the artificial dog AIBO and a living, medium-sized gentle dog, revealed that the residents who received these visits felt less lonely than those who got visits from neither (Url-12). Even though the study did not contain any statistical difference

between the impacts of the real and robotic dog on easing loneliness and fostering attachments, it on the other hand proved that the appearance, communication and interaction level of AIBO was not perceived alien-like. In other words, it is designed conformably with the technology behind, so that people's expectations did not exceed AIBO's real capabilities and they were well aligned with its given technology. As a consequence, not only a single person, but also a group of people were playing with AIBO in the waiting lounge. More interestingly, they all were playing with it, talking to it and more remarkably, they all were laughing around a single product. All those references might be linked to why AIBO today became so popular.



Figure 2.7 : Sony AIBO in nursing home with the residents (Url-12)

In terms of the static look, physical structure and attributes, personal and social service robots can be grouped by the design point of view in two main divisions, which are the ‘biologically inspired’ and ‘functionally designed’ ones (Fong et al., 2003). The first group ‘biologically inspired’ is basically composed of robots by which designers tried to demonstrate the social intelligence of living creatures through the internal simulations and mimics (Fong et al., 2003). They are mostly inspired by household animals given mostly the real embodiment thereof, like cats and dogs, with the main objective of creating robotic companions; such as iCat, AIBO, Robo Dog and Omron (Fong et al., 2003). On the basis of activities, those are mainly involved in entertainment, assistance to the handicapped and elderly people, daily tasks and even education (Sung et al., 2007). Although most of these activities require high level of interaction with humans, the way those robot companions express their emotions, which can be classified as artificial emotions, is very limited to specific embodiment parts and facial organs connected with relatively high technological actuators (Fong et al., 2003). For instance, Kismet that is made at the Massachusetts Institute of Technology (MIT) in the late 1990s can move its neck has also control on some facial parts; such as, ears, eyeballs, eyelid, eyebrows and a mouth with two lips in order to participate in human social interaction and to demonstrate simulated human emotion and appearance. Icat and AIBO can be given as other remarkable references to these limitations mentioned above.

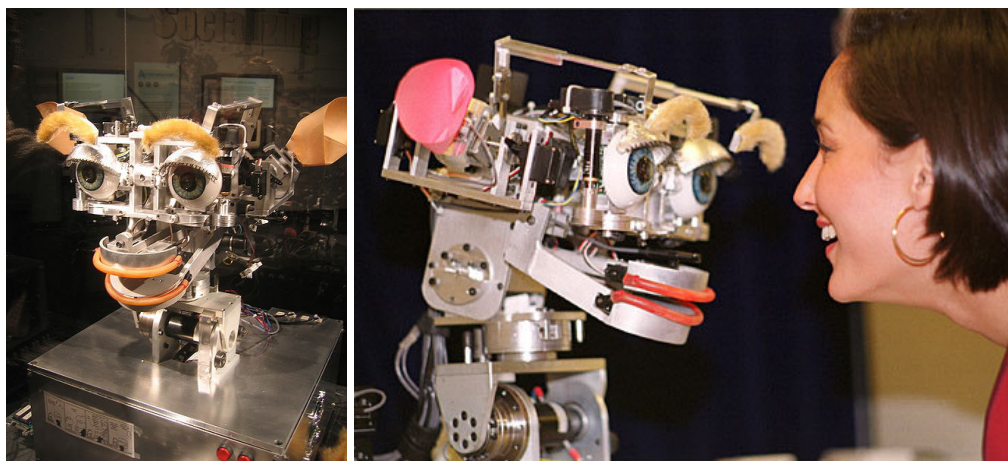


Figure 2.8 : Kismet the social robot (Url-8)

Considering the variety of the activities, the level of complexity thereof, the limitations in expressing artificial emotions, and the need for human support, which had been already mentioned before, there have been so far many studies focusing on personal and social robots that are used in different domains and applications ranging from pediatric robots to medical assistances for different target groups like children and elderly people (Fong et al., 2003). This robot companion group includes very important examples which might be considered as a first step toward a vision of the social intelligent system. As one of the well-known early examples “Asimo” (Advanced Step in Innovative Mobility) is an example to humanoid robots that is created by Honda. The development of Asimo started in 1986 with “EO”, which is followed by many upgraded versions with different names and changing appearance (Url-8). The name Asimo first showed up in 2000. The latest generation of Asimo is introduced in 2005 that is an astronaut like humanoid robot standing at 130 centimeters and weighing 54 kilograms (Url-8). The current generation of Asimo is capable of recognizing moving objects, postures, gestures, faces and distinguishing different sounds in the surroundings. Successors of Asimo have the potential to be involved in collaborations with people by helping with activities like laundry or assisting the elderly people within the domestic and other environments (Mutlu et al., 2006).



Figure 2.9 : Honda ASIMO the humanoid robot (Url-8)

Apart from the “biologically inspired” service robots, designers have another approach through which they aimed at building a strong connection between the service robots and their functions. This second group of service robot designs, where the functions come to stand out whereas the humanlike features and attributes stay

secondary, is named as “functionally designed” ones (Fong et al., 2003). The majority of service robots basically give clear clues about their functions through their look and designs. Moreover, this group might be corresponding to people’s common expectation that the service robots should appear and act conveniently for the given tasks (Dautenhahn, 2002). Nonetheless, there have been some studies arguing the fact that the appearance of each robot should definitely reflect the operation that it is meant to perform. In other words, the objectives and tasks should eventually guide the physical look, design and features of service robots (Fong et al., 2003). However, this idea of a strong coherence between the function and look does not necessarily mean that the interest in humanlike features and attributes is totally dried off. This tendency on functional look might be related more to the need for a better clarification between the ever-changing technology and the increasing level of complexity thereof. Norman (2007) distinguishes this issue by pointing out the idea of predictability. He basically underlines that people become less capable of perceiving how technology progresses and predicting its actions, as its gets more influential and more complex. The iCat case, which is already described above, could be again an interesting example referring to the same point as Norman’s. For instance, subjects participated in iCat trials could maybe have understood easily that iCat was capable of working as an alarm clock if it had the traditional press-buttons on its embodiment as a regular clock would have. However, in reality subjects rarely predicted iCat’s feature since they communicated with it in a different audio visual way (Grinten et al., 2007). Additionally, Zayera Khan’s survey on attitudes towards intelligent service robots (1998) proved that people were pleased to see clear functional parts on service robots. In his survey, Khan basically asked participants to make a drawing of their own ideal service robot. In total, he collected 43 drawings picturing the ideal service robot, and as a consequence, most of them contained clear references to the envisioned task and objective.



Figure 2.10 : Sketches about the ideal service robot (Khan, 1998)

2.1.2 Robots for Domestic Cleaning

Following the emerging interest in the personal and service robots used within domestic environment, recent reports monitor that some of the domestic tasks appear to be more popular and trendy comparing to others. For instance, robots began to take the control of domestic tasks; such as, cleaning, lawn-mowing, windows washing and pool cleaning (Url-5). Besides, entertainment robots like toy and hobby robots even become human companies and part of domestic life (UNECE/IFR, 2005). As a part of these smart devices, vacuum cleaning robots were significantly sold more than at least a million two years after their first launch in 2001 (UNECE/IFR, 2005).

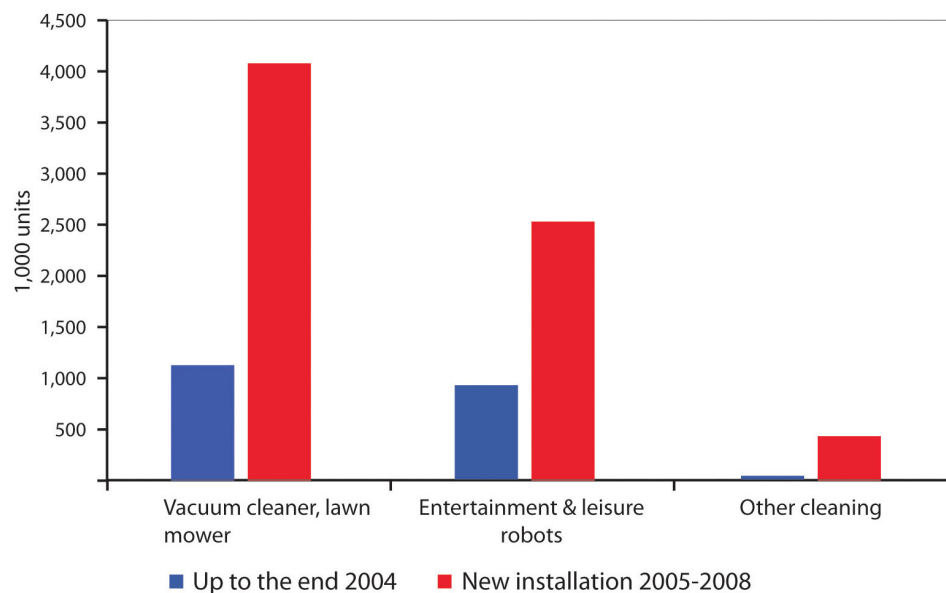


Figure 2.11 : Stock of service robots for personal/domestic use at the end of 2004 and the projected installations in 2005-2008, adapted from UNECE/IFR (2005)

Speaking of domestic tasks and the popularity, a group of six researches; Kerstin Dautenhahn, Sarah Woods, Christina Kaouri, Michael L. Walters, Kheng Lee Koay, Iain Werry, conducted a detailed research in 2005 on how people would imagine of future robot companions in their daily lives. The main scope of this study was to question the acceptance level of robot companions with respect to the different attributes, features and behaviours as well as the desirable tasks and their potential

importance. According to their findings, high percentage of participants described activities like guarding the house, entertainment and gardening to be popular at their home environment, whereas only a few people mentioned about robots to look after their children which can be considered to be more complex than the other described activities. On the other hand, the researchers observed as the most significant outcome that the majority of the participants (96.4%), without any precise gender, age and technology expertise differences, intended to have robots to do mainly vacuum cleaning activities.

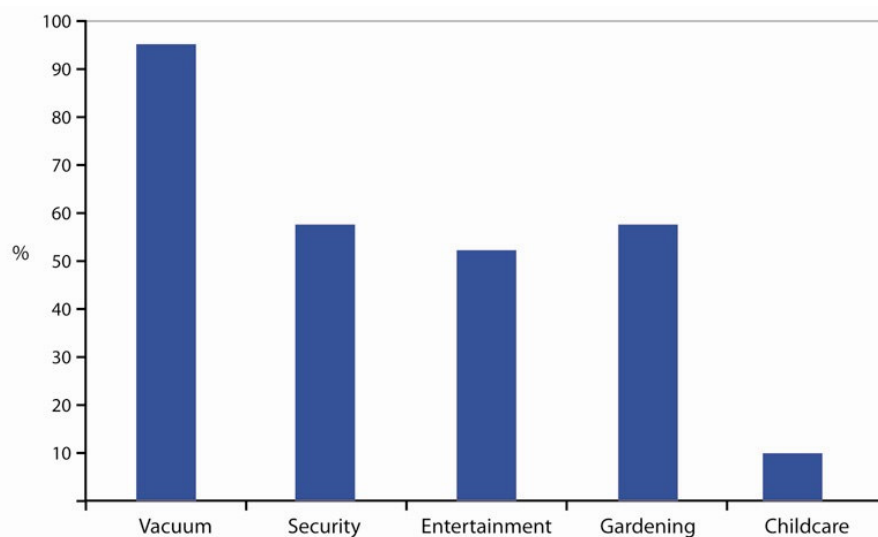


Figure 2.12 : Robot companion tasks, adapted from Dautenhahn et al. (2005)

Apart from being a popular and rapidly growing part of domestic robots, the robotic vacuum cleaners are described today to be self-moving devices, which have at least a basic vacuuming system inside, and is intelligent enough to clean the given space after it is programmed by the users (Url-8). Those smart objects usually contain general parts of the traditional vacuum cleaners like brushes, motors and dust-bins. However, the design of these parts may vary from one brand to another, which eventually results in the efficiency difference. Therefore, other components like motors, which keep the whole system running, sensors that help these devices interact intelligently with their surroundings, and navigation systems, by which they have a better understanding of the environment, are the common ones which give these smart devices the ability of cleaning the environment by themselves (Grinten et al., 2007).

In spite of its short history, the robotic vacuum cleaner industry already includes different brands in the market with a broad price range which starts from 350€ and goes to €3500 (Grinten et al., 2007). International companies like Sony, Electrolux, iRobot, Dyson and Samsung can be considered to be the dominant ones. All these brands usually try to differentiate through several technologies. For instance, the cheaper robotic vacuum cleaners clean the room randomly; and when doing so, they usually bump into obstacles and walls softly (Grinten et al., 2007). On the other hand, expensive ones have infrared sensors which prevent them from falling off stairs (Url-1). Optical sensors indicate situations like when the dust-bin is full, and additionally they also help the robotic device understand the level of dust on specific areas where the extra attention and effort is necessary. Some other robotic vacuum cleaners are capable of charging themselves by going automatically to their docking station before running out of the energy (Url-2). Besides, some of them also have two important features; first the remote control feature that allows the users to control the device within a certain range remotely, and second the environment mapping feature to decrease the time of cleaning as well as increasing the efficiency (Grinten et al., 2007).



Figure 2.13 : Robotic vacuum cleaners in the market (Grinten et al., 2007)

On the other hand, the common challenges remain the same no matter how the technology varies from one brand to another. As the major part of them, environment meaning the domestic structure, furnishing and people surrounding the robotic vacuum cleaner appear to be a big phenomenon. First of all, the structure and plan of the domestic environment is highly influencing how effectively the robotic vacuum cleaner could perform. Fundamental elements, like stairs or small corners might be potential obstacles that might hinder the robotic vacuum cleaner working properly (Grinten et al., 2007). Just like the structure, the furnishing within the environment may have negative impacts on vacuum cleaners' performance as well. For instance, studies pointed out that cables, wires, chairs and even rugs could be constraints when a robotic vacuum cleaner is running (Sung et al., 2007). Therefore, it also came out that many people today prefer removing all these obstacles before switching robotic vacuum cleaner on (Forlizzi, 2007).

Finally, the interaction between the robotic vacuum cleaner and people is also very important and crucial which affects both, the performance of the device and eventually the perception of people about robotic products. That is mainly because people are really easy to blame technological products when failing, even though they are mostly the ones who cause the problem due to the lack and weaknesses of interaction and communication model (Norman, 2007). For instance, people usually do not understand what the device is meaning or sometimes they think that they give the right command although it is not, which in the end makes them be annoyed of the technology, so they start seeing it useless and give it up after a while (Di Salvo et al., 2006). For that reason, a robotic vacuum cleaner, as a part of high technological objects, should be controlled ideally through an interface where each message is clearly and correctly communicated. Therefore, it should express itself and communicate with the user in a way that it keeps the level of interaction as intuitive as possible (Norman, 2007). As another important perspective, people also look for intelligent movements like overcoming physical obstacles by requiring the minimum amount of human assistance, responding to the every-changing environment sufficiently, and even learning the users' behaviours and the environment characteristics over time to adapt them easily and rapidly (Grinten et al., 2007).

