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Difference-in-relation: Diffracting human-robot encounters

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Abstract

This article adopts Donna Haraway's (1992) and Karen Barad's (2007) lenses of reflection and diffraction to probe into human-robot relationships in-the-making. Dominant practices of human-robot interaction aspire to an optics of reflection based on the belief that the differences inherent to machines need masking or assimilating. I propose that diffracting human-robot encounters requires becoming-with and co-worlding with artefacts and their asymmetries. Entering the robot lab to witness my collaborative Machine Movement Lab project and its diffractive strategies in-the-making, as well as the material-bodily knowledges they enact, offers situated insights into how they make tangible difference patterns and relational ontologies at work in our more-than-human encounters.

Keywords

Human-robot interaction; Diffraction; Reflection; Performative practice; Entanglement; Transcorporeality; Performance.

Introduction

Robots will soon be our drivers, couriers, receptionists, soldiers, teachers, nurses, therapists, and lovers, according to—mostly Western—technology-driven futurist narratives. News media commonly offer us[1] a limited binary vision of this future, with social robots either heralding a flourishing revolution (Glinska, 2020) or a job-stealing plague (Taylor, 2019). Granted, nowadays robots are still mostly confined to factory floors and public spectacles that often involve them dancing in unison. Yet major European policy makers already proclaimed that they will transform our society, influencing "every aspect of work and home" (euRobotics, 2013) in the next decade (see also Van Roy et al., 2021). Whether this will remain a (heavily funded) technophile futuristic vision or not, the practices we develop and support, as well as the boundaries, identities, and meanings they enact in pursuing this vision, both literally and ethically matter. They matter because they perpetuate conservative narratives and exclusive hegemonic politics oriented toward wealthy societies that dismiss and demobilise the matterings of both, the less-than-privileged human and the less-than-human nonhuman. Instead, they arrest both bodies and things in mimicry and servitude.

In this article, I will look at human-robot interaction (HRI) as a practice concerned with the making, affirming, and configuring of boundaries between subjects and objects, predicated on fixed notions of the model Human (Suchman, 2011), from the hybrid perspective of my interventionist material-bodily practice and new materialist thinking. From within HRI practice, subject-object boundaries are rarely looked at as a question of production or sociomaterial mattering. Rather, their effects of difference are deemed uncomfortable, in need of being assimilated, at the same time as the identities they engender are being taken for granted. From a new materialist perspective, subjects and objects, in contrast, are neither given nor fixed but rather emerge from the practices of imagining, designing, and enacting human-robot relationships (Suchman, 2007; Treusch, 2020). A number of theoretical works challenge our current visions of human-robot relations with regards to stereotypical gender performances and divisions of labour (e.g., Castañeda & Suchman, 2014;

[1] 'Us' here refers to American and European audiences.

Søraa, 2017; Stacey & Suchman, 2012); and a number of ethnographic studies have explored some of the material effects that these normalised performances produce (e.g., Alač, 2016; Broadbent, 2017; Robertson, 2017). They speak to our onto-epistemological practices and how they inscribe our beliefs and values into our robotic designs, manifesting boundaries that materialise how we differentiate potential human/nonhuman, mind/body, information/matter and subject/object divides. Furthermore, they affirm, evoke, extend, omit or inhibit agencies and, with it, the kinds of relationships that we can have with these social/ised machines, as well as who can have them. Beyond experimental propositions offered by artworks, critical research practices that offer material interventions that counter "restagings of the model Human" (Suchman, 2011, p. 80) are still rare. Pat Treusch's (2020) technofeminist intervention into robotic collaboration, for instance, contributes an alternative, entangled mode of coboting by bringing the sociomaterial dynamics of knitting to the robotics laboratory.

Common HRI approaches with a propensity to restage either the model Human or caricatured versions thereof deliberately shield us from the unpredictable, generative messiness and situatedness of relationships in which humans and machines entangle, dynamically co-constituting each other, and differences make meanings. Such hollow mirrorings of the Human are not only troublesome from an ethico-onto-epistemological viewpoint but also fail to engage with one of the most significant characteristics of human-robot relations—that we can bodily resonate with these machines and kinaesthetically extend into their embodied dynamics and the more-than-human sociomaterial relations they spawn. Participating in this significant potential, however, requires understanding both bodies and machinic things as multiple, porous and always already entangled. The aim of this article is to articulate a counter practice to universalist human-robot configurings by opening up my practice and introducing the material alliances, bodily knowledges and experiential processes that have forged my ontological disposition toward human-machine entanglings. The latter, in a nutshell, embraces the machinic and its differences as more-than-human, promotes an aesthetics of embodied, relational meaning-making (Gemeinboeck, 2021), and understands practice as a becoming-with the material, emergent, always unfinished, and never fully graspable.

