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Introduction to the Special Issue "Beyond Industrial Robotics: Social Robots Entering Public and Domestic Spheres"

Leopoldina Fortunati

Anna Esposito

Giuseppe Lugano

Industrial and domestic robotics provide fascinating and relevant perspective insights into current and possible trajectories for the development of contemporary societies. While industrial robotics has found its place since the 1960s, domestic robotics wherein humans interact with social robots is still an unsettled area. After reviewing data on the diffusion of social robots and on their use, the historical tradition from which social robots come is discussed. This discussion is followed by an analysis of the penetration of social robots in everyday life and the importance of interdisciplinary research is highlighted.

Keywords automata, automation, domestic robots, industrial robots, social robots

INDUSTRIAL AND SOCIAL ROBOTS IN NUMBERS

As the robot is an archetype and a cultural object (Bakardjieva 2015, this issue), it has inspired and continues to inspire movies, cartoons, and science fiction novels. Our imagination is so nurtured by many sources of narration and storytelling on robots that there is a need to take stock of the presence of real robots in the everyday life.

There are two different sources of data on the spread of robots: sales and robot prices on the one hand, and people's attitudes and perceptions toward robots as well as users' opinions and evaluations on the other hand. For the former, our point of reference is the World Robotics Report 2014, released by the Statistical Department of the International Federation of Robotics (IFR 2014). According to this report, in 2013 industrial robot sales reached 178,132 units, showing an increase of 12 percent (displayed in Figure 1).

The industries with the highest increase of industrial robot penetration were the automobile, the chemical, the rubber and plastics, and the food industries (IFR 2014). After a reduction of investments in 2012, the electrical/
electronic industry also showed an increase of robot installations. The countries that made the most robot purchases in 2013 were Japan, China, the United States, Korea, and Germany. It is noteworthy that China has become the biggest robot market and purchases 20 percent of the total supply. In Europe the most robotified countries are the two biggest manufacturing countries—Germany (18,300 units) and Italy (4,701)—followed by Spain (2,800), the United Kingdom (2,486), and France (2,200). Another useful data type for insights into robot