2.2 iRobot Roomba: The Domestic Cleaning Robot

In 2002, iRobot, a US based company founded in 1990 by Massachusetts Institute of Technology roboticists Colin Angle and Helen Greiner teaming up with Prof. Dr. Rodney Brooks, made the first release of Roomba robotic vacuum cleaners (Url-10). Apart from its other two divisions which are focusing on military and industrial purposes of use, iRobot released Roomba robotic vacuum cleaner series as a part of its consumer-based division that is mainly meant to be a combination of different cleaning developments and technologies which derive from the cleaning expertise grown especially in the industrial environment (Url-3). In spite of doubts particularly on its efficiency and functionality arisen when it was first introduced as an autonomous device to clean the floor within the domestic environment, Roomba happened to be well-known pretty quickly, which is today sold more than 4 million units worldwide (Url-10).



Figure 2.14 : Roomba Discovery Series, adapted from Di Salvo et al. (2006)

iRobot Roomba is described as a “robotic floor vacuum” with high level of mobility which also allows it to clean the floor as going along within the domestic environment (Grinten et al., 2007). It basically contains two rotating brushes to sweep the floor, a vacuum to suck the dust and particles off the floor, and side sweeping brushes to clean walls and baseboards (Di Salvo et al., 2006). The cleaning circle usually starts and ends in Roomba’s self-charging docking station. When each circle is completed or Roomba is about to run out of the battery, it returns automatically to its docking station and recharges again which takes approximately three hours. This connection between Roomba and its docking station is established

through infrared signal technology, which also prevents Roomba from falling off the high surfaces like stairs (Grinten et al., 2007). Additionally, same signals also locate Roomba's position in a room and define a route through several additional accessories to manage the cleaning operation throughout the entire place of activity (Url-10). For instance, accessories like "Virtual Wall" and "Lighthouse" constitute artificial borders where necessary and help also program Roomba. By switching on such external accessories, the user gets the possibility of defining some borders for the cleaning activity, and so he keeps the Roomba within a certain zone or directs it within the entire domestic area. Another accessory called "Wireless Command Centre" helps users program Roomba up to seven preset cleaning times per week. Therefore, users can also use it as a remote to control and steer Roomba from across the room (Grinten et al., 2007). Beside the accessories, Roomba through its integrated sensors recognizes dirtier areas where more effort and attention is needed. When bumped into such areas, Roomba basically stops there and starts drawing circles on the spot until it makes sure that there is no dust left (Url-10). All these different scenarios, like the start and the end of the cleaning cycles, the low battery case, getting stuck, blocked in an area or recognition of dirtier surfaces, is communicated to the user through series of futuristic and machine-like sounds which generally take the form of beeps (Sung et al., 2007). On the other hand, human-like sounds and audio voice are used only if the user walks through the demonstration showing how Roomba's initial should be set up, or Roomba alerts when requiring maintenance or additional assistance (Grinten et al., 2007).

In terms of the capacity, a Roomba is normally capable of cleaning about three 4.5 x 5 meter rooms (Di Salvo et al., 2006). The user needs to clean its brushes and empty the dust bin at least once in every two or three cleaning circles depending on how dirty the floors are (Grinten et al., 2007). There are also filters which should be replaced when it got clogged.

To date, Roomba robotic vacuum cleaner family includes five different series within three main generations in general. Generations are classified as 400, 500 and 600s, whereas series are divided as "normal", "green", "discovery", "pet" and "professional" series (Url-10). Each generation includes in its nature a variety of new technical improvements from sensors to software solutions with prices starting from \$160 and going to \$600 (Url-10). Contrary to technical and software-wise

improvements and differentiations, every Roomba model, regardless of which series and generation it belongs to, has the same dimensions which is the diameter of 34cm and height of 9 cm. On the other hand, the availability of different models alters from one country to another.

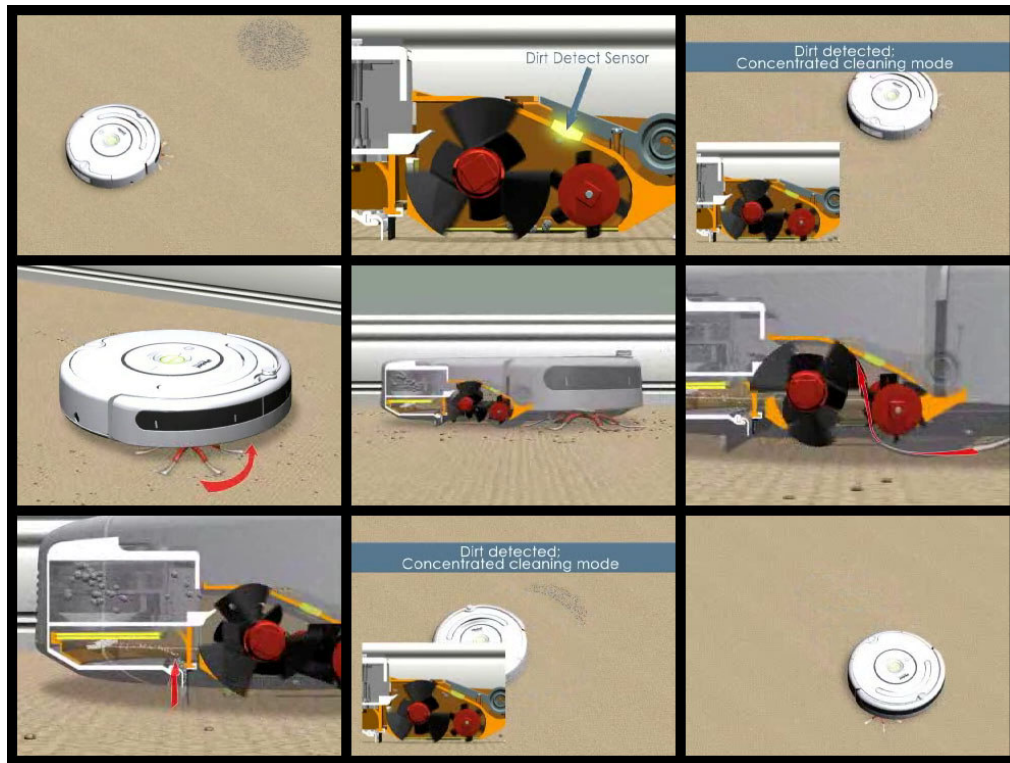


Figure 2.15 : The basic working principle of Roomba, adapted from Uri-10 (2010)

iRobot launched Roomba in Italy in 2002, shortly after its global launch. In the beginning, the device did not take so much attention within the Italian society due to reasons like the price and being brand new technology. However, following years the interest has grown, and recently Roomba is awarded as the Elettro Product of 2009 (Elettro Prodotto dell'anno 2009) in the category of domestic appliances, which is an annual award selected by 8000 representative consumers each year (Uri-2). To date, the current Roomba models in the Italian market are Roomba 581, Roomba 562 PET, Roomba 560, Roomba 555, Roomba 530 and Roomba 520 (Uri-10). Additionally, the price range from € 299 to € 514 as the maximum.

2.3 Product Ecology

Ecology as a word steams from the Greek word “oikos” which means “house”, “living relations” or “habitation” (Forlizzi, 2007). Beyond its literal meaning, contemporary science defines ecology to be an interdisciplinary study of the distributions, abundance and relations of organisms and their interactions with the environment (Url-8). Therefore, ecology is considered to be a set of interdependent parts that have particular relationships within a system which in the end investigates and explains the relationships of living organisms to the external world (Forlizzi, 2007). Since its broad meaning covers a wide range of topics and scales, ecology is today used in a vast discipline; such as, human ecology, industrial ecology, business ecology, social ecology, basically in fields where an ecological approach is applied through which people can explore the systems, relationships and the interaction level between different stakeholders, tasks, roles and the environmental factors (Url-8). More significantly, all these fields and ecological approaches eventually refer to a unifying theme which is the environment, the people and the mutual interaction between these two together with all other relevant factors within the given environment (Di Salvo et al., 2006).

Product ecology is described as an approach which aims at providing rich and detailed data about how people interact with products by mainly exploring a product’s social experience as well as its mutual adaptation with its users within a given environment (Forlizzi, 2007). Product ecology does not only focus on the named product and its users, but it also considers the system as a completion of dynamic factors like all other people in the same environment, their roles, organizational structures and other products used again in the same environment. Forlizzi (2007) refers to social ecology theory to be an important basis for the product ecology although social ecology mainly keeps the human in the center, whereas the product ecology shifts it to the products. According to Forlizzi, social ecology takes the environment and the social relationships among the people into consideration, where the human behavior is perceived as an adaptive fit to an external environment. The mutual relationship between the human and environmental factors is complex and dynamic, which is similar to the interconnection among product ecology factors (Forlizzi, 2007). Therefore, like the social theory assumptions about the dynamics of social relationships, product

ecology precisely assumes that each product has its own ecology where factors are adaptive and have different roles, and each product's ecology is facing artificial boundaries (Forlizzi, 2007). For instance, the use of a traditional domestic vacuum cleaner might be easily affected if its user sprains his ankle which in the end makes him unable to vacuum. Following that, the cleaning routine within this domestic environment may potentially change and this can cause drastic changes in the use of the named vacuum cleaner as well as people involved in cleaning. Moreover, the vacuum cleaner may remain unused for a long period which may eventually cause it to have some technical problems. In addition, new cleaning products may join the ecology which intend to modify the cleaning activity in one way or another. In other words, changes in the product ecology; such as, changing roles of people, having more than one product to do the same task, modifications on both the product and the social relationships thereof, may cause direct or indirect changes in the named product use and ecology (Forlizzi, 2007).

When speaking of product ecology, researchers basically come to draw a theoretical framework which aims at delivering three main benefits. As Forlizzi (2007) describes these three key deliverables, the product ecology firstly tries to explain the social use of a product and social behaviors it evokes, secondly it tries to create a roadmap to find the most convenient qualitative research methods for the exploration area, and finally it provides more flexible room for design-centered research planning and opportunity seeking. In other words, the theoretical framework of product ecology elicits alternative ways to make a better sense of the complex social and physical context of use around a product, and to suggest new opportunities for the development of future products by focusing on the current state of the real contexts. As Forlizzi (2007) continues, product ecology theory gives space for exploring outcomes arising from the combination of factors, and it also discovers how the perception of a product would vary from one person to another, and how differently it would build social, emotional, and symbolic relationships with them.

In addition to the social ecology and its relevancy with the product ecology, the information ecology theory should be also considered as another relevant approach, especially when speaking of technology, technological products and the product ecology thereof. The information ecology is basically defined as an approach to explore an interrelated system of people, practices, values, and technologies within a

local environment; and therefore its scope is to clarify the position of a new technology within an environment with respect to responsibilities and ethical values; and more importantly to understand how technology becomes a catalyst for change (Forlizzi, 2007). As explained already before in the introduction through examples like the dramatic changes on the house structure caused by the new communication technologies, the launch of new technologies are mostly linked to changes particularly within domestic environments. New technologies seem to have the same potential in the upcoming ages where smart machines, which robotic products are a promising part of, will probably have greater roles, responsibilities and will be more involved in the daily life and activities (Norman, 2004). In that sense, the importance and value of exploring the interaction between the smart machines and different ecologies are emerging since the relationships, symbiosis and cooperation is not only among people, but also among other smart machines. In the end, the overall picture of those interconnections gets more complex and difficult especially for those who are working beyond these new technologies (Norman, 2007).

Given that an environment is consisted of dynamic and ever-changing elements, individuals, routines and spaces, the product ecology theory should be highly valued as it mainly focuses on formulating how a product fosters social interaction by providing different units of analysis and criteria as accurate and precise as possible. Therefore, its goal is to understand the existing situations and how the social response to product features would be formed, and finally to investigate the ways to improve the future with the insights gained through the design of new artifacts, services, systems, or environments (Forlizzi, 2007). To do so, the approach first of all defines five dimensions of a product as a part of units of analysis, which are function, aesthetics, symbolism, emotion, and social attributions that help researchers understand how social relations with products are being built (Forlizzi, 2007). More specifically, as one of the boldest principles throughout the entire theory, the product ecology approach does not only focus on the product function, but also tries to enlighten the symbolic, aesthetic, social and emotional qualities of products. Moreover, the overall framework, which already covers these named units of analysis, draws a great picture of dynamic elements. It does not only focus on the targeted products and its users, but also evaluates the surrounding products, products of other systems, routines and norms of the named space, the cultural and social

context of use and sometimes even the people on the production line, as pictured on the diagram below.

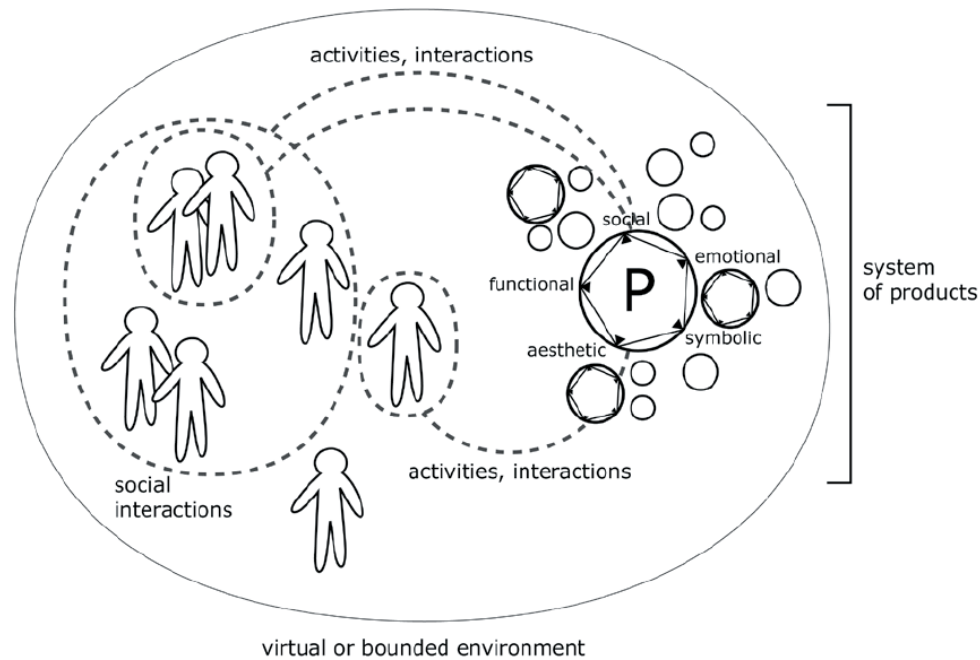


Figure 2.18 : Schematic diagram of Product Ecology (Forlizzi, 2007)

On the other hand, the product ecology approach sets the issue forth that the product ecology of each product is refracted depending on the place of activity and the people with different backgrounds and perspectives, where these two major variables also diversify over time. For instance, Orlikowski (2000) underlines the interdependence of the use of technological products, the subjectivity of people, time and the circumstances under that the interaction occurs. According to him, technology is composed of various aspects of the technological artifacts which are the personal and iterative versions of the experience, the order and the edition. Thus, he concludes that diverse people would experience a technological product differently, whereas even the same person may experience the same product differently depending on the circumstances and the time. Furthermore, Forlizzi (2007) defines first of all clear borders between product, people and the environment. When doing so, she particularly mentions about three key issues; such as, how the interaction between people and products occurs, how a product can influence the interaction that people have with one another, and finally how the interaction

between the product and the environment comes to happen. Following that, she puts the major emphasis on the fact that all these three key issues should be evaluated with respect to main variables which are the place, multiple perspectives and time.

2.3.1 Place

The physical and social environments have an important role within the product ecology framework. Therefore, the product ecology underlines the necessity and benefits of doing the research in the natural contexts rather than laboratories, and therefore it pays a lot of attention especially to the social norms and physical structures of these real environments (Forlizzi, 2007). Buchanan (1992) assumes every design problem to be a journey to the phenomena with a higher level of complexity, and he thinks that developing methodology for an in-deterministic approach to a design solution is almost impossible. But on the other hand, he believes in the possibility of creating a set of guiding principles to help design better solutions in spite of such a complexity only if the problems are considered in their own contexts.