This disposition is the heart of my Machine Movement Lab (MML) project, crafted in collaboration with dancers, choreographers, AI researchers, engineers, and numerous material participants (from cardboard, PVC tubes and machinery components to electronic assemblages and software programs), across robotics labs, dance studios, fab labs, and gallery spaces over the past six years. MML is an arts-led research practice that brings together creative robotics, choreography, performance techniques and machine learning, grounded in an enactive, performative framework. It opens up an intimate link to performance-based inquiries into the potential of transcorporeal reconfigurings and harnesses the generative potential of movement and its dynamic qualities to probe into the relational enactment of human-robot encounters. Robots here are abstract, machinelike artifacts, and probing does not happen from outside but involves material-bodily entanglings with the becoming-machine. The more-than-human entanglings allow us to attend to and aesthetically put to work difference-in-relation by fostering a horizontal becoming-with and productive enmeshment of material propositions, kinaesthetic experiences, movement dynamics, and relational affordances. It is this unknowable yet generative tangle of things, processes and resonances from which possibilities for encounter and meaning-making arise. The latter, as we learned over hundreds of variations of entanglings, are the result of the differentiating that is propelled by this generative embroil, producing the interference pattern from which subject-object boundaries emerge.

The relational material-bodily effects of interference patterns mobilised in our MML practice contrast overly simplistic representationalist approaches in HRI that disregard the performative potential of more-than-human encounters. I argue that common HRI approaches are invested in an "optics of reflection" (Barad, 2007, p. 135), whereas a new materialist approach works diffractively by attending to how subjects and objects are mutually constituted and differentially enacted (Suchman, 2007). My discussion of practices of boundary-making is thus framed by Donna Haraway's (1991, 1997) and Karen Barad's (2007) figurative lenses of reflection and diffraction. Reflection and reflexivity "only displaces the same elsewhere, setting up worries about copy and original" (Haraway, 1991, p. 16), whereas diffraction "attends to the relational nature of difference" (Barad, 2007, p. 72), shifting the focus from representationalism to performativity. I begin with discussing practices of reflection in HRI, in tandem with

some of the core beliefs and values that shape subject-object boundaries and, with it, the identities and agencies they manifest, such as gender and other (human) social norms. I then turn to the lens of diffraction to explore how difference patterns arising from the productive interferings that shape our more-than-human encounters materialise as differentiated subjects and objects. In the remainder of this article, I take a closer look at the entanglings and enmeshments that my MML project mobilizes to diffract the human-robot encounter. The encounter here begins with the first design stage and is re-enacted in each interactional situation; it cannot be designed or designed for but rather emerges from material-bodily reconfigurings and resonances, where subject-object boundaries are rendered elastic through transcorporeal bodying-thingings. Hence, instead of designing them as programmable events, human-robot encounters require us to get entangled with and attend to more-than-human interferings and embrace the emerging and multiple.

Reflection: human-robot interaction (status quo)

The "social robot" is a peculiar sociotechnical thing, which often—perhaps more so than others—is deliberately positioned on the boundary between subject and object. This precarious suspension, however, does not manifest itself in imaginative designs that experiment with human-nonhuman divides, but rather commonly gets resolved by making the object look like a subject. While, on the surface, this may appear as breaking down subject-object boundaries, it more commonly serves to echo and reaffirm the differences and hierarchies that this boundary is founded on (Suchman, 2011).

> "Meet Pepper … not your typical robot. […] Pepper is here to make people happy, help them grow, and enhance their lives. Think of it as high tech you can high five […] because Pepper is a friend, an advisor and a business partner – the emotional humanoid robot built to benefit mankind" (SoftBank Robotics US, 2016).

Pepper is one of the most high-profile social robots that we can already encounter in shopping malls or see on television talk shows. The promotional video paints a vision of a near future in which we live and work with robots reminiscent of ourselves—

helpful, polite and gendered—and human enough that we can easily empathize with or "high five" them. Pepper is representative of dominant approaches to developing a robot's relational capacities by relying on superficial qualities, for instance a familiar visual appeal and/or humanlike personality. The latter is supplemented with enormous cartoony eyes, soft shiny curves, head-tilting, gesticulating arms, and a girlish etiquette. It is up to the user to define the purpose of this friendly, humanlike shell and, with it, a role that befits a 1.2m tall robot girl with a perky voice. Although it is worth noting that, according to its manufacturer, Pepper does not have a gender" (SoftBank Robotics US, 2017).

Figure 1. Geminoid F and Jill Bennett, Creative Robotics Lab, UNSW, 2013.

In contrast to humanoids, androids or geminoids present us with a mirror image, which, on the surface, is unashamedly and unnervingly perfect (see Figure 1). Beneath their silicon skin and fluttering eyelashes, they often rely on a human operator to make sense of and connect to the world around them. The android as a phenomenon makes a case in point for Haraway's (1991) "worries about copy and original" and cannot simply be dismissed as a techno-fetish spectacle. It not only manifests age-old,

humanist desires for replicating human life and reiterates dominant assumptions about sex and gender roles (Robertson, 2010) but lends itself to reinforcing hegemonic social norms that "tend to both mirror and embody state and corporate ideologies and priorities" (Robertson, 2017, p. 82).

Many of the current approaches to human-robot interaction get caught up in, what Barad (2007, p. 135) describes as a "representationalist trap" of reflection. The relatively young robotics practice attracts considerable investment into bridging the ontological gap between humans and robots (Guzman, 2020); to mask the profound differences and "deep asymmetries" (Suchman, 2007, p. 11) between humans and machines, HRI research not only "look[s] for homologies and analogies between separate entities" (Suchman, 2007, p. 88) but makes it its mission to model and fabricate them. Given the entirely different mechanical, sensorial, cognitive and behavioural makeup of machines, in tandem with a complete lack of experiences embedded in a society and culture, one would think that no amount of cute or humanlike veneer can render these socialised machines more symmetrical opposites. Yet, the otherness inherent to machines is seen as disrupting pleasant interactions and successful exchanges with them and there is large agreement in HRI communities that it requires softening or obscuring altogether (Sandry, 2016; Castañeda & Suchman, 2014; Dautenhahn, 2013).

