Chapter 1

Introduction

Interviewer: Has the interview changed any perceptions that you have about humans?

Bill: It's actually made me appreciate what kind of complex things we are, and to try and emulate that with a robot just goes to show how complex we are – the fact that we can do, think, create, all within a flexible thing, really.

(Bill, vehicle mechanic, affected stakeholder, HERBIE)

◀ (Photo by Kate Davis)

1.0 Introduction

Technology has never been more invasive and disruptive than in present day Europe. Robotization, coupled with artificial intelligence, is transforming homes, public institutions like schools and hospitals, as well as workplaces, at a pace that can only be described as accelerating. In some ways it seems we live in a techno-paradigm, in an era of a new 'great history' of how technology can solve all problems presently and in the future. Many developers and policymakers see this development as promising, but they also acknowledge the need for closer contact with the general public and societal concerns. At the same time, many people affected by technological transformation find themselves unprepared and worry about the changes development brings. Media imagery of robots as intelligent and even violent humanoids may contribute to these worries enmeshed in a meta-narrative of how this development is inevitable. In this publication we try to bring together the voices of different stakeholders engaged in and/or affected by a robotic society - and to give politicians and the general public a reality check on what robots are, and what we can expect them to do.

This publication is the outcome of extensive ethnographic and economic research into robot design, development, implementation, and related ethical challenges conducted by an interdisciplinary team of researchers in the EU-project REELER (Responsible Ethical Learning in Robotics) which runs from January 2017 to January 2020. The ethnographic data consists of 11 cases selected for variation in robot types, application sectors, geographical places, and types of organizations (*see Hasse 2019*). With this multi-variation approach, REELER first sought diversity in case selection, then analyzed for patterns across cases. Each REELER case is given one case name, but can cover several robots within that sector or robot type classification.

The 11 REELER cases cover robots constructed for autonomous transport (HERBIE), logistics (WAREHOUSE), construction (WIPER), manufacturing (COOP), healthcare (REGAIN), agriculture (SANDY), inspection (OTTO), cleaning (SPECTRUS), and consumer/education (ATOM) and includes social robots (BUDDY) and collaborative robots (COBOT) applied across sectors. Our focus was not on robots already applied, but robots being developed and tested from ideas and beginnings (TRL 1) to 'ready for market' (TRL 9). However, since many robot developers build upon off-the-shelf robots when developing new robots, our research also includes some robots already on the market.

