What is a Robot? Designerly Workshops for Speculating on Robot Futures in HCI

Amy Ingold
University of Bristol, United Kingdom

Janusz Swierczynski
University of Oxford, United Kingdom

Buse Aktaş
Max Planck Institute for Intelligent Systems, Germany

Alice Haynes
KTH Royal Institute of Technology, Sweden

Yanheng Li
City University of Hong Kong, China

Lisa May Thomas
University of South Wales, United Kingdom

David Wagmann
Saarland University, Germany

Amy Winters
Eindhoven University of Technology, Netherlands

Willa Yunqi Yang
University of Chicago, United States

The concept of the *"robot"* no longer evokes a single, stable image. As robot forms and functions diversify, so too do the assumptions, values, and priorities that shape their design. We report on the CHI 2026 workshop *Everything Is a Robot (and Nothing Is)*, which brought together HCI researchers to explore what robots are, what they could become, and how their futures might unfold. Discussions revealed themes spanning agency, communication, emotion, symbiosis, and technical challenges, while also exposing contrasting disciplinary assumptions, values, and future imaginaries. We identify three observations arising from the workshop: robots provide a shared conceptual space for interdisciplinary dialogue; designerly workshops make tacit assumptions and imaginaries visible; and timeline activities reveal an "inevitability trap", in which speculative futures become interpreted as likely trajectories. We argue that designerly workshops offer HCI a valuable means of imagining future robots while critically examining the assumptions that underpin them.

Robots, Designerly HRI, Futures, Workshop, HCI

1. INTRODUCTION

"Robot", the notion itself no longer conjures up a clear representation. The concept has ballooned. So when we now encounter this term, we may ask: Does it need a body? Does it speak? Does it follow instructions? Can it be worn? Can it grow? Can it become part of your body? Will it obey you? And, are you being manipulated by it? We are now in a place where what we call a robot, comfortably exceeds what we previously dreamt. This proliferation of functions and forms has not only been driven by advances in technological capability, but also by creative visions.

Within Human-Computer Interaction (HCI) the designerly[1] perspective constantly pushes boundaries. As a deeply multidisciplinary field, it engages a wide range of methodological tools with which to interrogate, innovate, and imagine. HCI researchers have led robot development through engaging Speculative design, critical design, Research through Design, and soma design to expand concepts (Auger 2014; Höök 2026; Lee et al. 2019; Rozendaal et al. 2026). Designerly approaches have expanded what robots can be, producing robots that are wearable, soft and intimate; that are embedded in furniture, act as interfaces, and extend our intentions through our clothing (Ingold et al. 2026b; Balaam et al. 2024; Haynes et al. 2024). In doing so, it continually challenges expectations about what a robot could, or should be, introducing robots that can be fragile, unpredictable or disobedient (Alves-Oliveira et al. 2021; Weir et al. 2025).

As the concept of the robot expands, so too does the diversity of assumptions, values, and priorities brought to its design. This plurality presents both an opportunity and a challenge. It expands the range of futures we can imagine, while making it harder to understand one another's perspectives, and recognise the assumptions that shape our own. Without such reflection, we risk reproducing inherited imaginaries of robotics and reinforcing narratives of technological inevitability rather than genuinely expanding the design space (Gamboa 2025). Rather than seeking consensus, HCI is well positioned to create spaces in which

[1] We use *designerly* in the sense established by Cross' account of "designerly ways of knowing" (Cross 1982), referring to forms of inquiry and knowledge production particular to design practice. This is in line with recent adoption of the term within human–robot interaction (HRI), where it has been used to describe work with a strong orientation towards design, including the development of novel robotic artefacts and engagement with design methodologies (Lupetti et al. 2021; Rozendaal et al. 2026).

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these assumptions, disagreements, and competing imaginaries can be made tangible and discussed.