The superficial human façade is not only a short-cut, arising from an overly problem- and solution-focused approach and a desire for control (Gemeinboeck & Saunders, 2021), but builds on the belief that humanlike features and behaviours can be orchestrated to program social agency into the machine (Alač, 2016; Jones, 2017). A robot's social capacity is thus considered a property, which is intrinsic to the agent, rather than a matter of enactment, which unfolds through the dynamics of the encounter and the social situation it is embedded in (Suchman, 2007; Alač, 2016). Cut off from the world and equipped with their own autonomous agency, our humanoid companions boldly reflect our "humanist preoccupation with the individual actor living in a world of separate things" (Suchman, 2020, p. 362). Furthermore, understanding social agency as an attribute requires a machine's social qualities to be defined and represented, whether in the form of physical features or programmable behaviours. Behind every individual robotic social actor is thus a designer or a whole team, whose

beliefs and intentions shape its apparently autonomous capabilities and, with it, the relationships it participates in (Mindell, 2015). Importantly, these beliefs and intentions do not only manifest in perky or uncanny features but also material boundaries that delineate who and what matters and whose agencies are affirmed, extended, inhibited or omitted (Suchman, 2011; Treusch, 2020). Robotics practices favouring sameness and mimicry over difference and heterogeneity are thus vulnerable to becoming complicit in affirming and perpetuating hegemonic networks of power.

Rather than attempting to answer the rhetorical question of why we are so invested in the pursuit of rendering our machines as humanlike as possible (Suchman, 2007; Wajcman, 2017), the following sections explore what I believe is a much more interesting question: what if, instead, human-robot relationships are about getting entangled and resonating with something more-than-human to make meaning with entities that dramatically differ from us?

Diffraction: human-robot intra-action (the entangled kind)

Diffraction, itself a phenomenon of the entangled kind, attends to the specificity and materiality of entanglements (Barad, 2007). According to Haraway (1991, p. 300), it is "a mapping of interference, not of replication, reflection, or reproduction". A diffractive approach to HRI thus problematises subject/object and human/nonhuman dichotomies engrained in current robotics research. To get entangled and resonate with machines then requires collapsing the distance between subjects and objects, such as the one produced by a representationalist approach of reflection. Within the context of boundary-making, it is worth reminding ourselves, however, that diffraction and reflection are not opposites (Barad, 2014). Our practices, whether doing HRI reflectively or diffractively, enact cuts that produce separations and effect boundaries; where they differ is a matter of disposition—whether we understand subjects and objects as pre-existing and fixed or as enacted, differentiated-entangled. Thinking and making machines from the (super)position of "together-apart" (Barad, 2014, p. 168) also makes for a differentiated set of possible relations: an entangled approach provokes more entangling.

> Meet the Cube Performer … definitely not your typical robot. You didn't even take note of the box until one of its corners suddenly raised upwards and gradually tilted toward you. The Cube Performer is not here to make people happy; it is here to stretch our imagination and 'become with'[2] something more-than-human. Think of it as a thing you can dance with, entangle with, and be moved by … you don't know what. The box begins to skitter, reaching toward you, then halts, precariously tilts onto one of its corners and slowly sways, as if waiting for you to respond. You are disoriented … then re-orient yourself toward it, sway with it, and find yourself in tune—a tune you will never fully understand.

Figure 2. *Cube Performer #1* with Marie-Claude Poulin (right), AMATA, Falmouth University, UK, 2018.

We built the Cube Performer[3] (see Figure 2), our first robot prototype, after fostering and attending to material entanglings between dance performers and a wide range of materials and shapes for two years (Gemeinboeck, 2021); not to benefit humankind but out of curiosity of what could happen if we quite literally folded humans and nonhumans into one another (see Latour, 1999). Rather than accessorising the robot with googly eyes and pre-packaged emotional mannerisms like Pepper, the Cube

[2] I refer here to Haraway's use of 'becoming with': "The partners do not precede their relating; all that is, is the fruit of becoming with" (2008, p. 17).

[3] Despite introducing my robot in a parallel fashion to Pepper's introduction here, it is worth noting that I do not present the Cube Performer as a 'social robot'. Rather, its purpose is that of a material research proposition allowing us to inquire into the relational-performative potential of machine artefacts and the possible relations they may enact, as well as to engage publics in more-than-human performance scenarios (Gemeinboeck, 2021).

Performer relies on the relational, enactive potential of movement qualities and how they can propel the dynamics of an encounter to participate in it. Movement here is no longer an instrumental capacity but a material, diffractive phenomenon itself, generating interferences and entanglings that give rise to affects and meanings.

