Numerical Methods for the Solution of Population Balance Equations Coupled with Computational Fluid Dynamics

Cumulus Association

Cumulus Conference
Proceedings Series
07/2021 Rome

Design Culture(s)
Cumulus Conference
Proceedings Roma 2021
Volume #2

Editors
Loredana Di Lucchio
Lorenzo Imbesi
Angela Giambattista
Viktor Malakuczi

Layout and Graphic Design
Viktor Malakuczi
Concept for Cumulus
Conference Proceedings
Series was developed in
2018 by Jani Pulkka

Cumulus conference
Design Culture(s)
hosted by
Sapienza University of Rome, Italy
on June 8-11, 2021.
Conference website:
www.cumulusroma2020.org

Published by Cumulus
Cumulus the Global Association of
Art and Design Education and
Research. Aalto University, School
of Arts, Design and Architecture
PO BOX 31000, FI-00076 Aalto
www.cumulusassociation.org

ISBN 978-952-64-9004-5 (PDF)
ISSN 2490-046X
Cumulus Conference Proceedings
Series, N°7

Cumulus Conference
Proceedings Series

Editor-in-Chief
Cumulus President
Mariana Amatullo

Publications in the Series

01/17	Kolding, REDO
02/17	Bengaluru, Letters to the Future
03/18	Paris, To get there: designing together
04/18	Wuxi, Diffused Transition & Design Opportunities
05/19	Rovaniemi, Around the Campfire – Resilience and Intelligence
06/19	Bogotá, The Design After
07/21	Rome, Design Culture(s) Volume #1, Volume #2

DESIGN CULTURE(S)

Cumulus Conference Proceedings Roma 2021

Volume #2

Cumulus Conference
Proceedings Series

Cumulus the Global Association
of Art and Design Education and Research

Rome 2021

DESIGN CULTURE(S)

ROMA 2021

JUNE 08.09.10.11

CUMULUS CONFERENCE

OVERVIEW

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

CONTENTS

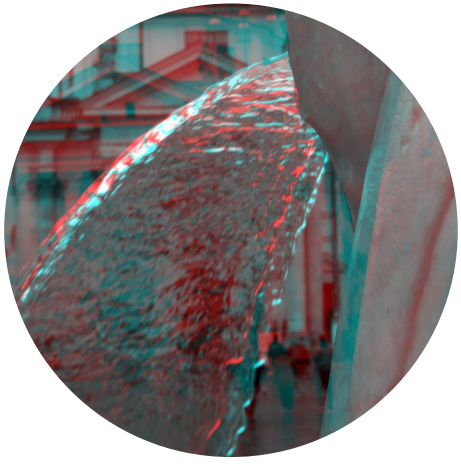
CONTENTS

CONTENTS

DESIGN CULTURE(OF)

ARTIFICIAL

DIGITAL
TECHNOLOGY
ROBOTIC



TRACK CHAIRS

DESIGN CULTURE (OF) ARTIFICIAL
DIGITAL | TECHNOLOGY | ROBOTICS

João de Sá Bonelli,
PUC-Rio Department of Arts & Design, Brasile
“If Design is the Sciences of the Artificial, then how can Design theories and practices promote a better quality of life for us, humans?”

Mathias Funk,
Eindhoven University of Technology, Netherlands
“How must design deal with a slow culture shock of the artificial that smart objects manifest in personal or professional spaces? Which forms of business or political machines do we need to reject?”

Patrizia Marti,
University of Siena, Italy
“In the digital age, a new culture of design can flourish to value the complexity and uniqueness of being human, bringing aesthetics, creativity, sense making and value-oriented propositions at the forefront of technology development.”

Giuseppe Mincolelli,
University of Ferrara, Italy
“Data are a substantial part of our life, that we do not perceive and understand by nature. Design is called to empower humans, bridging this new phisical and cultural gap between us and our environment.”

DESIGN CULTURE(S) | CUMULUS ROMA 2021
JUNE 08.09.10.11, SAPIENZA UNIVERSITY OF ROME

The role of Design in telepresence robotics experience.