As another reason to do research in natural settings, the natural context sets and affects the product anticipation and the expectations of subjects through given physical conditions, social norms and relations. For instance, the experience of drinking coffee may vary from one place to another. Literally, the experience of drinking coffee at a smoky coffeehouse with a jazz melody and entertaining ambient can be way different than drinking coffee at a conference break (Forlizzi, 2007).

As another example, a study done by Bilge Mutlu and Jodi Forlizzi in 2008 points out how dramatically the use and perception of the same service robot could alter from one hospital department to another. In the beginning, the researchers benefited from an autonomous delivery robot and asked the hospital staff to use it in two different divisions, which were the medical and post-partum departments where the place, routines, structural and organizational factors drastically varied. As a result of these differences, the same robot was evaluated and judged totally different among these two departments within the same hospital. For instance, post-partum department with calm ambient was very satisfied with the robot's performance, therefore they perceived it to be very collaborative as it could fit in with the environment and organizational structure as the participants described. On the other

side, the medical department, where things should happen very fast and urgently, was not happy with the robot and did not want to keep it since it was slowing down their processes and routines. Apart from the micro reasons behind these differences like the diversities in patient profiles, workflow, goals, social dynamics, Mutlu and Forlizzi generally figured out that the use of physical environment, the structure, physical constraints and obstacles clearly influenced the success of the robot which eventually affected the perceptions and the interaction between the staff and the autonomous delivery robot. This overall finding also confirms the assumption that a robot should fit the context as well as its task performance (Woods et al., 2005).

On the other hand, the contrast between the laboratory and natural environments stands out drastically when especially the home environment becomes the natural place of activity. Among the natural contexts and environments, the domestic environments, in other words homes are assumed to be more complex because of its material culture, the everyday domestic routines and tasks of homemaking and its intimate social nature where typical users turn into be families, couples (Di Salvo et al., 2006). That is mainly because the interconnections and relationships within the home environment is more unpredictable and diverse comparing to environments where routine services occur, like hospitals as Mutlu and Forlizzi investigated before.

2.3.2 Multiple Perspectives

In general, the main focus of the product ecology theory is put on the micro scale dissimilarities occurring mostly among individuals rather than the macro level differences that are assumed to happen between big groups of individuals and societies. In other words, the product ecology is contrary to the other systematic approaches, like the human factors which seek to generalize human behaviours, because the product ecology is mainly after differences at individual levels which are meant to be beneficial to enlighten patterns regarding the use and adaptation of products (Forlizzi, 2007). For instance, the theory claims that people's roles within a cultural setting, an organization or a society may have a great impact on the social use of a product. Therefore, it investigates this claim through a group of people by combining the aspects of a social product, and it comes up with questions regarding product values, adaptation and the long term of use. Speaking of such differences,

Forlizzi (2007) summarizes the main scales as an individual's demographics, background, life-stage and role in a situation at any given time.

Based on one of the previously mentioned assumptions done by the product ecology that each product has its unique ecology, it can be also said that each product experience has the potential in its nature to contain subjective and individual reflections and reactions which would probably vary from one person to another. Therefore, when considering these variations to be fed by subjective perspectives, they come to be important resources to discover new opportunities and improvements which end up being cumulative knowledge for the future design-oriented activities (Forlizzi, 2007).

In addition to the individual product experiences, reflections and consequences, the rich diversity among individuals also shapes and influences the users' expectations one way or another. This is very important because once a product can not fulfill users' expectations, it will probably remain unused, and users may even reflect their negative impressions either onto the product itself and the brand thereof or onto the general product group which the named product belongs to (Dautenhahn, 2002). Many studies point out that users encounter confusion, frustration and experience disappointment if their expectations are not met by the given products, especially in cases of technological products (Dautenhahn, 2002; Di Salvo et al., 2006; Grinten et al., 2007; Norman, 2007; Sung et al., 2007). As a matter of fact, first of all it is important to understand what the real expectations of the targeted individuals could be, and secondly it is also crucial not to create wrong impressions and incorrect interaction models that would mislead users through poor expectations and assumptions that are way different than how the products work in actuality (Fong et al., 2003). Furthermore, the interaction models are becoming more important especially in today's technology-related industry since the current users already started to select the products in the ways that they would like to interact with the provided technology (Orlikowski, 2000).

2.3.3 Time

Within its framework, the product ecology depicts time as an important ingredient by asserting that designers should always consider the various sequences of time meaning ages, seasons, days and even hours when analyzing existing situations

around products. Therefore, Forlizzi (2007) draws a strong relationship between the various assets of product interaction, the users and the flow of time to have the best picture of the true experiences. According to her, the real needs of the people are dynamically changing, and for that reason designers should repeatedly keep an eye on how these dynamics surrounding products change over time. Additionally, she strongly believes that time can dramatically affect all the dynamic elements within the product ecology framework like people, place and other products proactively in use. To sum up all those, she pictures an example that a new technological product could easily influence other products with the same functionality used within the same environment, and encourage some activities while discouraging others. Moreover, such a technological product could even set drastic changes in the entire place, or generate new features within particular areas.

As another example, three researchers, Terrence Fong, Illah Nourbakhsh and Kerstin Dautenhahn did a survey about the socially interactive robots in 2003. Through this study, they aimed at seeing how emotional behaviors develop through long-term physical contact and interaction. As the most significant outcome, they concluded that a pet robot could emotionally attach people at the same level as a real pet could do if the relationship occurs over the long-term periods. This conclusion also proves that the long term relationship does not only change the dynamic elements within the environment in a physical way, but it also affects the emotional side of the interaction. Speaking of emotional assets, even expectations are redefined after the start of product use. For instance, there have been ethnographic studies showing remarkable results about how the preliminary opinions and expectations of users gently and positively changed over time after they started using the given technological products (Sung et al., 2007).

3. METHOD

3.1 Objectives

In spite of being mainly conducted in Turkey, this thesis has picked Italy as the country of exploration due to two reasons. Firstly, the release of Roomba in Turkish market has been done in February, right after the start of this study. On the other hand, Roomba had been released in Italy long time ago that was enough to find users with reasonably long experience. Secondly, the researcher had the opportunity to do the research in Italy. So, the thesis is aimed at creating a comparative basis for future studies that could be potentially done in Turkey.

Based on the literature research and findings, this ethnographic study is divided into two sub-phases where different research methods are going to be applied. Survey and interview techniques are defined as the relevant ones to be conducted along the named sub-phases. To gain preliminary data and understanding of the subjects and environments as clear, direct and fast as possible, the research flow will start first with the survey method which is considered to provide the first data that is meant to create a basis for the upcoming sub-phase of interviews. The preliminary results of the surveys will be studied before the interviews start, so that all the potential areas of exploration will be covered deeply through a vast perspective. Furthermore, before moving on the interviews the researcher will already have a better ethnographic knowledge by means of those survey results.

As the first sub-phase, an online survey will be conducted on two different participant groups; the first one is for Roomba users (estimated number of participants: $n=25-30$), whereas the second survey is done with non-Roomba users (estimated number of participants: $n=25-30$) in Italy. The main goal of the first survey is to have the preliminary understanding and insights about the Roomba experience in Italy. For that reason, the majority of the questions are particularly focusing on Roomba users through several aspects. On the other hand, the second survey is targeted at the average people living within Italian domestic environment,

who never used Roomba before. The second set of findings is considered to be a basis for comparison and further discussion.

Both surveys are done anonymously and aim to collect qualitative data, that is not only putting the emphasis on the answers to “what”, “where” and “when” questions, but also investigating the “why” and “how” aspects of experiences and decision making process. All of those will be explained and analyzed in the upcoming sections further.

Following the survey results, the second sub-phase will be composed of a series of semi-structured interviews with Italian Roomba users, preferably in their home environment. The real space is important as it empowers an in-context/ethnographic research to enable to have an effective understanding even through a small sample groups. Therefore, the interviewees will probably feel more comfortable in their naturalistic settings. On the downside, it is not that easy to enter people’s house, especially in Italy where people are pretty skeptic about such activities. For that reason, the place of interview will be kept flexible depending on interviewees’ confidence.

The main emphasis of the interviews will be on the Roomba use and its interaction within the home environment together with cleaning routines. On the other hand, key values like the general robot concept and how the Italians picture a robot will be discussed further in the final phase of interviews.

The flow of conversations (Appendix 5) is planned to be similar to the flow of Roomba user survey, but questions are going to be more open which will contain not only “when” and “what” approaches, but also include “why” and “how” questions to get a better and deeper sense of the topic which may even end up opening up new discussions. In addition, the designed flow will be absolutely ready for improvisation at any time. All the other key issues to be taken into consideration within the interview structure will be explained in the upcoming sections further.

3.2 Survey

3.2.1 Group of Participants

First group of participants is composed of a broad range of Italian Roomba users (RU) with a various level of Roomba experience. The main attributes for participants are defined as being Italian speaker, living in Italy, being eager to share, and open for any questions. There isn't any gender, personal status and age limitation.

Second group is titled as non-Roomba users (nRU) in Italy. In addition to the main attributes cited for the first group above, another main criterion is to have no past experiences with Roomba. Like the first survey, the second survey does not contain any limitation related to gender, age and personal status.

3.2.2 Instruments

Google Documentation and Spreadsheet System available at “www.docs.google.com”, which is a Web-based word processor, spreadsheet, presentation, form, and data storage service offered by Google Inc., is chosen as the platform to generate and track all the online surveys.

Both surveys contain five different question types; such as, “single-line-text” for short answers, “paragraph-text” for long answers, “multiple-choice” to pick one of the given choices, “checkboxes” to pick more than one among the given choices and “choose-from-a-list” allowing one choice visibility at a time.

All communication including announcements and invitations will be done through an online platform and a local iRobot forum (Url-1; Url-2), which is directly related to iRobot, Roomba and domestic robots in general. Potential participants will raise questions for more explanations again through these named platforms. An international Roomba user group on Facebook is also found as a secondary tool for communication.

All gathered data will be first collected in an Excel (*.xls) file for further evaluation. Then, they will be translated into English first via Google Translate (www.translate.google.com), which is a trusted service provided by Google Inc. to translate a section of text, or a webpage, into another language. A native speaker will be also involved in the final confirmation of translation, in order not to miss the real

values of words used by participants. Afterwards, the data will be manually classified and grouped to have a better way for evaluation. Additional statistics like visual charts will be provided by Google Inc. as a part of their service.

3.2.3 Set of Questions

Both surveys are prepared in Italian by the help of a native speaker. Roomba user survey (to be named as “RUS” from now on) is two pages long and including 26 questions (Appendix 1), whereas non-Roomba user survey (to be named as “nRUS”) is only one page long with 12 questions (Appendix 3). However, they both follow up a similar pattern in the beginning and in the end.

Introduction & Description

Surveys first open with a brief introduction and description about the study. Thus, each participant learns by whom this work is done and what the main purposes are. However, the introduction of second survey that is done with non-Roomba users does not include the word “Roomba” anywhere on the page in order not to distract the objectivity and attention of the participants. The given description is “smart home technologies” instead.

1st Part:

The initial questions are about the house dynamics and cleaning routines in general. Participants are asked first to pick their current house type among the given choices, which is followed by questions about people whom they are sharing the house with and then people that participate in cleaning activities, the cleaning frequency within a week, and finally, products used for cleaning.

2nd Part (for Roomba users only):

Second group of questions is only asked Roomba users, because it includes questions particularly targeted at Roomba experience. The focus is first on the number, model and accessories of Roomba. Then, the period in which they bought Roomba and the reasons behind this decision are questioned. The last question of this section is to see if there is any emotional bonding between the user and the Roomba:

Does your Roomba have any name (Il tuo Roomba ha un nome) ? Why (Perché)?

3rd Part (for Roomba users only):

This part is to learn about Roomba's interaction level with both, the people and the physical environment. Questions like "Who cleans Roomba?" and "How many times per week do you switch your Roomba on?" are to have an in-depth understanding of users' Roomba routines. Their preferred Roomba communication channels like magazines and websites are questioned as well. In the final part, it is asked if they make any pre-preparation within the domestic environment before running Roomba, and where they keep its docking station, together with the motivations behind. By doing that, it is assumed that users would talk about physical constraints and other personal concerns. This part ends with the following question that aims at learning how the word "robot" is anticipated by them:

Apart from Roomba, do you have any other robots in your home (Possiedi uno o piú altri robot diversi da Roomba che usi in casa)?

4th Part (for Roomba users only):

This part starts on a new page, because the participants should not see their former answers anymore as those may influence their upcoming responses. Questions are mainly pointing out the "before-the-Roomba" period. Cleaning habits, people involved in cleaning and routines are questioned first. The existence of vacuum cleaner is also directly asked to see if there is any link between the use of Roomba and traditional vacuum cleaners. Another key issue is the time and effort spent on cleaning before the Roomba period.

In the end of this part, participants are also given a list of tasks which contain a diverse level of physical and intelligent features beyond. They are basically supposed to pick the desired task(s) for the upcoming robot which they would like to have in their home environment. For instance, choices; such as, cleaning, dish washing, window cleaning are representing activities which are dangerous to perform and/or people do not enjoy doing, while others like food preparation, babysitting, security require high level of artificial intelligence covering both, social and environmental interaction.

5th Part (for non-Roomba users only):

In the beginning of this part, participants are asked if they would consider buying a robot for floor cleaning. They are also prompted to write the reasons. Following that,

the same question as the one in the end of 4th part, which is about the desired task(s) of the robot that they would like to have, is asked here again in order to investigate if there is any differentiation between those with no past Roomba experience and the others with Roomba experience.

6th Part:

Both surveys end with the basic demographic information; such as, gender, personal status, city, nationality and age.

3.3 Interview

3.3.1 Interviewees

The number of Italian Roomba users to be interviewed with is estimated to be around 4 and 6. There isn't any specific limitation with gender, personal status and age. However, interviewees should be enthusiastic about exchanging information, and open for various questions. English speaking is a plus, but not a requirement. As another important point, Interviewees' time reserved for those interviews should not be a negative impulse which may potentially interrupt the flow of conversation and the overall synergy.

3.3.2 Instruments

A non-disclosure agreement officially signed by Istanbul Technical University representatives is prepared per each interview to make the interviewee feel more comfortable and encourage to exchange information. All interviews are planned to be recorded. Following interviewees' given permission, all of them will be captured with a portable digital sound recorder to be able to listen again during the analysis phase. Photos will be taken on their permission as well. In addition, sessions will be captured partially with a video camera if considered to be necessary and important for the topic. Throughout all interviews, the researcher will take notes.

Since the structure and protocol should be flexible for improvisation, the researcher also prepares a checklist of questions to make sure that he captures and goes through all the information and topics that are essentially needed.

The interview announcements and related communication will be first done through the local iRobot forum at www.irobot.it/forum. Word-of-mouth is another effective tool to use while searching for interviewees.

After each interview, a de-brief documentation (Appendix 8) will be done to capture what is spoken and discussed with respect to the envisioned interview protocol. Same documents will include all important photos as well as the digital recordings.

3.3.3 Procedure and Protocols

The interviews are planned to last for about an hour depending on interviewees' availability. Only one researcher will be present at conversations, but depending on the confidence of interviewees, an interpreter might join the conversations to translate dialogues from Italian to English and vice versa.