Shifting the focus from representation to performativity prompts us to re-imagine a robot's social agency as emerging from the dynamics of the encounter. Agency, in this relational view, is not a property that someone or something can have or be fitted with but rather "agency is a matter of intra-acting … an enactment" (Barad, 2007, p. 178). It is the ongoing "material (re)configurings of the world" (Barad, 2007, p. 151; see also Haraway, 2008; Latour, 2005) through which the boundaries of subjects and objects and, with it, meanings and identities, are differentially enacted (Suchman, 2007). Questions of agency and meaning in HRI design are often taken for granted and amenable to technical reappropriation; determined by individually held representations, the effect of social agency becomes a design feature, similar to an animated character, e.g., expressive eyes, quality of voice, a pre-programmed repertoire of gestures, etc. (see de Graaf & Ben Allouch, 2013; Sabanović, 2010). A designer's intra-action enacting the cut (Barad, 2014) of a girlish voice paired with flowing curves arrests the machine in the performance of a gendered object; it takes a great leap of the imagination to participate in an encounter with Pepper, for instance, that could enact a differentiated identity.

Representationalist/reflective approaches thus seem to confront us with a set pattern, which resists reconfiguring. While diffractive patterns, only revealing themselves to those who seek the entanglement, open up the possibility to become-with, rework and "being reworked by patterns of mattering" (Barad, 2014, p. 187). Yet our relationships, whether human or more-than-human, and their ongoing becoming-differentiating-entangling are of the diffraction pattern of their mattering. There is no outside of the diffraction pattern (Barad, 2014), which also implies that practices of boundary-making and the sociocultural situation they are embedded in are deeply intertwined. Human-robot relationships of the reflective kind with their set pattern thus place themselves outside of the diffraction pattern; they have already ceased to matter, trapped in re-executing the same pattern, over and over again. In contrast, more-than-human relationships of the entangled kind are open for subjects and objects to be

differentially enacted, unanchoring humans and machines from their universalist, culturally neutral categories (Nakamura, 2003).

Doing HRI the entangled way also challenges the Cartesian trap that requires an agent to be autonomous to participate in an interactional exchange. Narratives of machine autonomy deliberately position the designer/engineer outside of the diffraction pattern and its ongoing reconfigurings (see Stacey & Suchman, 2012) and serve to detach the machine from both humans involved and the wider network that the machine and design process are embedded in (Gemeinboeck, 2021). From an entangled viewpoint, autonomy is reduced to an effect, rather than a capacity—the effect of a machine that had its relational network cut off (Suchman, 2007). A diffractive approach thus positions the designer/engineer in the middle of the human-machine encounter, no longer distant to or outside of its matterings and the conditions they arise from.

In the remaining sections I will take a closer look at the more-than-human entanglings that we foster in my Machine Movement Lab (MML) project, the co-worldings they enact, and the new forms of transcorporeal meaning-making that arise from difference-in-relation.

Diffracting the encounter: bodying-thinging

Shifting from a representationalist to a relational-performative view, human-robot relationships are no longer anchored to distinct entities, given agencies and fixed subjects and objects but instead unfold through dynamic entanglings and differentiatings from which meanings emerge. It is important to keep in mind that our more-than-human relationships always already are entangled; hence, diffracting human-robot encounters in practice is not about designing these entanglings but rather about designing-with entanglings (Gemeinboeck, 2021). This distinction is vital as it moves us from a position outside of the encounter, which apparently grants us a view from the top to define and control what unfolds, to a position in the middle of the encounter, where we find ourselves amidst a thicket of more-than-human actants. The latter opens up a more horizontal playground, where meaning-making can only be a matter of enactment rather than control. Diffracting here means designing-with the

encounter, to continuously form alliances between bodies and materials and their relational, affective capacities and aesthetically attend to possibilities as they emerge.

To provide a more situated, material account of the unforeseeable, dynamic encounters this playground opens up, let's briefly step into our dance studio, set up temporarily in a robot lab[4]. Imagine a large space with a few work benches, pushed to the sides; on one of them sits Kaspar, a "child-sized" humanoid robot (IEEE, n.d.), with its small feet dangling over the edge; next to it is a jumble of electronic components, cables, a soldering station, and an oscilloscope. Around the corner, Paro, a fury robot seal (Paro Robots, n.d.), rests on a shelve, surrounded by more tools, cables, and components. The opposite wall looks surprisingly rugged in this environment, dotted with holes and bits of plasterboard hanging off; it is a four-meter-long installation of my artwork Accomplice, turning walls into a noisy, playful machine habitat.[5] As we turn toward the middle of the space, we witness a large cardboard box with a pair of (human) feet, lumbering toward my camera. About two meters away, the choreographer sits on a lounge chair, bent forward and intensely watching the box. I'm standing behind the camera tripod, next to a stack of springy, textile tubes; they used to be foldable garden bins and I still need to tape them together so that we can play with this springy potential.

