Friction in Processual Ethics: Reconfiguring Ethical Relations in Interdisciplinary Research

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Abstract

Friction – disagreement and breakdown – is an omnipresent aspect of conducting interdisciplinary research yet is rarely presented in formal research reporting. We analyse a performance-led research process where professional dancers with different disabilities explored how to improvise with an industrial robot, with the support of an interdisciplinary team of human-computer and human-robot interaction researchers. We focus on one site of friction in our research process; how to dance – safely – with robots? By presenting our research process, we exemplify the different ways in which we encountered this friction and how we reconfigured the research process around it. We contribute five ways in which we arrived at a generative ethical outcome, which may be helpful in productively engaging with friction in interdisciplinary collaboration.

CCS Concepts

• **Human-centered computing** → **Interaction design theory, concepts and paradigms**.

Keywords

ethics, processual ethics, felt ethics, research ethics, artist-led research, somabotics, robots, dance, disability, crip feminism, friction, misalignment

1 Introduction

Friction, even in its fine-grained forms such as constructive disagreement, is an inherent characteristic of many research processes. Many knowledge contributions in Human-Computer Interaction (HCI) are collectively arrived at within interdisciplinary teams spanning different areas of expertise [10, 68]. Often, researchers working in teams will have differing – even contrary – epistemic commitments, theoretical conceptualisations, preferred methodologies, and professional best practices [43, 55]. In these contexts, frictions will inevitably arise. Here, we argue that ethics, rather than being primarily a mechanism for curtailing such friction, can be a means of engaging with friction productively. In this way, friction can characterise a *process* of exploring the underlying ethical assumptions of our practices and the ethical relationships they create, which in turn, can prompt collective reflection and ethical reconfiguration. This, we argue, is vital to the generation of new ethical understandings between different professions and practices.

Our point of departure is that ethics are not solely the domain of approvals or checklists intended to guide research processes, but are also *implicit* in many other aspects of practice [23]. We adopt the position of felt ethics [23], that views ethics as grounded in our bodies and lived experiences [60], and intimately shaped by our

Figure 1: Robots, Dance, Different Bodies: dancer Welly with a Franka Arm robot.

interpersonal, socio-cultural, and political relations [23]. A felt conception of ethics draws attention to how ethics shape the situated interactions between people in research processes, for example, in response to situations of risk [15] or to recover from moments of breakdown or failure [53]. Ethics are also inherent to our positionalities as researchers and the situatedness of our knowledge [26], as our concepts and categorizations are non-neutral and present the world in specific ways [11]. As such, researchers themselves implicitly hold different values and ethical sensibilities which become crystallized into designed artefacts and research outcomes, which encourage specific ways of interacting [72] or building on the knowledge presented [24].

Frictions – such as disagreements concerning theoretical assumptions, methodological choices, or desirable research outcomes – are moments where implicit embodied ethics can be explored. There have been numerous calls over the last decade to attend to the ethics implicit in our research practices. This includes the ethics that unfold in situational research [51] or 'in the wild' [20]; contextual decision-making that falls below formal ethics review [65]; emotional difficulties and other labours that are traditionally underreported [2]; and racial or ableist biases that exist structurally within different methodologies [8, 27].

We, the authors of this paper, are a group of interdisciplinary researchers and practitioners whose work spans areas of HCI, Human-Robot Interaction (HRI), dance research, social science, interaction design, soma design, computer science, and robotics. Many of us either work or have collaborated in interdisciplinary research through design [54] or artistic-led [5] approaches that are exploratory, often characterised by successful as well as failed improvisation, abandoned research directions, and ideas which emerge and are then discarded through collective engagement, experimentation, and reflection. As such, friction – often implicit, but sometimes less so – is an omnipresent aspect of our work. In response to recent work that calls for deeper reflection and critique concerning implicit ethical positions in research practice [23], we are motivated to explore the role that friction plays in our work.

We describe and reflect on the research project "*Robots, Dance, Different Bodies*" (See Figure 1). This interdisciplinary collaboration explored physical contact with robotic systems, motivated by the increasing migration of industrially-designed robotic systems into domestic and social contexts. It employed a performance-led research process [5] wherein a team of professional dancers with different disabilities employed dance improvisation to reconceptualise ethics in human-robot interaction as embodied, creative,

and generative – rather than harmful and a problem to be avoided. Due to the framing of this project, frictions were not unexpected – indeed, directly broaching our underlying ethical positions was the defining motivator for this research. We present our research process to exemplify the different ways in which we encountered a specific site of friction: how to dance safely with robots? We analyse our work in five stages to show the role it played in our research process; (i) how we intentionally configured the research space to produce uncertainty and uncover potential frictions; (ii) how friction exposed where lived experiences of disability challenged our ethical assumptions; (iii) how friction revealed the ethical differences between professional best practices; (iv) how immovable friction prompted us to reconfigure the research space; and (v) how, through friction, we cultivated our ethical sensibilities. We contribute five ways in which we arrived at a generative ethical outcome, which may be helpful in productively engaging with friction in other interdisciplinary research processes. We conclude that a *generative ethics* entails being open to each other's different ways of knowing and allowing our academic bodies to be challenged and reshaped.