Claudio Germak [a], Lorenza Abbate*[b],

[a] Politecnico di Torino, Full Professor, Turin, Italy
[b] Politecnico di Torino, Phd Student, Turin, Italy

* claudio.germak@polito.it; lorenza.abbate@polito.it

Abstract | The emerging role of telepresence robotics has led to increased interest on the subject, opening reflections on man-machine-man relationship and their acceptance in the contexts of application. The nature of telepresence robotics lies in the condition offered to users "to be there", in a place, although not physically, through a body, which allows the user to move freely in the spaces. The flexibility of this technology has extended its introduction and testing in high-impact social contexts, such as school, where the remote user for serious reasons may contact the individual or the community in a natural way. For this reason, it is necessary to investigate the perceptual and communicative aspects connected to this interaction and the technological ones, in order to outline an innovative design scenario both for the telepresence service and for the physical and digital artefact, where the robot will perform a very expected social task.

KEYWORDS | TELEPRESENCE, ROBOETHICS, INTERACTION DESIGN, UX DESIGN, SOCIAL INNOVATION

1. Introduction

Telepresence is a technology that integrates video conferencing and robotics systems, allowing one to be present in an environment, even if one is not physically there (Marvin, 1980). This offers the possibility to connect two remote locations, adding the value of movement and presence in that place to traditional systems. Many studies have revealed that a person's quality of life is affected by their inability to participate in activities of daily living with family, friends, colleagues, which is often the case for people with special needs. Telepresence is a technology with great social potential, allowing one to be "virtually" present for people at a distance (Newhart, Warschauer & Sender, 2016). The promise of these robots is that they will be tools that can mediate communication in real time, in different contexts and enable accessibility on different scales. Although these systems have been around for several years and are mature in some areas such as the world of teleconferencing for businesses, there is still evolving research in some areas, especially in understanding their functional/behavioural potential and level of acceptance (Tsui, Desai, Yanco, & Uhlik, 2011). The use of telepresence robotics has attracted particular interest due to its ability to make places accessible that were not, either because of geographical and/or architectural barriers, or because of the special needs of certain individuals (Tsui et al., 2011). Examples of this new open dimension, aimed at overcoming barriers, speak to us of experiments in the context of schools, health care and support for the elderly. This experimentation scenario has given rise to actions capable of overcoming problems such as isolation and social exclusion of weak individuals (Bamoallem, Wodehouse, & Mair, 2014).

An interesting application in this sense, which still needs in-depth study, is in the world of education, where students who cannot participate in school activities have telepresence systems at their disposal. This allows them to watch the class, access content, communicate and interact with teachers and classmates. The use of telepresence robots can improve the life of the telepresence student by watching, listening, moving and interacting in a realistic, independent and live way. Despite the continuous development of technology, capable of supporting these new types of communication, there are still challenges to be faced, starting with a study of the application context and the users with whom to interface (Rae, Venolia, Tang & Molnar, 2015). In general, these robots are designed for a wide range of users and contexts: businesses, hotels, museums, hospitals and schools; this does not allow a distinction according to the context they are intended for, to the detriment of the effectiveness and engagement of the interaction (Figure 1). The impossibility of robots to make non-verbal gestures in support of communication also places a limit on the effectiveness of the message and interaction, but above all on the social presence of the remote user. The contribution aims to analyse human-robot-human interaction and the factors involved, with the potential to be developed. In this it will address in methodological terms the aspects to be applied to a project of experimentation of telepresence robotics in a university context. The aim is to arrive at a robotics project in which there is full knowledge

and awareness of the needs of the user and the reference context, through ethnographic research.

Figure 1. The most used telepresence robot models on the market: Double Robot, Beam, Beam Pro, Ohmni, VGo, Padbot.

2. Robots as a communication technology

The role of robots in everyday life is becoming increasingly important and their numbers will increase significantly in the near future. Service robotics in this regard aims to develop new solutions that can collaborate positively with humans. Telepresence robotics is an application of service robotics, which provides a virtual presence from a remote location, using a videoconferencing system (Kristoffersson, Coradeschi & Loutfi, 2013). Telepresence robotics represents a reference of particular interest in the field of social robots, especially in the field of socially assistive robotics (SAR) through interaction driven by user need through multimodal interfaces. In telepresence, interaction is not only between man-machine, but represents the means of human-machine-human connection, linking two or more individuals. Their nature is halfway between social and physical presence, which is why it is called co-presence in the literature (Nowak, 2001).