The choreographer shouts a range of words into the room, they serve as prompts for the dancer, whom the feet belong to … "listening!" … we see the box slowly lifting and twisting sideways, dithering … "question mark!" … "what?", a muffled voice returns, "QUESTION MARK!" … there is a pause, the box gradually lifts, tilted at an angle, seemingly positing layers of time along the way, as if duration could perform a shape, then a sudden shift in gears and the shape accelerates upwards with a twist before it comes to sudden halt. We stop for a break and the dancer thrusts the box backwards and wriggles out of it. When I asked her what she was thinking/doing when she heard "question mark", she said that she did not know, she was just searching, attempting to find a trajectory with the box, struggling to not loose balance. When we looked at the recording together, we saw how the weighting of the box changed along the search for a trajectory; the box clearly participated in the shaping and rhythming of this

[4] Creative Robotics Lab at UNSW Sydney.
[5] Accomplice by Petra Gemeinboeck and Rob Saunders, 2013 (see Gemeinboeck and Saunders, 2016).

performance of a question mark. The bodily processing of what a question mark does, interfered with by the mattering of the cardboard box, and gravity, no less.

We are not interested in what any of these words represent or what performances they shape. Rather, we are interested in how this entangled performance of a human performer and non-humanlike forms with their non-humanlike matterings unfold; how they couple , interfere, or "undo and redo each other" (Despret, 2013, p. 61), and what kind of relations and sensations they co-world. To explore this more-than-human performance, we asked dancers to bodily extend into a wide range of simple, abstract shapes with varying material qualities by entangling with them (mostly from the inside) and moving with them (see Figure 3). We then selected some of these simple geometric shapes to build wearable costumes using lightweight, sturdy materials (e.g., fluted plastic, thin plywood, and aluminium extrusions). The costumes stand in for the morphology of a becoming-robot and its unique spatial-material affordances. They also allow us to trace the kinetic dynamics unfolding in this more-than-human entanglement, which, later, co-shape the robot's machine learning process, where the robot learns to improvise its movements.[6]

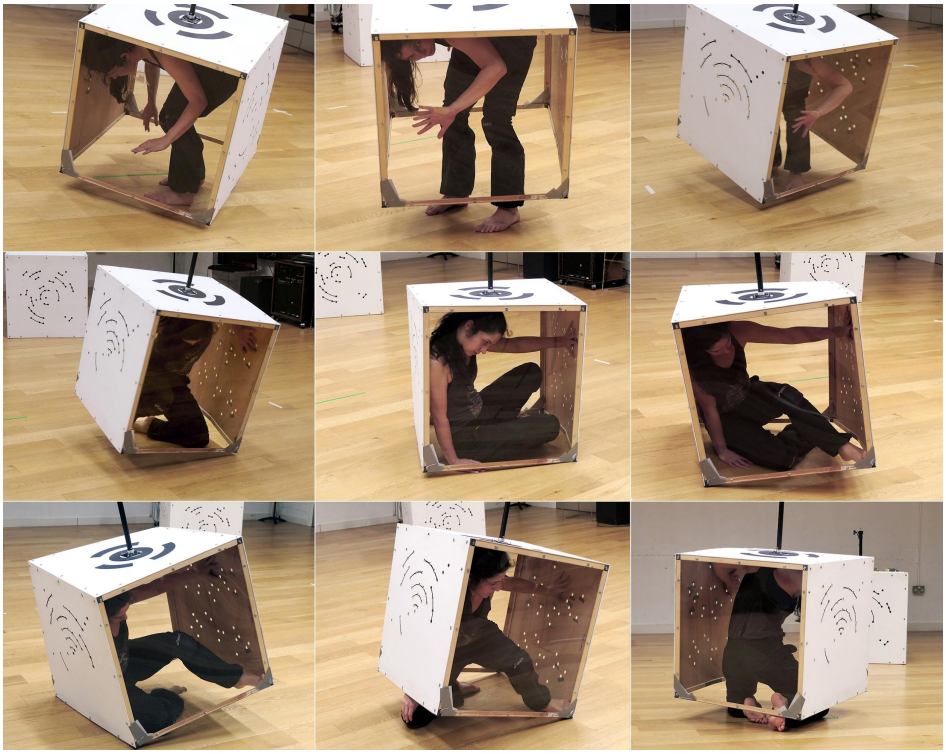

Figure 3. Performer-cube entanglement with Audrey Rochette, 2019.

[6] More details on our Performative Body Mapping methodology, robot design, and machine learning can be found in (Gemeinboeck, 2021; Gemeinboeck & Saunders, 2021).

Sometimes, prompts to propel the entangled performance of dance performer and cube costume (from here on referred to as performer-cube) come from just sounds, their rhythms and dynamic amplitudes, with the choreographer chirping, whistling, or stumping her feet. Other times, they come from experiences one of us brings to the studio/lab, the sensation of a pressure cooker[7], for instance; or a particular material behaviour of one of the costumes itself. One day, I cut openings into a costume (to increase the air flow for the performer inside), and the fluttering motion of the flaps, loosely covering the vertical openings, quickly inspired explorations of breathing-with the costume. Pressing herself against one of the edges of the cube-shaped costume, the performer precariously balanced on one of its corners while raising the opposite corner using varying qualities of speed, weight, and rhythm; the entangled cube rocked forward and upward with increasing haste, culminating in the stuttering, jumpy rhythm-shape of a hiccup. Sometime later, I caught the Cube Performer (our robot) perform a sequence that contained traces of this distinct fragile rhythmic pattern within the context of a dimly lit gallery space and the effect was puzzling. The robot's machinic enactment of what was no longer the same movement—cut together-apart again in the machine learning process—but still had some of its rhythmic qualities rendered the artefact at the same time more strange and more familiar. "Cutting together-apart" (Barad, 2014, p. 168) in loops[8] can make for familiar-strange.