Importantly, we first outline our crip feminist position on disability. The term 'crip' is a reclamation by disability activists and scholars to celebrate disabled experiences, forge political coalitions for justice, and highlight how the dominance of able-bodied experiences has shaped our society (See [41, p.15]). Our team includes dancers and dance-researchers with different disabilities who practice dance professionally and also research dance practice within an academic context. As such, we purposefully do not position our colleagues and co-authors as being "limited", "vulnerable", or "disempowered" in the research process. Instead, we resist such "slippery" conceptualisations of disability [8] and find alternative ways to explore how embodied, expert, and professional experiences reveal an ethically rich way of knowing the world and challenge some of the ethical assumptions and power structures that pervade our research practices. We expect this contribution to interest researchers who are investigating the underlying ethics of interdisciplinary work or exploring how crip perspectives challenge our established ethical practices. This contribution might also be of interest to practitioners working with the body in design research or looking for ways that creative robotics and artistic-led research can contribute to broader conceptions of ethics in HCI.

2 Theory and Related Work

We (i) outline our theoretical position on knowledge production in order to situate our research. Then, (ii) we describe how friction can be considered as an aspect of processual ethics.

2.1 Emergent and Transitional Research Processes

Robots, Dance, Different Bodies adopts an emergent approach to conducting research. Such approaches are common in HCI. Methodologies such as research through design [54, 77] and performance-led research [5] are exploratory approaches where knowledge is developed through practice, for example, designing, making and deploying artefacts [17, 18] or creating, performing and engaging with an audience [5]. These processes are provisional; the research

contributions are generally unknown at the outset of the project and multiple forms of research contribution might surface as the research progresses. This provisionality contributes to generativity, as different ideas can be explored to uncover the most promising research directions, and possible outcomes are not pre-emptively foreclosed. Such processes produce new ideas, concepts, and methods for HCI [4, 5], as well as intermediate level knowledge that can inform design [35, 48]. Exploratory and creative approaches to robotics [31, 56], for example, have produced insights into; the role that robots could play in multispecies worlds [59]; future interactions between humans and care robots [40]; the deployment of robotic technologies into artistic contexts [16]; and the reimagining of relationships and configurations between different bodies and machines [39, 44].

Here, we argue it is also ethically and politically important to treat the knowledge that we produce as provisional. Often, ethical issues, such as racial bias or inaccessibility, are not results of a "once-off bad design" or a "poorly conducted study" [7, 12]. Rather, they can arise from positions that are implicit in the assumptions underlying our work [23]. For example, many societal conceptions of different bodies are based on problematic assumptions. Disability scholar Alison Kafer demonstrates how societal discourses, even well-intentioned ones, can position disability as a "natural" – rather than a "cultural" – categorisation of bodies [41]. This makes it more difficult to push for systemic and political changes that would make the world more livable for people with disabilities, as it positions disability as being an inherent quality of the body, rather than caused by a meeting between body and a particular context [41]. Ashley Shew details in her book *Against Technoableism: Rethinking Who Needs Improvement* how these attitudes also permeate technology development: technology is often framed as a "solution" for disability, which reinforces the idea that it is bodies that in need of fixing rather than an inaccessibly designed world [62]. In contrast, Sara Hendron presents examples of how design can be reimagined to meet different bodies, rather than trying to "fix" them to inhabit a poorly designed society [30]. In short, if we treat our research processes as open and provisional, then we can potentially critique, challenge, and cultivate our ethical conceptions of how technology should be designed and the role it should play.