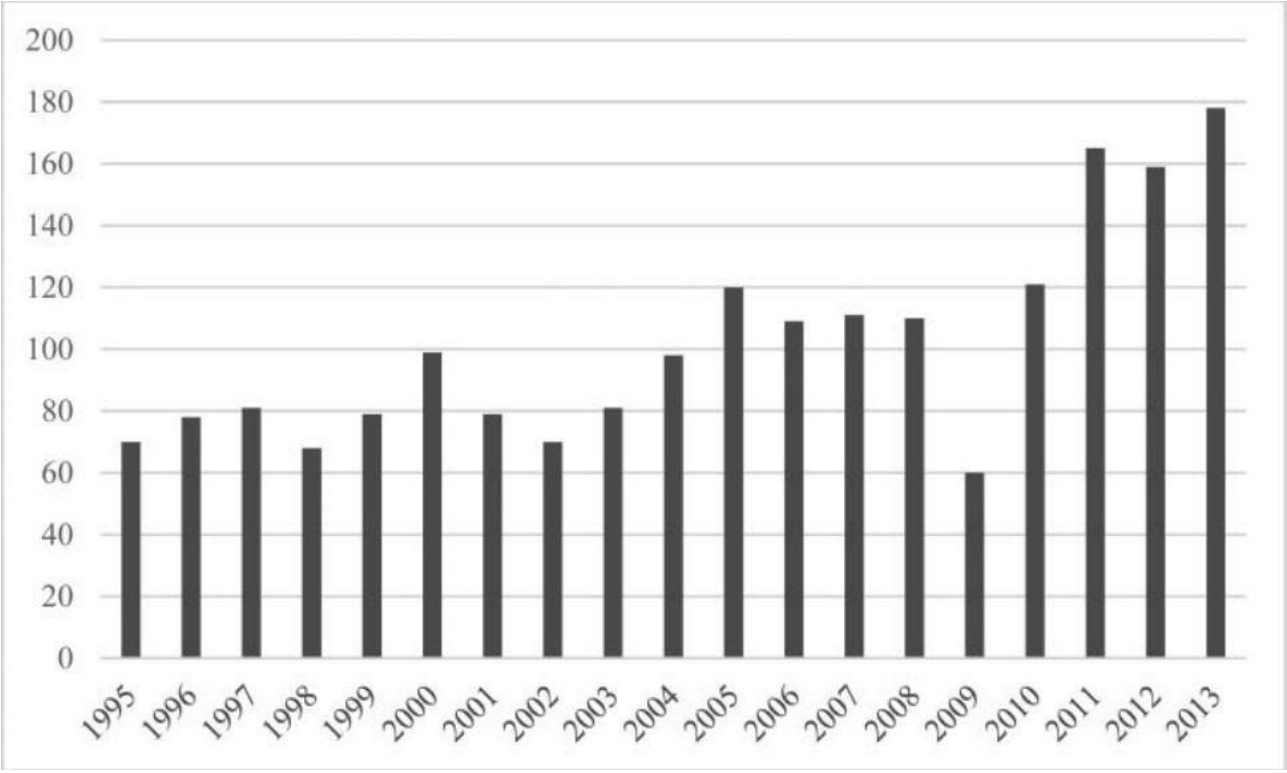

FIG. 1. Industrial robots sold worldwide from 1995–2013 (in thousands of units). Source: IFR (2014)

penetration in the industrial sectors is "robot density." IFR as defined this measure as "the number of multipurpose industrial robots per 10,100 persons employed in manufacturing industry or in the general industry" (which is all industries excluding the automotive industries) (IFR 2014). Here it transpires that in 2013 the average robot density worldwide was 62, in Europe 82, 73 in
the Americas, and 51 in Asia. In the same year, the Republic of Korea had the highest robot density in the world: For 10,000 employees, there were 437 industrial robots (IFR 2014). If we calculate the total sales, since the introduction of industrial robots at the end of the 1960s, they amount to about 2,650,000 units. However, most of the early robots are no longer in service. Let us recall that the average cycle of life of a robot is from 12 to 15 years. This means that the "total worldwide stock of operational industrial robots at the end of 2013 was the range of 1,332,000 and 1,600,000 units" (IFR, 2014). These indicators suggest that robots still serve a small niche in the large market for information and communication technologies (ICTs).

"Service robots" are meant for professional use in various fields, including defense, agriculture, logistics, medicine, construction, hazard waste removal, underwater exploration, and personal/domestic use. In 2013 the sales of service robots (20,200 units) decreased 4 percent over the previous year. However, if we consider the last 5 years, we see that around 100,000 robot units were sold, compared to the 68,000 units sold in the previous decade (1998–2008). When we look at disaggregated figures, we see that the defense field was at the top with 45 percent of the total number of service robots in use (9,500 units), even though there has been a surprising decrease in the sales of drones. Another important sector is agriculture, with milking robots and robots for livestock husbandry (e.g., mobile barn cleaners or robotic fencers for automated grazing control), with 5,100 robots units sold (see Figure 2). Another sector

that is rapidly growing is the logistic systems (mainly automated guided vehicles), with 1,900 units sold in 2013. The sector that is instead slightly decreasing is that of the sales of medical robots (robot-assisted surgery and therapy), which reached 1,300 units in 2013. These figures contrast with the relevant public and private research and development (R&D) investments in the field of health robotics, indicating that the market has much potential growth. However, the large amount of investments and promises has not corresponded yet to convincing high-quality technologies.

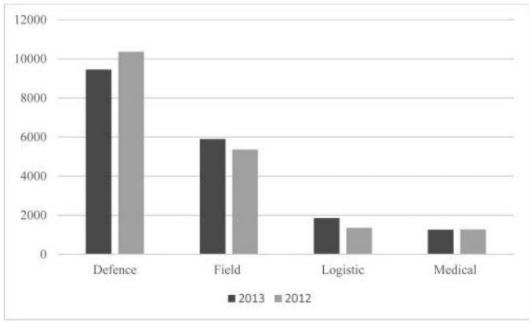

FIG. 2. Service robots sold in 2013 and 2012 for professional use in the main sectors (units). Source: IFR (2014)

Other sectors such as construction and demolition systems, cleaning, and underwater systems show for the moment much lower numbers, as illustrated in Figure 3.