Introduction

Conversations will start with a brief introduction explaining the aim and main focus of the work together with the brief information about the researcher's background. Then, the interviewees will be given a non-disclosure agreement, and their permission for capturing photos and videotaping will be asked.

1st Part

The first part is fixed and will set the interview off. It starts with demography-oriented questions and will shift then to interviewee's domestic organization. Here, the main goal is to warm the interviewee up while starting to learn about him and his background little by little; "*Why don't you start by introducing yourself briefly?*"

Through the questions like "*Who are you sharing this house with?*" the interview will be addressed to describe households. Along he mentions about home organization and dynamics, responsibilities of each house member will be questioned to get closer to the cleaning habits and routines. His and others' role and involvement in cleaning activities is an important ingredient which will open up new topics. On the other hand, products used for cleaning, in particular the traditional broom and vacuum cleaner are key factors to be taken into consideration. Later on, the interviewee is expected to make his first expressions about Roomba.

Topics to be covered in the end of this part are name/surname, age, profession, personal status, type of house, household, people involved in cleaning, products used for cleaning, cleaning routines and habits, and finally the relationship between broom, vacuum cleaner and Roomba.

2nd Part

The interviewee will be asked about how and when he got familiar with Roomba for the first time. This conversation should bring out the reasons and motivations that led them buying such a domestic robot. Basic information like its model as well as interviewee's overall knowledge about Roomba product line will be questioned again in this session. The words that he uses to describe Roomba are assumed to provide first hints about the relationship and interaction level between the user and the Roomba. His shopping and out-of-box experience is another important value to be spoken about.

3rd Part

Asking where the docking station of Roomba is kept, it is targeted that the interviewee starts thinking about the interaction between the environment and Roomba. This point is also foreseen to be the beginning of the session in that the interviewee will be speaking about pros and cons of owning a Roomba. "Why" and "How" questions compose again the majority of this part. Another key question is whether he makes any pre-preparation in the environment, like lifting some chairs and carpets up, before starting Roomba.

The interviewee will be also prompted to show his Roomba accessories. The maintenance of Roomba is meant to open a new conversation which will end up with Roomba routines; "*How often do you have to clean it?*" and "*How often do you switch it on per week?*".

4th Part

This part is generally focusing on the emotional aspect of Roomba-human interaction. It start with the question "*Does your Roomba have a name?*". Following questions will be again about Roomba's personality, gender and attributes as well as its movements and attitudes. Along the interviewee begins to declare adjectives, he will be directed to talk about Roomba's attributes that he likes or dislikes. As an

essential element of interaction, Roomba's communication features, meaning the sound and visual signals, and their compatibility will be discussed.

This part ends with two fixed questions to see the level of interviewee's attachment to his personally owned Roomba; *"Would you consider changing your Roomba through the warranty conditions if that were a possibility?"*, *"If yes, how would you name the new one?"*.

5th Part

This part is focusing on the past cleaning habits and routines. Here, the word "past" is representing the period that is before the Roomba's existence. Conversation follows a similar path to the first part where the current cleaning habits, routines, actors and products had been questioned. However, this time it is aimed to investigate the changes, that Roomba caused within the overall house organization. Those changes are expected to be on the basis of cleaning products, households, environmental structure and other products used within the domestic environment.

6th Part

The main objective of the first part is to get initial insights about how Italian people would define an object as a robot. But instead of direct questions, the conversation continues with indirect ones; such as, *"Do you have any other robots in your house?"*. Following that, the interviewee will encounter "What" and "Why" questions to gather a better sense of how he perceives a robot, what features turn an object into a robot. As he tells scenarios and describes features and attributes, the focus is switching to the overall look and definition of the word "robot" in Italian society. Dishwasher, washing machine, kitchen-mixer, cars and the navigation systems are key tools for the researcher to open new discussions.

Finally, the interview is concluded by asking about the potential task(s) of the domestic robot that they would intend to buy next.

3.4 Preconceptions

It is envisioned that the introduction of Roomba into the Italian domestic environment will not only remain focused simply on the floor cleaning activity, but also it will firstly decrease the use frequency of the other cleaning products, secondly

reduce the number of subjects involved in cleaning, thirdly minimize the period and time spent on cleaning, and finally cause some modifications on the environmental structure.

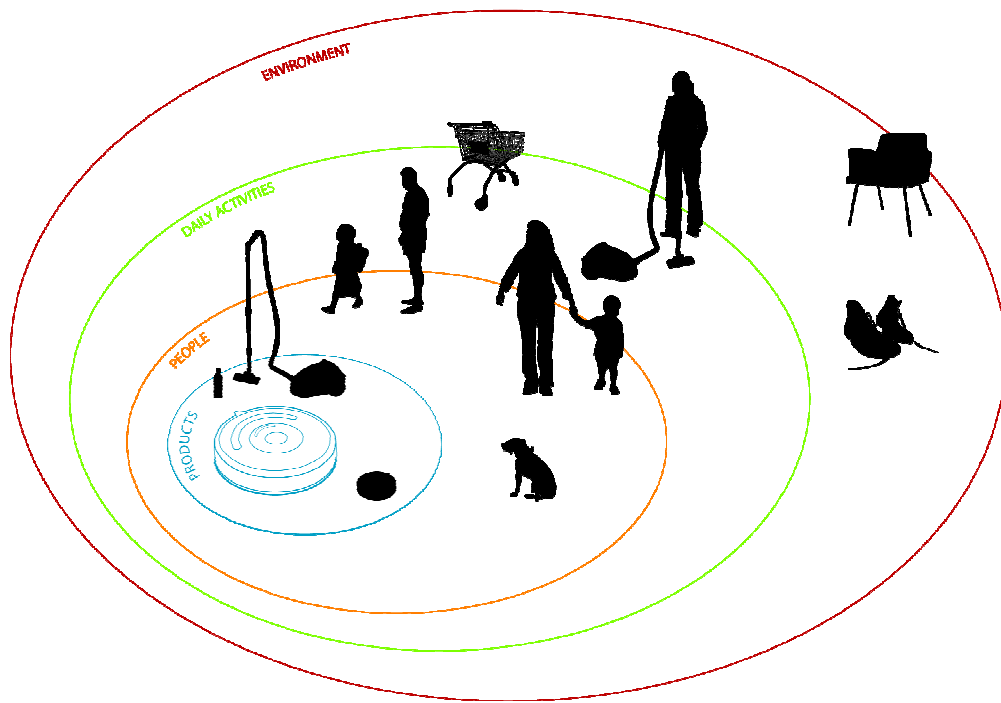


Figure 3.1 : The envisioned schema of Roomba product ecology

As described on the diagram above, Roomba is considered to initiate positive changes within the Italian domestic environment on the basis of four different environmental factors, which are the cleaning products, people, cleaning and other daily activities, and the home structure where all these interactions occur. In addition to those, Roomba might also have a secondary impact on how Italian people would describe a domestic service robot.

3.5 Limitations

Before and during the research period, some challenges and limitations came to happen which influenced the overall research plan and flow both in positive and negative ways. Most of these difficulties were in particular to Italy, which eventually came up as a result of doing a research in a foreign country, where the cultural diversity and geographical boundaries came into play.

The most challenging issue has been experienced during the recruitment process in which the potential survey participants and interviewees were sought. The communication with those was driven through several resources like the online Roomba community sites, Facebook and personal network via word-of-mouth. Especially in online communities, language stood up as the main difficulty which misled both parties in many cases. Therefore, it was observed that the preconceptions of the Italian people about the online communication ways were negative due to the high rate of online advertorials in the country. For that reason, they were easily judging any requests to have a survey or an interview as having definite commercial concerns behind. As a consequence, each word in messages should have been picked very carefully by the support of a native speaker, which naturally required extra time to have the corrected responses back. This obviously extended the period of communication and caused some delays on the overall research planning.

Besides, Roomba is fairly new technology in Europe, especially in Italy that is used within the domestic environment. For that reason, it was not so easy to reach to Roomba users with a reasonably long Roomba experience. The majority seemed to have short engagements so far; in the end their ideas and experience were not mature yet. Additionally, those with longer Roomba experience were not easy to convince again due to the language difficulties. As a result of having such a small cluster of potential interviewees, the interviewee criteria could not be drawn very precisely and was dramatically affected by the availability of potential candidates.

As the third challenge, most of the potential participants were very skeptic about the length of the survey. They all seemed to be very keen and eager to exchange information in the beginning. However, they felt like mentioning about the length of survey for many times. Thus, they did not sound to fill in if the survey would look too effort and time consuming. That ended up influencing the overall survey structure drastically, and so questions were picked as short and direct as possible.

As another side-effect of the pre-feedback given by survey participants, most of them did not intend to give their names and contact details. For that reason, the survey was created anonymously to make the participants be more collaborative and proactive when exchanging the information. On the other hand, anonymous survey took away the chance to track some answers back, although some of them were so interesting that their owners could have been contacted again to set an interview. As a useful

tool to overcome this problem, participants could have been asked to pick a nickname in the end of the survey, which could help to trace them back on the online communities that were actively used in the recruitment process.

During the second sub-phase of the research, an interpreter also joined the interview sessions as a support to overcome any language-based conflicts. In general, this support worked very well, but in some cases it was also observed that the interpreter added or combined his personal thoughts and perspective with the responses given by interviewees. Since this issue was already expected, extra questions were added to the flow, so that the interviewees' answers were taken out as pure as possible.

Finally, there were also families and couples among the interviewees. Interview sessions with the simultaneous participation of all partners caused some unexpected internal discussions and arguments within the family members, especially during the first interview. Even though this seemed to have extended the duration of interview and changed the scope of the conversation, this variety of ideas turned into a positive input by the help of small arrangements applied on the techniques and flow for the rest of the interviews. Thus, this internal discussion supplied a lot of useful feedback and insights as a part of serendipity.

4. FINDINGS

4.1 Surveys

In total, both surveys received 41 responses in a period of two weeks. The distribution of participants was very close to each other as a result of the fact that 44% of them (n=18) participated in the first survey targeting at Roomba users, whereas 56% of participants (n=23) replied the second survey prepared for non-Roomba users.

In the first survey which is also the primary one, the amount of gender was unequal; 61% male (n=11) and 39% female (n=7) participants. The average age was 40, where the youngest one was 20 and the oldest was 54 years old. 72% (n=13) was living in an apartment and 22% (n=5) was staying in a duplex villa. Additionally, one participant was staying in a house which he had been also using as a shop. On the other hand, the marital status was distributed over participants as 72% married (n=13) and 28% single (n=5). In terms of house members, 77% of total (n=14) was accommodating together with their family, and the rest was living alone.

Before the start of analysis, the participants were also grouped by the duration of their Roomba experience in three levels as follows:

- 1st Level: The users with the Roomba experience shorter than three months were classified within this group. There were 6 participants as one female and five male with the average age of 40. The newest member had bought Roomba four days ago, whereas two members considered to be the most experienced ones had been using Roomba since three months. The other three were also assumed to be fairly new since they owned Roomba for 2 weeks.
- 2nd Level: This group was consisted of the users with the Roomba experience between three months and one year. The number of participants fitting in this group was 5 (27%) as 2 female and 3 male, whereas the age average was 44. One of the participants had been using it for ten months, whereas the other four had Roomba since one year.

- 3rd Level: This group included the users with the Roomba experience longer than one year. In total, 40% of the whole participants (n=7) took place within this group where the age average was 37. 4 of participants were female and 3 of them were male. The relatively newest member of this group had bought Roomba one and a half year ago. On the other hand, two participants had been using it since 2 years, whereas another two had 3 years of Roomba experience. Finally, as the most experienced ones throughout the entire participant group, two participants had first interacted with Roomba 4 years ago.

In the second survey, which is considered to be secondary to back up the primary Roomba user survey, there were 9 females and 14 males within the group where the average age was 34. The majority of participants, which was covering 92% of total, was living in an apartment. Only two were staying in a detached house with multiple floors. In terms of marriage status, participants were mostly single with a rate of %78 (n=18). However, 52% (n=12) was living as couples, including both already married and not married yet. Only two persons were living alone, whereas 8 of participants had flat mates. Additionally, there had been 6 families in total.

4.1.1 Products

Regarding the interaction between Roomba and the other cleaning products, there wasn't any significant change that came to happen after Roomba's arrival, except the difference on the use and presence of traditional vacuum cleaners within the domestic environment. Only 40% of participants (n=7) mentioned about having a vacuum cleaner. Considering the outcome that the majority of non-Roomba users (16 of 23) talked about the current use of a traditional vacuum cleaner, it can be also assumed that some of those Roomba users might have already replaced their traditional vacuum cleaners by Roomba. Beside this assumption, it is clearly distinguished that 45% of participants (n=8) substituted their traditional vacuum cleaners with a Roomba. Among those who made such a replacement, there were one from the 1st level, three from 2nd level and four from 3rd level user group. Nonetheless, this relation possibly designates that the more experienced users tend to substitute the traditional vacuum cleaner by a Roomba. On the other hand, the majority were using the other floor cleaning products like the traditional brooms and detergents in the same routine.

4.1.2 People

Concerning the current domestic cleaning chain, only one person with a first level of Roomba experience mentioned about having an additional cleaning support given by a housekeeper. Therefore, it also came out that only 2 of the participants did not need this additional support anymore once they started using Roomba. Apart from that, the rest did not necessarily underline a significant change on the people involved in cleaning. On the other hand, in the second survey of non-Roomba users the rate of those who mentioned about the housekeeper support was only 15% (n=4). As a consequence, this low frequency of housekeepers arises a new question about the popularity of the additional housekeeper support in Italy.

Nevertheless, it is also noticed as a common issue shared among the three different Roomba user groups, that 9 of 11 men were extensively involved in the Roomba maintenance. This responsibility and relatively new role within the home environment took also men into the cleaning activity indirectly. Contrary to that, second survey of non-Roomba users revealed that men were not involved in cleaning activities where females appeared to be taking care of main responsibilities.

When the Roomba users were asked if they named their Roomba, almost half of them replied positively. Therefore, it is observed that those names are strictly influenced by the Italian grammar. For instance, the name “Tino” picked by several participants derives from the Italian word “robottino” which has the meaning of a small and cute robot. On the other hand, some participants refer their name preference to Roomba’s movements as well, like the one called “Rimba”. The other names came out were “Roby”, “Ariel”, “Faust” and “my baptized son”.

4.1.3 Cleaning and Other Activities

Roomba users did not mention about any significant changes with the weekly cleaning routine between now and before the Roomba periods, however they either explained about spending less time on cleaning sessions, or more interestingly, they seem to be enjoying cleaning with their Roomba assistance.

When speaking of Roomba as a rigid product, its two main interconnected assets turn out to be highly appreciated by Roomba users. First of all, many participants, no matter which level of experience they have, mentioned about the fact that Roomba

works autonomously and takes care of floor cleaning on its own, which results in giving the user the flexibility of focusing on other activities that is in the end assumed to be very important benefit. Additionally, people who have pets in their houses sounded to be extra appreciated by the Roomba presence.

In terms of Roomba routines, it is observed that especially new users were keen on using Roomba at daily basis. The average frequency of use in the group of first level Roomba users was five or six times a week, which became three or four times in the group of second level users. Moreover, the advanced group intended to run Roomba on the average once or twice a week. As another remarkable finding, new users consider Roomba's effort very extra because they mentioned doing the main cleaning once or twice a week, whereas they intend to run Roomba at least four times a week within the same environment. In general, both surveys revealed that Italian people tend to make the main cleaning activity once a week.