Movement in robotics is commonly a matter of safely navigating space and in HRI also is employed to bestow robots with an expressive character or personality. MML, in contrast, harnesses movement as a dynamic, relational, and generative force, producing the trajectories along which meanings are made and unmade. Erin Manning and Brian Massumi (2014, p. 39) argue that it is movement, which "bodies forth", rather than the body that moves, as common-sense would suggest. As we enact and experience meaning through movement, we make sense of other bodies by resonating with them and their movements (Fuchs, 2016). As Thomas Fuchs and Sabine Koch (2014, p. 1) put it, "one is moved by movement … and moved to move". Meaning-

[7] The choreographer, Tess de Quincey, has introduced this particular image from her BodyWeather practise; in her own words, "the whole point about BodyWeather is to go beyond the biomechanics through images, [that is] we recruit the biomechanics to find ways to move, which are not normally positioned as human movements" (recorded conversation, 26 March, 2015, unpublished).

[8] 'Cutting together-apart in loops' here refers to the iteration of diffracting diffraction patterns that this methodology propels: from performer-cube, motion capture, machine learning and improvisation, to the Cube Performer's resituated, mechanical performance.

making here is transcorporeal (Alaimo, 2010), arising from difference-in-relation. Entangling performer and cube (performer-cube) thus allows us to materially inquire into possibilities for transcorporeal feeling-thinking-with a machine artefact; how we can extend toward it and its uniquely material-machinic ways to relate to the world and how the artefact-in-motion can extend toward us, in return. Movement and its relational, affective capacities give us access to other world-making and fosters an ongoing embodied, playful attunement to the intertwined processes of worlding (Haraway, 2016), a co-worlding.

I look at performer-cube as the first encounter; human-robot encounters do not only happen when a robot design is complete. Rather, I propose, the encounter needs to be understood as a refrain (Stewart, 2010), a co-worlding and becoming-with the becoming-robot that unfolds through the design process and its sociocultural context and is re-enacted in each interactional situation. Dancers, at first, often get frustrated encountering the cube in this entangled way; they try to move "the box" and the box does not let them move the way they would like to; it is only when they begin to re-orient toward the different sensations they receive from the box (its shape; how it bends, where it resists, its weight, etc.) and reconfigure themselves in ways that allow them to become-with the box that they begin to bodily feel-think-with and move-with the box[9]. This is where the difference pattern begins to move and transform; as material qualities are exchanged, prompting reconfigurations and re-worlding; affects emerge and flow across; and the dancer's and the cube's ways of being in the world intermesh; giving rise to co-worlding, the transcorporeal kind. What starts out as a juxtaposition becomes a superposition.

I previously described the effects of this superposition as an ongoing bodying-thinging[10] (Gemeinboeck, 2021). Bodies are always already relational and porous, ready to being reconfigured and, with it, feeling-thinking across other bodies (Alaimo, 2010). The thing's entanglement with the world, in contrast to an object's, has never been completely severed, opening it up to new configurings. Bodying-thinging or thinging-bodying traces the ongoing mutual material attunement to the dynamic

[9] This account is based on conversations I had with collaborating performers, captured in video recordings (unpublished), specifically with Audrey Rochette, 24 November, 2018; 9 July, 2019; and 10 December, 2021, as well as with Sarah Levinsky, 15 March, 2018; and Linda Luke, 24 January, 2019.

[10] Bodying-thinging superposes Manning & Massumi's notion of bodying (2014) and Heidegger's thinging (1975), which unties the thing from an object's utility (see also Grosz, 2005).

effects of the difference pattern that is the encounter and is itself a diffractive pattern moving in synch with cutting together-apart (Barad, 2014) subjects and objects. It speaks to the entangledness and multipleness of bodies and things and their ongoing constitutive differentiatings, undoing and redoing each other (Despret, 2013). Human-robot interaction as an ongoing material-corporeal differing—human-robot intra-action—thus destabilises the engrained dualisms of robotics practices and their manifestations of subjects and objects predicated on the fixedness of bodies and things.

Diffracting the encounter: performing together-apart

Writing about our encounters with companion species, Haraway observes that embodied communication is more akin to a dance than it is to a word:

> "the flow of entangled, meaningful bodies in time—whether jerky and nervous or flaming and flowing, whether both partners move in harmony or are painfully out of synch or something else altogether—is communication about relationship, the relationship itself, and the means of reshaping relationship and so its enacters" (2008, p. 26).

Watching audiences encounter our Cube Performer for the first time, I'm often reminded of Haraway's sometimes jerky, sometimes flowing dance; with dynamics that unfold in unpredictable configurations and participants finding themselves, alternating, in moments of harmony or 'painfully out of synch' with the cube artefact. The encounter is a dynamic diffraction pattern itself, with humans and machines moving in phase, then out of phase, and back into phase. In phase, we are bodying-thinging with the thinging-bodying of the artefact, bodily resonating with the relational, affective qualities it enacts. We are drawn into… whatever this is. Then something jars, the flow begins to stutter, and we might suddenly notice ourselves dancing with a box: out of phase again. The goal is not to stay in phase but to keep dancing, undoing and redoing each other, and to remain open to what unfolds.