Openness is not always an easy attitude to adopt [22]. However, Soden and colleagues argue that engaging with the uncertainty produced by academic boundary crossing, can be invaluable in producing deeper understanding of where different training and expertise might clash [63]. Interdisciplinary research processes are unlikely to be smooth or seamless, wherein academic training and professional expertise transform easily into new understandings. Rather, we argue that such processes are more likely to be *frictional*. For example, Annemarie Mol's ethnographic study of medical practitioners demonstrates how differently trained professionals work across different specialties, methodologies, and practices to treat the same disease [49]. In particular, Mol notes the processes that enable them to work together, including; how knowledge is translated between areas of expertise; how the work is distributed and coordinated across different practices; and how hierarchies are established when choosing between courses of action. As such, practice unfolds through multiple ways of knowing, in a way that allows for frictions and differences to coexist rather than trying

to achieve consensus [49]. Mol's work has inspired our analysis, although here, we focus more closely on the role friction plays in the ethics of the process of collaborating to produce knowledge.

2.2 Friction and Processual Ethics

Friction is a fundamental dimension of human society [50]. However, with some notable exceptions [6, 27, 29, 36, 53], it is still relatively uncommon to detail frictions that occur during the research process. In many ways, this is understandable. Presenting moments of potential breakdown or discord (or even fine-grained constructive disagreements) for the scrutiny of the wider research community is difficult. It entails a significant amount of vulnerability for both the research team and others within the process [53], and potentially contributes to common cross-disciplinary misunderstandings of ethicality, validity, and rigour in research [69]. Research is generally only disseminated when outcomes have been collectively agreed upon or proven to be successful [36]. This can render the ethics that characterise the process of conducting research invisible.

Here, we adopt a non-dualistic stance where knowledge is produced through and ingrained in the body [33]. This means that we do not consider 'knowing' to be an exclusive property of the 'rational' mind, somehow detached or separate from our living, moving, corporeal bodies [61]. Similarly, we view factors generally considered 'external' to the body – such as our academic training or professional expertise – as shaping our bodies on a very fundamental level [23]. Höök, who adopted this epistemic position to develop soma design, argues that articulating our felt experiences can open pathways for deep engagement with our knowledge and values [33]. This might, for example, create space to reflect on why a situation has provoked discomfort, and enable a discussion as to whether everyone feels similarly. Garrett and colleagues argue that such a process can draw attention towards our ethical sensibilities – our preconceived ideas of the "right way" to conduct research – and allow for such sensibilities to be challenged, deconstructed, or cultivated [23]. This enables a form of processual ethics. Processual ethics are less concerned with establishing fixed ethical procedures or abstract moral imperatives, but rather focuses on enhancing our capacity to act ethically as the research process unfold [71]. However, cultivating ethical sensibility often requires opening ourselves up to others; allowing our assumptions to be challenged by those who know differently [22]. This can produce friction, however, if we engage with friction productively, this can ultimately lead to richer understandings of the ethical differences that exist between practices.

We encountered friction between multiple academic and professional bodies, including colleagues with lived experience of disability. Though disability is only one perspective in our analysis of this interdisciplinary process, we deem it crucial to highlight contributions that crip technoscience [25] and disability justice perspectives [32, 70] have made to HCI. Crip theory seeks new ways of understanding lived experiences of disability, particularly how notions of "cure" prioritize some lives over others [14], and contesting harmful societal conceptions and essentialisations of people with disabilities [41]. Disability – both as lived experience and a critical lens – has produced rich insights into the ethics of our

technologies and research practices. This includes challenging presumptions of able-bodiedness [47] or neurotypicality [67], but also other deeply ingrained assumptions within technological research. For example, Forlano shows how the technologies on which she is reliant are designed on the false assumption that transmitting data is all that is required for her to engage in everyday activities such as eating, sleeping, and being in the world [19]. Janicki and colleagues use "crip time" to trouble technologies that are designed on the assumption that we all should strive for maximum productivity [38]. Bennett and colleagues explore the care work needed to create access, and challenge the assumption that task completion should be the solely goal of assistive technologies [9]. Crip perspectives are also invaluable to the ethical reconfiguration of HCI knowledge [66, 75], for example, outlining design strategies of adaption based on the experience of chronic illness [37] and problematising harmful societal conceptions of pain [52]. As such, disability is a valuable – and often intersectional perspective [28, 42] – that can reveal our ethical assumptions and identify sites of friction.

Our contribution is situated in this body of work. We first present an interdisciplinary and exploratory research process where our research outcomes were open and provisional. Then, we focus on one site of friction where we encountered disagreement between different academic backgrounds, professional expertise, and lived experiences: how to dance safely with robots? Through analysing our process from the perspective of processual ethics, we examine the role that encountering this friction played in reconfiguring our ethical knowledge and ways of relating to one another as the process unfolded.