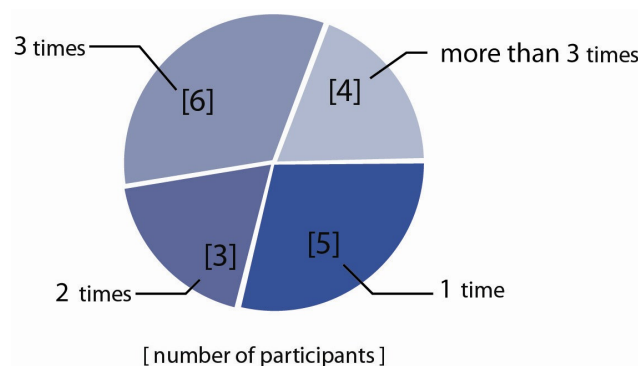


Figure 4.1 : Frequency of weekly cleaning activities among Roomba users

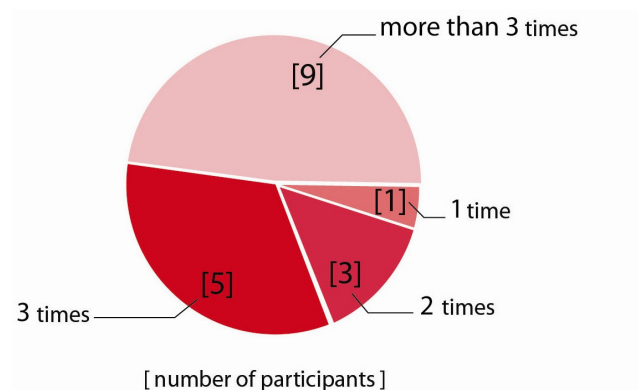


Figure 4.2 : Overall frequency of weekly Roomba use

4.1.4 Environment

Considering the interaction between Roomba and the environment, the arrangement of the space and structure, the place given to the docking station and Roomba's accessories became the main touch points that people mostly referred to. Therefore at that topic, the survey did not reveal remarkable differences among the three groups with different experience levels.

In terms of space arrangement and preparation, each participant declared clearly that they definitely make an initial preparation within the domestic environment each time before switching the Roomba on. Those preparation activities are mainly mentioned as removing chairs, thick carpets and cables, which eventually takes 10 minutes on the average. Even though these activities might have been perceived to be an extra activity, people usually explained them in a positive attitude.

Speaking of docking station to which Roomba is capable of going on its own, none of the participants mentioned about a permanent change on the home structure done to fit the docking station, therefore docking station fits in with the current house structure in many cases. For instance, users were usually concerned about the obvious presence of the docking station in their public spaces like dining and living rooms. In other words, they did not want to have docking station visible to their guests and visitors. For that reason, many of them preferred to hide it in corners behind or under their furniture instead of creating new spaces. It also came out that some users intend to move docking station temporarily depending on where Roomba is going to work. That could be related to the limited range of docking station and insufficient number of guiding accessories they owe.

In terms of accessories, almost every participant owes at least a "Virtual Wall" which generates artificial borders within the environment that Roomba is programmed not to pass as if it bumps into a wall. On the other hand, it is observed that especially 3rd level users have additional advanced accessories like "Lighthouse" or remote control.

4.1.5 Robots

When participants were asked if they had another robot in their houses, only one participant from 3rd level user group referred to his dishwasher and washing machine as a robot, whereas the majority ignored these objects. On the other hand, three

participants from in 3rd level had Scooba which is another domestic robot produced by iRobot especially to do wet-floor cleaning. Besides, two families, one from 2nd level and the other from 3rd level, had Bimby (known also as Thermomix), which is a cooking robot developed in 1996 by Vorwerk, a company located in Germany.



Figure 4.3 : Bimby the cooking robot (left) and Scooba (right), adapted from Uri-8 (2010)

Additionally, it is also observed that the answers given to the question regarding the next potential tasks and fields for the desired domestic robots were mainly based on participants' former experiences and impressions about robots and robotic products in general. For instance, only some people from the 3rd level user group picked tasks like babysitting which require high level of artificial intelligence among the other given multiple choices like cleaning, dish washing where the level of complexity was relatively low. On the other hand, 1st level users were more conservative and as a result they picked basic tasks which were less complex, but dangerous to perform or they might even hate doing (cleaning, dish washing, window cleaning). Not surprisingly, cleaning was the major selection of participants no matter what level of knowledge and experience they had. Only the second level users picked cooking as another option. In general, tasks requiring artificial intelligence seemed to be far to those participants for the time being. Supporting that, the second survey of non-Roomba users revealed similar results, which described floor cleaning to be the most popular activity. Following that, window cleaning became second and dish washing was the third. These results also showed that just like the Roomba users, the group of

non-Roomba users focused on activities that they didn't enjoy doing. Additionally, one couple also suggested a robot to compress and store the domestic waste.

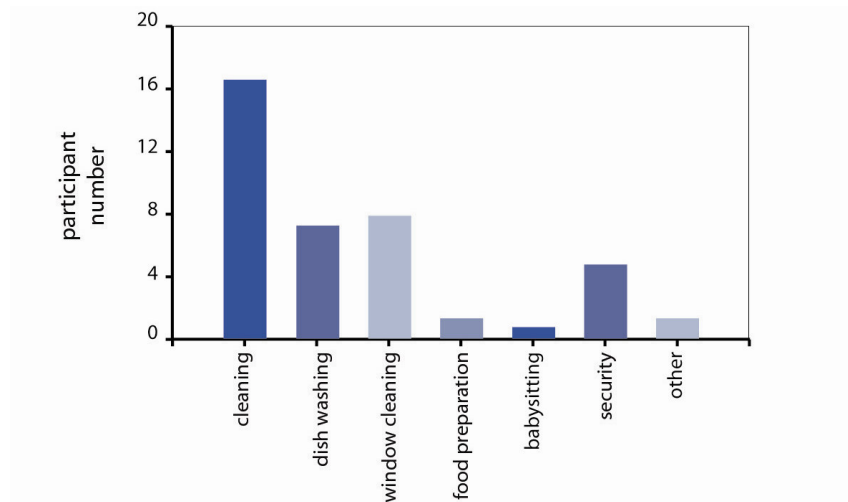


Figure 4.4 : The overall view of Roomba users' selections about the desired task for the next generation of domestic robots

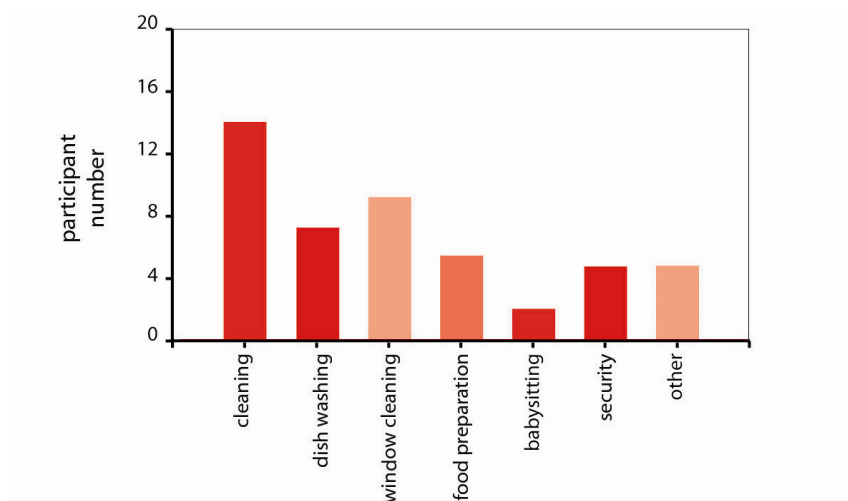


Figure 4.5 : The overall view of non-Roomba users' selections about the desired task for the next generation of domestic robots

The second survey also showed that people with no Roomba experience were really open to the idea of having a floor cleaning robot within the domestic environment. As a matter of fact, half of the participants said 'yes' to a service robot responsible of

floor cleaning. There was such a big tendency mainly because non-Roomba users assumed a service robot to do things autonomously and generate extra time for other activities. In addition, they also referred to the intelligent movements which most of the time took their attention. Moreover, one person felt even mentioning about a robot feature to take the stairs. On the downside, those who did not like the idea of having a floor cleaning robot were mostly concerned about the robot's efficiency. They basically could not believe in a cleaning robot with full efficiency.

4.2 Interviews

Within the context of the interview phase, five Italian Roomba user groups, including three females and four males from Milan and Monza, were interviewed in a total period of two weeks. Each interview lasted approximately for one hour on . Two of the interviewees were single males, who shared the house with their parents. The other three groups of interviewees were couples including three females and two males. Therefore, two of the interviews were conducted simultaneously with both partners, whereas one female interviewee was alone during the entire session. All the interviewees were employed in incoherent industries. The average age was 39 in the interviewee group where the youngest (CC) and the oldest (FP) were 20 and 55 years old. Four of the interviewees were living in one storey apartment flat, and another family was living in a double storey loft.

The average of Roomba experience among the interviewees was 12 months. The newest participants had purchased it 10 months ago, whereas the most experienced one had been using it since 2 years. Three of the interviewees had one Roomba, one another had been using two. As the maximum, one of the participants had three Roomba, two in his house and one in his summerhouse. Speaking of buying decision, only a few people declared that they started with the idea of buying a cleaning robot and made further research towards this purpose. On the other hand, the majority of users made this decision occasionally. Therefore, it is observed that the promotional catalogues given by supermarket chains, through which consumers were to purchase various products by using their shopping points, had a great impact in many cases. For instance, many interviewees told that they considered buying Roomba even though they did not it in mind. In terms of Roomba familiarity, people mainly

mentioned about the technology focused exhibitions and fairs as well as the cases in which they met Roomba for the first time in their friends' houses.



Figure 4.6 : Overall view of interviewees' Roomba

4.2.1 Products

Concerning the cleaning products, every participant intends to keep a traditional vacuum cleaner and a broom at home, which they already had before the Roomba period. As an exception, only one couple never had a vacuum cleaner as yet. However, it can be generally assumed that Roomba did not have a big impact on the existing cleaning products. However, the use frequency of vacuum cleaner is descending due to Roomba's presence. Moreover, in one family, female person is not using the vacuum cleaner anymore soon after the start of her Roomba experience.

In addition, people do not use the other heavy cleaning products together with Roomba at the same time. In other words, vacuum cleaners and brooms are not present in the environment when Roomba is functioning. Nonetheless, vacuum cleaner and broom are used on the areas which Roomba poorly cleaned. Speaking of which, people prefer to use traditional vacuum cleaner or broom especially for spot

cleaning, for instance right after having dinner which eventually affects only a small area within the environment. Interviewees presented two main reasons to that. First of all, Roomba is not programmed to clean specific areas; therefore it tends to clean the entire space once switched on. For example, NP who is 44 years old and married woman expressed this missing point: *“You can not tell him where to go”*.

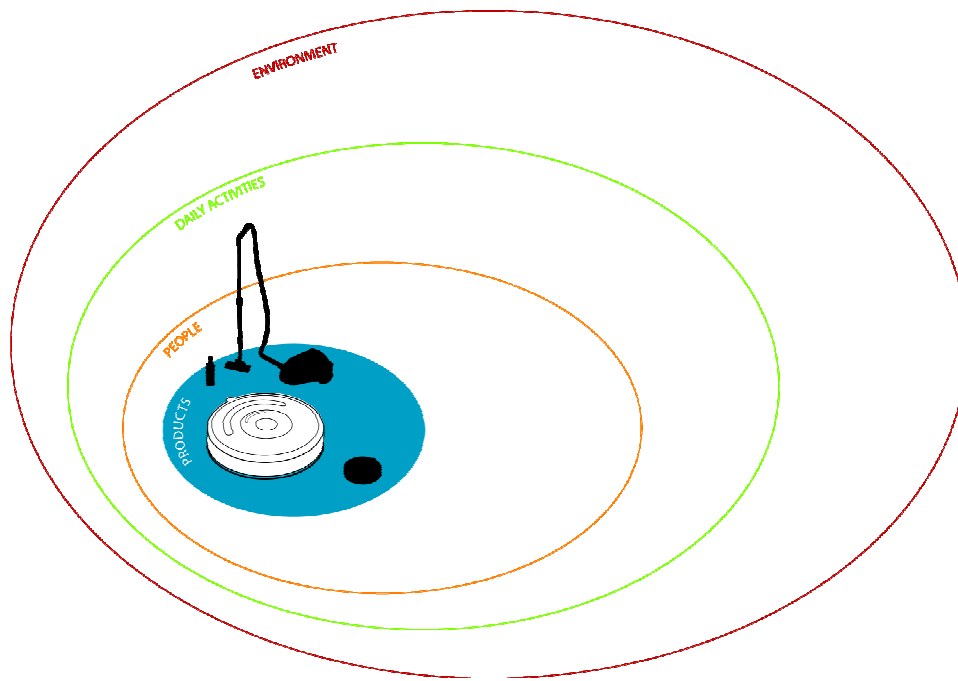


Figure 4.7 : The position of products in the envisioned schema of Roomba product ecology

Secondly, participants commonly cited that in some cases it is easier to grab vacuum cleaner in traditional way, instead of pushing some buttons to give commands to Roomba. On the contrary, the overall tendency showed that Roomba is used more often comparing to regular vacuum cleaner and broom because of two reasons. First, it works autonomously and does not require users' maintenance very much. Second, it is not as noisy as a vacuum cleaner, which provides time flexibility in the cleaning activity. For instance, GM who is 38 years old single clearly considered this flexibility as a strong benefit because now he can even run Roomba at 4 AM in the morning without bothering his neighbors in the periphery.



Figure 4.8 : The other domestic cleaning products of the interviewees

4.2.2 People

In terms of the interaction between Roomba and the people, it is mainly observed that in general men were more passionate and interested in the use and maintenance of Roomba. First of all, during the interviews, where both partners were interviewed simultaneously, males had the main words quite often, therefore they considered themselves to be the main players in the decision making process. Being interested in the new technology stood out as a common expression which they usually referred to when speaking about the motivations beyond owning a Roomba. This interest grew their technical knowledge as well. In fact, men were way comfortable than women when they both had been asked to tell the basic principle behind the Roomba technology. As another consequence, men also seemed to be precise and conservative on its use. Consequently, they were checking Roomba's condition very often and also looking after the maintenance activity which is required once in every 2 or 3 times.

In addition, single and male Roomba users, who share the house with their parents, intend to use Roomba in their personal spaces within the house, instead of sharing it

with the other house members for the cleaning of shared places. As a result of that, those single users started to be a part of cleaning by means of the Roomba experience. On the contrary, it is also discovered that housekeepers do not interact with Roomba in any of the houses even though in some cases they were permitted to. They basically prefer using traditional vacuum cleaners instead, since it makes them feel more comfortable to stick to traditional methods.

