
Negotiating Ethical Making Between Humans and Machines

Tara Campbell
OCAD University
Toronto, ON, Canada
tcampbell@faculty.ocadu.ca

Sowmya Somanath
OCAD University
Toronto, ON, Canada
ssomanath@faculty.ocadu.ca

Abstract

While making can be a beneficial activity for many reasons, what gets made may not always be in the best interests of the wider world (i.e., others and the environment). It is the responsibility of makers to ensure their creations comply with a set of societally-agreed-upon ethical principles. However, the act of making is increasingly facilitated by machines, and these machines could also be involved with encouraging ethical behaviour. In this paper we explore this position from the perspective of a 3D printer, looking at what interactions between humans and machines might look like as they negotiate the process of making.

Author Keywords

3D printing; maker culture; ethics; sustainability; persuasive technology; experiential futures; speculative interfaces; post-anthropocentric design.

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]:
Miscellaneous

Introduction

The vision of the Maker Movement is to democratize technological practices and empower people to become producers of artifacts and knowledge [16]. As part of the Maker Movement, people build artifacts such as toys, robots, and

practical products using art and craft materials, programmable electronics, software, and fabrication tools. While making is beneficial and provides a means for self-expression and personal empowerment as well as improved technical literacy, the artifacts that people create are not always in the best interests of others. For example, one could make an artifact that could be used to physically harm someone. Or, one might not put much thought into the design and utility of their creation, leading to something that could end up as junk and contribute to issues of unnecessary resource use and waste [18]. As the Maker Movement grows, it is important to consider these potential issues. Currently, it is the maker's responsibility to ground their creations in societally-negotiated ethical principles - a responsibility they can choose to ignore. However, makers are no longer the only party involved; making is increasingly facilitated by machines (such as 3D printers, for example), who could also be actively involved in the consideration of these issues. In this paper, we explore the question: *how might we design future interfaces that allow humans and machines to negotiate and monitor the making process to encourage ethical making?*

Machines that motivate ethical behaviour in humans have been explored extensively through persuasive technologies - "interactive computing systems designed to change people's attitudes and behavior" [8]. Persuasive technologies have historically been explicitly programmed. With the goal of encouraging ethical behaviour in others, one can build persuasive technologies, embedding ethical guidelines into machines to inspire a change in their users. However, with the increasing power of machine learning it is not difficult to imagine that machines might soon have something to say about how to be ethical as well. Thomas Metzinger [12], in an article exploring agency, states that "superrational future AI systems could not only possess a much higher degree of

mental autonomy and internal consistency than we do, but that they'd likely be much better at moral cognition, too."

In possible futures where humans and machines are both ethical agents, what would human-machine interaction look like, and how should ethical issues surrounding machine-facilitated behaviour be navigated? Do humans even want machines involved in their decision-making process? If they do, what level of control should machines have over the making process? Should the machine act to encourage self-reflection around these ethical issues and inspire greater social change? To explore these questions we will consider interactions with 3D printers, a popular maker tool, as a case example. We will first position ourselves within the current research in this realm, followed by a discussion of our plans for conducting a study to understand the process of how machines and people can negotiate ethical behaviours related to 3D printing tasks.

Related Work

Our proposed study methodology draws upon a variety of research and techniques spanning multiple disciplines. Our research touches on the possible ethical capabilities of machines, how machines could be used to promote ethical behaviour, and how to both design for and engage people to explore a world where machines are considered moral agents.

Persuasive Technologies

Persuasive technology has been used to facilitate behaviour and attitude change in a variety of different contexts. For example, DiSalvo et al. [7] review the landscape of human-computer interaction that aims to promote sustainability. Specific examples include BinCam, which takes photos of one's personal trash and shares them online, encouraging self-reflection and behaviour change around

the production of waste [17], and Lockton et al.'s [11] digital platform that gave employees at a workplace feedback about the sustainability of their work-related actions (e.g. commuting, lunch choices, energy use) and provided them with motivation to improve.

Post-Anthropocentric Participatory Design

The process of negotiating what gets made invites the machine in as a participant and co-author of the making process. This position was explored by Devendorf et al.'s [4, 5] *Being the Machine* project (retitled *Redeform*) in which the human, machine, and materials were viewed together as co-creators. In this project participants embodied a machine, going through the motions of what it might be like to be a 3D printer. Considering the machine as a participant in the design and making process calls for a greater understanding of the machine perspective on the situation. McLuhan's idea that "we shape our tools and, thereafter, our tools shape us" [3] requires acknowledging the agency of a machine and the transition to a post-anthropocentric viewpoint [9]. How does one glean an understanding of the subjectivity of something unlike us that we cannot really communicate with? It is a longstanding question [13], but it is increasingly being explored from a methods standpoint. A few projects have attempted to see the world from an object's point of view; by attaching cameras to an object we can see what the world is like from its perspective. This kind of method has been used to explore urban environments from the viewpoint of small robots [6], and the perspective of everyday household objects [9]. In another vein, some projects involved 'embodying' nonhumans (machines, animals, objects). Woebken and Okada's *Animal Superpowers* project [19] used tools to augment people's perceptual abilities so that they could experience what it might be like to be an ant with advanced visual perception, or a bird that can sense the planet's magnetic field, etc. Abraham