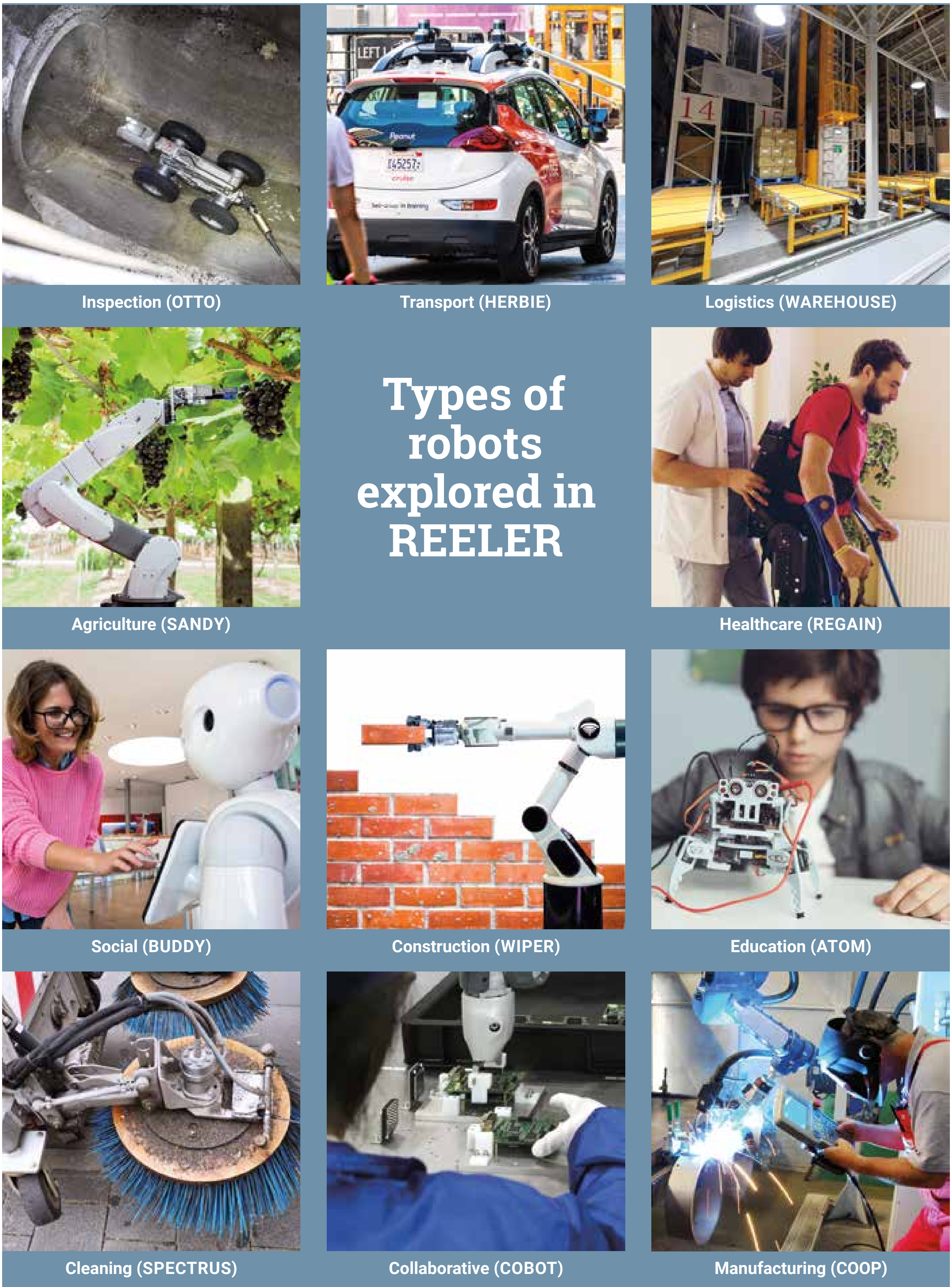


Figure 1.1. Overview of REELER case categorizations

In total, 160 in-depth ethnographic interviews with both robot developers and end-users/affected stakeholders have been conducted. These interviews and observations from the field are compiled into case write-ups and processed in qualitative data analysis software, which formed the basis of our initial analysis. Selected excerpts from these interviews and field notes are anonymized and used throughout this publication to illustrate the key arguments in each chapter.

1.1 The goal of the REELER project

The goal of the REELER project is to align robot makers' visions of a future with robots with empirically-based knowledge of human needs and societal concerns, through a new proximity-based human-machine ethics. By giving voice to those affected by robots, the project intends to close the gap between robot makers and these affected stakeholders. REELER's research brings forth data on how individuals and communities connect with robotic technologies, with special attention to the ethical, economic, and social impacts of robots. The outcome of the REELER project is the REELER Roadmap, consisting of this publication, the Human Proximity Model, research publications, a collection of tools for collaborative learning, and condensed findings for robot developers presented in our Awareness-Raising Toolbox (see responsiblerobotics.eu/toolbox).

Our tools for collaborative learning include:

- BuildBot, an interactive board game,
- BRICKSTER, a serious puzzle game,
- REELER mini-publics, a forum for knowledge transfer and debate among experts and the general public, and
- Social Drama, a method to explore our own assumptions.

The purpose of the publication *Perspectives on Robots* is to raise awareness of the issues identified in REELER's ethnographic and economic research. Through engaging closely with the people making robots *and* the people affected by robots, the REELER project identifies one central finding:

In order to ensure ethical and responsible robot design, it is essential to adopt a two-pronged strategy to: a) enhance robot developers' awareness of affected stakeholders and b) align robot makers' and affected stakeholders' motives by increasing human proximity through the involvement of alignment experts, for effective collaborative learning.