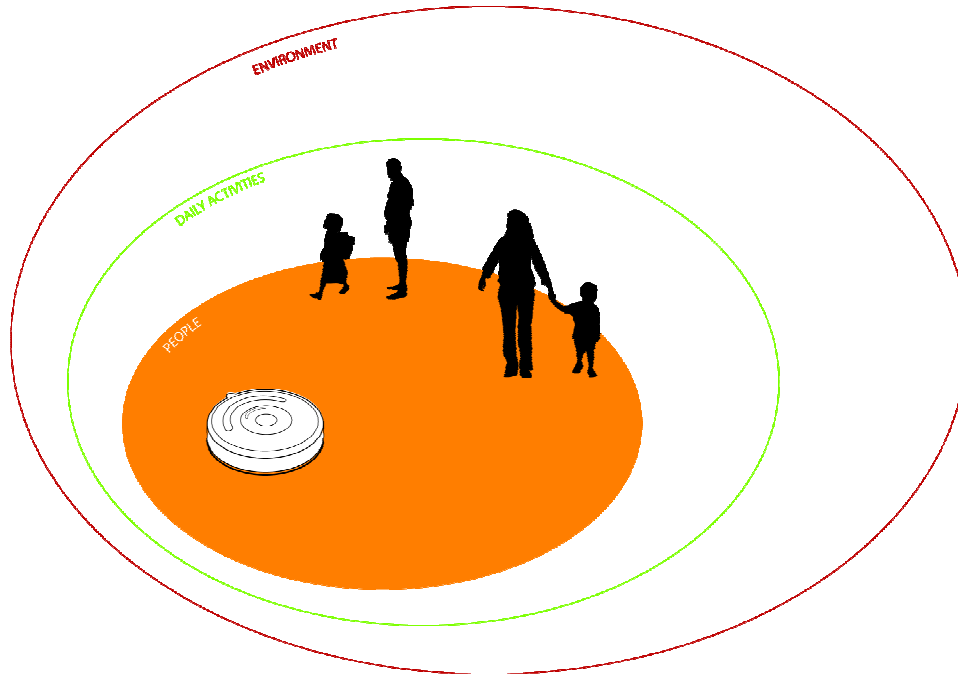


Figure 4.9 : The position of people in the envisioned schema of Roomba product ecology

Apart from the dominance of men, the interviews revealed also two main significant outcomes to be summarized as the tendency to create emotional attachment around the product and the references to be the proof of efficiency.

As the first one, almost every interview showed that people tend to create emotional bonding with the Roomba regardless of the facts like age and gender. This means that they do not only consider Roomba as a product, but they also treat it as being another person within the domestic environment. The reasons behind that bias lie mostly on the expressions and the nuances. For example, two people told that Roomba locked itself in the bathroom, when in reality it closed the bathroom door accidentally. As another example, the majority of participants used adjectives like

‘confused’ and ‘happy’ when describing some of the Roomba states. Or, three of participants were very concerned about Roomba’s safety, especially in cases where Roomba might get stuck or fall off high surfaces like the stairs. In some situations users wanted to keep Roomba away even from the dusty areas, which was totally contrary to the essence of a product that is designed specifically for the cleaning activity. For instance, an interviewee mentioned that she would not use Roomba in the balcony: *“Balcony is too dirty and dusty for him”*. Or, another user said: *“I never let him suffer, I would help him”* when talking about the extra effort that she had to spend by keeping an eye on the Roomba to keep it secure and functioning properly.

As another detail here, users even ascribed a gender. When talking about the Roomba, the majority showed a tendency to describe it as male which is supposed to derive mainly from the Italian language because the word “robot” is a masculine one. On the other hand, interviewees also referred to the color as an element to define gender. For example, three of the interviewees said that they would consider Roomba as female if it were pink. At that point of the discussion, interviewees were also asked about how it felt to have a male not a female for the cleaning activity. They did not give a significant feedback except a female interviewee: *“The task is perfect for him. Men don’t have to think so much”*. This expression summarizes also the general impression and expectation gained during all the interviews. Generally, almost every user was aware of the fact that Roomba had certain boundaries and was capable of serving only a limited level of services because of its limited technology. However, people are still attracted by such a device mainly because it is quite new technology which takes people’s attention and curiosity, and for that reason they can still anticipate these limitations to be at a reasonable level. For example, the interviewee with three Roomba said: *“Roombas are nice piece of technology but they are far from being perfect. They do sometimes quite well, but they have a lot of limits”*. On the other hand, some technical weaknesses of Roomba turn out to be advantages. Roomba’s poor suction power can be given as an example since some interviewees mentioned that Roomba does not throw the dust in the air unlike the other traditional vacuum cleaners because it is not very powerful.

In addition to color, sound is also another reference influencing people’s perception on Roomba’s gender. For instance, Roomba’s introduction is done by a female voice which basically gives the first product introduction including essential information

like how to start or clean the product. Given that the majority of Italian users considered Roomba to be masculine, the female voice feature is assumed to be conflicting with this shared anticipation. As a matter of fact, one of the interviewees changed his mind about Roomba's gender when he was spontaneously reminded of this female voice feature. As a consequence, he ended up deciding that his Roomba was a gay.

Apart from the female voice feature, Roomba is programmed to make also futuristic and machine-like sounds to indicate some certain scenarios, in other words to interact generally with the users. However, although Italian users cited that they were comfortable with such communication signals, it was observed that they faced difficulties to understand the transmitted messages through these machine-like noises in some situations. On the other hand, this complication might be caused by the low rate of people who read the guidelines and instructive booklets, which additionally steamed out of the interview results. Besides, the user interface on Roomba's top surface, which is another element of the direct interaction, was not clear for the interviewed Italian users either. As a matter of fact, an interviewee for instance spent almost 5 minutes to try to program the schedule of the cleaning activity. He went back and forth among the options to understand the logic behind the interface. More interestingly, he was not sure if he gave the right command after this intense effort, which again links back to the fact that the feedback given through sounds was not clear to subjects.

Like done in the Roomba user survey, the interviewees were also asked if they gave any specific name to their Roomba. Two of the users did not explain about naming their Roomba, contrary to the other three. All the mentioned names were highly influenced by Italian vocabulary, just like the survey results had pointed out. In addition to the same names derived already from the survey like Tino getting the meaning from the Italian word "robottino", there were also other names like Gino, Dusty, Bot, Bibot and Tribot. In addition to naming, one user even put stickers on his Roomba when especially they owe more than one.

Beside the house members, participants also mentioned about the interaction between Roomba and visitors like friends, colleagues and even grandparents. For example, one of the users had taken Roomba once to his office. All his colleagues were amazed and in the end they decided on buying a new one for the office cleaning. In

another case, one of the users was about to give his old Roomba to his grandparents since he had bought a brand new one. He told that his grandparents used to watch the Roomba carefully every time they visited him.

Apart from people, Roomba interacts with house pets as well. Among the interviewees, two of them had cats in their houses and they told interesting stories about this relationship. The overall tendency among these cats was to watch first Roomba carefully, and then jump over and spend some time on its surface. This shared reaction might be related to the fact that cats could perceive it scary and even feel annoyed since they usually like sleeping on the floor. Seeing such a noisy device coming towards them might be annoying in its nature, thus they tend to react in this way. Furthermore, one user said that his cat even learned how to switch Roomba on and off when he occasionally jumped over it.



Figure 4.10 : A proof of clean floor

As the second main significant outcome, it also came out that users have certain points of references to judge Roomba's efficiency. In its essence, floor cleaning is already an activity which results are directly and obviously communicated to the users in many cases. Some users already explained about certain techniques like walking around the flat with white socks and checking its whiteness in the end to have a better understanding of cleaning performance. In addition to these final result-focused approaches, users also mentioned how satisfactory it was to see the level of dust that Roomba collected in its dust-bin. All the interviewees explicitly said that

they were so surprised to see the amount of dust collected in Roomba's dust-bin. Moreover, they were ironically proud of showing this huge bunch of dust during the interviews. Besides, there were also happy to see that Roomba was focusing particularly on extra-dirty areas by means of its special spot cleaning feature. As another smart movement they referred to, Roomba's cleaning path was also reasonably satisfactory. Per contra, users were not precisely sure about the efficiency of Roomba's path since they were concerned about having it pass through the same areas again and again, which could make Roomba miss eventually some of the other areas which would remain unclean and dirty.

4.2.3 Cleaning and Other Activities

In general, it is observed that people consider Roomba being an additional support to the cleaning activities. In fact, all the interviewees knew that Roomba was not capable of cleaning as good and efficient as a vacuum cleaner would do. On the other hand, the interviewees mentioned that they could spend more time on detailed cleaning since they have Roomba as an assistant. As a matter of fact, there isn't any significant change observed regarding the weekly cleaning time and routine, although the interviewees said that they could have extra time for other external activities, except those minor domestic activities that can be done in the Roomba's surroundings. On the other hand, it is observed that young users were more comfortable with leaving the house when they turned Roomba on, whereas elderly couples felt like staying at home. Nevertheless, Roomba provided time flexibility at daily basis because of not being as noisy as a regular vacuum cleaner. In other words, the majority of the users were happy with that because they were even able to run Roomba early in the morning. However, a few people were still dissatisfied with the Roomba noise level.

In addition to the house cleaning, the users were also aware of the fact that Roomba's maintenance had to be done periodically depending on how big the house is and how dirty it gets. Speaking of the period, some users should clean Roomba every time before they start, whereas some others do that in every 2-3 runs. It is also needless to say that this frequency was higher for those who own pets within the domestic environment. In general, cleaning Roomba takes minimum 10 minutes. Users basically disassemble components like various brushes as well as the dust bin. There

is an additional tool to clean brushes in an efficient and rapid way (Figure 4.12 :). However this accessory given by iRobot does not communicate with users visually very well and almost all interviewees used it in wrong way and had difficulties to adapt afterwards. More remarkably, none of the users complained about this extra effort to clean Roomba as a whole task, even though it was obviously an additional effort in cleaning activity. On the other hand, some of the interviewees were not happy with the hard process of disassembling some components.

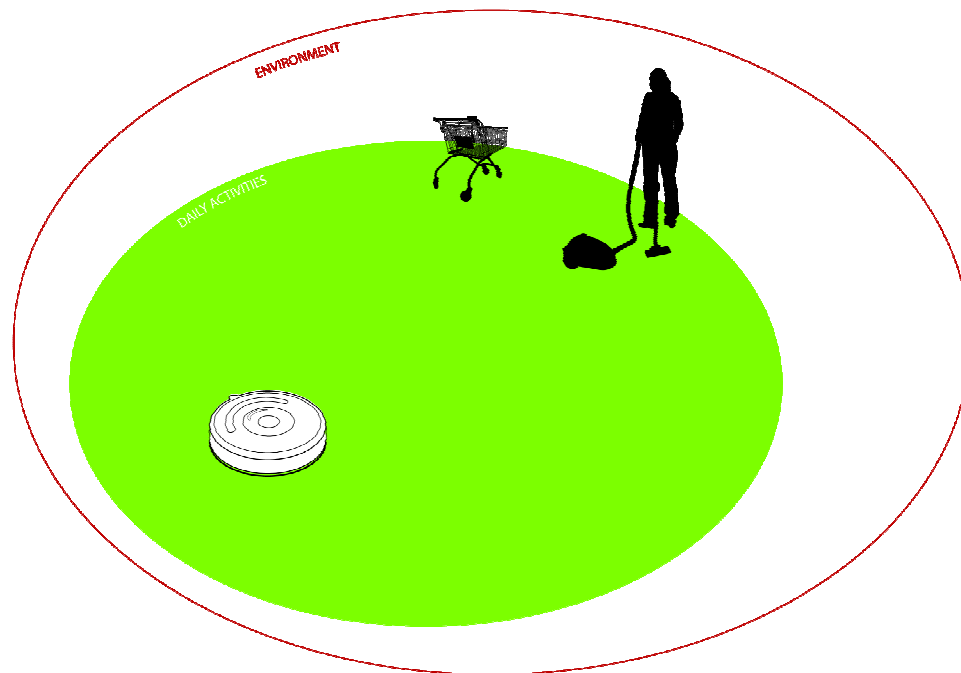


Figure 4.11 : The position of cleaning and other daily activities in the envisioned schema of Roomba product ecology

In terms of the cleaning actors, Roomba affected in some cases the routine of housekeepers. Two participants mentioned that they changed the housekeeper from an expensive and high quality one to a low quality and cheaper one due to the additional support of Roomba. Therefore, some of them even reduced the number of the days in housekeeper's labor shift to decrease costs. As mentioned before, this is done because they strongly believed in Roomba's positive contribution. As another side effect of Roomba, men also started to be a part of cleaning system as they were interested in gadgets and new technology. Basically, they became the ones who took care of the maintenance of Roomba and looked after it, which eventually put them into the overall picture of cleaning activities.



Figure 4.12 : The maintenance of Roomba

4.2.4 Environment

In terms of the environmental and structural organization, there was a bold difference between the use of Roomba in a single storey flat and in double storey loft especially when taking the physical obstacles into consideration. As the most remarkable contrast, people living in double storey loft were very concerned about the high stairs and deep steps thereof, even though Roomba has built-in sensors which had been designed to prevent it from falling off in such cases. Moreover, those living in double storey loft preferred usually using Roomba only in one of the floors, and never took it to the other. This matter put the emphasis on the fact that people were not completely ready to count on Roomba's given technology yet.

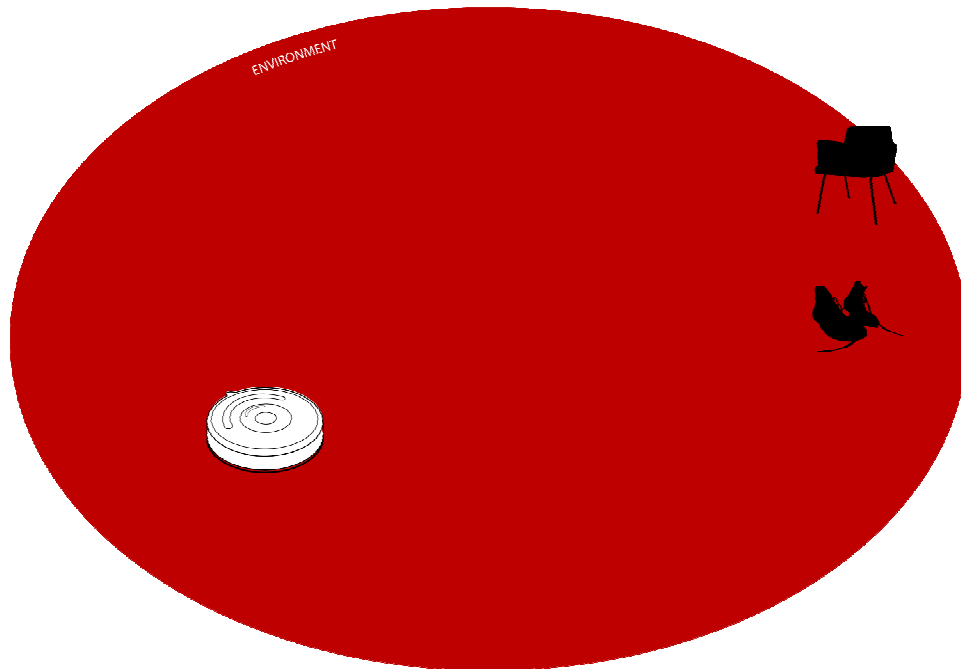


Figure 4.13 : The position of environment in the envisioned schema of Roomba product ecology

When considering the other physical obstacles within the domestic environment, all interviewees shared the common problems and very similar opinions. First of all, they all were aware of the necessity to make pre-arrangements in the home structure before switching Roomba on, like lifting up chairs, removing rugs and tiny cables out of the Roomba's path in case it might get stuck to. For example, a family described the base and legs of their chairs as being great labyrinths for Roomba where it spent

at least ten minutes, which is relatively much for an object that can only run for three hours at the most (Figure 4.14 :). Although this pre-arrangement activity sounded to have negative influence at first, half of the interviewees perceived this activity to be a plus provided by Roomba because they considered that this necessity ended up keeping them and their environment in order. In other words, all the house members were more careful and paying attention not to leave anything on the ground in order not to have Roomba getting stuck. In addition, furniture like sofa, armchairs with low bases, and small structural corners through which Roomba was not capable of passing, was another commonly mentioned problem. But in these cases, interviewees were comfortable with cleaning these surfaces by the support of the traditional vacuum cleaners instead of making major structural changes within the context of pre-arrangement activity. Apart from these temporary structural solutions, any of interviewees thought of doing a permanent change so far to give more room for Roomba to process.



