The robotic service objects. Design approach for the multidimensional evaluation of robotic aesthetics

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Francesca Zanella · Giampiero Bosoni ·
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Multidisciplinary Aspects of Design

Objects, Processes, Experiences and Narratives

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Introduction

This book is the result of a long research process. The work started in 2020 with an exhibition held in Parma (*Design! Oggetti processi esperienze*, CSAC Università degli Studi di Parma), and a book of the same title, edited by F. Zanella (with essays by G. Bosoni, E. Di Stefano, G.L. Iannilli, G. Matteucci and R. Trocchianesi) and published in 2023 (Electa Milano) centered on the role of archives as memory repositories and agents for contemporary design. This first period of reflection was followed by an international conference: *Design! O.P.E.N.* (https://www.designopen.it) held in Parma on May 5–6, 2022. The present volume contains most of the papers presented at the conference.

Starting from the first volume (*Design! Oggetti processi esperienze*), the research was always characterized by a multidisciplinary approach, which became even more multidisciplinary at the international conference held in 2022.

In fact, the conference was organized by a network of scholars from the world of design, philosophy and history of art, whose aim was to intertwine several types of knowledge. Consequently, multidisciplinarity is also the main feature of this second volume whose objective is to reflect, in an integrated manner, on the different dimensions of design, using competencies from the field of design and from that of humanities.

The aim of this project is to create a repertoire of opportunities of exchange and of relation among the culture of designers and the applied marketability of humanists in the project and in the innovation processes, in particular those design processes characterized by an important social and cultural impact.

In this context of exploration and experimentation in the territory of bordering subjects, stands the interpretative model in Fig. 1. It represents the potentialities in the interdisciplinary relations which verify the logics and dynamics in the "behavior" of a designer dealing with some project variables. On the vertical axis, humanities and techniques can be found, and on horizontal one, research and project.

Where these variables intersect, there can be four types of intervention:

- The intersection of techniques and research generates technological experimentation considering techniques and technology fields in continuous and fast evolution.
- Where research and humanities intersect, we are in the field of a historical/social/philosophical approach in which the analytical and critical dimensions of the research itself are developed.
- Between humanities and project, we are in the area on which our project focuses: here the meta-project approach becomes the synthetic expression of the relation among the two poles.
- Finally, between project and technique, we are in the area where the executive component of the project itself emerges.

There have already been significant studies which have stressed the importance of humanities for design and have shown that design can be a stimulus for humanities; this

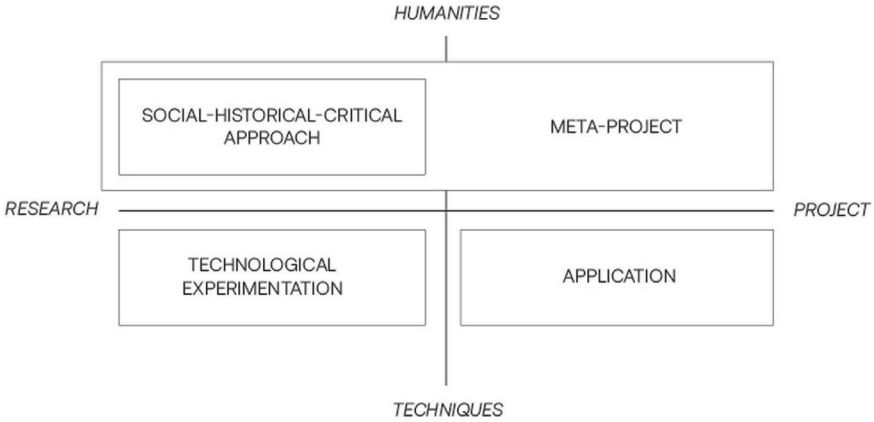

Fig. 1. Potential synergies between design and humanities [1]

is why the conference *Design! O.P.E.N.* intended to be an opportunity for research and debate with the objective of continuing this fundamental line of work.

Some crucial issues which interdisciplinary research must tackle are:

– The research of "new problems for design", that is, the collective need, as a scientific community, to find new directions toward which work must be periodically re-oriented, and this can be done only through a process of joint reflection.
– Research investigating the "meanings" that the product can have for design.
– Research that investigating the "value" that the design product shows.

As far as meanings are concerned, design and humanities integrated research can challenge, in a theoretically sounder way, "sustainability" by enhancing those concepts that are on the boundary between ethics and esthetics. Today, design cannot afford to dismiss ethical reflection, and, in this direction, humanistic culture can help to reinterpret the reflection on the mere functionality, in the more philosophically complex terms of the concept of "suitability for the purpose".