To explore these tensions, the CHI 2026 workshop Everything Is a Robot (and Nothing Is) (Ingold et al. 2026a) brought together researchers from across the diverse disciplines that contribute to HCI. Through a series of designerly activities, participants were invited to examine emerging robot forms, challenge assumptions, and collectively imagine alternative robot futures. This paper examines the ideas shared throughout the workshop, exploring how researchers from across HCI imagined future robots. Participants proposed remarkably different robot forms, values, and research priorities, demonstrating the breadth of perspectives that coexist within contemporary HCI. We contribute three observations concerning robots as an intellectual meeting ground, the role of designerly workshops in surfacing assumptions, and the tendency for speculative futures to become interpreted as inevitable trajectories.

2. METHOD (WORKSHOP)

The workshop aimed to bring together diverse disciplinary perspectives to collectively imagine, question, and discuss robot futures. This workshop was held as a closed event, with attendees all previously submitting position papers or work summaries. Twenty-five people participated in the workshop. Participants came from a wide range of disciplines including engineering, computer science, psychology, design, sociology, management, and the arts.

Three hours in total, the workshop was delivered in two sessions. The first session was focussed on designing robots, the second explored possible future directions for robotics research within HCI. To begin the design session, a soma-focussed activity acted as an icebreaker, bringing participants into an embodied, relational space. Participants then engaged in a novel puppeteering design activity, collaboratively creating and performing imagined robots through movement and interaction (Weir et al. 2026). Working in small groups, participants selected and combined assorted craft, household, packaging and play materials (e.g. fabrics, sponges, bubble wrap and balloons), to prototype a robot entering a person's intimate space. The playful format encouraged participants to experiment freely with materials and ideas, while collaboratively exploring how a robot might move, behave and relate to a person. Each group presented their imagined robot to the wider workshop through embodied performance, sharing the ideas, narratives, and reflections that had developed through the creative process. During the activity and presentations, organisers captured concepts through notes. Within the break these concepts were grouped into themes. Participants then self-selected into the theme they wished to explore further.

Each group considered the significance of their theme for the future of robotics, identifying opportunities, challenges, and research priorities. Ideas were captured on Post-it notes before being shared with the wider workshop. Finally, participants placed their contributions onto a timeline spanning the present day to fifty years into the future, indicating when they believed each research direction could, or should, be pursued. The themes presented in the following section are those explored and developed during the workshop through this collective process of making, reflection, discussion, and synthesis. Each section has been written by participants who contributed to the corresponding thematic discussion. As a reflective synthesis, this approach offers a way to articulate the situated perspectives and points of tension that emerged through the workshop's collective activities and discussions.

3. THEMES

3.1. Agency

Our interdisciplinary discussions quickly allowed us to realise that there are multiple (overlapping) ways of thinking about agency (Noteboom et al. 2026). One of the most prolific social theorists, Anthony Giddens, provides an intuitive and encompassing approach to agency as the capability to "act otherwise" within a structured (social) system (Giddens 1984, page 14). Sourav et al. (2026) helped us to point out that agency is often conflated with concepts such as animacy, mind perception, anthropomorphism, and intentionality. This abundance of conceptualisations has resulted in research that has characterised agency as something inherent to the agent (a person or robot) e.g., consciousness, reflexivity, and intentionality (Burris et al. 2023) or as something behavioural e.g., when an entity displays a specific goal-oriented action (Beaudry et al. 2020). In effect, both these ways of thinking about agency assume that it is something that an individual actor possesses (Kuss and Meske 2025).

There is already a growing body of work around how people perceive agency in their non-human counterparts including the wider environment, flora, fauna, and technologies (Gray et al. 2007; Reddy et al. 2021; Trafton et al. 2024) as well as provocative work around how intelligent systems perceive and monitor the agency of their human counterparts in order to meaningfully work together (Sourav et al.

2026). This perception of agency can itself be consequential, as it may encourage over-reliance and diffuse accountability on both parts when "too much" autonomy and intentionality is attributed to one entity (van der Woerdt and Haselager 2019).