Figure 4.14 : Physical obstacles in the domestic environment

Docking station and its position is also highly influenced by the structural organization as well as the technological and physical boundaries. In general,

docking station was mainly kept where Roomba was often used, which was selected most of the time as a corner in the living room. On the other hand, people did not want to have the base visible to visitors. Thus, the idea of having less presence appeared to be a requirement. Additionally, electrical plug turned out to be another big influencer on the space selection of the docking station. Besides, some users moved the docking station inside the home when they needed to use it in the other parts of the house. However, Roomba had limitations regarding the signal range between the Roomba and docking station. In such cases, Roomba gets most probably lost within the domestic environment.



Figure 4.15 : Roomba's docking station in the domestic environment

Single people living with their parents seemed to own Roomba at personal level and use only in their personal spaces defined within the domestic environment. It is also observed that they do not likely share it firstly due to personalization and secondly because of the range limitations Roomba has in terms of docking station communication.

Any of the Italian users intended to use Roomba outside of the domestic environment before. Even the idea of using it in the balcony was not an issue. Once, only one of the interviewees took his Roomba to his office. As one the main reasons not to take it out, the interviewees mentioned many times about the danger of having Roomba wet.

4.2.5 Robots

When interviewees were asked if they had another robot in their houses, only one of the interviewees clearly pointed at a cooking robot which was a Bimby. He showed big commitment to it by even citing that he learned cooking by Bimby. According to his words, he never cooked well before, but after Bimby he became a spectacular chef. Besides, his Bimby was named as Gustavo, which was a character in Asterix comic book series, who was responsible of making sure that the Emperor's food was safe and healthy. He said: *"If Gustavo stays alive, the food is good then ..."*.

Another interviewee referred to his security cam as his another existing robot. Features like having internet connection, being programmable and tracking movements were his points of reference that make an object a robot. In addition, two of the interviewees mentioned about their washing machine, mixer and auto switching lights since they could easily sense automated movements. On the other hand, the dish washer was a common topic of discussion about which almost each participant abstained. In the end, the majority did not consider it as a robot. As another topic of discussion, participants never hesitated to declare that car was not a robot even though it had navigation systems inside because it was driven by the users.

In terms of the desired tasks for the next generation of robots, all users generally referred to activities which they hate doing like. For instance, they explained tasks like ironing and car parking. One family also mentioned about a robot with the full house control, even including tasks like deciding who should come in and go out. On the other hand, three of the interviewees particularly talked about Scooba, iRobot's wet floor cleaning robot. One user cited that he learned new languages through his Nintendo, so he is also open for educational tasks.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This thesis aimed at exploring the human-robot interaction, in particular between the Roomba robotic vacuum cleaner and the Italian domestic environment. It was conducted through qualitative and ethnographic research methods in order to question existing literature findings through new perspectives and to open new arguments to make contribution to the development of future robotics.

The research model mainly followed product ecology guidelines that derived from the “Product Ecology” approach by Jodi Forlizzi. It did not only investigate the functional part of the robotic product, but also explored social behaviours it evoked among Italian people and changes it caused in the surrounding. With respect to product ecology guidelines, the standard house model was envisioned as a group of four main divisions. Those were cleaning products, people, cleaning and other daily activities, and finally the environment. However, it grouped cleaning activities and environmental structure separately, which might be assumed to be contrary to product ecology approach. It was especially done not to miss out micro dissimilarities and to simplify patterns and inter-connections between different divisions and actors. The main goal was to conclude with a better view of current situation and to create meaningful and basic insights to be used in future activities regarding domestic service robots.

The study eventually found out that Roomba’s entry caused changes on some factors within the Italian domestic environment and organization, whereas some parts of those remain the same as they were before. In the final part, the research also presented the general thoughts about the concept of domestic service robots. It basically questioned how Italian users describe a domestic service robot and what other tasks they would likely to be served.

1) What is the impact of Roomba on cleaning products and tools?

The study highlights a common belief among the Italian users that Roomba is not very efficient comparing to the traditional vacuum cleaners. Therefore, the majority still own a traditional one and stick to it depending on the level of the cleaning activity. This matter clearly indicates that Roomba is assumed to be an additional support within the cleaning system. As a result, Roomba did not cause any major changes in terms of the presence and the frequency of use of the other cleaning products like vacuum cleaner, broom and liquids. On the other side, the study pictured that all these cleaning products, including Roomba, support each other's work and performance depending on the different steps of the cleaning.

2) What is the communication level between Roomba and people?

Italian Roomba users tend to create emotional bonding around the product. Unlike some of the previous studies (Sung et al., 2007) where it came out that people described Roomba even as a member of their families, Italian users did make such bold descriptions. On the other hand, it is observed that they name their Roomba and ascribe gender. Given names are majorly inspired by the Italian language and include even word games. Those names do not reflect any references derived from Roomba's visual design and embodiment. As another impact of Italian grammar, Roomba is perceived to be a male because the word "robot" is masculine. In addition, color is secondary element effective on the gender perception. For instance, some users relate pink to female gender. Apart from the domestic users, pets also reacted to Roomba in a proactive way instead of getting scared or running away. In the figurative sense, overall findings regarding the domestic interaction enlighten that Roomba finds itself a room between being a domestic device and a house pet.

As a tangible part of the interaction, Roomba's futuristic signals and user interface are not well communicated with Italian users yet. Even though they declare the opposite, the researcher witnessed problems in the real environments where the users were misled in many cases or they found themselves in a dead-end conversation. Therefore, it is observed that they do not control Roomba very consciously.

3) How much does Roomba influence cleaning and other daily habits?

The study showed that Roomba did not constitute major changes on the weekly cleaning routines yet. The number of weekly cleaning sessions remains the same as

they were before the Roomba experience. Therefore, the duration of each cleaning session does not change drastically either. But it is found out that people intend to turn Roomba on more than their weekly cleaning circles. This issue can be related to the Forlizzi's (2007) observation about opportunistic cleaning. Basically, people run Roomba without making any rigid plan, which strengthens the idea of taking the advantage of Roomba whenever possible.

On the opposite, Roomba increased the number of activities in cleaning because first of all users now have to clean the Roomba itself in addition to cleaning the house. Italian users are doing this maintenance activity almost every time before they switch Roomba on. As another indirect activity, users have to make pre-arrangements in the home structure before starting Roomba. This extra effort mainly includes removing chairs, tiny cables and rugs out of the Roomba's path in case it might get stuck to. However, any of the users complain about doing these additional activities; therefore they are happy with Roomba's existence as a cleaning assistance. This proves that robots and humans in a domestic setting do not just coexist, but they also cooperate. Furthermore, it indicates that Italian users eventually make a trade off between the functionality and the emotional aspects of Roomba, where they believe it stays within the acceptable range. From another perspective, it can be also assumed that Roomba fulfills Italian users' expectations.

The number of people involved in cleaning activity is drastically influenced by the presence of Roomba in two directions. As the first one, the findings point out that Italian men appear to be more involved in cleaning activities. That is probably because Italian men's interest in technology is observed to be greater than women. As a matter of fact, it is noticed that the idea of having a robot within the domestic environment attracts men more, and consequently they start taking care of all the Roomba related activities meaning the use, maintenance and the cleaning of the device. As a result, men take place in the domestic cleaning system one way or another. Therefore, this outcome suits with the fact that Roomba shifts the cleaning activity from an individual act to a household activity, where all people participate in different steps, which had also concluded in the previous studies (Sung et al., 2007; Di Salvo et al., 2006).

As the second direction regarding the actors in cleaning system, Roomba had a negative impulse on the presence of housekeepers within the domestic environment.

Some of the Italian users made changes in the labor shift by decreasing the number of working days. Some others even dropped the quality of cleaning service to cut the prices and take the full advantage of Roomba's presence. This outcome also refers to Norman's (2004) discussion about the negative side effects of the robotic technology on the labor force, in which he generally underlined the direct and indirect impacts caused by the development in robotic technologies. Supporting that, the study proved that Roomba's presence in Italian domestic environment results in having negative influence on the labor force of housekeepers and related domestic services.

4) What are the counter-effects between Roomba and the domestic environment?

High percentage of Italian Roomba users underlined that Roomba requires pre-arrangements activities within the domestic environment before it starts processing. Thus, users have to move temporarily furniture like sofas, armchairs whose bases are lower than Roomba's height, where Roomba naturally is not capable of passing through. However, none of the Italian users consider making major and permanent changes on the environmental structure in order to give more space to Roomba. So, the overall tendency of Italian users is conflicting with the "Roombarization" theory which basically claims that people intend to make major and permanent changes to their houses in order to accommodate Roomba (Sung et al., 2007).

To conclude, this study clearly agrees with former studies (Di Salvo et al., 2006; Sung et al., 2007) in the way that domestic service robots and domestic environment must adapt to each other no matter if it requires short or long term engagements.

5) Which features and attributes of Roomba shape the robot concept among Italian people?

The conversation about robots in general opened up three main topics that were importance of robots' visible movements, the relationship between robots' reliability and generations, and finally the references communicated with the intelligence of robots. As the first, participants were asked if they had any other robots in their domestic environments and they usually referred to various objects where the movements were clearly visible. Therefore, users did not only pick mobile devices, but they also pointed at devices whose moving parts were clearly visible on their embodiments. On the contrary, the devices in that the moving components were

hidden are simply abandoned since their dynamic components were not clearly communicated with users.

Secondly, it is observed that the approach of young population towards the domestic robots were more positive than elderly people who seem to have doubts about the idea of domestic service robots. The findings pointed out that the younger users are, the more they count on robots. During the field research, it is found out that young population leaves the house when they turn Roomba on, whereas elderly couples feel like staying at home and checking what it is doing. Contrary to former studies that underline the strong connection between the visibility of Roomba's results and the growing reliability (Sung et al., 2007), this study concludes that Roomba's results are not effective on the correlation between generations and reliability.

As the third, users clearly referred to smart and intelligent references when they were asked about the characteristics they would like to see on a domestic task robot. Movements and being mobile play an important role. However, users mentioned about smart movements as well. They specifically listed Roomba features like slowing down near objects, walls and furniture instead of bumped directly into, or like jumping over small cables and carpets. In addition, they described Roomba to be intelligent because it was aware of its own and the environmental conditions. Here, signals have an important roles which indicate different states of conditions, like getting stuck or about to run out of the battery or the dust-bin is full. Besides, Roomba "spot cleaning" feature, which makes it focus on extra-dirty areas, was also a plus.

People also mentioned about specific features and adjectives. Apart from being mobile, the other major ones were doing task autonomously, the visibility of those results and requiring users' guidance as less as possible. On the other hand, being programmable, working software-based and having internet connection appeared to be secondary determining factors. On the contrary, things driven by users are strongly rejected to be a robot. For instance, car was never considered to be a robot even though it had navigation systems inside.

In terms of the future tasks for the next generation of robots, the Italian users generally named activities that they hate doing or that require less complexity and human guidance. On the other hand, tasks that demand on high level of artificial intelligence seem to be non-preferable by current users in Italy.

5.2 Future Studies

This ethnographic study focuses on the use of a specific domestic service robot within a certain geography and culture in order to contribute to the future of robotics. On the other hand, it also aims at creating a comparative basis for other ethnographic studies related to the same or similar domain of interest, that can be potentially done in other geographies and cultures. In that sense, matching and seeing correlations among those studies would be instrumental in the progress of domestic service robots from both engineering and design perspectives.

The thesis is conducted through a qualitative approach, but the same topic contains opportunities for quantitative studies. Service robots' attitudes and attributes like their appearances, movements, noises could be important topics for future quantitative studies. Usability test of Roomba and its graphical user interface (GUI) could be another area of exploration. Studying Roomba user profiles with respect to genders, generations as well as the social status could elicit useful findings and open up new discussions.

In the end, fusing those various studies will not only improve the current situation, but it will also clarify trends and trajectories, point out new opportunities, and help human take the next step of technological era.

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APPENDICES

APPENDIX A	: Roomba User Questionnaire (in English)
APPENDIX B	: Roomba User Questionnaire (Original, in Italian)
APPENDIX C	: Non-Roomba User Questionnaire (in English)
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APPENDIX A: Roomba User Questionnaire (in English)

1. Gender:
2. Age:
3. Country of residence:
4. Type of house:
 - ☐ Two storey flat
 - ☐ Apartment
 - ☐ Detached house - two storey
 - ☐ Detached house - single storey
 - ☐ Other
5. Who are you living with? :
 - ☐ With my family
 - ☐ With my parents
 - ☐ With my friends
 - ☐ Alone
 - ☐ Other
6. Who cleans the house mostly?
7. How many times do you clean the house during the week?
 - ☐ 1
 - ☐ 2
 - ☐ 3
 - ☐ Other
8. Which products and objects are used for the house cleaning (broom, detergents etc.)?
9. Are you using a vacuum cleaner? Which brand and model?
10. Since when have you been using Roomba?
11. How many Roomba did you have so far?
12. What is the current model of your Roomba ?
13. Which Roomba's accessories do you use (battery charger, virtual wall, etc.)?
14. Why did you decide to buy Roomba?
15. Does your Roomba have a name? Why?
16. Who is doing Roomba's maintenance? How long does it take?
17. How often do you switch Roomba on per week?

18. Do you make any preparation within the house structure before starting Roomba?
19. Where do you place Roomba's docking stations in the house? Why?
20. Are there any Roomba-related websites that you usually follow?
21. Do you any other robots in your house?
22. Who was cleaning the house before the Roomba experience?
23. Which products and objects did this person use for the house cleaning before the Roomba experience (broom, detergents etc.)?
24. How often was the house cleaning done before Roomba experience?
25. If you should take a robot for home, what would be the main reason (possible to make multiple choices)?
- ☐ Cleaning
 - ☐ Washing dishes
 - ☐ Cleaning glasses
 - ☐ Preparing foods
 - ☐ Babysitting
 - ☐ Security
 - ☐ Other

APPENDIX B: Roomba User Questionnaire (Original, in Italian)

Questionario: Tecnologie smart per l'ambito domestico (ru)

Salve,

il seguente questionario serve per la mia tesi di laurea che svolgo presso il Politecnico di Milano e l'Università Tecnica di Istanbul sulle tecnologie smart per l'ambito domestico. Il tempo richiesto per la compilazione è molto breve e i dati forniti saranno esclusivamente per uso accademico e non verranno comunicati a terzi. La vostra partecipazione contribuirà al mio lavoro che ha l'obiettivo di sviluppare una casa intelligente. Vi ringrazio in anticipo per la pazienza e il vostro contributo.