Collaborative learning is a process of alignment of different motives and expectations in working toward a common goal. This definition is inspired by Anne Edwards' work on relational agency (Edwards 2010). Robot makers engage in the *activity* of creating robots and are thus working towards a common *object* – the finalized robot. The motives for their daily *actions* lie in how the object is envisioned through a common understanding developed among the robot makers. In other words, they share an *object motive* when they collaborate: "The idea of **object motive** importantly recognizes that our actions are elicited by our interpretations of the object" (Edwards 2007, 7). In our research, motives were often not overtly stated or even acknowledged, but constitute the underlying reasons for engaging in development activities. Because the robot makers often meet each other and have similar backgrounds, their object motives are to some extent already aligned when they work towards creating new robots. Their motives to make robots stem from what is at hand in their shared cultural world (or inner circle of robotics), which includes developers, funding agencies, and application experts (*see Figure 1.2*) negotiating everyday design decisions and shaping the direction of robotics through these close collaborations.[1]

> **Collaborative Learning:** *a process of alignment of different motives and expectations in working toward a common goal.*

> **Motive:** *The underlying reason for engaging in activities of collaboration to achieve a common goal defined as 'an object'.*

When collaboration is expanded to the wider context of development, we see gaps in the motives of the persons working together to solve a particular problem (nursing staff shortages, for example). How the robot makers interpret the problem may differ from how nurses or hospital managers interpret the problem; *and*, their motives for collaborating may be very dissimilar. The managers may want to procure a robot to avoid recruitment costs, while the nurses may choose to be involved in the development to ensure the robot assists them without taking over their core care tasks and the patients need a robot that can help them get well. Meanwhile, a robot developer seeks to prove the application of a new breakthrough in robotics, while the company he works for aims to tap into an emerging market in healthcare robotics. Bringing these motives together in alignment with the shared goal of robot development requires increased *human proximity*, i.e. bringing the robot and robot makers closer to the needs of the various affected stakeholders. This need for alignment of motives is recurring across REELER cases irrespective of what type of robot, where the robot is produced, or the sector of application.

1.2 Human Proximity Model

In order to organize our findings of patterns analytically, as well as to talk about these findings cross-disciplinarily, we have found it necessary to develop a new vocabulary for the groups of people we have studied and their roles in development. In the following sections, we define the main terms you will meet throughout the publication. These terms are

1 More can be found on motives and collaborations in 2.0 Robot beginnings and 3.0 Collaboration in the Inner Circle.

presented through our model of human proximity, which in many cases functions as our analytical lens.

REELER has developed a *Human Proximity Model* (HPM) to illustrate how changes in collaboration practices may bring about greater human proximity, to contribute to more responsible and ethical design of robots. To start with, we have made a descriptive model of the types of collaborations observed in REELER's fieldwork. Each of REELER's ethnographic case studies begin by identifying one or more **robots** and the people responsible for their development. From there we trace out a network of collaborators that are involved in the development processes. In our exploration of these robot beginnings, we begin to see insular patterns of involvement, where persons with particular expertise take on the same roles in case after case. First, we identify **robot developers,** who use their technical expertise to actually make the robots. We also find that no robot is created by developers alone. Many robots would never have been made without funding from **facilitators**, for example. In fact, it is often facilitators who define the problem that a particular robot development intends to solve. Many of the developers we have spoken to point out that in order to adequately solve a problem in an unfamiliar field, they engage with **application experts**, whose knowledge helps them specify requirements in the design process. These three groups of people often gather at conferences, fairs, and expositions to shape the future of the robotics field. They attend EU organized events to shape policy or access funding. But most importantly, they *make* the robots happen and are thus collectively termed **robot makers**. At the center of this group are shared motives and activities around the **robot**. In the context of REELER, we define a robot as a material object consisting of adequate technical parts that facilitate sensing, processing and acting on the basis of information from the environment. Simultaneously the robot is a conceptual entity, which is subject to continuous negotiation.