We discussed how agency emerges from the interaction between human and robot, rather than being associated with one of the entities in isolation. We connected this with more-than-human theoretical perspectives, in which human behaviour and society cannot be understood or sustained in isolation from the ecological and technical environment around it (Pyyhtinen 2016). Here, agency is a relational feature of interaction, rather than an inherent or behavioural characteristic associated with a single entity (Kuss and Meske 2025).

Given this entangled ecosystem, how and when should we design robots with the capability to "act otherwise"? This is particularly important as under certain configurations, robots have been shown to take on "leader" roles with humans taking a more submissive role (Ohata and Tani 2025). As well as raising ethical questions related to responsibility; at what point do robots become moral agents that are capable of taking responsibility for their actions (Gray et al. 2007)? Sooner than we imagine, we may be able to sue a robot or invite it as a witness in a trial (Michalski 2018). At a more immediate level, HRI researchers can interrogate these types of questions in relation to current robotic form factors e.g., digital chatbots, self-driving vehicles, with longer-term ambitions aimed towards more emerging or speculative forms of "agentic" machines that may become our interaction partners within our homes, workplaces, and public spaces. As robots take multiple embodiments and fulfil multiple roles in our lives, we just might have to move away from our anthropocentric and/or technocentric approaches, and consider not just more-than-human, but also more-than-robot perspectives, where robots are treated as part of a distributed socio-technical assemblage rather than as a singular agent.

3.2. Communication

How do robots and humans (users) communicate? Which robots and which humans? What are the issues? And what are some directions for future thinking and research around this theme? Robot communication of internal state, intentions, and actions is key to ensuring efficient and safe human-robot interaction.

First, we see a current trend in robotics that focuses on humanoid robots and iteratively improves their human-like communication methods, such as speech and gestures. Although these approaches leverage familiar human communication channels, they also constrain the broader design space for robot-human communication and risk overlooking potentially more efficient or effective alternatives. For instance, while current robot communication relies predominantly on auditory and visual feedback (Bonarini 2020), we also see potential in the remaining sensory modalities, such as tactile, proprioceptive, olfactory, and gustatory feedback (Mullen et al. 2021; Li et al. 2023; Noh and Kim 2026).

Furthermore, there is a need to adapt communication methods to the specific robot system (i.e., robot-aware communication). In contrast to humanoid robots, many robotic systems, such as drones (Walker et al. 2018) and domestic robots (Song and Yamada 2018), lack anthropomorphic features and hence cannot rely on conventional cues. Future work should therefore investigate communication concepts that can be applied across robots with diverse morphologies.

Moreover, robot communication must be adapted to the scenarios and environments in which robots operate (i.e., context-aware communication), as not all communication methods are equally effective in all settings (Lemasurier et al. 2021). For example, auditory signals may be ineffective in noisy industrial environments, while visual or gestural signals may be limited in crowded or cluttered spaces. Robots operating in such environments must dynamically adjust their communication strategies to maintain effectiveness. This involves more field studies to systematically assess robot communication across diverse real-world environments.

We identify a gap in robotics around these context-based communication needs with bystanders. Field studies have investigated how robots engage bystanders for assistance in public spaces when the robots are encountering uncertainty, and examined how these interactions impact bystanders' perceptions and attitudes towards robots (Yu et al. 2025). In safely communicating its motion intent to prevent collision, one scoping study identified that there is no common language established to systematise robot motion intent (Pascher et al. 2023). Using implicit, non-verbal cues (such as light patterns, spatial movements, and machine sounds) rather than direct speech may prevent cognitive overload for bystanders. Multi-sensory communication provides more than one approach. Essential in time-sensitive situations, in which robots (and humans) may need to act quickly (Tanjim et al. 2025).

Lastly, we discussed the use of robotics for human augmentation. The integration of mechanical and

technological devices with the human body to enhance, extend, and distribute the body beyond innate or "natural" capabilities. We see promise in robot feedback beyond human capabilities, such as expressive skin (Hu and Hoffman 2023), wearable devices (Mullen et al. 2021), and augmented reality interfaces (Walker et al. 2018). Ethical aspects remain critical, the 'augmented human' is not a phenomenon of our futures, it's already here in many different guises, through the work of performance artist Stelarc (Stelarc 2019) and in the development of military strategy and capability (Ministry of Defence 2021).