With this orientation, telepresence robotics has developed different levels of interaction: the first, between humans and the space to be explored or controlled through the machine, where the robot is an ocular prosthesis, although there is no shortage of examples that equip the body with prehensile arms or other aids; at the second level are those models that integrate camera and screen, using the tablet as an example, bringing people into visual and

auditory connection; while the third level, of more recent configuration, in addition to connecting people through live digital images, aims at the possibility of being directly piloted by both people, in a form that we might now call co-piloting (Desai, et al., 2011). Some features are common to all levels of telepresence: the ability to move, to connect, to videoconference, and to be equipped with sensors. Each of these can be important in reinforcing the human presence in distance communication, enriched also by that set of elements that can characterise and increase the sense of closeness, just as happens between people in face-to-face communication. And it is also by working on the elements proper to social presence that this perception can be improved: by implementing the video and audio system and the ability of the robot to move in the coverage paths, and not only this dimension, because we already have robots capable of moving with a certain level of naturalness of human memory (Vu, Rissanen, Pang & Foo, 2012). In a telepresence system it is therefore essential to consider the ways in which we are able to reinforce a real perception of closeness with the remote user, including through non-verbal communication. In fact, research, such as that of Mehrabian (1980), claims the non-verbal language of communication to be more important than the mere reproduction of words.

3. Robotics project definition

The possibility of connecting people remotely and having them participate in everyday activities has allowed telepresence robotics to be used in experimental activities in different social contexts, allowing issues such as inclusion and accessibility to be addressed (Moyle, Jones, Dwan, Ownsworth & Sung, 2018). The robots used in these experimental and research contexts are the same as those intended for work environments, for which they were born, and for this reason satisfactory results are not returned in terms of a User Centered Design approach. What is needed is a design in which the user is at the centre of the project with his or her own needs and the context for which the robot is intended (Casiddu & Micheli, 2011). The continuous evolution of these artefacts, mainly from a functional point of view, has led to unresolved issues such as the acceptance and ethics of the robot.

Consequently, it is necessary for a robotics project to be explored and compared by different competences, which no longer include only mechatronic and computer engineering, but also disciplines from the humanistic sphere. This leads to a simplification of the highly sophisticated engineering approach to have artefacts that reflect social and cultural changes. The different disciplines (anthropology, psychology, design, engineering) can contribute to the development of answers in terms of robot adoption and perception, through a holistic approach to the topic, in which Design assumes the role of knowledge mediator (Germak, Lupetti & Giuliano, 2015).

Design is among the disciplines that can make a significant contribution at different levels of the robotic project: expressive (in terms of appearance and morphology), passing through language, behaviours and interactions with the user. The contribution can be consolidated

and extended by adopting a co-design approach, in which the actors of the system are involved, bringing knowledge for a shared and accepted robotics project (Freeman, 1984). Through design, robotics can expand its competences to generate value and meaning, creating continuous relationships between technology, human needs and context.

Consequently, telepresence robotics products need further reflection based on the actors and the context of interaction (Stappers & Sanders, 2003). Indeed, in the literature there are more and more experiments in which robots are personalised by the user, even simply through a garment, to identify who is representing the robot.

3.1 Acceptance factors

The concept of acceptance is central to human-robot interaction, as users must be enabled to interact with the tool in a natural and intuitive way. Acceptance of robots depends on several variables and is defined as the robot's ability to fit into a person's life and willingness to be used in the long term (Broadbent et al., 2009).