With regards to the analysis of the value generated by the action of design, it may be interesting to speak of "technology of value", which only humanistic investigation can help to process and fill with tools useful to produce not only ex-post critical knowledge, but first and foremost, oriented toward experimentation and to showing new corridors for contemporary design [1].

The volume follows the paths of reflection which structured the conference *Design! O.P.E.N.*, focusing on current themes and issues that are still at the center of the multidisciplinary debate on design, investigated through four keywords: objects, processes, experiences and narratives, which correspond to the book chapters.

The first chapter focuses on object-oriented design, enhancing its functional narrative and experiential values. In fact, objects, beyond their value in use, bear symbolic, anthropological, political and social meanings and worldviews. This section also develops a theoretical reflection on the esthetic categories used to interpret the design object

in relation to the classic dichotomy useful-beautiful, to the category of game, to artistic values and the relation between ethics and esthetics.

The second chapter is on the designer's self-reflective moment which is focused on the analysis and on the definition of processes in various contexts, spanning innovation, social engagement, reflection on emergencies or forecasting. This section investigates how designers develop and test their models, both at production, implementation and research levels. The areas of investigation are those addressing innovation, social engagement and pursuing a reflection on emergencies or forecasting. The section is intended as an arena for discussion on topics revolving around both the different moments in the history of design and the contemporary condition. The contributions collected in the Processes Section reflect the current condition of the disciplinary debate, which is strongly characterized by a profound transformation of design processes due to the comparison with scientific research methods, with a prevailing interest for methodologies and contemporary priorities as the environmental one, or to the dematerialization of processes.

The third chapter focuses on as a theoretical and practical strategy aimed at facilitating and fostering experiential interactions among people, between people and objects or environments. This section aims at investigating the foundations and the implications of a specifically experiential turn in design from various perspectives and in various disciplines. Due to the multifaceted nature of this turn, both theoretical and practice-based research are testified by contributors.

Finally, the last chapter is on narrative. The narrative vocation of design represents a crucial key of interpretation in contemporary cultural expressions such as making history, representing through different media, archiving and exhibiting. This section explores narratives in three different "dimensions": narrative as a scenario (envisioning new contexts, behaviors, uses, spaces); narrative as a tool (creating new ways to trigger innovation); and narrative as a process (framing new methodologies to face complex issues).

Each chapter reflects the results of the conference held in Parma and is constituted by the analysis of concrete case studies and theoretical and methodological proposals aimed at highlighting the "multiverse" character of design. It is organized in the thematic subsection defined for the conference program, just to emphasize the prevailing interpretative trajectories.

A special thanks to the institutions that have funded the conference and the present publication (The Department of Humanities, Social Sciences and Cultural Industries and CSAC, University of Parma; the Department of Philosophy and Communication Studies, University of Bologna; the Department of Humanities, University of Palermo; the Department of Design, Politecnico di Milano; and the Department of Engineering Enzo Ferrari, University of Modena and Reggio Emilia) and all those who, in different ways, have contributed to reach this result (particularly Alice Biancardi and Marta Elisa Cecchi, and also: Okuniev Avhustyn; Katia Botta; Gabriela Del Rosario Abate; Giorgia Ferri; Salvatore Martino; Serena Massimo; Diego Valle; and Laura Xhaja).

Without their help, it wouldn't have been possible to make this event and this volume happen. We hope that this book will become a useful tool of reflection on the theoretical and methodological aspects between humanities and design.

The scientific committee and book editors:

Giampiero Bosoni, Elisabetta Di Stefano, Gioia Laura Iannilli, Giovanni Matteucci, Rita Messori, Raffaella Trocchianesi and Francesca Zanella.

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Contents

NARRATIVES. Critical Approach, Languages, Explorations

The Robotic Service Objects. Design Approach for the Multidimensional Evaluation of Robotic Aesthetics

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Abstract. With the growing popularity of service/social robots in different contexts and for many users, it becomes one of the future challenges for research to achieve a higher level of acceptability through the characterisation of the interaction with the machine, both from an expressive and functional point of view. A characterisation will depend on the type of user, work context and tasks to be performed by the machine. In this scenario, telepresence robots require an in-depth characterisation study, as they are machines intended to represent the extension, and therefore the personality, of remote subjects, mediating their communication. Through an analysis of case studies, this paper aims to provide an overview of approaches to telepresence robotics's physical and/or cognitive characterisation. The use and application contexts dynamics will be explored to build support for experimentation.