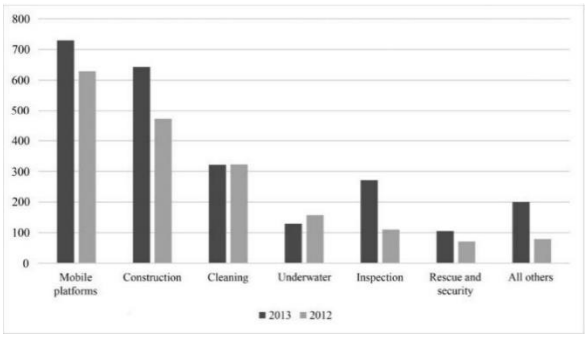

FIG. 3. Service robots sold for professional use in units in 2013 and 2012. Source: IFR (2014).

Very different numbers are shown by the service robots for personal and domestic use, which are elementary proto-forms of what the current research in ICTs considers social robots. Here we refer to a mass market with relatively low-price affordable robots. In 2013, about million service robots were sold with an increase of 28 percent in comparison to 2012. More than half of them, approximately 2.7 million (and this is a low estimate), were domestic robots. These robots include vacuum and floor cleaning and lawn-mowing robots. The remaining 1.3 million robots include entertainment and leisure robots such as toy robots, hobby systems, education, and research. Lastly, disabled assistance robots, robots for personal transportation, and robots for home security and surveillance account for almost 1,000 sold units (IFR 2014).

However, not all the robots entering the sphere of social reproduction, which is characterized by unwaged domestic tasks (Fortunati 1995), are high-tech artifacts. For

example, robots designed to assist people with disabilities and robots for the entertainment sector include increasingly more sophisticated products, which are sold mostly for supporting research efforts. We mention two prototypical research projects:

a. The robotic device platform Care-O-bot 3 that is at the basis of the EU research project ACCOMPANY, aiming to provide "physical, cognitive, and social assistance" to elderly people.
b. The NAO robot, which is used in the project ALIZ-E devoted to "the development of integrated cognitive systems capable of naturally interacting with young users in real-world situations, with a specific goal of supporting children engaged in a residential diabetes management course."

By contrast, the current household robots (vacuum and floor cleaning and lawn-mowing robots) are low-tech artifacts, which seem to be secondary by-products of the "noble" evolution of the industrial robots in the domestic
sphere. This continues to be in line with the traditional technological interventions in the domestic sphere,
where a double strategy has usually been pursued: concerted effort to develop technologies for immaterial labor (the one that is not formally contracted and is mostly done by women), and the general neglect of material labor, which continues to rely on low-tech technology (Fortunati 2011). This double register is dictated by the need of the economic system to maintain in the domestic sphere a high level of value production, undertaken mostly by women.

The projections for the period 2014–2017 foresee a substantial growth in sales to 50 million robots sold for the personal and domestic sphere. This is the right time to design high-tech robots able to address housework also for tasks performed by material labor. Social robots should finally offer a solution to address the housework in its complexity and double aspect—material and immaterial labor. To this end, we need to intensify the research on end users' attitudes, opinions, and behaviors, in particular those of women, children, the elderly, and the disabled. This is necessary in order to understand properly their needs and desires, and to analyze the tasks and rituals of the domesticity for formalizing them. This is what the study "Integrating Constrained Experiments in Long-Term Human–Robot Interactions Using Task- and Scenario-Based Prototyping" by Dag Sverre Syrdal et al. (2015, this issue) endeavors to further. It takes on the challenge of prototyping long-term interactions with robots in a domestic environment. Here the authors applied two different methodologies: constrained experiments and open-ended narrative interaction scenarios.
The study situates itself in the human–robot interaction (HRI) field of research and reports on various human–robot interactional research setups carried out at the Robot House at the University of Hertfordshire (UH) in the United Kingdom. In particular, 12 participants were required to interact with the UH Sunflower and AIBO robots, as well as to perform a constrained physical and mental task 4 times over a period of 8 weeks. Participant responses were collected using a variety of measures including the System Usability Scale, NASA Task Load Index (TLX), and ad hoc and open-ended measures. The results stress the importance of a user-centered approach to assistive technologies designed for domestic use, to allow both a personalization of the assistance and a level of assistance that can be gradually scaled. With a usercentered approach, it becomes easier to modulate the assistance according to the changes intervened in users' task mastery and identify strategies that the robot users are more likely to adopt.