When designing these artefacts and their interaction with humans, reference is always made to the human body, which is the starting point. However, the continuous search for the resemblance of machines to humans faces several challenges, including Uncanny Valley (Mori, 2012). In general, people are more likely to interact with humanoid robots, but there is a limit beyond which a sense of proxemic insecurity is created in humans as the distances between the two decrease. Assessments are therefore required regarding the physical, expressive and empathic clarity through which the technology becomes recognisable and acceptable (Salvini, Laschi & Dario, 2010), because it is assumed that people's attitudes towards robots are influenced by their appearance and personality, which in turn influence their acceptance (Kiesler & Goetz, 2002). Conceiving, planning and designing robots therefore also requires an effort to anticipate the future, to simulate ideal scenarios, in which pervasive technologies find a balance with the social and cultural dimension of humans, made up above all of relationships with other individuals and with the context (Šabanović, 2010). For this reason, the role and effect of human resemblance must be investigated in different cases and in the final rendering, especially when the morphology of the robot differs from the human one, albeit with a new language, as in the case of telepresence robotics. Precisely in this area, it is necessary to investigate body language and non-verbal gestures, which play an essential role in communication between individuals, enhancing the remote user's sense of presence. Telepresence robots need a deeper investigation into the possibility of extending the language and communication they express.

3.2 Robots as a somatic configuration

Gestures represent an extremely important communication mechanism that allows people to accompany speech and contribute to interaction (Stahl, Anastasiou & Latour, 2018). What is missing in telepresence robots today is the ability to express hand gestures and body posture. Several studies show that the acquisition and mastery of gestures is an essential aspect of human cognitive development, and that gestures not only express their thought, but can also be considered a factor influencing the development of thought itself. Gestures facilitate group communication, as pointing or moving shared objects during a discussion provides a clear spatial relationship for the communicator and group members (Björnfot & Kaptelinin, 2017).

The telepresence robots we find on the market today have very specific morphological characteristics: the head represented by a camera/display (usually a tablet), the body by a vertical rod and the feet by a base with wheels. With a few minimal design gestures, these robots allude to the morphology of the human skeleton, becoming humanised machines with a new language. However, their new morphology still needs some improvements, including non-verbal communication, which is currently absent. Some have tried to equip these robots with arms to overcome these limitations, such as ProP, an experimental telepresence robot equipped with a pointing device resembling a human arm. Another example is the QB robot (Slack et al., 2018), equipped with an anthropomorphic hand manipulator to allow interaction closer to the local user, and have a positive social experience. Moreover, on movement it worked a lot, as it represents a characterizing element of the interaction with the robot, both in terms of naturalness and fluidity, as it represents the biological nature of human characters (Kupferberg, Glasauer, Huber, Knoll & Brandt, 2001). However, if these performances fail and the variety of gestures is limited and repetitive, to highlight the mechanical origin of the robot, the user tends to become detached and uninvolved in the interaction. Human-robot communication codes will therefore assume great importance, implementing those that telepresence already guarantees through the display.

4. Telepresence: an ethical issue

With the advent of service robotics, ethical considerations regarding the privacy and security of users have been raised. An increasing number of robots are entering spaces lived in by humans: private or public spaces, often equipped with cameras and sensors, such as telepresence robots, capable of collecting data (Niemelä, van Aerschot, Tammela, Aaltonen & Lammi, 2019). Telepresence robotics still raises some concerns especially due to the presence of the camera that can collect sensitive data. This is precisely why privacy and security are considered the main barriers for the continued growth in the adoption of these technologies. The ability of telepresence systems to move within remote spaces, even if guided by cameras, raises questions about the physical safety of the user, the environment,

and the robot itself. The robot must be designed to be safe in the environment in which it moves, with the right technological devices. For example, whenever the robot moves, it should provide some form of feedback to people, thus improving interaction with users and ensuring a way to prevent harm. At the same time, the robot should be able to avoid collisions, either against static obstacles or other people. Giving the remote user a physical body equipped with a camera raises additional privacy issues related to the subjects participating in the conversation and the environments being filmed (Krupp, Rueben, Grimm & Smart, 2017).

