Human Centered Robotics: Designing Valuable Experiences for Social Robots

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ABSTRACT

As robots get more capable and begin to leave the lab and enter the real world, it is becoming increasingly important to ensure that we are building applications that solve real world problems and provide valuable experiences to their users.

Designing for social robots presents many challenges, including identifying a valuable use case, dealing with limitations of robot capabilities and setting expectations for our users. Additionally, designers need to consider multiple methods of interaction. These include voice interfaces, gestures and other methods of perception and input that may be available on the robot. From a user perspective, many of these elements of the interface are not yet familiar. Therefore designers need to consider interaction with social robots by supporting familiar cognitive models, while also helping to build new ones.

This paper explores various design tools and methods that can be used in the area of social robot design to encourage consideration of the target user in the process. Principles for Human-Centered Robotics are presented and an overview of some collaborative design activities are provided that can be applied to the design of social robots. To provide context to these activities, examples are given of how some of these methods have been used during the development of commercial applications for SoftBank's robots.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **User centered design**; **Interaction design**; **Interaction design process and methods**; • **Computer systems organization** → **Robotics**;

KEYWORDS

Human Robot Interaction, Human Computer Interaction, Human Centered Design, Processes and Methods

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1 INTRODUCTION

Some of the biggest challenges for roboticists working on social robots is determining an appropriate and valuable use case. Many challenges exist that a team must overcome in order to effectively design an experience that both achieves a specific user goal and provides a satisfying experience. Roboticists must try to understand the most valuable use cases in which to design a solution, how to best manage users expectations of the robot and how they can support an effective interaction. Couple this with the many complexities of social interactions across various dynamic environments and it is easy to see why this growing area is attracting more attention from both academic and industry circles.

As new interfaces such as those using voice and gesture based interaction are introduced to the market, new interaction models are built and expectations are set of how a technology works. For example, people are getting more used to speaking with their technology using voice interfaces such as devices using the Amazon Alexa voice service [2] and voice assistants such as Google's Assistant [4] and Apple's Siri [3]. Robots are also becoming more commonplace in people's homes, with the recent releases of new robots designed for entertainment and companionship (For examples, see: Aibo [1], Jibo [7] and Kuri [8]). As these technologies get more widespread, they are beginning to define how humans expect to interact with robots. With this brings new challenges for social roboticists, who must build upon these newly evolving models as well as creating new ways to support social interaction with robots.

Building successful experiences for these robots requires a good understanding of the target user, their needs, expectations and their motivations. Additionally, observation of how the user responds to various interaction patterns provides valuable feedback to allow those designing for social robots to iterate on their design. This paper argues that bringing a Human-Centered approach and including the target users in the design and development of social robots will result in more successful products and provide an overall better experiences for those interacting with social robots.

2 HUMAN-CENTERED ROBOTICS

Putting the user first in the design process is not a new concept. Designers focused on solving many varied problems have used a Human-Centered Design approach in order to ensure that the end user is the heart of everything that they do. By building products with this philosophy in mind, we are better able to understand the problem space in which we are designing our solution and to understand whether the solutions we propose solve the problem and provide the value as intended.

Human-Centered Design is an approach to design that places the target user at the forefront of the experience. This approach is

concerned with understanding the user's needs, desires and intent so that we can build systems and services that provide value to these users. This view agrees with Giacomin's [15] definition, which states "Today's human centred design is based on the use of techniques which communicate, interact, empathise and stimulate the people involved, obtaining an understanding of their needs, desires and experiences which often transcends that which the people themselves actually realised. Practised in its most basic form, human-centred design leads to products, systems and services which are physically, perceptually, cognitively and emotionally intuitive."

A number of approaches to Human-Centred Design activity have been documented. For example, The British Design Council's Double Diamond [14] is one example of documenting the design process. In this model, divergent and convergent thinking is encouraged across a series of stages, starting with 'Discover' in which user needs are identified. Each proceeding stage then goes through a series of steps, each focused on progressing the design through to implementation. These stages (at a high level) are described as: Discover, Define, Develop and Deliver [14].

This approach is similar to one promoted by IDEO.org as a part of their own Human-Centred Design process [5]. In IDEO.org's example, divergent and convergent thinking is also promoted, this time across three stages consisting of Inspiration, Ideation and Implementation. In both of these examples, the idea of empathizing with users and testing possible solutions is encouraged.

Design Thinking is yet another solution-based approach that aims to include the targeted user during the design process as various solutions are tested. Stanford's d.school approach [6] follows a similar series of steps to that given by The British Design Council's 'Double Diamond' [14] and IDEO.org's approach to Human-Centred Design [5]. In Stanford's Design Thinking process, they define each stage as Empathise, Define, Ideate, Prototype and Test [6].