The other data that are useful for our present purposes are the attitudes and opinions of citizens. Here we refer briefly to the Eurobarometer survey in 2012 (Eurobarometer 2012). According to this survey, only 15.2 percent of Europeans have used a robot at work (the percentage is 5.9 percent) or at home (the percentage is 6.2 percent). This highlights two things about the present state of robot development and use: (1) robotics involves only a small share of the overall industrial sector in Europe; and (2) homes are becoming more equipped with some types of robots.

WHERE DO SOCIAL ROBOTS COME FROM?

While industrial robots have a well-known history, that of service robots and especially social robots has just about started. As Baudrilliard (1993) pointed out, industrial robots have represented a clear shift with respect to automata. Automata represented the mechanical and theatrical counterfeit of the human being, whereby the technique served to build the analogy with human beings or animals and produce the effect of simulacrum. Industrial robots, differently from automata, do not aim to refine the imitation of the entities that inspired their development. They are designed only to replace human labor.

If the automata astonished and entertained the public with their human likeness, industrial robots only demonstrate their mechanical effectiveness in comparison with human capacity for work. Engineers and designers have observed, stolen, and reproduced features of human labor in the industrial robot.

What motivates the development of these robots is the will to reduce fatigue and danger in the production of commodities or services, including those of military nature, or to improve the precision of the work itself (like in surgery robotics), or to avoid repetitive or dirty jobs. These motivations may vary according to the specific sector of human life that becomes robotified and in which the works and the professions to be substituted are defined. Here the logics of the dissimilarity of robots from human beings often work better because the simulation of human beings behavior regards only their capacity for work.

While robots are beneficial because they replace workers in repetitive or dangerous tasks, in other areas where they compete with willing workers they are seen as a threat to workers' employment prospects. This explains why 72.6 percent of European citizens still share the fear that robots steal people's jobs (Taipale et al. in press). Robots' relationship with the labor market can be summarized in the following terms. Usually, if there is a large offer of cheap and disciplined labor, robots are not deployed. When this offer diminishes, at least in perspective, or the human labor becomes too expensive, robots are introduced. Hence, the diffusion of robots is connected to the trends of the labor market or to the necessity of the states to improve their military capabilities, avoiding at the same time the loss of a high number of soldiers' lives. In the industrial sectors the logic
inspiring the use of robots is substitutive. It is for this reason that their introduction has been contested by trade unions or stopped by policymakers concerned about
increase in the unemployment rate. Such resistance, combined with the high prices of industrial robots and a service life of 12 years, explains why robots have remained a "niche" commodity in the industrial sectors.

Given these premises, when the robot becomes social, where and how does it situate itself? Do social robots represent a further development of industrial robots or is there a discontinuity between industrial robots and social robots? Will they enter as a normal technological artifact in the mass market like mobile phones, tablets,

computers, and so on? The only answer for now is that they are technological artifacts, made possible by the developments of science and technology. From a technological point of view, the social robot is designed to be able to reproduce the labor force of a human being, understood as the material and immaterial capacity of care and housework. The idea that we advance here is that social robots, while representing a further step of industrial robots, are a synthesis of automata and industrial robots They aim in fact to recuperate certain aspects of automata, such as their ability to amaze and entertain and, in the case of Android and Gynoid, also their ability to refine the imitation of human beings or animals. Last but not least, they are present, like the automata in society, in the public sphere.

Antonio Bicchi and Guglielmo Tamburrini (2015, this issue) offer an original perspective, that of the sociability of social robots. They point out that social robots need to operate not only in interaction with humans and in social contexts in which other non-interacting humans might be present (H€oeflich 2013; H€oeflich and Al Bayed in press), but also in groups or teams. In this visionary scenario, they talk of societies of robots embedded in human societies that develop rich robot-to-robot exchanges and robot subcultures. Here the practical realities will require a limiting and streamlining of interactions between robots and human beings. That very likely reality calls for a rethinking of social robotics research and development, which focuses narrowly on human–robot interaction. According to the authors, this scenario would also offer a unified research horizon for different streams of social robotics research.