Keywords: Human-robot interaction · Aesthetics · User Experience · Telepresence design approach · Personalization · Embodiment design

1 Introduction

Service/social robots, often clustered in the same category, are gaining popularity, particularly in health care, home care and education. Although the differences appear nuanced, the former (service robots) are purely functional machines, while the latter (social robots) develop stronger interpersonal skills. From the most specific services offered in terms of order execution to more complex cognitive processing, the service/social robot possesses its physical form (a body) and a communication system based on sensory properties expressed at different levels: capable of speaking, touching, gesturing, pointing, even expressing emotional reactions. Bartneck & Forlizzi [1] define a social service robot as "an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioural norms expected of the people with whom the robot is intended to interact." Therefore, these robots take on different identities depending on their functional role and the context for which they are designed. In other words, they possess an overall form (the Anglo-Saxon form) that is not only determined by the sophisticated technologies used here but is the result of well-defined design choices [2]. The service/social robot, as an intelligent machine to entertain, assist, and educate, or as a telepresence robot to communicate with people at a distance, is perhaps the object with the most complex system of interaction with humans. It is a system that can offer

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different performances, the impact of which has to be measured through the degree of acceptability of the robot by the people who interact with it, obviously divided into categories: children, adults, the elderly, the frail, etc. The aesthetics of the machine, which in this category of the robot is determined by a complex of relationships not only of a somatic character but also of a sensory and interactive nature, has its fundamental importance [3]. In robotics, the concept of functionality proper to industrial objects extends to the semantic nature of formal and interaction relations, with the primacy of embodiment, i.e., the principle of the embodied mind, where human reactions arise from a complex interweaving of mind, brain and body [4].

In this multidimensional direction that places at the basis of the morphological reading of the robot the integration of interaction and expressiveness of the body, there are several studies of an anthropological and psychological nature that inform us about the requirements for the acceptance and adequacy of certain forms without, however, systematizing all the elements that contribute to a descriptive synthesis of the methodologies for their measurement.

The research, therefore, aims to present a series of approaches aimed at characterizing telepresence robots through the analysis of case studies in the literature to identify the directions that telepresence should take in the future. These robots enable remote communication between people so they can fully experience individual, group, and remote spaces through the functions and features they possess motion, screens, sensors, and voice commands [5]. This task raises questions about the characterization of the machine depending on who experiences and shares it.

2 Enhanced Human-Robot Interaction and Human-Robot-Human

In the case of telepresence, human-robot-human social interaction is a dynamic and complex phenomenon influenced by specific factors such as socio-cultural context and past experiences. Therefore, most scholars think that in order to create a positive interaction between the robotic machine and the user, especially in the case of telepresence, it is necessary to introduce the concept of "humanized natural" through the reproduction of only some traits and behaviours that belong to humans [6]. This, on the other hand, is not the case at the two opposite extremes of robotics: at the bottom, household appliance robots, generally characterized by a curated but aseptic design expressiveness, typical of tools subjected to a good design process; at the top, humanoid laboratory robots such as iCub, designed by IIT Istituto Italiano di Tecnologia, a reference model for recent application experiments such as RoBee, the first Italian cognitive robot intended for Industry 5. 0 (Oversonic Robotics), equipped with anthropometric dimensions and somatic features almost identical to the human standard, to better contribute to the performance of tasks that are not repetitive but require great precision (pick and place) and cognitive performance (facial recognition).

In the less performant, social and service robots, including telepresence robots, we find examples of humanizing aesthetics that look to the human model according to three scalar design attitudes: copying, quoting and allusion.

In the direction of humanoid copying are perhaps the digital technologies that today allow for novel explorations: among them is Furhat Robot (Fig. 1), a rear-projected

robotic head that can be modelled after a range of human likenesses through the choice of skin colour, expression of the eyes, mouth, and nose [7]. Experiments that could, in part, be introduced into telepresence machines as well, where the goal of greater acceptance of the robot as a mediating element in human-to-human relationships at a distance is driving research to explore different levels of characterization, most of which use quotation and allusion, particularly in body definition.

Fig. 1. The Furhat Robot (2022) designed by the start-up Furhat Robotics.

The robot Pepper, equipped with a humanoid body and a screen for communication, cites some elements of its human appearance and behaviour (movement and voice) in a comic key. Others, however, depart from the quotation through a formal simplification of the body, which we call allusive. As a result, human features are present only partially, as in Ava Robot (mainly for the hospital context) and Temi (for housing and entertainment) to minimal ones like Double, where the machine is reduced to a few components: a screen representing the head, an adjustable rod for the body, and wheels as feet.