Regarding the issue of privacy, Calo (2010) in his book Robot Ethics writes the chapter Robot and Privacy where he summarises the rapid trend of robots towards ubiquity and identifies three main dangers posed by robots in relation to privacy: surveillance, access to private living and working spaces and social impact. These issues translate into the continuous search to solutions for the disclosure of sensitive data related to the user who is not always aware of what is going on. Compromise systems between privacy and the usefulness of robots in the context of their application, for the performance of activities for the creation of human well-being, must therefore be developed. Having a mobile robot equipped with a camera within an environment raises several concerns. Among these is that the robot can be guided, after authorised access by the remote user, to visit and retrieve location data. This also means that unauthorised access is possible and that software security can be circumvented. The data collected by the robot for its operations in the environment must remain inaccessible from the outside, remaining encrypted and authenticated. Unfortunately, these conditions of uncertainty and instability of the technology make its adoption limited despite its great potential in different application contexts. An ethical project must consider these issues from the earliest stages, to arrive at a final product that is accepted by the user who establishes a relationship of trust in its use.

5. Robotics in Education

The education sector, like many others, has faced several changes with the rapid growth of digital technologies and robotics. Education systems have been able to exploit the new opportunities of robotics, which have made the sector more collaborative and accessible to students with different needs. Indeed, robots are considered useful tools to include those with learning difficulties and disabilities in classroom activities, especially with the use of social robotics (Robins, Dautenhahn & Dickerson, 2009). Robots in these environments are used in different ways: from robots as tutors or classmates, to telepresence robots as assistants and teachers (Sharkey, 2016). In the education environment, experiences managed through telepresence support school learning for students who cannot reach school, but also experiences of cultural and language exchange between different groups, where for example new languages are learned with telepresent native teachers. Noteworthy is the fact that the robot can promote collaboration between different actors interacting with each other, with a view to achieve a common goal; this especially in the educational

field allows learning not only by interacting with the artefacts themselves, but by sharing common goals among students, improving their social and relational skills among them. The robot responds to the needs of modern society and manages to be an important tool to increase the motivation of users who interact with it, to be protagonists of the learning process (Benitti, 2012). But even in this context it is clear how the perception of the robot changes according to the different age groups of students and therefore how different measures are needed for a successful interaction. For example, a school-age child does not perceive the robot as a mechatronic device but gives it a set of characteristics that are generally associated with living beings, animism (Piaget, 1929), contrary to what an adult perceives. Most telepresence robots have an industrial appearance, and this affects the developmental needs of different users such as children, who have particular needs relating to the expression of their identity. just think of the personalisation of technology that takes place all the time, through mobile phone covers, tablets.

5.1 Telepresence in education system: case study in university spaces

The school is a social environment of development and growth, where different groups (teachers, students, administrators, and parents) interact to shape the student's life experiences. In the school context we are confronted with different needs, ranging from the development of the student's identity, image, integration, and affirmation within the group. Attending school has positive effects on the student's self-esteem and contributes to making him an individual capable of relating to society.

In many situations, students find themselves having to leave school for short or long periods of time for health reasons. The provision of training services must be the preventive factor with negative psychosocial consequences. Data emerging from the literature show that students who are unable to attend school face learning difficulties and subsequent problems with social integration (Reis, Martins, Martins, Sousa & Barroso, 2018). Few experiments attempt to address this problem by adopting telepresence robots, with which absent students can go to school, albeit at a distance, finding themselves in a wide variety of situations that change daily. This has made it possible to ensure the physical accessibility of classes and content offered by teachers to distant students. This type of intervention occurs mainly in the early grades of education (primary and secondary), to the detriment of the university context which is still little investigated (Reis et al. 2017). Some solutions for the university are those related to e-learning courses, which offer the possibility of autonomously managing the times and modes of their study, but at the expense of the interaction between student and teacher that fails. Telepresence could therefore eliminate this distance and create new opportunities. The few research on telepresence robots in the university context are those for cultural exchanges with other universities and distance learning for professionals. This is the case at Duke University, where telepresence robots have been used as a teaching tool to engage nursing students in clinical simulations to be passed on to early college students (Shaw et al. 2018).