The most important thing to stress, however, is that the model of society that is embodied in the industrial robot is quite different from the model that was embodied in the automaton and is also different from the model of society embodied in the social robot. With the industrial robot, the challenge to God and to woman (Fortunati 2013) is set aside and, as we already mentioned, the starting point is the human being as a worker. While the automata had the mission to evoke wonder and entertain the public, the industrial robot and the social robot have the mission to substitute or support the workers as well as the social workers, including women, the elderly, the disabled, and so on. However, a distinction has to be made between the industrial and the social robot, because the latter re-includes also the complexities of automata and also embraces the myth of a machine as a replica of human beings. While the robot in the industry is used inside a frame of substitution of workers, in the public and domestic sphere the social robots are being used inside a twofold frame, which is in part substitutive and in part integrative of reproductive labor (Taipale et al. in press).

THE PENETRATION OF SOCIAL ROBOTS IN CURRENT SOCIETY

The recent Barometer survey 382 "Public Attitudes Towards Robots" (2012) acknowledges a shift that has been produced in robotics. The shift occurs from the production sector (industry, advanced information technology [IT] services) to the social reproduction one (houses, social services, public sphere) (Taipale et al. in press). This technological development has been made possible by the new level reached by science and has been made necessary by two factors: first, the new social needs and desires expressed by people in the communication, information, emotional, affective, educational, and entertainment spheres, which call for practical and innovative solutions and can be addressed through social robots; and second, the domestic needs connected to the material tasks of housework (such as cleaning the house, washing, ironing, cooking, and so on), which also call to be addressed in a more appropriate way. The sectors that will be likely to be penetrated by robots in the near future are: the care

sectors, health care, entertainment, education, and the domestic setting. The targets of this emerging wave of robotics are the so-called weak social subjects, "weak" because traditionally they have not been protected by trade unions in their social and political negotiations. What social robots address is the care labor, both immaterial and material. This is a completely different labor, which presents difficult problems to identify and to resolve at formal level.

This shift to the social reproduction sphere of individuals intertwines in parallel with another shift from the unitary conception of robots as machines to a more articulated conception of robots. We inherited from the past several forms of robot: anthropomorphic or zoomorphic ones, or particular objects with their own specific shape not resembling to anything existing in nature. These objects include, for instance, the automatic musical instruments built by Erone (Fortunati 2013) until the current robot bands, such as the Japanese Z-Machines, the German Compressorheads, and the New Zealander The Trons. These forms have, however, begun to be in part renovated, because the setting that the social robot enters already counts on a series of technologies. The question is: With the proliferation of various types of technologies in society, do we need to remain bound to the traditional forms or is it possible to take advantage of the network of information and communication technologies so diffused in the society and imagine different forms?

To answer this question, it is important to take into account that robotics has been subject to four parallel trends:

1. The development of robots as continuation of the classic forms of robot: manufacturing, leaning, emergency, and space exploration robots.
2. The deconstruction of robots in many new forms: intelligent agents, automated personal assistants, ambient assistive living technologies, computational intelligent games/storytelling devices, embodied conversational avatars, and automatic health care and education services (Esposito, Fortunati, and Lugano 2014).
3. The rise, in society, of different processes of robotification: the technologies that people already use in everyday life such as cars or washing machines.
4. The development of processes of automation in social behaviors, which Fortunati (2013) calls "ubiquitous social roboting": the expanding network of robots and robotified machines, domestic appliances, and ICTs everywhere.

A process of robotification involves also almost all the technologies that we currently use in everyday life. This includes self-driving cars, metros, or trains, washing machines that are increasingly able to weigh the load, identify the type of fabric, and measure out the detergent, and refrigerators capable of reading product labels and reporting with a text message that the milk is running out. In the domestic context, robotic vacuum cleaners have reached a certain level of sophistication and user-friendliness, although their battery remains a major limitation. Robotification has also addressed domestic tasks that until yesterday were neglected, such as picking up the garbage, delivering it, and properly performing the separate waste collection, or doing the shopping for the elderly who have difficulty with moving (Cavallo et al. 2014). Even mobile phones are incubators of robotic interfaces (Sugiyama and Vincent 2013) such as virtual assistants (Siri in iPhone, Microsoft's Cortana, Google Now, Samsung S-Voice). The software agents use a "natural" language to answer questions, perform searches, make recommendations, do real-time translations, and execute actions on

behalf of their users. Sugiyama (2013) talks of mobile phones as quasi-robots, and Vincent (2013; in press) argues that mobile phones are personalized and emotionalized social robots. We use these cognitive (or smart) machines (Maldonado 1997) for many purposes.