Per ulteriori informazioni o qualunque dubbio sono a vostra disposizione:

Koray Ozsoy

Telefono: +39 389 057 1600
E-mail: korayozsoy.roomba@gmail.com
Sito Web: <http://www.korayozsoy.com>

* Required

Tipologia casa: *

Dublex

Attualmente con chi convivi: *

☐ Con la mia famiglia

☐ Solo con i genitori

☐ Con degli amici

☐ Con nessuno (abito da solo/a)

☐ Other:

Chi pulisce principalmente la casa? *

Quanto volte in settimana si pulisce casa? *

☐ 1

☐ 2

☐ 3

☐ Other:

Quali sono i prodotti e oggetti che vengono utilizzati per le pulizie? *

(Scopa, detersivi, ecc)

Nel caso si faccia uso di un'aspirapolvere, di quale modello e marca è? *

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Figure B.1 : Roomba User Questionnaire Page 1

Questionario: Tecnologie smart per l'ambito domestico (ru)

* Required

Pagina 2/2

Quanti Roomba hai avuto fin ora? *

☐ 1

☐ 2

☐ Other:

Qual é il modello attuale di Roomba che possiedi? *

Di quali accessori di Roomba fai uso? *

(possibili risposte multiple)

☐ Base per autoricarica

☐ Muro virtuale

☐ Telecomando

☐ Centrale di Comando

☐ Other:

Perché hai deciso di acquistare Roomba? *

16. Il tuo Roomba ha un nome? Perché? *

Chi fa la manutenzione di Roomba? *

Quante volte in settimana viene usato Roomba? *

☐ 1

☐ 2

☐ 3

☐ Other:

Figure B.2 : Roomba User Questionnaire Page 2a

Prima di usare Roomba, vengono spostati i mobili come preparazione? *
In quale parte della casa si trova il caricatore di Roomba? Perché? *
Ci sono dei siti web su Roomba che segui come utente?
Possiedi uno o più altri robot diversi da Roomba che usi in casa?
(In caso affermativo, si prega di indicare i loro nomi.)
Da quando usi Roomba? *
Chi ha pulito la casa, prima di Roomba?
Prima di Roomba che prodotti/oggetti venivano utilizzati per le pulizie?
(scopa, detersivi, ecc)
Quante volte in settimana si facevano le pulizie prima di Roomba?
☐ 1 ☐ 2 ☐ 3 ☐ Other:

Figure B.3 : Roomba User Questionnaire Page 2b

Se dovresti prendere un robot per la casa, quale sarebbe il motivo principale? *

(possibili risposte multiple)

☐ Pulizia

☐ Lavare i piatti

☐ Pulire i vetri

☐ Preparare i cibi

☐ Babysitting

☐ Vigilanza

☐ Other:

Sesso: *

Stato civile: *

Età: *

Paese di residenza: *

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Figure B.4 : Roomba User Questionnaire Page 2c

APPENDIX C: Non-Roomba User Questionnaire (in English)

1. Gender:

2. Age:

3. Country of residence:

4. Type of house:

☐ Two storey flat

☐ Apartment

☐ Detached house - two storey

☐ Detached house - single storey

☐ Other

5. Who are you living with? :

☐ With my family

☐ With my parents

☐ With my friends

☐ Alone

☐ Other

6. Who cleans the house mostly?

7. How many times do you clean the house during the week?

☐ 1

☐ 2

☐ 3

☐ Other

8. Which products and objects are used for the house cleaning (broom, detergents etc.)?

9. Are you using a vacuum cleaner? Which brand and model?

10. Would you use a robot for cleaning the house? Why?

11. If you should take a robot for home, what would be the main reason (possible to make multiple choices)?

☐ Cleaning

☐ Washing dishes

☐ Cleaning glasses

☐ Preparing foods

☐ Babysitting

☐ Security

☐ Other

APPENDIX D: Non-Roomba User Questionnaire (Original, in Italian)

Questionario: Tecnologie smart per l'ambito domestico (nru)

Salve,

il seguente questionario serve per la mia tesi di laurea che svolgo presso il Politecnico di Milano e l'Università Tecnica di Istanbul sulle tecnologie smart per l'ambito domestico. Il tempo richiesto per la compilazione è molto breve e i dati forniti saranno esclusivamente per uso accademico e non verranno comunicati a terzi. La vostra partecipazione contribuirà al mio lavoro che ha l'obiettivo di sviluppare una casa intelligente. Vi ringrazio in anticipo per la pazienza e il vostro contributo.

Per ulteriori informazioni o qualunque dubbio sono a vostra disposizione:

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Sito Web: <http://www.korayozsoy.com>

* Required

Tipologia casa: *

☐ Dublex
☐ Appartamento
☐ Villetta a due piani
☐ Villetta a un piano
☐ Other:

Attualmente con chi convivi: *

☐ Con la mia famiglia
☐ Solo con i genitori
☐ Con degli amici
☐ Con nessuno (abito da solo/a)
☐ Other:

Chi pulisce principalmente la casa? *

Quante volte a settimana pulisci la casa? *

☐ 1
☐ 2
☐ 3
☐ Other:

Quali sono i prodotti e oggetti che vengono utilizzati per le pulizie? *

(Scopa, detersivi, ecc)

Nel caso si faccia uso di un'aspirapolvere, di quale modello e marca è? *

Figure D.1 : Non-Roomba User Questionnaire Page 1a

Utilizzeresti un robot per le pulizie di casa? Perché? *

Se dovessi prendere un robot per la casa, quale sarebbe il motivo principale? *

(possibili risposte multiple)

☐ Pulizia

☐ Lavare i piatti

☐ Pulire i vetri

☐ Preparare i cibi

☐ Babysitting

☐ Vigilanza

☐ Other:

Sesso: *

Maschile ▼

Stato civile: *

Non coniugato ▼

Età: *

Paese di residenza: *

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Figure D.2 : Non-Roomba User Questionnaire Page 1b

APPENDIX E: Announcements on Italian Roomba forums

contatti | registrazione prodotti

iRobot iRobot Robot domestici Robot tattici Shop

Benvenuto Visitatore (Connettiti | Registrati)

> Community iRobot > iRobot > iRobot EXPERIENCE

4 Pagine: 1 2 3 4

NUOVA DISCUSSIONE

iRobot EXPERIENCE Opzioni Forum

	Titolo Discussione	Risposte	Autore Discussione	Visite	Ultima azione
Annunci					
+	Annuncio: Numero matricola sul Roomba	-	Supporto iRobot	3503	-- Ultimo msg di: Supporto iRobot
+	Annuncio: Arriva Scooba	-	Supporto iRobot	6200	-- Ultimo msg di: Supporto iRobot
+	Annuncio: Supporto iRobot	-	ADMINISTRATOR	8662	-- Ultimo msg di: ADMINISTRATOR
Altre discussioni					
📁 ⚠️	Info Urgente: Si Cercano Degli Utenti Roomba In Italia	46	koray	2.510	18th May 2010 - 08:48 PM Ultimo msg di: cicziuz
📁	Assistenza iRobot E Assistenza Niogin Ottima I-robot	6	pitù	1.795	7th May 2010 - 02:33 PM Ultimo msg di: rideang
📁	0 Complimenti Ad Assistenza	0	rideang	88	7th May 2010 - 12:20 PM Ultimo msg di: rideang
📁	Spedizione In Assistenza	1	elettrovalvola	302	7th April 2010 - 01:15 PM Ultimo msg di: vatuttbene
📁	Un Confronto Tra Robot. C'è una logica nei movimenti random!	2	elettrovalvola	338	4th April 2010 - 04:54 PM Ultimo msg di: pina
📁 ⚠️	iRobot 562 Pet	3	Mariass	555	28th March 2010 - 02:38 PM Ultimo msg di: elettrovalvola
📁	Fantastico!	3	Mariass	523	21st March 2010 - 08:45 PM Ultimo msg di: pina
📁	0 Roomba Addestra I Cani	22	vatuttbene	756	18th March 2010 - 10:05 PM Ultimo msg di: soledinapoli
📁	Tecniche Di Pulizia: idee ed esperienze	26	Alessandro71	4.230	9th March 2010 - 10:00 PM Ultimo msg di: vatuttbene
📁	Esperienze Sulla Manutenzione	3	vdfl	635	9th March 2010 - 02:13 PM

Figure E.1 : Screenshot from online announcements (1/2)



Figure E.2 : Screenshot from online announcements (2/2)

APPENDIX F: Interview Protocol

Roomba User Interview Protocol

Roomba User Interview Protocol

70 min. interview+ demonstration

Date _____

Time _____

Interviewee: _____

TIMELINE	INTRODUCTION & EQUIPMENT SET-UP (5 min) - o Who am I? - o Why am I doing this? - o Set of expectations - o Give NDA (Non Disclosure Agreement)
	PART 1 - GETTING TO KNOW YOU & CLEANING (10 min) - o First Name / Last Name - o Age - o Status - o House Type Photo: ☐ Overall look of the place - o Profession - o Households (Pet?) - o Cleaning Routine - o Actors - o Cleaning Products Photo: ☐ Products in general ☐ Vacuum Cleaner

1

Figure F.1 : Interview protocol Page 1

	PART 2 – ROOMBA BASIC INFORMATION (10 min) - o Since when... - o How many so far? - o BUY ROOMBA: Why & How? - o Model Photo: [] <u>Roomba</u> in docking station PART 3 – ROOMBA & ENVIRONMENT (10 min) - o Docking station - o Any preparation / Home structure Photo: [] objects he talks about. - o <u>PROS & CONS</u> [] Shape [] Batteries [] Physical limitations [] Movements - o Accessories Photo: [] Accessories - o How often a week? PART 4 – ROOMBA & USER (15 min) - o Who cleans <u>Roomba</u>? - o Any name? - o Gender? - o Illuminations - o Sound - o Warranty Question > Name the new one? - o Websites and other communication channels? PART 5 – PAST CLEANING (5 min) - o CHANGE?
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Figure F.2 : Interview protocol Page 2

	Cleaning Routine
	Actors
	Cleaning Products
	PART 6 – ROBOTS (15 min)
	- o Any other robots at home? - o If he does not talk about: ☐ Dish washer ☐ Washing Machine ☐ Car ☐ Navigation - o What makes things robot? - o The next task.
	Photo: ☐ Interviewee

Figure F.3 : Interview protocol Page 3

APPENDIX G: Introduction Text of the Interview (Original, in Italian)

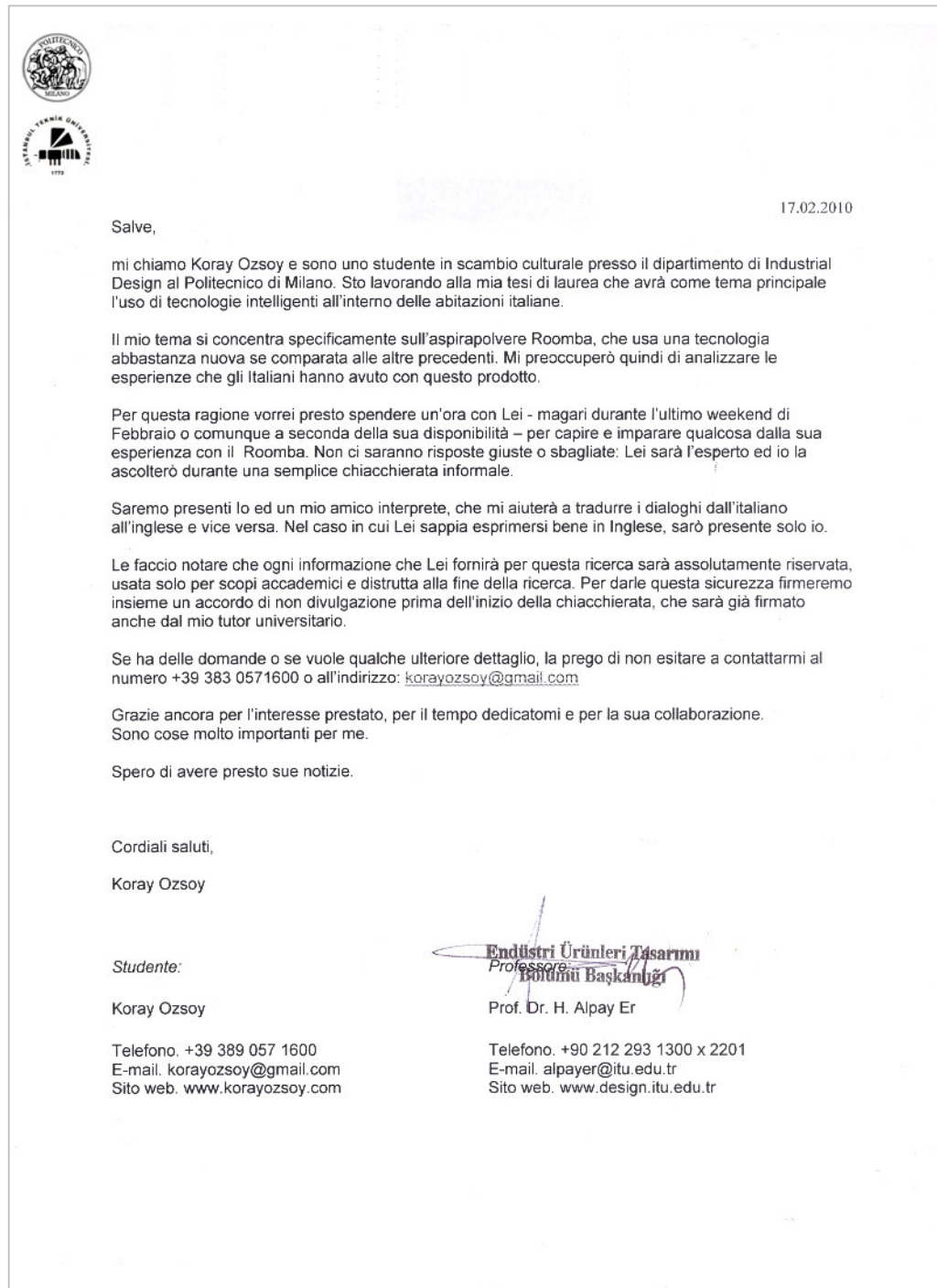


Figure G.1 : Interview Introduction

APPENDIX H: Non-Disclosure Agreement (Original, in Italian)

 **ISTANBUL TECHNICAL UNIVERSITY**
Faculty of Architecture
Department of Industrial Product Design

Issue : B.30.2.İTÜ.0.44.00.00/2010/
Ref. : Koray Özsoy

17.02.2010

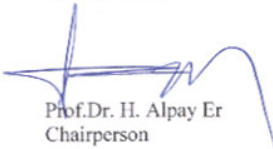
Egregio Signore, gentile Signora,

Koray Ozsoy è iscritto al corso di laurea specialistica in disegno industriale presso l'Università Tecnica di Istanbul, dove sta studiando elettrodomestici robot per la sua tesi.

Per quanto riguarda i suoi studi, ha bisogno di parlare personalmente con utenti di iRobot Roomba. L'argomento di questa conversazione sarà utilizzato solo per la tesi e non sarà condiviso con altre persone.

La ringrazio per la Sua collaborazione.

Cordiali saluti,


Prof. Dr. H. Alpay Er
Chairperson

Endüstri Ürünleri Tasarımı
Bölümü Başkanlığı

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Figure H.1 : Non Disclosure Agreement.

[illegible]

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APPENDIX J: Snapshot from the interview analysis phase



Figure J.1 : Interview analysis phase

CURRICULUM VITAE

S. Koray Özsoy was born in Çorlu, in 1983. He received his BSc degree in the Department of Industrial Product Design at Istanbul Technical University in 2005. In the following semester, he began the M.Sc. program in the same department. In the fall semester of 2007/2008, he studied in the Industrial Design Engineering Faculty of Delft University of Technology as an exchange student under the Erasmus Exchange Program.



Koray has been working and writing articles for Designophy, Design Publication as an editor since 2002. In the last year of his masters, he also joined Design Continuum Team in Milan and currently works as a junior designer.

He is interested in music, drums and tango.