Poincheval, a French performative artist has done several exhibitions embodying other lifeforms or objects [15], such as living inside a life-sized bear sculpture and consuming bear foods [14]. Bodystorming, a design research method, may have people play the role of an object in an interactive, physical experience [10]. In all of these examples, the researchers, designers, and artists, were able to expand their understanding of the capabilities and perspectives of nonhumans.

Our work is inspired by these projects and aims to explore how future interfaces for maker tools, such as 3D printers, can allow for their participation in the making process to encourage negotiation, reflection, and behaviour change around the ethically-oriented creation of fabricated artifacts.

Proposed Study Methodology

To explore how a smart 3D printer interface could be designed to promote ethical behaviour, we will invite participants to an immersive experience where they engage and create with a morally cognizant printer. We will explore these interactions with the ultimate goal of determining how interfaces might be designed to allow ethical negotiation between a human and a machine, the extent to which humans feel the machine should be involved in the making process, as well as implications on the making process.

In a possible post-anthropocentric future where machines are treated as a partner in ethical decision-making, a 3D printer and a human may have a dialogical relationship to negotiate what gets made. To demonstrate what these interactions might be like, we have prepared a scenario illustrating an ethical issue that may arise when interacting with a 3D printer. This scenario takes place in a possible future where 3D printers are smart, connected, and have advanced moral cognition.



Figure 1: Negotiating sustainable behaviour

Scenario: ‘I want to print many variations and copies of this prototype I’m working on’

This scenario explores a printing negotiation based on sustainability considerations (see Figure 1).

1. An industrial designer was commissioned to design a novel set of cutlery. They are working on designs for a fork, and they create many 3D models which they want to print and test.
2. They send their designs to the 3D printer. They want to print 10 variations of their design, and 50 copies of each. That means they want to print 500 prototype forks in total.
3. The printer receives the files and analyzes them.
4. The printer asks what material should be used to print them. The printer informs the creator about the different materials, and their ecological footprints.
5. The printer also asks the designer why they need to print 50 copies of each design, showing how the ecological footprint increases with additional copies.
6. The designer explains that they want to bring in many participants to test each design, and the printer suggests some alternative situations where fewer copies would be needed. For example, perhaps their participants could take turns with the prototypes.
7. The designer considers this, and chooses to print only 5 copies of each of their designs using recycled plastic.
8. The printer informs the designer how the plastic can be recycled once the fork prototypes have satisfied their purpose.

To further explore interactions like those outlined in the scenario, we will create an immersive experience using experiential futures techniques [1, 2]. Using a Wizard of Oz

method for testing prototypes, where an interactive system is controlled from behind the scenes while a participant engages with it [10], a researcher will control the printer, while the participant will act as the maker wanting to print an object. The participant will engage in a negotiation with the printer as to whether an object should be printed based on the maker’s internal moral code, and the ethical framework guiding the printer. We will be observing our participant and conducting interviews with them before and after to capture insights into how they felt about both the experience and a future where these kinds of interactions might take place. We will also explore the experience of the researcher playing the part of the machine.

Some aspects of the study need to be considered before moving forward:

- **Printer Interface** While a human will be acting as the machine, what will the interface between them and the other participant look like? We have to determine how they will be communicating, and if the maker will be able to tell that they are interacting with another human as opposed to a smart 3D printer prototype.
- **3D Printer Ethical Guidelines** Humans have their own internal moral codes, as well as an awareness of socially-agreed upon ethical principles. However, we will need to develop guidelines for the machine to follow. Multiple sets of guidelines could be employed amongst the different machine prototypes to test how alternate guidelines affect the interaction.
- **Measuring the Artifact** There are many ways to evaluate the experience we are creating. Contrasting the opinions of the participants playing the human and the researcher playing the machine, we can see how an alternative perspective of the interaction may change one’s attitude. Measuring how much the human and machine participants agree on the outcome

of the interaction could help determine the success of the negotiation. We could also aim to determine how ethical the agreed-upon artifact that gets made is by measuring it against some external ethical standard.

Future Work

Our short-term future work is to conduct a study to determine the effect of ethics on human-machine facilitated making process. Next, informed by our study findings we will develop an interface prototype. Through our work we hope to contribute to visions of preferred interactions between humans and future machines with moral agency, and to a better understanding of design principles for these interactions.

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