Thus, the inner circle of the model, with robot makers surrounding the robot, consists of the following sub-categories:

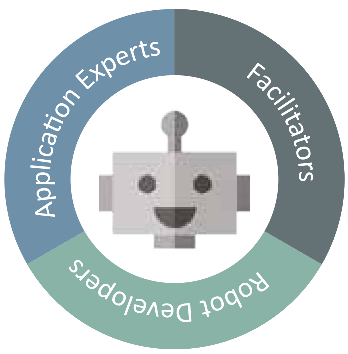


Figure 1.2. The 'inner circle' where robot developers such as engineers work together with facilitators (funding agencies, e.g.) and application experts (psychologists, e.g.).

Robot: *Simultaneously a conceptual entity and material object, affecting people in different ways.*

Robot makers: *People directly involved in robot development.*

Developers: *People with technical expertise, whose role is to develop robots in whole or in part (e.g., mechanical engineers, computer scientists, industrial designers).*

Facilitators: *Decision-makers whose role is to set the framework for development. This includes people with legal, regulatory, or bureaucratic expertise (e.g., funding bodies, regulatory agencies), but also persons who otherwise facilitate the funding, access to market, or testing (e.g., lawyers, investors, marketing, or public-relations persons).*

Application experts: *People with an expertise in the application area or sector particular to the robot under development. They have a role of sharing their expertise with developers, and are often robot buyers (e.g., a contractor or building developer for a construction robot, or a dairy owner for a milking robot).*

Despite the diversity within this group of robot makers, we see a common culture in what we call the robot makers' *inner circle*. Each of us is equipped, by our experiences, with particular tools for engaging with the world; anthropologists call it culture when people share the same tools and develop a common mindset. We find that persons in the inner circle often work from a shared set of expectations and backgrounds. The persons are most often male, and often have similar backgrounds including a higher education. Likewise, to some extent, they share a common language around robotics and have relatively aligned motives that bind them together. Robot developers are very good at collaborating in complex networks with many different actors within this inner circle of robotics.

1.2.1 Moving outside the inner circle

These engagements do, however, not necessarily entail alignment of the motives of robot developers and those we term *affected stakeholders* – among these most notably the *end-users*. To give an example from a healthcare robot, a group of robot developers invite a hospital manager to establish a business case. They invite nursing managers to help specify requirements in the beginning stages of design. During prototyping, they test the solution among patients in a real hospital setting (including the porters and nurses), and finally, they might consult with a representative of the nursing union to ensure acceptance upon implementation. All of these collaborations are integral to good design.

Yet, none of these steps involve actual *collaboration* with affected stakeholders (in this case nurses and patients) with the aim of finding out about their motives and needs. Going

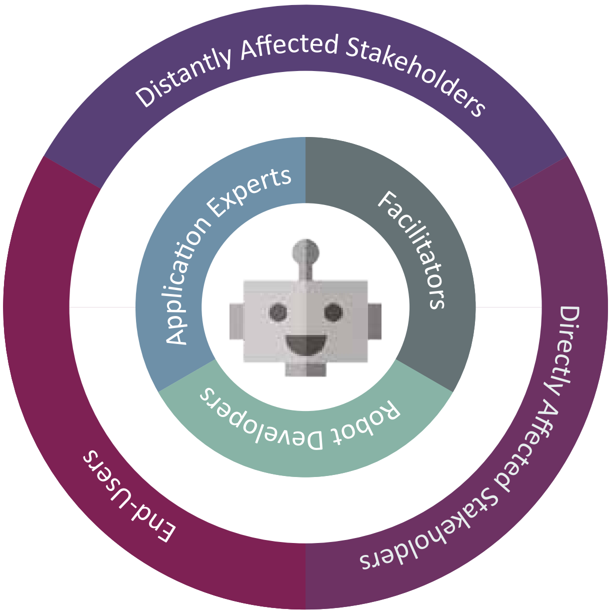


Figure 1.3. The proximity gap between robot makers (in the inner circle) and the affected stakeholders (end-users, directly- and distantly affected stakeholders).

across cases, REELER finds that **end-users** (for instance a patient training to walk with a robot) are typically simply involved as test-persons in the later stages of robot development. They are not given an independent voice in the process of development. Thus, we identify a proximity gap between robot makers and end-users, which is one of the gaps the REELER project (and this publication) aims to address.