Lean principles are another focus of modern digital product development. Toyota's approach to focusing on lean teams to help speed product development has been widely covered as a desirable practice to create products (to learn more about this approach, see: [21]). The lean approach has also been heralded as a strong approach for new start-ups ([24] and [19]) as a philosophy for launching products quickly.

Regardless of which design method that a social roboticist might look to emulate, the common themes of user research, feedback and iteration in the design process exist. To help facilitate a Human-Centered Design approach, this paper looks to provide a set of examples of activities that can be applied in the area of social robotics.

3 APPROACH AND PRINCIPLES

In looking to apply the principles of Human Centred Design to the field of social robotics, we must first define them in the context of robot design. Building upon the themes presented, this paper suggests three principles to help guide the design of social robots:

- **Human first**: Approaching design through research focused on empathising with users, understanding user behaviour and how (through interaction with robots), these needs and behaviours can be supported. In a discovery phase involving design for robots, multiple domains must be considered. These include managing user expectations, environmental conditions, communication with the robot (both verbal and non-verbal), hardware capabilities, emotion design and the activities or tasks supported.
- **Collaboration**: Bringing together a group of people with a diverse set of skills, backgrounds and experiences in order to broaden the pool of knowledge contributing to a given solution. This group should include members involved in the design and development of the solution as well as business stakeholders so that all views can be represented in the process. By facilitating collaborative activities with a team, many ideas can be shared and brought into a possible solution at an early stage of the design process.
- **Iteration**: Iterative development through testing. An emphasis on prototyping and testing in which unexpected behaviours and responses to given solutions can be identified early in order to contribute to the design process. Prototyping and testing provides an important feedback loop in which designers and developers can learn from the implementation throughout the process and iterate on the solution as it is designed and developed.

4 TOOLS AND METHODS

In order to support a collaborative, human centred approach to designing social robots, it is important to select and apply appropriate tools in order to facilitate the process. Common themes with the tools presented here are collaboration across multiple disciplines (including wider project stakeholder groups) and the use of physical media such as post-it notes, whiteboards, paper and pens. The physicality of these tools is important, as it allows for people to share ideas in an environment where all participants can contribute as a group to an idea or solution to a problem. Finally, these activities allow for rapid iteration of ideas without the need for formalising proposals or reviews until the team begins to form a consensus on an approach to solving a design problem.

A few examples are provided below of some of the various tools and approaches that can be applied to the area of social robot design.

4.1 USER NEEDS AND PROBLEM SPACE

Perhaps the most important aspect of designing a solution is to understand the problem space or opportunity in which a given solution will operate. For this to be successful, we must first understand the needs of those who will be interacting with the robot, so that we can best design an experience to support those needs.

To provide a foundation for understanding these needs, the creation of artefacts that help to define a target user are developed. Two such examples of these artefacts are personas and behavioural archetypes. Personas are based in user research and are focused on defining the attributes of a specific user group or segment, whereas behavioural archetypes help to describe the set of target behaviours that the design is looking to support or modify (see for an example: [12]). The effectiveness of these types of tools has been widely published and have gained traction as an effective tool to be used as a part of the design process (e.g. [23] and [20]).

It is the opinion of the author that a focus on user behaviour (by looking at the needs and goals of a user) over those that emphasise

demographic attributes provides the most benefit to the design of social robots. As an example, if we were to consider building an entertainment application for a social robot, we can look to understand the user's needs and motivations from the perspective of 'why' they do what they do. In the case of an entertainment application, the 'why' might be that our users are 'bored' and their goal is to be entertained. As these motivations are agnostic of the user's demographic, we are able to service particular behaviours in a given context without needing too much emphasis on specific demographic attributes.

Proto-personas (see: [16]) are another tool used when speed in development is a priority. Unlike the Persona that is created as a product of user research, the Proto-Persona is created without prior research and is intended to be validated later through research. This allows the design to continue based upon an assumption of a targeted user group, and can be validated during development of the robot application. In this case, the Proto-Persona can help support a business or strategic goal in testing whether a presumed target market might exist (and for who), through short iterations of research and testing.

Another approach to design that focuses on user needs is provided by the 'Jobs to be Done' framework first popularized by Harvard Business School Professor Clayton Christensen [13]. In this framework, Christensen et al argue that focus should be placed on the jobs that customers are 'hiring' the product or service to do, rather than looking at what they are buying or using at the time. This approach helps social roboticists to put those jobs first, so that the robot can be successful at helping the user to achieve their intended goal.