3 Approaches to Telepresence Machine Characterization

The formal reduction that is characteristic of this new generation of telepresence robots, however, brings with it a need of an opposite sign to their minimalist conception: characterization. We are witnessing a phenomenon that had already presented itself with serial design objects and that had led the industry to manufacture differentially from the standard, as a response to the demand for products that are more familiarizing with each specific user but also adapting to different contexts: in other words, custom design [8]. The characterization of social robots, from the hardware point of view, has led researchers to explore different possibilities to transform the morphology of the machine's appearance. This is a complex concept, away from references to taste, thus also to style, which looks at design as a multidimensional expressive language beyond the actual form, a

concept that also applies to robotic design: "a path to the non-thing, where form is immaterial" [9].

The modes of characterization are of course many: from the robotic kit that allows the controlled transformation of the machine directly by the user to spontaneous characterization by adding physical elements to the embodiment of the machine, such as tattooing a body or customizing one's smartphone to enhance interaction and empathy with the machine [10]. The research, from the perspective of characterization affordance, is also tasked with exploring ways to make the robot's appearance more consistent with the context of the activity. The motive stems from the observation that, particularly in telepresence, identical machines now operate in fields as diverse as hospitals, care, commercial, and education. Therefore, characterization becomes a central value in telepresence as it can enhance the identity of the remote person to achieve appropriate work cooperation, caring assistance or hands-on learning. This complexity is associated with the two simultaneous roles that the telepresence robot assumes in the task. For the remote operator it is a human proxy, while for the co-located interlocutor it is also a physical machine, which is at the same time and increasingly indestinguishably, embodiment and body.

4 Methodology

This section will discuss different approaches to research on the characterization of human-machine-human interaction (telepresence) through an analysis of case studies that represent milestones in this direction. Several experiments characterizing the telepresence machine have appeared in the literature in recent years, distinguishable into four main approaches. The first is the *spontaneous* one, in which the robot, through spontaneous initiatives, acquires anthropomorphic characteristics. The second is the *playful one*, where the user chooses his or others' configuration through construction kits. The third is an *anthropometric* approach in which the robot reproduces known human dimensions; finally, *mediated reality*, where the user's identity is expressed through different modalities. Indeed, by acting on the material and digital interface of the robot, it is possible to give the machine gender identity and character, where the body (head, torso, and limbs) and sensory communication (looks, gestures, and voice) become the protagonists of the interaction.

4.1 Spontaneous Design Approach: *I'm Wearing What I Want*

Several studies on the introduction of telepresence robotics in social contexts show spontaneous characterisation initiatives of the robot through the introduction of the dress. The machine wears T-shirts, togas, hats, ties, necklaces, and wigs to acquire more distinctive traits of the subject at a distance. In the study by Fitter et al. (11), the impact of personalisation on clothing was measured. The results showed an appreciation on the part of remote users and the perception on both sides of a humanising effect of the machine. This, however, did not exclude the appearance of feelings of discomfort, especially for in-presence users, associated with the Uncanny Valley [12].

Indeed, when representation becomes stereotypical, it can evoke feelings opposite to the quest for characterisation: standardisation vs customisation.

Among the work on the personalisation of the telepresence machine, the one presented-to by Tsui et al. [13], through the VGo robot, experiments with some modes of communication closer to users with co- cognitive and motor disabilities, in addition to the ease of driving. In summary, these are two proof of concept machines, Margo, and Hugo, characterised by distinctive and easy-to-read symbols such as a Hawaiian shirt for the former and a tie for the latter.

This approach can also be found in the educational sector. This is the case with the study by Han & Conti [14], who, to investigate the factors determining the acceptance of the telepresence machine, made the robot wear a T-shirt to impersonate the student at a distance. Indeed, it has been shown that people are more likely to interact with robots whose personality conforms to their role [15].

4.2 Playful Design Approach: *Building Myself*

The characterisation in telepresence assumes an increasingly important role, as it is a factor in the interpretation of the individual's personality. As a result, initiatives for do-it-yourself construction are emerging, as in the case of Smartipresence (Fig. 2), made by The Crafty Robot, a low-cost telepresence robot associated with a smartphone. The small cardboard robot is designed to support one's smartphone, which enables remote communication via audio, video and movement. Smartipresence was created as an expansion of the Smartibot kit, where the user can build his or her robot with printed circuit boards, motors and a battery, choosing the physical cardboard embodiment from several available characters.