In addition to end-users, REELER has identified two new categories of potential affected stakeholders, which are often overlooked in any types of collaborations in the inner circle. We call these two categories of people directly affected stakeholders and distantly affected stakeholders. Among the **directly affected stakeholders** we identify people close to the end-users; people who are supposed to interact with the robots without being intended users themselves. This group of directly affected stakeholders are often overlooked (in the case of the healthcare robot it could be the nurses helping the patient engage with the robot or porters bringing the robot). If this group of directly affected stakeholders are included in the development phase, it is often as test-persons, as with the end-users. Thus, their voices about how the robot affects their work or life are not heard in the design phases. This can have severe implications for the uptake of robots when the robot is brought to market.

The group of **distantly affected stakeholders** comprises people who are affected by the robots, even though they are never near the robot or never meet anyone from the inner circle. As robots come out of the industrial cage into people's everyday lives, people are increasingly distantly affected. These people have no say in the form of design and implementation. Distantly affected stakeholders might be fruit pickers, nurses, shop-floor workers, cleaning ladies, or warehouse workers who get new tasks or need re-skilling to be able to accommodate to changes in their work situation (for instance, to become end-users who collaborate directly with robots). The REELER's research also includes these distantly affected stakeholders, and their voices are heard throughout the chapters of this publication.

We refer to this group of end-users, directly and distantly affected stakeholders as **affected stakeholders.** Their motives are not represented – or considered – by the people in the inner circle because they are outside the purview of the robot developers and their direct collaborators.

Affected stakeholders: *Those who may use robots or be affected by robots, directly or distantly.*

End-users: *People who will use (operate or interact with) the robot directly (e.g., a patient using a rehabilitation robot, a machine operator at a factory, or a consumer using a robotic vacuum).*

Directly affected stakeholders: *Non-users who encounter the robot and are affected by it (e.g., a family member assisting patient with use of a rehabilitation robot, or a nurse interacting with a cleaning robot).*

Distantly affected stakeholders: *People who will likely never operate, use, or interact directly with the robot, but may nevertheless be affected by it (e.g., a physiotherapist made superfluous, a farmworker on a traditional farm rather than a farmer working in a precision-farming setting).*

The first REELER case studies took their point of departure in a given robot. This approach showed that the robot makers were not aware of or did not experience the alignment gap we identify between robot developers and affected stakeholders. Many of them sincerely believe they cover the interests and experiences of the end-users. Nevertheless, they largely overlook directly affected stakeholders and do not see distantly affected stakeholders as part of the problem their robot is designed to solve. Moreover, it brought some surprise to the robot makers to hear about the people REELER considers 'end-users' in our research. When the robot makers spoke about end-users they referred to, for instance, people buying robots, but not people who would be operating or be in close proximity to the robot.

The following de-identified story from the field exemplifies this issue of robot developers speaking about end-users as the managers of a cleaning company, not the staff who will be operating the new cleaning robot.

STORY FROM THE FIELD:

The process of developing robots in the inner circle

Here we follow the process of developing a cleaning robot, FLOSSI, from the perspective of a group of robot developers. They draw inspiration from a technology developed in a previous project and from an existing social collaboration with people from the inner circle of robotics. They meet on a regular basis at fairs, competitions and conferences where they also listen to policymakers and hear about funding possibilities. At some point they decided to develop a new project together.

Interviewer: "But was it your idea in the beginning? It was with your Belgian colleagues?"

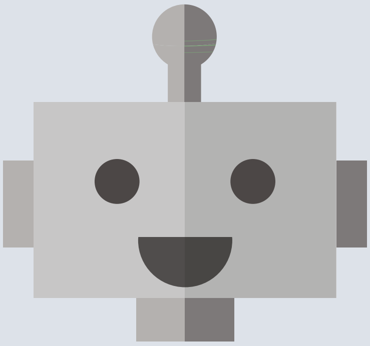
Vincent: "Yes, it was this partner we worked very close with on several projects. This is exactly an example of how it works because it was not one person saying this, it just came through brainstorm. So, discussing with a partner, one says this, another that, and based on that, we start going a bit more into details."