Lastly, an important aspect of understanding user's needs is being able to empathise with them. Empathy Mapping is a tool suggested by Gray [18] that provides an activity in which a group of people work together to form an understanding of a target user. In this approach, the assumed target user is identified and the group explores what the target user may be 'Hearing', 'Thinking', 'Seeing', 'Saying', 'Feeling' and 'Doing' in a given experience. Variations on this model (e.g. [17]) have included 'Pains' and 'Gains' and 'Goals' in which emphasis is placed on what the user is trying to do and what aspects may be getting in their way.

At SoftBank Robotics, we have begun using the approach of empathising with our users and understanding their goals in our design process in order to help prioritise the tasks that the robot can do. One such example is during the development of an initial interaction approach for the 'Host' application of the Pepper robot (see: [10] and [9]) in which we were looking to understand what additional features to prioritise or promote in an initial interaction. In this example, Pepper plays the role of host in our customers lobbies and is able to notify employees of their guests arrival. To provide focus on the user and their goals we used a variation of an empathy map that focused in on the 'Jobs', 'Pains' and 'Gains' of a visitor in a lobby environment (for an example see: [22]). By focusing on these goals of the visitor in the context of a lobby, we were able to better understand the needs of the user so that we could support the primary use case, before pushing any secondary use cases for the robot. As an example, a visitor to a lobby may be there to attend a meeting, deliver a package or attend an interview. In this case, the robot would prioritise these goals by suggesting supporting this use case first, before offering secondary uses such as playing a game or doing a dance to entertain the visitors. Our assumption here is that once the initial goal of the lobby visitor is realised, they will be much more open to other, more ad-hoc interactions suggested by the robot.

4.2 VALUE PROPOSITION DESIGN

Once a target user is identified, and the needs are understood (or assumed for later validation) it is important to define how the product or experience might support these needs and provide value to the user. One such tool suggested by Osterwalder et al [22] is the creation of a value proposition canvas that helps to describe the value being generated for the user of the product. Once this value has been identified, a value proposition statement can be created which explicitly states the value that is provided to users.

At SoftBank Robotics, we have used a statement that follows the following format to help to communicate the user value provided by a solution:

For: *identified user or group*
Our solution: *provides this user value*
Unlike: *alternative product, service or experience*
Our experience: *provides this unique differentiator.*

The purpose of creating this statement is to provide focus on the value we aim to provide through the social robot experience and becomes a testable proposition that we can communicate for the purpose of seeing how it resonates with users. Additionally, this statement encourages the exploration of other (sometimes competing) solutions so that we can aim to provide an experience that provides additional value to the world, rather than reproduce something that already exists.

4.3 PROTOTYPING AND TESTING

An iterative design method is a common attribute of the Human-Centered Design approach. Emphasis is placed on fast iterations of ideas that are generated, tested and built upon or thrown away depending on the results of a given observation. Software development approaches such as the Agile Software Development Methodology [11] provide a practice that allows for the flexibility in delivery that is required to support the iterative process. This allows learning to take place during development and changes to be made in response to shifting needs as they are identified. In the authors experience, a combination of up front discovery work (in order to provide definition and purpose), followed by an iterative development methodology (supported by Agile practices) is the most successful at supporting learning and incorporating user feedback into future product iterations.

In the case of designing experiences for robots, prototyping and testing can present a unique challenge. Unlike web and mobile development, it can be difficult to scale the testing process due to the limitations around the need to have robots and participants in the same physical location for testing purposes. An example of overcoming this problem has been described by Srinivasan and Takayama [25] who used a multi-method approach to investigating politeness strategies for robots. Srinivasan and Takayama used

both on-robot prototypes and video prototypes to investigate their research and argue that this approach gave more confidence in the results [25].

An approach employed at SoftBank Robotics to overcome the limitations in being able to quickly test on physical robots has been to use role play as a tool to model an interaction. In this example, members of the team developing an application for the Pepper robot used a role playing exercise where a member of the team would play the role of the robot and a would interact with a participant who was playing the role of the human. The participant had no prior knowledge of what had been designed and was only given enough information about the experience that they would be reasonably expected to know. Using this method, we were quickly able to understand which parts of the interaction were not adequately supporting the interaction and needed to be modified. This method allowed for very quick design iterations without the need for any software development or deployment of the robot. A limitation of this approach is that we are not able to understand the limitations of the robot or it's capabilities in the experience, or observe the specific human-robot interaction limitations inherent when a human is interacting with a real robot. While it is acknowledged that this limitation exists, this method allows for quick iterations early in the design process ahead of prototyping using the robot.

5 CONCLUSION

This paper has argued the importance of applying a Human-Centered Design process to the design of experiences with social robots. In doing so, this paper has suggested three principles to help guide the design of social robot applications: Human First, Collaboration and Iteration.

Lastly, this paper has presented a number of tools that teams working to design experiences for their robots can apply to help bring a Human-Centered lens to their work.