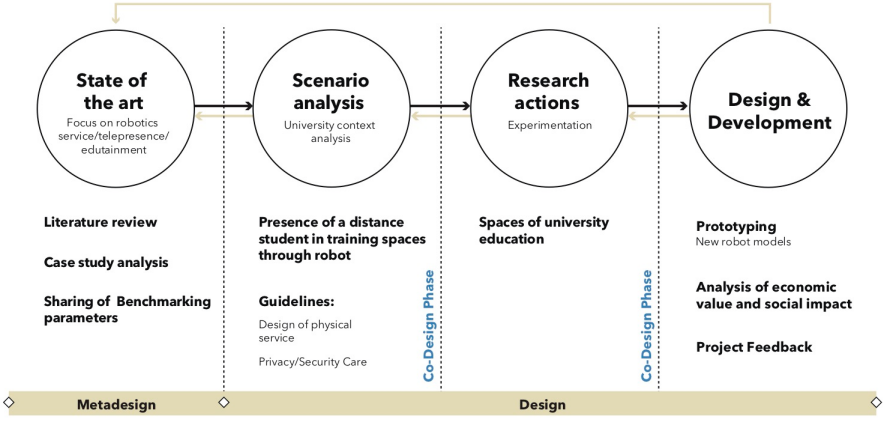


Figure 2. Methodology applied to research on the university context, through an iterative process, in which different professional figures collaborate to arrive at a new product accepted by users. In the process, users take part in the design on different levels.

From this analysis of telepresence robotics in education, new challenges, and research on the context of the university that we intend to investigate and analyse arise. An analysis that involves observing the interaction of students within environments with telepresence robots. The latter will have to be tested by users and evaluated, based on the market offer of existing models, through a multi-criteria methodology to understand the limitations and opportunities for the development of new applications (Elara, Rojas & Chua, 2014). Observation with shadowing techniques will allow to collect data on the interaction between the user and robot, to obtain an understanding of the factors that influence it. As already introduced, a co-design approach is necessary for the success of a user-accepted product, where users are involved in each phase of experimentation and design, where needs are interpreted by different figures. Participatory design succeeds in bringing out the continuous changes between society and technology. With a co-design approach, it is possible to consider the context for which a project is designed with user observation as a tool to investigate the scenario and develop a new proposal. For example, the possibility of co-piloting from both places of these robots, or the possibility of being able to transmit the communication message through body signals. A telepresence robot should be able to express the emotions and moods of the user it is impersonating, thus creating interaction scenarios that are more natural and closer to other users. Emotional design helps to support the design of such artefacts and the creation of innovative interaction scenarios, in which communication must be in a language alluding to that of human beings.

Designing robots for specific environments, such as the educational context, therefore means considering different variables involved in the process to avoid failures, ranging from the perception of the usefulness of the tool, to the level of complexity in terms of usability,

to the study of the robot's own forms of communication (expressivity, movement, speech), because it is known that its acceptance also depends on its appearance and personality (Kiesler & Goetz, 2002).

6. Conclusion and future works

The reflections reported on the technological development of telepresence robotics and the creation of new strategies, capable of managing the relationship between man and machine, are necessary to increase the level of acceptance of these robots, in order to improve their coexistence with man. In this direction, design plays a key role in shifting the focus from a technology-driven process to one in which an ethical approach and acceptance are characteristic. This means putting people, the community, their needs and the social context at the centre of design, to achieve the main requirements of interaction: empathy, involvement and collaboration (Fitter et al., 2018). Evaluating. As with all interactive systems, the experience of the user interacting with the robot needs to achieve benefits, so it needs to be intelligently designed. UX with social robots, such as telepresence robots, must be a central issue in the development of such artefacts (Germak, Lupetti & Giuliano, 2015). The paper introduces several issues related to telepresence, such as the context of use of telepresence, the target user groups and the lack of non-verbal communication to support the interaction. Security and privacy aspects that are still present in these robots and that need an adequate and conscious design must also be considered. Through a co-design approach with the different actors and entities, which take part in the project, it is possible to create a collaborative system, where the maximum transparency and the purpose of the intervention itself is present. Therefore, this study intends to promote and continue the experimentation of a service robotics in situations of discomfort or impossibility of physical encounter of the university student at a distance, where the robot is a tool for inclusion and social progress, through the creation of a new physical service.

References

Bamoallem, B. S., Wodehouse, A. J., & Mair, G. M. (2014). Design for an optimal social presence experience when using telepresence robots. DS 77: *Proceedings of the DESIGN 2014 13th International Design Conference* (pp. 653-662). Dubrovnik, Croatia.