Tony adds: "The collaboration was amazing on this project. They brought their German people from Germany so it was really like a Belgian- German collaboration and now us from Austria coordinating these activities and helping them."

The group wants to seize new opportunities for funding a project by answering a call for service robots. They already have some technological ideas based on their previous technological development in a project for easing transportation for people in hospitals. This time, however, they decide to go for a service robot in cleaning. Tony, who takes part in the first meetings (together with Vincent) with important interested parties that can ensure funding, explains that *"when you are in the R&D, the first thing you do is speak with the end-users. So that is only a problem if you don't do it. Sometimes you're thinking, 'let's do something in the cleaning area' but you end up not liking the idea. But in this case, it was the opposite. Everyone liked it. The cleaning provider liked it."*

Both Vincent and Tony feel certain they have invited end-users into the collaboration from the very beginning by making sure everybody likes the idea. From their perspective, the end-users are the big companies who provide cleaning and are ready to pay for cleaning robots in all of their departments across Europe. Yet, these end-users who are top CEOs and company owners will never themselves operate the robots in questions.

As the collaboration developed and Tony and Vincent took on the task of writing the proposal for funding, they



began to look for more relevant partners. Several completely new partners were involved as they could provide access to relevant markets.

Yet, the broadened collaboration around developing the robot remained within in inner circle of robot makers: robot developers in charge of the technical aspects, facilitators such as the big companies willing to fund the project and the cleaning manager as application experts.

Tony: "So, this is very important, the ones who are going to buy, collaborate! These companies, they make millions."

Vincent: "I think the German [partner] make more than a billion."

Tony: "Yes, imagine now how many robots they should buy in the future."

Interviewer: "So they're [the partners] already built into the business model?"

Tony: "Yeah, exactly!"

What is missing in this collaboration are the affected stakeholders: the actual end-users, the people who will eventually operate the robots; the directly affected stakeholders, such as employees working next to it and whom may have to change routines so as not to interfere with the paths of the moving robot; and the distantly affected stakeholders, who could be the cleaning staff that will have to find new occupations or education providers who have to teach them new skills, etc.

(Based on statements from Tony & Vincent, robot developers, SPECTRUS)

Similar patterns of not including affected stakeholders in the design phases recur throughout our material. Some robot developers in our case material are, however, aware of the end-users' motives and needs early on, and really strive to include their perspective in their research. Yet, this endeavor is not without challenges as the end-users, and other affected stakeholders, tend to come up with many diverging ideas and the robot-developing engineers are simply not equipped to separate the wheat from the chaff.

On the basis of this observation, REELER researchers identify a need for a two-pronged strategy to close the gaps between affected stakeholders and robot makers, addressing developers' need for ethical education and proposing a new type of collaboration with social scientists.

Thus, we suggest an entirely new category of **intermediaries** which supplement the spokespersons already engaging with the people in the inner circle of robotics by speaking for affected stakeholders. The spokespersons are typically affiliated with the robot makers in one way or another, whereas **alignment experts** like the social scientists in REELER are able to more freely explore potential gaps between affected stakeholders and robot makers.

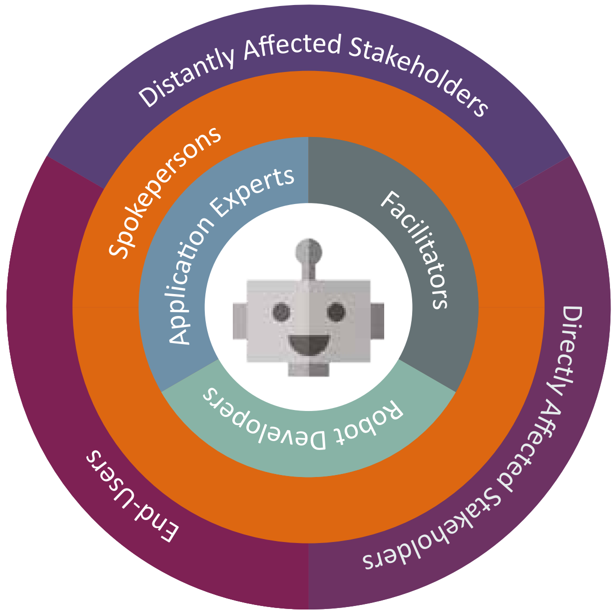


Figure 1.4. Today, the spokespersons (company owners, e.g.) speak on behalf of affected stakeholders (such as workers).