Figure 4. Performing together-apart with performers Katrina Brown, 2019 (left) and Audrey Rochette, 2020 (right).

Our second project stage of diffracting the encounter extends to performance-making with human-machine interference patterns, involving various configurations of entanglings, e.g., a Cube Performer with one (human) performer; a performer-cube with a Cube Performer, or two Cube Performers. Building on the first encounter stage, performance-making here is rooted in an ontology of becoming and focuses on aesthetically attending to expanded notions of encounter (beyond performer-cube) to foster entanglings of entanglings (see Figure 4). Similar to the first stage, we are interested in the emergence of new relations and any meanings they may acquire, rather than choreographing the encounter or any dynamics that may unfold. Giving ample space to co-worldings and bodying-thingings, I found, is best done through improvising with the material minglings as they arise. Let's briefly step back into the studio; this time a dance studio[11], which is mostly empty apart from two tables and four chairs, the Cube Performer (robot), some tools we brought with us for any maintenance needs, and four tall stands elevating motion capture sensors that mark out a five-by-four-meter playground for the matterings of performer-cube.

As we step in, we witness the performer kneeling on the ground in front of the cube costume, coupling herself with the cube by placing her right hand underneath the

[11] University of Applied Arts Vienna.

bottom edge closest to her. Her kneeling posture refigures her body's kinesphere[12] to align with that of the cube; she carefully lifts the edge and begins to shuffle sideways, sliding the cube along with her, while taking care that they remain tightly coupled, facing each other the same way as they started (with the cube having four equal faces, "facing the other" is a fluid matter). The two appear to be moving together, rather than one being moved by the other. She softly places the cube's edge on the floor, pauses, and tilts the cube upwards to slip into it. Next, we see the cube lifting the opposite edge with slightly more weight than we saw earlier, and performer-cube shuffle-slide along a trajectory very similar to the previous scene. Interestingly, the cube still appears to face something or somebody; it is the ongoing material attunement that supported the coupling and "facing each other" earlier, now re-enacted by performer-cube, that refigures the omnidirectional geometry of the cube and renders it relational, extending toward … something (elsewhere).

The above experiment is part of a sequence of explorations that began with the image of a ventriloquist performance. Initially, the choreographer conceived of the image of a ventriloquist's relationship with a puppet because she struggled with the notion of a cube (on its own) being able to actively participate in the encounter and enaction of agency[13]. The image allowed her to kinaesthetically probe into a power constellation that transfers agency to a 'thing' (and the possibility to reverse the direction of transfer) from both the ventriloquist's position and that of the puppet. I was concerned that this problematic premise of agency shifting between a body and a thing (rather than emerging in-between) would disentangle performer and cube by addressing and, more so, foregrounding them as an already formed subject and object. Once performer-cube began to improvise with the image, in tandem with choreographic instructions for finding different points of attaching and mapping between, however, we witnessed increasingly porous performances of together-apart, rather than transactions of power between a given subject and object. We learned from the performer that, when outside, she used the points for coupling herself with the cube to extend herself into it, and, when inside, reoriented-with the cube to the same lines (for extending into), now in

[12] The term kinesphere was coined by Rudolf von Laban (1966), referring to an imagined sphere around the body that it can easily extend into without changing position. Given that both the robot's and costume's bodiness emerge from movement, we attend to the cube's 'body space' in relation to its extended potential as body-in-motion.
[13] My account of our process is based on video documentation material from 1-9 July, 2019, and the choreographic notes from choreographer Marie-Claude Poulin, 2 June, 2020, and 21 December, 2021 (unpublished).

reverse, to extend-with the cube beyond it[14]. This is cutting together-apart (Barad, 2014) along transcorporeal "lines of flight"[15] (Deleuze & Guattari, 1987, p. 3).

The more we transcorporeally extend into and resonate with the difference pattern, the more it becomes meaningful. Developing a more horizontal (play)ground for enacting human-machine relationships, I believe, has thus much to do with our ability to extend into the other's world (Alaimo, 2010). Mirroring façades in HRI not only reflect back what we already know but also conceal the difference patterns at work beneath the façade. A robot's perception of the world, for instance, like its embodiment, radically differs from human perception, no matter how humanlike or machinelike it looks. Hence, as humans and robots entangle, they are, from a biosemiotic viewpoint, each embodied in their own unique umwelt (von Uexküll, 1957; Ziemke & Sharkey, 2001). We are bodying-thinging across differentiated ecological niches. To foster performers' ability to bodily feel-think-with the robot's umwelt, we expanded the cube costume to include the Cube Performer's machinic sensorium. The sensed data, dynamically mapping surfaces and relative distances in the cube's surrounds, is made tangible to the performer in the form of a dynamic soundscape. Dancers like to make use of their cube entanglement to play this soundscape like an instrument, reshaping it with every move; what is performed here is intra-action at work: performer-cube co-world refigurings of the soundscape and the refigured sounds, in turn, reshape the unfolding performance of co-worlding. Entangling the dancer's and the machine's umwelts thus allows us to extend into the robot's world-making and aesthetically attend to the difference pattern of their respective worldings.