Benitti, F.B.V. (2012). Exploring the educational potential of robotics in schools: a systematic review. *Computers & Education*, (pp. 978–988), 58(3).

Björnfot, P., & Kaptelinin, V. (2017). Probing the design space of a telepresence robot gesture arm with low fidelity prototypes*. In Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 352-360). Vienna, Austria.

Broadbent, E., Tamagawa, R., Kerse, N., Knock, B., Patience, A., & MacDonald, B. (2009). Retirement home staff and residents' preferences for healthcare robots. In Proceedings

of the *RO-MAN 2009 - The 18th IEEE International Symposium on Robot and Human Interactive Communication*, Toyama, pp. 645-650, doi: 10.1109/ROMAN.2009.5326284.

Calo, R. (2010). Robots and privacy. *Robot ethics: The ethical and social implications of robotics.* In G. B. Patrick Lin & K. Abney (Eds.), Cambridge: MIT Press.

Casiddu, N., & Micheli, E. (2011). *Human Centered Robotic Design*. Alinea Editrice, Firenze.

Desai, M., Tsui, K. M., Yanco, H. A. & Uhlik, C. (2011). Essential features of telepresence robots, In Proceedings of *IEEE Conference on Technologies for Practical Robot Applications,* Woburn, MA, pp. 15-20, doi: 10.1109/TEPRA.2011.5753474.

Fitter, N.T, Chowdhury, Y., Cha, E., Takayama, L., & Matarić, M.J. (2018). Evaluating the Effects of Personalized Appearance on Telepresence Robots for Education. In Proceeding of *IEEE International Conference on Human-Robot Interaction (HRI '18)*, New York, USA, pp. 109–110, doi: https://doi.org/10.1145/3173386.3177030

Freeman, R. E. (1984). *Strategic management: A stakeholder approach.* Marshfield, MA: Pitman.

Germak, C., Lupetti, M. L. & Giuliano, L. (2015). Ethics of robotic aestethics. In *Design and Semantics of form and movement* (pp. 165-172). Milano.

Kiesler, S. & Goetz, J. (2002). Mental models and cooperation with robotic assistants. *In Proceedings of Conference on Human Factors in Computing Systems* (pp. 576-577), Minneapolis:ACM Press.

Kristoffersson, A., Coradeschi, S., & Loutfi A. (2013). A review of mobile robotic telepresence. *Advances in Human-Computer Interaction,* (pp. 1–17). doi.org/10.1155/2013/902316

Krupp, M. M., Rueben, M., Grimm, C. M, & Smart, W. D. (2017). A focus group study of privacy concerns about telepresence robots. In *Proceedings of the 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, Lisbon, 2017, (pp. 1451-1458).

Elara, M. R., Rojas, N., & Chua, A. (2014). Design principles for robot inclusive spaces: A case study with Roomba. In *Proceedings of the 2014 IEEE International Conference on Robotics and Automation*, (pp. 5593–5599), Hong Kong, China.

Marvin, M. (1980). Telepresence (essay). Omni Magazine, Vol. 2, No.9, 45-52. Omni Publications International Ltd.

Mehrabian, A. (1980). Silent Messages: Implicit Communication of Emotions and Attitudes. Wadsworth Publishing Co Inc.

Mori, M. (2012). The Uncanny Valley. In IEEE Robotics Automation Magazine.

Newhart, V.A, Warschauer, M., & Sender, L. S. (2016). Virtual inclusion via telepresence robots in the classroom: An exploratory case study. *International Journal of Technology in Learning,* (pp. 9–25), 23(4).

Niemelä, M., van Aerschot, L., Tammela, A., Aaltonen, I., & Lammi, H. (2019). Towards ethical guidelines of using telepresence robots in residential care. *International Journal of Social Robotics* (Online First). https://doi.org/10.1007/s12369-019-00529-8.

Nowak, K. (2001). *Defining and differentiating copresence, social presence, and presence as transportation.* Paper presented at the Fourth International Workshop on Presence, Philadelphia, Pennsylvania, USA, ISPR '01.