6 NEXT STEPS

The work to apply and understand how modern methods of design practice can be used to support the creation of valuable experiences for social robots is ongoing. Much like the methods themselves, this investigation is iterative and is best served by trying new methods and learning from their application to determine success.

Continued research, testing and application of these methods is an area in which could provide a lot of value for the field of robotics and will help to highlight opportunities for design and solution-based thinking to support the development of robot products.

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REFERENCES

[1] [n. d.]. Aibo Robot. https://aibo.sony.jp. ([n. d.]). Last Accessed: 2018-01-19.
[2] [n. d.]. Amazon's Alexa voice service. https://developer.amazon.com/alexa. ([n. d.]). Last Accessed: 2018-01-19.
[3] [n. d.]. Apple's Siri Voice Assistant. https://www.apple.com/ios/siri/. ([n. d.]). Last Accessed: 2018-01-19.
[4] [n. d.]. Google's Voice Assistant. https://assistant.google.com/intl/en_us/. ([n. d.]). Last Accessed: 2018-01-19.
[5] [n. d.]. IDEO.org Approach. https://www.ideo.org/approach. ([n. d.]). Last Accessed: 2018-01-19.
[6] [n. d.]. An Introduction to Design Thinking Process Guide. https://dschool-old.stanford.edu/sandbox/groups/designresources/wiki/36873/attachments/74b3d/ModeGuideBOOTCAMP2010L.pdf. ([n. d.]). Last Accessed: 2018-01-19.
[7] [n. d.]. Jibo Robot. https://www.jibo.com. ([n. d.]). Last Accessed: 2018-01-19.
[8] [n. d.]. Kuri Robot. https://www.heykuri.com. ([n. d.]). Last Accessed: 2018-01-19.
[9] [n. d.]. Pepper as Host. https://www.softbankrobotics.com/us/solutions/host. ([n. d.]). Last Accessed: 2018-01-19.
[10] [n. d.]. Who is Pepper? https://www.ald.softbankrobotics.com/en/robots/pepper. ([n. d.]). Last Accessed: 2018-01-19.
[11] Kent Beck, Mike Beedle, A Van Bennekum, Alistair Cockburn, Ward Cunningham, Martin Fowler, James Grenning, Jim Highsmith, Andrew Hunt, Ron Jeffries, et al. 2009. Agile manifesto, 2001. *URL http://www. agilemanifesto. org* (2009).
[12] D. Ben-Menachem. 2016. Behavioral Archetypes. (2016). https://smashingideas.com/behavioral-archetypes/
[13] Clayton M Christensen, Taddy Hall, Karen Dillon, and David S Duncan. 2016. Know your customersâĂŹâĂIJjobs to be doneâĂİ. *Harvard Business Review* 9 (2016), 54–62.
[14] Design Council. 2015. The Design Process: What is the Double Diamond? *Available: www.âĂŃ designcouncil.âĂŃ org.âĂŃ uk/âĂŃ news-opinion/âĂŃ design-process-what-double-diamond, Abfragedatum* 10 (2015), 2015.
[15] Joseph Giacomin. 2014. What is human centred design? *The Design Journal* 17, 4 (2014), 606–623.
[16] Jeff Gothelf. 2013. *Lean UX: Applying lean principles to improve user experience.* " O'Reilly Media, Inc.".
[17] Dave Gray. 2017. Updated Empathy Map Canvas. *Online at https://medium.com/the-xplane-collection/updated-empathy-map-canvas-46df22df3c8a* (2017).
[18] Dave Gray, Sunni Brown, and James Macanufo. 2010. *Gamestorming: A playbook for innovators, rulebreakers, and changemakers.* " O'Reilly Media, Inc.".
[19] Laura Klein. 2013. *UX for lean startups: Faster, smarter user experience research and design.* " O'Reilly Media, Inc.".
[20] Tomasz Miaskiewicz and Kenneth A Kozar. 2011. Personas and user-centered design: How can personas benefit product design processes? *Design Studies* 32, 5 (2011), 417–430.
[21] James M Morgan and Jeffrey K Liker. 2006. *The Toyota product development system.* Vol. 13533. New York: Productivity Press.
[22] Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, and Alan Smith. 2015. *Value Proposition Design: How to Create Products and Services Customers Want.* John Wiley & Sons.
[23] John Pruitt and Jonathan Grudin. 2003. Personas: practice and theory. In *Proceedings of the 2003 conference on Designing for user experiences.* ACM, 1–15.
[24] Eric Ries. 2011. *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses.* Crown Books.
[25] Vasant Srinivasan and Leila Takayama. 2016. Help me please: Robot politeness strategies for soliciting help from humans. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems.* ACM, 4945–4955.