Diffracting the encounter: toward human-robot experience (HRX)

Diffracting the encounter in-the-making and, with it, human-robot relationships, we also need to attend to the built-in hierarchy between designers/manufacturers and so-called users. Designing robots and imagining the relational scenarios in which we encounter, work, or live with them[16] requires a much wider participation of a much

[14] Based on video documentation material from 1-9 July, 2019, and an interview with performer Audrey Rochette, 9 July, 2019 (unpublished).

[15] In French, *ligne de fuite*; in Notes on the Translation (Deleuze & Guattari, 1987), Massumi notes that *fuite* not only relates to notions of fleeing but also flowing or leaking.

[16] It is worth noting that my notion of 'social robots' refers to robotic artefacts designed to participate in or operate within social scenarios, including domestic spheres, workplaces or artistic contexts.

broader range of actors, most of whom are currently excluded from the making of our sociotechnical futures. I recently started a four-year research project to develop performance-based participatory strategies for opening up[17] this diffractive practice to a much broader range of design participants; to engage possible future stakeholders in bodily-feeling-thinking-with machines that do not reflect the model Human and a sociocultural context that is not and never will be theirs. After all, most stakeholders of the social futures that our technical imaginaries seek to shape are not to be found in robot labs. I call this practice human-robot experience (HRX) to both, align it with the familiar practice of HRI and, at the same time, deviate it from the simplistic interactional transmission model oriented toward autonomous agents, which much of HRI builds upon.

Figure 5. Robot design workshops with school children at AMATA, Falmouth (left), and The Exchange Gallery (right), UK, 2018.

My HRX practice builds on and significantly expands our robot design workshops with children (Gemeinboeck & Saunders, 2021) that revolved around playful mock-up scenarios in which they invented new kinds of human-robot relationships by undoing and redoing subject-object boundaries using simple cardboard boxes and an array of arts and crafts materials (see Figure 5). Building on performance and theatre techniques, the main focus of HRX is to engage participants in bodily-material enactments of their own human-robot encounters, instead of the Cartesian hall-of-mirrors we are currently given. Participants will be invited to develop their own co-worlding scenarios, in tandem with bringing/selecting materials and designing-with

[17] The Cube Performer's making, learning and performing have so far been situated in a relatively singular sociocultural context, despite the project spanning across three continents and involving eight performance practitioners and five researchers and their different backgrounds and experiences.

and bodily-feel-think-with their own machinic forms and sensorial soundscapes to connect with a robot's particular world-making and negotiate emerging interference patterns. Traditionally, HRI labs open their doors to people from the outside to 'test' their experiences with already designed robots within the context of a tightly orchestrated, fixed study frame (Sabanović, 2010), rather than inviting them to co-design their own, entangled experiences. I believe that a much wider public access to more open, rich, bodily in-situ experiences of the transcorporeal possibilities and interferences at work in our encounters with robots, before we begin to manufacture them, is key to making a difference in how we envision our sociotechnical future.

Diffracting the politics of human-robot interaction: concluding remarks

The article's main proposition is that diffracting human-robot encounters requires becoming-with and co-worlding with artefacts and their asymmetries. Dominant HRI practices, in contrast, pursue an "optics of reflection" (Barad, 2007, p. 135) based on the belief that the differences inherent to machines need masking or assimilating. My collaborative Machine Movement Lab (MML) project develops a counter approach to this reflective practice; building on Barad's (2007) concept of agential realism and a performative-material understanding of movement, we attend to the relational enactment of subjects and objects by aesthetically putting to work the difference patterns at play in our more-than-human encounters. I explored how our performative, material strategies for diffracting human-robot encounters bodily enact human-robot co-worldings and attend to the transcorporeal resonances of their interference patterns to mobilize subject-object boundaries. It is these performative strategies, the situated material-bodily knowledges they enact, and how they aesthetically attend to and make tangible difference patterns and relational ontologies at work in human-robot encounters that I would like to contribute to the unfolding discourse of new materialist informatics.

The political potential of this new materialist artistic practice is that it materially mobilises an ontological disposition toward entangled human-robot configurations by opening up ontological boundaries to bodily-material reconfigurings. The transcorporeal entanglings that MML provokes challenge hierarchical dualisms still engrained in HRI and the limited humancentric ways in which we envision our robotic

futures by reorienting our bodily ways of knowing and attending to the performative potential of the encounter. Subjects and objects, bodies and things, humans and nonhumans here are no longer fixed, universalist binaries but are entangled, multiple, and porous; constituting and reconfiguring each other and effecting transcorporeal resonances through the diffractive attunement of bodying-thinging. Experiencing more-than-human co-worlding 'through the looking glass' rather than distorted reflections of the model Human, I believe, could open up pathways toward a horizontal ethical playground for humans and machines. Furthermore, the Cartesian politics that delineate subjects and objects are the same at work in designating the model Human; a horizontal-diffractive playground could thus lend itself to opening up human-robot relationships and how we enact them to a much wider range of actors to foster more diverse and multiple visions of our robotic future. After all, to participate in this more-than-human playground, our relationships with machines do not require diffracting (they always already are); instead, they require us to not conceal the "patterns of difference that make a difference" (Barad, 2007, p. 72) by masking them with reflection patterns. They hold us at a distance and keep us from entangling and becoming-with machines. And dance with them.

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