Piaget, J. (1929). *The child's Conception of the world*, Routledge & K.Paul, London

Rae, I., Venolia, G., Tang, J. C., & Molnar, D. (2015). A framework for understanding and designing telepresence. *In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (pp. 1552–1566).

Reis, A., Martins, P., Borges, J., Sousa, A., Rocha, T., & Barroso, J. (2017). Supporting accessibility in higher education information systems: a 2016 update. In: *International Conference on Universal Access in Human-Computer Interaction*, (pp. 227–237). Springer, Cham.

Reis, A., Martins, M., Martins, P., Sousa, J., & Barroso, J. (2018). Telepresence Robots in the Classroom: The State-of-the-Art and a Proposal for a Telepresence Service for Higher Education. In *Proceedings of the First International Conference*, (pp.539- 550), TECH-EDU 2018, Thessaloniki, Greece.

Robins, B., Dautenhahn, K., & Dickerson, P. (2009). From isolation to communication: a case study evaluation of robot assisted play for children with autism with a minimally expressive humanoid robot. In: *Second International Conferences on Advances in Computer-Human Interactions*, ACHI 2009, pp. 205–211. IEEE

Šabanović, S. (2010). Robots in society, society in robots: Mutual shaping of society and technology as a framework for social robot design*. International Journal of Social Robotics*, 2(4), (pp.439-450).

Salvini, P., Laschi, C. & Dario, P. (2010). Design for Acceptability: Improving Robots' Coexistence. In Human Society. *In International Journal of Social Robotics*, 2. Springer.

Sharkey, A.J. (2016). Should we welcome robot teachers? *Ethics and Information Technology*, 2016. 18(4), (pp.283–297).

Shaw, R., Molloy, M., Vaughn, J., Crego, N., Kuszajewski, M., Brisson, R., & Hueckel, R. (2018). Telepresence robots for pediatric clinical simulations: Feasibility and acceptability. Pediatric Nursing, 44(1), 39-43.

Slack, J. T., Del-Row, K., Anderson, Z., DiBartolomeo, R. M. A., Gorlcwicz, J. L., & Weinberg, J. B. (2018). Design of a lightweight ergonomic manipulator for enabling expressive gesturing in telepresence robots*. In Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems* (pp. 5491-5496).

Stahl, C., Anastasiou, D., & Latour, T. (2018). Social telepresence robots: The role of gesture for collaboration over a distance. *In Proceedings of the 11th PErvasive Technologies Related to Assistive Environments Conference* (pp. 409–414). *New York, NY, USA*

Stappers, P.J., & Sanders, E.B.N. (2003), Generative tools for context mapping: Tuning the tools. *In Design and Emotion: The Experience of Everyday Things*, edited by D. McDonagh, P. Hekkert, J. van Erp, J., and D. Gyi, 77–81, London: Taylor and Francis.

Tsui, K. M., Desai, M., Yanco, H.A., & Uhlik, C. (2011). Exploring use cases for telepresence robots," *2011 6th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, Lausanne, 2011, (pp. 11-18).

Tsui, K.M., Norton, A., Brooks, D.J., Yanco, H.A., Ma, L., & Kontak, D. (2011). Designing Telepresence Robot Systems for Use by People with Special Needs. *Proceedings of the International Symposium on Quality-of-Life Technologies 2011*: Intelligent Systems for Better Living, held in conjunction with RESNA 2011 as part of FICCDAT, Toronto, Canada.

Vu, S., Rissanen, M. J., Pang, N. & Foo, S. (2012). Towards evaluating social telepresence in mobile context. *In Proceedings of the 11th ACM SIGGRAPH International Conference on Virtual-Reality Continuum and its Applications in Industry* (pp. 75-78).

About the Authors:

Claudio Germak full professor of Design at the Politecnico di Torino, he has developed new service and product design methodologies with a high degree of accessibility. Today he leads the UXDPoliTO research team expert in HCD and UXD design methods and evaluation techniques.

Lorenza Abbate PhD student at the Department of Management, Production and Design of the Politecnico di Torino. Her research focuses on Human-Robot Interaction, on social robotics for school children, and User Experience Design.