They interact with our mind; they help us to develop many cognitive abilities, although at the same time they may under develop some others (e.g., short-term memory). In the future, they will be increasingly able to interact with our emotions and will become proactive and relational. One could wonder whether mobile devices will be also made capable of moving. Right now, the mobile phone is steady, even if portable. The same is applicable to the laptop and tablet. Desktop computers and televisions are steady and not portable. Two technological trajectories seem equally possible: to apply robotic technology to the media or to integrate media in robots. What would be the best option remains an open question, but in general mobile phones and computers could take big advantages from robotics and vice versa.

As to the fourth trend, the processes of automation of immaterial labor in social behaviors that have been observed so far in society concern various fields such as tastes, communication, and information. While several scholars have started to investigate and reflect about these processes (on the automation of taste, see, e.g., Barile and Sugiyama 2015), two articles of this special issue contribute to set up this debate on the role of social robots towards communication. The first contribution is by Maria Bakardjieva (2015, this issue), who stresses the

importance of studying the robotic side of the Internet in order to understand to what extent the automation of communication and the rationalization of sociability are developed in social networks. In particular, Bakardjieva invites scholars to focus their attention on socialbots— software robots that operate on social networking sites and present themselves as human users. The author motivates the invitation by stating that social-bots represent "another branch of social robotics [that] has remained somewhat tangential to the burgeoning field" (244). By taking the case of social-bots, Bakardjieva traces the evolution of online sociality from the perspective of theories of social rationalization. The rise of automated profiles (socialbots) on social networking platforms, according to Bakardjieva, can be seen "as a logical step in the progressive enclosure of online social interaction in standardized, simplified, and trivialized forms, frames and gestures" (244). From this viewpoint, robot sociality may be realized in the form of smart assistants as mentioned earlier in charge of taking care of repetitive and time-consuming social tasks that a human user may not want or may not be able to follow. The author's conclusion is quite provoking and suggests the "dawning age of robo-sociality where the robots are actually us" (244).

With regard to the automation of information, Bakardjieva underlines not only the growth of robo-communication and robo-sociality, but also robo-political manipulation in the online public sphere. Specifically, by automating online information, bots help in astroturfing, the manipulation of political discussion online. Astroturfing is only one of the manners in which today automation and even robotification are increasingly shaping the field of news. Similarly, the production of information about weather, earthquakes, sports, the stock market, and the like has started to be automatized.

The following is an example of an earthquake report published by the *Los Angeles* Times and generated by its algorithm:

A shallow magnitude 4.7 earthquake was reported Monday morning five miles from Westwood, California, according to the U.S. Geological Survey. The temblor occurred at 6:25 a.m. Pacific time at a depth of 5.0 miles. According to the USGS, the epicenter was six miles from Beverly Hills, California, seven miles from Universal City, California, seven miles from Santa Monica, California and 348 miles from Sacramento, California. In the past tendays, there have been no earthquakes magnitude 3.0 and greater centered nearby.

The shift from the automation to the robotification of news, for instance, passes through robot-journalism. The use of drones is becoming increasingly frequent when a camera is needed from above, like during the last Olympic Games when drones were used to record the sky races and during the Fashion Weeks in Milan, Italy, when some fashion shows were recorded by drones. Students of the University of Nebraska thought of drones even to deliver print newspapers at home. Another view on the automation trend is offered by Naomi S. Baron, a linguist, who intervenes on the problem of the automation of communication. She problematizes the field of human–robot communication, where too often the ideal is to build robots capable of replying using natural language. She illustrates the complexity of human language, which does not respond only to laws of intrinsic rationality but incorporates at the same time emotion. Do humans wish to deal with a robot that, like a human, does not always tell the truth, make jokes, sometimes goes off-topic, or is wordy or obscure? Replicating in robots characteristics, capabilities, and affordances of human beings is a frequent temptation for social robots designers. However, Naomi S. Baron in the article "Shall We Talk? Conversing with Humans and Robots" (2015, this issue) wonders to what extent we need to design robots that take advantage of all the improvements made on speech recognition, natural language parsing, and physical embodiment. She points out that the most crucial problem is to understand the range and quality of the linguistic abilities we want from a social robot. She advances the idea that in social robots maybe people would appreciate informational and empathetic modes rather than social control or critique. This issue resonates with an analogue issue about the degree of autonomy that a robot should have. Many think it should be 100 percent, while others theorize it as deliberately limited.