Intermediaries: *Those acting as go-betweens for robot makers (especially developers) and robot recipients (affected stakeholders and end-users).*

Spokespersons: *An intermediary who speaks on behalf of recipients based on their own experiences. Often these people are management level in the same organization as the end-users (e.g., the factory owner speaking on behalf of the workers).*

Alignment experts: *Intermediaries seeking to align robot makers and affected stakeholders based on empirical knowledge of both. Often these people have an expertise in Social Sciences or Humanities (SSH) (e.g., an anthropologist or ethicist).*

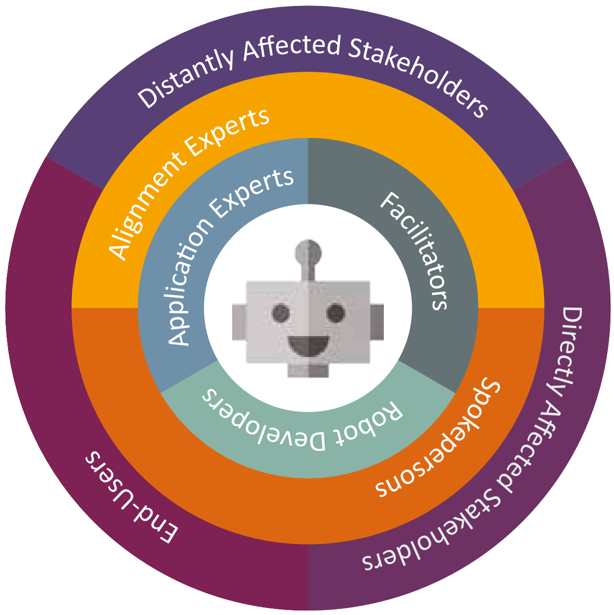


Figure 1.5. Alignment experts can ensure that the voices of affected stakeholders are heard in the inner circle of robot makers.

As intermediaries with close knowledge of both robot makers' practices and affected stakeholders' life-worlds, alignment experts are professionally equipped with tools to bridge the proximity gap and see potential alignment of separate motives.

Overall, REELER sees a need for alignment tools and people trained in fostering **relational responsibility** in collaborative learning. This relational responsibility places the responsibility for learning how to make ethical robots on both the robot makers and the affected stakeholders, while acknowledging the need for spokespersons and alignment experts to make it happen. Thus, the complete Human Proximity Model, which includes alignment experts in the circle of intermediaries, is a prescriptive model consisting of three rings: the robot makers developing the robot, the affected stakeholders whose work and lives are changing as a result of the development, and the intermediaries who are tasked with translating the needs and values of the two other groups.

Learning: *The process of developing material and conceptual knowledge through engagement with a situated social and material world.*

The subsequent chapters build on this model of human proximity, toward more responsible, ethical (and collaborative) learning in robotics.

1.3 Overview of content in Perspectives on Robots

We have divided *Perspectives on Robots* into three parts, each followed by concluding remarks.

Part One: Introducing the inner circle of robotics

1.0 Introduction, is primarily a first introduction to the Human Proximity Model, developed and used in the REELER project for analytical purposes of understanding and mapping the relation between those who make robots and those who are affected by robots.

2.0 Robot Beginnings, explores the catalyzing ideas that get projects started and the driving motives that see them to completion. This chapter demonstrates how familiar beginnings can lead to exclusionary development processes.

3.0 Collaboration in the Inner Circle, forms the empirical grounding for the Human Proximity Model, exploring collaborations in the inner circle of robotics and exposing gaps in collaboration.

Part Two: Enhancing robot developers' awareness of affected stakeholders

Here we introduce empirical findings and analysis that can help robot developers directly by enhancing their knowledge of their own conceptions of ethics, design pitfalls, the innovation networks around their work and the situated practices of users.