3.3. Technical

A robot's body determines what tasks are easy, hard, or impossible. While a humanoid robot promises general-purpose capabilities, many everyday tasks are spatially local, and might be better supported if the robot is embedded in, attached to, or distributed across the environment. A robot or actuation system can sit on a desktop (Anki n.d.; LivingAI n.d.; M5Stack n.d.), a shelf (Moyer et al. 2026), or attach to an object (Yang et al. 2024). Diverse robot forms can cover tasks that a general-purpose humanoid fails to address. Such robots broaden what a robot can look like or mean, introducing a distinct set of technical requirements: miniature sensors and actuators for compact bodies, flexible mounting for easier situating of a robotic device, and power-efficient operation for small robots running on small batteries. A distributed, multi-robot approach also introduces a different kind of complexity, where robots must communicate and coordinate with one another (Nurmaini and Tutuko 2014; Sheng et al. 2006). This requires a communication protocol that functions across heterogeneous robot systems.

Robots must also handle instructions of varying specificity, from direct teleoperation and manipulation, to specific or open-ended verbal instructions. The less specific the instruction, the more interpretive and decision-making work the robot must perform. In particular, what counts as successful task completion differs from user to user. Robots that interpret only a narrow range of task definition success may serve some users well while excluding others. For example, 'clean the room' could mean: organising misplaced objects and removing dust, or removing dust without changing the objects existing arrangement. Since "success" differs by user, the robot needs to confirm with the user or learn personal preferences. Handling this spectrum requires the robot to support multiple control modes and to fall back to direct control when its interpretation confidence is low (Tellex et al. 2014; Sadigh et al. 2017; Erdem et al. 2020).

People's needs change over time requiring robots to perform different types of physical tasks. Because many physical tasks depend heavily on hardware — the sensors, actuators, and materials the robot carries — when that hardware no longer matches users' needs, reconfigurability allows users to swap, upgrade, and recycle parts of the robot. This can range from short-term, task-specific modifications to long-term adaptations across a robot's life stages. Reconfigurability also supports more sustainable repair and maintenance (Chen et al. 2026), since the robot can be replaced and upgraded part by part rather than as a whole, lowering the cost of maintenance. To achieve such reconfigurability, modules must first be self-identifiable (IEEE Standards Association 2010), so that the robot architecture can apply universal control over them. Connectors must be robust mechanically and electrically while remaining easy for users to detach and reseat. Robust quick-change couplers are well established, from industrial tool changers (ATI Industrial Automation n.d.; Zimmer Group n.d.; Berenstein et al. 2018) to the genderless connectors developed for self-reconfigurable modular robots (Murata et al. 2002; Liu et al. 2023; Romanishin et al. 2013). However, this carries costs: connectors add failure points, weight, and calibration burden, and modular systems may be bulkier and underperform relative to integrated designs.

3.4. Emotion

We came from a range of backgrounds and brought very different ideas about what actually counts as a robot. For some, robots were primarily conversational agents, such as chatbots, virtual assistants, and AI companions that interact through language. Others thought of robots as embodied systems, ranging from soft robots and wearables to interactive artefacts such as pillows. These different perspectives influenced how emotion was approached and perceived in our discussions. Some focused on conversation and communication, while others were more interested in embodied and material forms of interaction.

Regardless of how we defined a robot, the conversation repeatedly returned to relationships. Discussions about emotional recognition and expressivity soon gave way to a more human concern, what happens when humans become emotionally invested in robots? Questions of attachment, companionship, loneliness, and dependency quickly came to the fore. This led us towards emotionally responsive technologies and the surprisingly intimate roles they already occupy in many people's lives. Digital assistants, AI companions, and therapeutic chatbots are becoming increasingly common. They are designed to listen, provide reassurance, and offer companionship, yet

they remain computational systems rather than sentient beings. If individuals already confide in chatbots or use them as a form of therapy, what happens as these technologies become more capable and more deeply woven into everyday robotics? And what happens when your emotions become part of someone's business model?