The forms of automation that we have presented and discussed so far can be considered as forms of roto-robotization of the immaterial sphere in society. Digital technologies have paved the way for an incredibly large number of people to express their opinions and tastes, to buy and consume goods. The management of all this has required in turn the implementation of automatic solutions that could allow simplified and easy behavior (e.g., the like/dislike button on Facebook). This has enabled billions of people to easily participate in several forms of self-expression but at the cost of reducing their complexity and particularity. This form of reengineering of society in the direction of a larger automation has the negative effect of entailing the implementation of uniform, undifferentiated, and homogeneous social behavior, which can be more easily influenced, manipulated, and controlled. It has also the effect of preparing humankind for the acceptance of social robots, aided by what Michaela Pfadenhauer defines (2015, this issue) as "the contemporary appeal of artificial companions." Pfadenhauer analyzes deeply the cultural and social roots of this metaphor that has inspired, as a guiding vision, the development of a series of European Union (EU)-funded research projects on social robots. The author suggests that the key of people's fascination toward social robots lies in the fact that they are vehicles of cultural worlds of experience and of a re-animation of the life-world. Moreover, she concurs with other studies such as the one by Baron (2015, this issue) and Katz et al. (in press) in affirming

that the use of information and communication technologies has had a significant influence on the positive attitude toward social robots.

The contributions in this special issue point to the importance of interdisciplinary research. Bicchi and Tamburrini alert us that this will entail a significant reorganization of the way in which we do science, as we need go out of our disciplinary homes and interact with other scholars. The example provided in their contribution is the Pisa-IIT SoftHand project that brings together engineering, neuroscience, and kinesiology to research and develop the soft, robotic hand. Until now, the focus of academic and industrial research efforts has been predominantly linked with the development of core robotic disciplines. However, to achieve a successful integration and use of robotic technologies and services in society it is time to integrate knowledge and frameworks from all relevant disciplines. The creation and sustainable development of a transdisciplinary research community dealing with this issue was the main objective of the international workshop on social robotics organized by COST (European Cooperation in Science and Technology) in Brussels, Belgium, in June 2013. The articles included in this special issue are a selection of the works born of the talks at the COST workshop, which brought together different perspectives on issues related to social robotics.

NOTES

1.http://rehabilitationrobotics.net/cms2/node/6 (accessed February 7, 2015).
2.http://www.aldebaran-robotics.com/en (accessed February 7, 2015).
3.www.youtube.com/watch?vDGK9n97fN1Go (accessed February 7, 2015)
4.http://www.youtube.com/watch?vDc2JChnwv2Ws (Accessed on February 7, 2015)
5.https://www.google.com/landing/now/ (Accessed on February 7, 2015).
6.http://www.samsung.com/global/galaxys3/svoice.html (accessed on February 7, 2015).
7.http://support.apple.com/en-us/ht4992 (accessed on February 7,2015).
8.http://www.windowsphone.com/en-us/how-to/wp8/cortana/start-using-cortana (accessed on February 7, 2015).
9.https://www.google.com/landing/now (accessed February 7, 2015).
10.http://www.samsung.com/global/galaxys3/svoice.html (accessed February 7, 2015).

REFERENCES

Bakardjieva, M. 2015. Rationalizing sociality: An unfinished script for socialbots. *The Information Society* 31(3): 244–56.

Barile, N., and S. Sugiyama. 2015. The automation of taste: A theoretical exploration of mobile ICTs and social robots in the context of music consumption. *International Journal of Social Robotics*. doi:10.1007/s12369-015-0291-1.

Baron, N. S. 2015. Shall we talk? Conversing with humans and robots. T*he Information Society* 31(3): 257–64.

Baudrillard, J. 1993. *Symbolic exchange and death*. London, UK: Sage.