Fig. 2. Av1 Robot by No Isolation designed for education technology for inclusion.

My Classroom Robot [16] was realised in this direction as an interactive game led by players (the students) operating a telepresence robot in a virtual classroom. The aim was to explore the use of telepresence robots for K-12 education. The virtual environment allows for fast and flexible experimentation with different telepresence solutions, familiarising the students with the interaction between the machine and the remote subject. With this experience, the students became familiar with the topic of personalisation through different tools. These include the light signals emitted by the robot for non-verbal communication, which makes the interaction more functional and expressive.

4.3 Anthropometric Design Approach: *I Am as You See Me*

The need to represent a subject at a distance through a robot has led designers to consider certain anthropometric elements for the natural presence of the robot. These include flexibility in height, a feature that some commercial robots offer (e.g. Double Robot, Beam +, Ava robot), to activate a conversation on par with the human individual [17].

However, expressing one's personality at a distance has also been interpreted by reproducing images that are as realistic and faithful to the human body as possible. This is the case with the Large Screen Mobile Telepresence Robot and Mixed Reality Window prototypes [18]. This is a family of products where large screens are integrated into robotic systems capable of moving in remote environments. Working at full scale, it is possible to imagine new strategies for Mixed Reality and ubiquitous computing for the not-too-distant future. By allowing remote users to participate and superimpose their images and content directly onto the two-way window, accessibility to these spaces is greatly expanded in ways that are not strictly related to physical proximity.

The use of an anthropometric approach has also been used in the Profesor Avatar holographic projection system [19], a telepresence model developed at the Tecnológico de Monterrey that combines the use of real-time holographic projection and telepresence robots. The subject's image at a distance is projected in real-time and at full scale through a screen that allows the lesson to be followed where there are problematic geographical situations, environmental insecurity, and high travel costs. Furthermore, telepresence specialists, tutors and students interact in real-time, exchanging knowledge and experience in different contexts. Hardly probable but possible, holography presents itself as the future goal of remote telepresence: a robotic representation of the individual in 3-D, full-scale, and capable of moving through space as most social/service robots allow today.

4.4 Mediated Design Approach: *See-Through*

The mediated reality in telepresence represents one of the most relevant approaches in this field; think of telemanipulation applications where a machine reproduces them in a remote environment through replicating human movements. This approach has also been applied to telepresence social robots such as the AV1 Robot, capable of imitating presence through the robot's body acting as a representation. The applications of this robot are intended for the school context where the robot represents the child or adolescent in the classroom. Children can control the robot's head, the direction of the camera in the classroom and the microphone and decide whether it is open for communication or

mute and 'raise their hand' by switching on the light at the top of the robot's head. This type of robot design implies that the child cannot move within the remote space and is therefore always dependent on the other students [20]. This customisation is provided by the interface created by the remote user's movements.

From the perspective of a mediated approach, the study conducted by Luria et al. [21] shows an advancement in the concept of re-embodiment of the machine, communicating through the design of eyes and audio. The work aims to map the design space of social presence flexibility to help designers and researchers understand how to design conversational agents and social robots for personalised interactions.

5 Conclusions

The development of social robots will continue to grow at a strong rate, even during the Covid-19 pandemic. Against this backdrop of future uncertainty, telepresence robots will gain strategic relevance to communicate with humans at a distance.

For these reasons, the degree to which the machine's appearance matches the context and the actions to be performed will be crucial to the acceptance and introduction of robots with a role and appearance consistent with the assigned context and task. In addition, the shape, size, and technologies used will require human-centred design considerations to enable the design to meet the needs of the various stakeholders. On the one hand, the remote user manifests his/her presence through the robot; on the other hand, the in-presence actors interact directly with the robot. The analysis of the case studies revealed the need to establish specific criteria for characterizing the machine according to the context and the tasks to be performed. The physical characterization of the machine (body) is an aspect that is still under-explored, except for small spontaneous and playful design interventions. However, it is hoped that solutions allow the conformation to be modified through actions left to the discretion of the users and the subject at a distance. Just think of the school context and child users, where the physicality of the machine is crucial for good interaction. At the same time, we are witnessing in the marketplace the proposal of machines that are increasingly an expression of formal synthesis and mediated reality, certainly more aimed at an adult audience. Reflections such as these require further (and rapid) experimentation from the perspective of design thinking to increase a conscious diffusion of telepresence tools that are also consistent with users' needs and different contexts of use.

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