4.0 Ethics Beyond Safety, positions REELER in the field of robot ethics with new empirical findings of how robot developers and other robot makers present their notions on ethics, and ends with a discussion of a need for a relational responsibility.

5.0 Inclusive Design, exemplifies some of the ethical issues, and identifies pitfalls, arising from design and wider development decisions (like funding, e.g.), and suggests new, grounded ways of thinking about end-users and affected stakeholders that enhance robot developers' possibilities to make ethical and relevant robots.

6.0 Innovation Economics, discusses the innovation economics systems, which the robot makers engage in, which entail multiple actors engaging in situated everyday practices to bring technological breakthroughs from the research laboratory to the market.

7.0 Learning in Practice, argues that by developing new ways of thinking and pursuing different ways of knowing (about end-users, and other affected stakeholders, as well as about the effect of robots in everyday lives) can result in closer proximity and more ethical robot developments.

Part Three: Expanding beyond the inner circle

In this part, we present issues that go beyond robot developers' ability and responsibility, pertaining to society as a whole, where policymakers have a special ethical responsibility, and where society (and citizens) can benefit from addressing these broader issues. We end by explaining why a two-pronged strategy is needed.

8.0 Imaginaries, builds on the ways robots are represented by media people, some of whom are hired by robot developers and makers, with special attention to the different representations of the robot in popular and news media as opposed to real-life settings, and how media imaginaries created there affect perceptions of the robot.

9.0 Economics of Robotization, presents a large-scale discussion of the future of work, specifically addressing the expected economic impact of robotization.

10.0 Meaningful Work, is a close-up discussion of the many qualitative transformations of work that robotization entails, and the responses to these changes, including resistance, reskilling, and universal basic income.

11.0 Gender Matters, presents issues of gender in design and robotics/engineering culture which, if left unchecked, may contribute to an inequitably gendered society. The point in this chapter is that issues of gender also need to be addressed at a societal level..

12.0 Human Proximity, is one of REELER's primary theoretical contributions and proposes a new solution to some of the issues emerging from the human proximity gap we have identified.

13.0 Conclusion, presents a summary of our findings in REELER and proposes a two-pronged strategy for closing the gaps between affected stakeholders and robot makers.

More online content

A number of supplementary annexes are available on our website. These are:

Annex 1 Methods and Methodology is a detailed description of how we have worked, including how we anonymize all cases and persons interviewed in order to make quotations and stories from the field de-identifiable. This is both to protect our interlocutors and because our cross-case analysis show that the individual person or robot is not what matters, but the patterns identified across cases. It also holds a selection of cases, Nvivo-coding, description of methods applied in ethnographic and economic analyses (*see responsiblerobotics.eu/annex-1*).

Throughout this publication, we highlight the experiences and the voices of affected stakeholders. (Photo by Kate Davis)

Annex 2 Supplementary Quotations. This annex provides insight into the rich body of quotations, chapter by chapter, that underlie our argumentation in this publication (*see responsiblerobotics.eu/annex-2*).

Annex 3 Glossary which lists all the key terms mentioned in this publication with video explanations by the REELER team (*see responsiblerobotics.eu/annex-3*).

Annex 4 Reviews of REELER. Concepts and robot typologies (*see responsiblerobotics.eu/annex-4*).

Annex 5, REELER outreach tools, offers brief descriptions of the online TOOLBOX, the game BUILDBOT, Mini-publics, Social drama & Sociodrama as well as *the game BRICKSTER (see responsiblerobotics.eu/annex-5*).

We hope this publication raises awareness about affected stakeholders and how they might be aligned with robot makers' motives through closer proximity in processes of collaborative learning with the help of intermediaries such as alignment experts.

1.4 How to read this text

The chapters can (and should) be read together. Each chapter includes the following features:

You will find – you will acquire: Bullet points summarizing key awareness-raising findings and what the reader can expect to gain from reading the chapter.

Key terms: Central concepts presented in bold face, defined, and included in a glossary in *Annex 3*.

Stories from the field: Narratives based on REELER case examples explaining an issue in a contextual manner.