Bicchi, A., and G. Tamburrini. 2015. Social robotics and societies of robots. *The Information Society* 31(3): 237–43.

Cavallo, F., R. Limosani, A. Manzi, M. Bonaccorsi, R. Esposito, M. D. Rocco,F. Pecora, G. Teti, A. Saffiotti, and P. Dario. 2014. Development of a socially believable multi-robot solution from town to home. *Cognitive Computation* 6: 1–14. http://dx.doi.org/10.1007/s12559-014-9290-z

Esposito, A., L. Fortunati, and G. Lugano 2014. Modeling emotion, behavior and context in socially believable robots and ICT interfaces. *Cognitive Computation* 6: 623–7. http://dx.doi.org/10.1007/s12559-014-9309-5

Eurobarometer. 2012. Public attitudes towards robots. Special Eurobarometer 382. European Commission. http://ec.europa.eu/public_opinion/archives/ebs/ebs_382_en.pdf

Fortunati, L. 1995. *The arcane of reproduction: Housework, prostitution, labor and capital*. New York, NY: Autonomedia. Originally published 1981. L'arcano della riproduzione: Casalinghe, Prostitute, Operai e Capitale. Venice, Italy: Marsilio Editori.

Fortunati, L. 2011. ICTs and immaterial labor from a feminist perspective. *Journal of Communication Inquiry* 35(4): 426–32. http://dx.doi.org/10.1177/01968 59911417713

Fortunati, L. 2013. Afterword: Robot conceptualizations between continuity and innovation. *Intervalla* 1: 116–29.

Hoeflich, J. R. 2013. Relationships to social robots: Towards a triadic analysis of media-oriented behavior. *Intervalla* 1:35–48

Hoeflich, J., and A. El Bayed. In press. Perception and acceptance of social robots – An exploratory study. In *Social robots from a human perspective*, ed. J. Vincent, S. Taipale, B. Sapio, G. Lugano, and L. Fortunati. Berlin, Germany: Springer.

International Federation of Robotics (IFR). 2014. World robotics report 2014. http://www.worldrobotics.org/uploads/media/ExecutiveSummaryWR201402.pdf

Katz, J. E, D. Halpern, and E. T. Crocker. In press. In the company of robots: Views of acceptability of robots in social settings. In. *Social robots from a human perspective*, ed. J. Vincent, S. Taipale, B. Sapio, G. Lugano, and L. Fortunati. Berlin, Germany:Springer.

Maldonado, T. 1997. *Critica della ragione informatica*. Milano, Italy:Feltrinelli.

Pfadenhauer, M. 2015. The contemporary appeal of artificial companions: Social robots as vehicles to cultural worlds of experience. *The Information Society* 31(3): 284–93.

Sugiyama, S. 2013. Melding with the self, melding with relational partners, and turning into a quasi-social robot: A Japanese case study of people's experiences of emotion and mobile devices *Intervalla* 1: 71–84. http://www.fus.edu/intervalla/index.php?optionDcom_content&viewDarticle&id D7&ItemidD5

Sugiyama, S., and J. Vincent. 2013. Special issue, "Social robots and emotion: Transcending the boundary between humans and ICTs." *Intervalla* 1:1–6. http://www.fus.edu/intervalla/index.php?optionDcom_content&viewDarticle&id =16&ItemidD13

Syrdal, D. S., K. Dautenhahn, K. L.Koay, and W. C. Ho. 2015.Integrating constrained experiments in long-term human-robot interaction using task and scenario-based prototyping. *The Information Society* 31(3): 265–83.

Taipale, S, F. de Luca, M. Sarrica, and L. Fortunati. In press. Robot shift from industrial production to social reproduction. In *Social robots from a human perspective*, ed. J. Vincent, S.Taipale, B. Sapio, G. Lugano, and L.Fortunati. Berlin, Germany: Springer.

Vincent, J. 2013. Is the mobile phone a personalized social robot? *Intervalla* 1: 60–70. http://www.fus.edu/intervalla/index.php?optionDcom_content&viewDarticle&id D6&ItemidD4

Vincent, J. In press. The mobile phone: An emotionalised social robot. In *Social robots from a human perspective*, ed. J. Vincent, S. Taipale, B. Sapio, G. Lugano, and L. Fortunati. Berlin, Germany: Springer.