Looking ahead to the next decade, we speculated on what might be lost. Human relationships can be demanding. Yet, many felt that these difficult moments also give relationships significance. If emotional needs are increasingly met by artificial companions, will new emotional gaps emerge? Several reflected on the importance of reciprocity in relationships. Caring relationships derive meaning not only from receiving support, but also from being needed by others. Parents, for example, often describe being needed by their children as a central part of what gives the relationship meaning. What happens when emotional support is always available, but no longer reciprocal?

A recurring concern was whether people might become less comfortable navigating the messiness of emotion within human relationships if artificial companions become attractive alternatives. Some wondered whether social expectations might gradually shift. If companionship becomes increasingly personalised and available on demand, how might this influence how people relate to one another? Reflecting on these discussions of companionship, intimacy, and emotional support, we can begin to question the role of friction in emotional life. Should the goal of emotional technologies be to completely erase discomfort? Many of the relationships that we value the most are not seamless. They might involve awkward conversations, misread signals, strange body language, and sometimes mutual disappointment. Although our discussion here was not explicitly focused on negative emotions, many of the concerns raised point towards their value. Discomfort, awkwardness, irritation, and uncertainty are often treated as experiences to be avoided. However, emerging work in HCI and HRI suggests that such experiences can create opportunities for reflection, engagement, and emotional release that smoother interactions do not always provide (Luria et al. 2020; Op het Veld and Winters 2026).

3.5. Symbiosis

Symbiosis refers to close, long-term relationships between dissimilar agents, originally a biological term referring to relationships between organisms of different species. What might a symbiotic relationship between robots and humans look like? Can robots be designed to engage in and sustain such relationships? And what might future robots be like if we designed them for symbiosis? Within the workshop group this proved a generative theme, offering a perspective that most of us had not previously applied to robots.

To think of a robot as a symbiont is to locate it within a much older repertoire of relationships we already maintain with non-human others. Long before we shared our homes with machines, we shared them with pets and houseplants. A person and a dog are not two pre-formed beings who happen to enter a relationship; they are partly constituted by it, becoming who they are in and through the entanglement: we adapt our rhythms to theirs and they to ours, until the boundary between "mine" and "other" in the shared space grows soft. Brought to bear on the robot, this leads us to think about who we are becoming by living with it, and who is it becoming by living with us.

A large part of our conversation centred on bodily symbiosis, relationships in which, as one participant put it, "you are part of them, and they are part of you." This included discussions of puppetry, wearable robots, prostheses, and other extensions of the body. Puppetry came up from one of the participants who has expertise in puppetry and performance. We discussed how the boundary between the puppeteer and puppet blurs as the puppeteer controls the puppet's body while simultaneously presenting the puppet as a distinct agent with its own apparent autonomy and agenda. Transferring this to robotics, we can think of wearable and robotic limb technologies - devices that augment or extend the body - in similar terms.

Prosthetic technologies that can extend, replace, or magnify the body's natural capacities have been part of human experience for centuries, for example, clothing, spectacles, and walking sticks are common prosthetic technologies of daily life. Over time, with advancements in technology, the degree of autonomy these technologies can possess has increased. As robots become more capable of sensing and responding to their wearer's intentions, the relationship could shift from tool use toward something more genuinely symbiotic; a responsive entanglement in which the device anticipates, adapts, and perhaps changes alongside the wearer over time. The boundary between the body and technology blurs here also, for example, do we view a prosthetic limb that sends and receives feedback with the nervous system via implanted electrodes as in symbiosis with the body, or part of the body itself? This brought up Haraway's concept of the cyborg (Haraway 2013), which troubles the dualisms of human/machine, self/other, and nature/culture,

arguing that these boundaries are unstable and that the human body is not a closed, bounded thing.

Following this thread, our group discussed wearable robots and jewellery that inhabit or adorn the body's surface. For example, what might technologies from the HCI field such as Omnifiber (Kilic Afsar et al. 2021), Jizai arms (Yamamura et al. 2023) or kinetic wearables (Kao et al. 2017) become if designed as autonomous systems on the body? This discussion expanded to living robots, grown from or incorporating living materials, such as plant- or microorganism-based structures that grow on and around us, changing in form as the relationship evolves. To us, this topic felt more speculative and far in the future, yet biohybrid systems are already being explored through microorganism-bots, tissue-based robots and artificial control of animal bodies (Webster-Wood et al. 2023).

As a final reflection, we note that symbiosis may not be a single or uniformly positive mode of relation. In biology, symbiotic relations may take different forms: mutualism, in which both parties benefit; commensalism, in which one benefits while the other is largely unaffected; and parasitism, in which one benefits at the expense of the other. These distinctions help us ask more carefully what kind of relationship a symbiotic robot might establish with its human co-inhabitants and which kind of relationship we want to design for.

4. DISCUSSION

With this workshop, we set out to explore HCI's unique strengths of interdisciplinarity and designerly methods, and apply them to understandings of what robots are and what robot futures might look like. We suggest that the concept *"robot"* functioned as a boundary object (Star and Griesemer 1989), allowing each discipline to bring their own preconceptions, while creating a shared space of common identity under the umbrella of this term. Rather than producing fragmentation, these disciplinary differences generated recurring themes that cut across perspectives, revealing shared concerns around agency, communication, emotion, symbiosis, and design. We argue that the term *"robot"*, within HCI, has collaborative value as an intellectual meeting point.

However, within these unifying themes, disciplinary assumptions surfaced and tensions were revealed. For example, while conversations about agency questioning the implications of robots 'acting otherwise' leant towards caution, those discussing emotion suggested this relational friction may be desirable, or even essential to avoiding social risk. Further, the terms employed to refer to humans varied across thematic discussions, ranging from "people" to "users". Was this due to the context of the subject discussed, or does it define what can be discussed, and how outcomes are produced? Whether these assumptions simply reflect the context of discussion or actively delimit what can be imagined remains an open question. Nevertheless, the workshop made these otherwise tacit framings visible, creating an opportunity for participants to question how disciplinary perspectives shape both the topics discussed and the futures that emerge from them.

One assumption became particularly apparent during the timeline activity, where participants were asked to situate their speculative robot futures across the next fifty years. Despite this extended timeframe, many ideas were positioned as urgent, imminent, and responsive to contemporary developments in robotics. In other words, once speculation was forced onto a temporal trajectory, imagined futures quickly became likely futures. We describe this tendency as an inevitability trap: the implicit assumption that envisioned robot futures are not only possible, but inevitable.

Questioning the rush to close down uncertainty is particularly important as many robots are increasingly discontinued (Cagiltay et al. 2026) or remain deeply contested, as in the case of warfare drones (Gamboa 2025; Kramer 2026). Rather than fixed trajectories, robotics appears to be undergoing a broader sociotechnical transition, one characterised by radical uncertainty: the recognition that we do not know, and cannot predict, what the future holds (Knight 1921). In this sense, the future cannot be reduced to an epistemic barrier awaiting resolution through further research alone (Hovorka and Mueller 2025), and we risk reproducing the research-centric and capitalist imaginaries of technological inevitability described by Gamboa (2025) if we treat it as such.

As HCI researchers, we should resist closing down uncertainty and ambiguity too quickly (Wilde and Karyda 2026). Workshops such as ours demonstrate that bringing together diverse perspectives around boundary objects such as "robots" does not require consensus. Instead, they create space for assumptions to become tangible, for competing imaginaries to be questioned, and for speculative futures to remain open to debate. If the concept of a *"robot"* is becoming increasingly expansive and contested, then embracing this plurality may be one of HCI's greatest designerly strengths.

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