3 Our Research Process

"*Robots, Dance, Different Bodies*" emerged from a longer-term collaboration between the Mixed Reality Lab at the University of Nottingham and the Centre for Dance Research at Coventry University, who jointly proposed this research. Another long term collaborator – Candoco Dance Company – was invited to support as an artistic partner. Ethical approval for the project was granted by Coventry University. Here, we (i) outline our methodological approach and composition of the research team, (ii) chronologically describe our research process, and (iii) describe our data collection and analysis.

3.1 Method Overview

We adopted the overarching method of *performance-led research* where artists are invited to produce performances with technologies, so that HCI researchers can engage deeply with their processes and practices, and identify design knowledge, tools, or methods that can inform HCI [5]. Our team's professional dancers and dance-researchers – who have different disabilities and some of whom dance with assistive devices – led the creative exploration of industrially-designed robots. The project also intended to contribute embodied, creative, and generative conceptions of ethics that could inform the design of robots that come into close proximity with human bodies. As such, our team was supported by researchers who specialised in developing and evaluating assistive technologies using co-design methods [73, 76] and soma designers, whose methods centre on engaging with the body in design practice [33, 34]. The expert dance practitioners drove the research process by employing
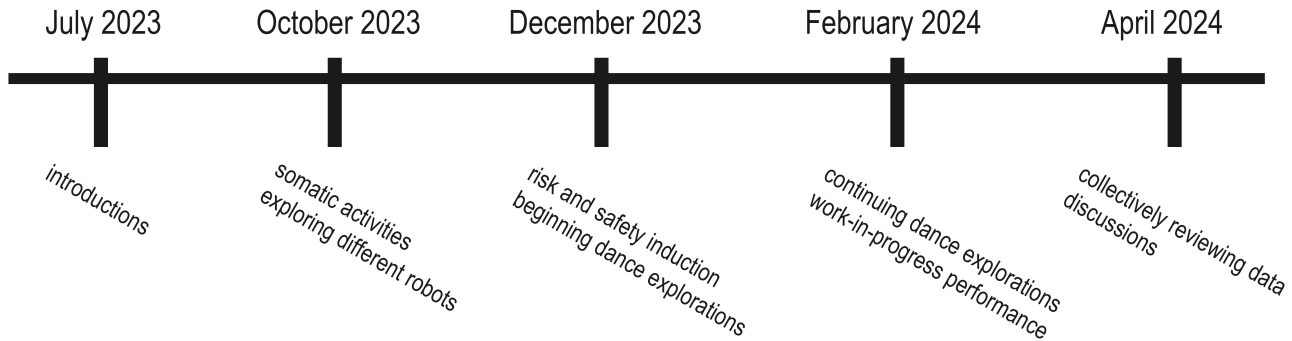
Figure 2: A timeline of workshops from July 2023 to April 2024.

a mixture of dance improvisation and choreographic methods [13] to explore how to best perform with robots, with the support of the wider research team, including roboticists and technicians. Finally, the research process was not geared towards a formal, finished performance. Rather, we presented our ongoing work as a work-in-progress, where we invited a small group of people, including other researchers, dancers, and disability activists, to engage with our project.

3.2 Research Team

The core team of this project consisted of fourteen people, who were variously present at the different workshops. On the technological side of the project, our team contained two senior researchers with backgrounds in computer science, focusing mainly on creativity, the arts, and performance-led research. One senior researcher had a background in engineering with expertise in HRI, embodied intelligence and assistive robotics, and another senior researcher has expertise in HCI and soma design. The team also contained a computer science based technician specialising in robotics and software development, and an early career researcher with a background in HCI, with further expertise in HRI and robot programming. Additionally, we included one social scientist trained in experimental psychology working with qualitative and trans-disciplinary approaches to interaction design research and one student who studies interaction design ethics. On the dance side of the project, our team contained one senior researcher in performing arts with a background in dance and choreography, one disabled/crip dance researcher-artist, and one researcher-artist with a background in journalism and a focus on dance, somatics, critical disability studies, philosophy and technologies. The team also included two professional dancers associated with Candoco Dance Company. Here, we note that though we differentiate between parts of the team (e.g., the academic team, the dance team) when discussing professional perspectives, these are not stable categorisations (e.g., we include people who practice dance in an

academic context). Most importantly, everybody is a member of the wider research team. We also note that while interdisciplinary friction was expected to arise in such a process, examining it was not the main goal of this project. Rather, this contribution arose from the work of the first author, whose research pertains to ethics in research practice.

3.3 Description of Workshops

Here, we offer a narrative overview of our research process. We conducted five workshops between July 2023 and April 2024 (See Figure 2). The workshops were all conducted on-site at the Cobot Maker Space at the University of Nottingham. Our purpose here is to chronologically detail our process in order to contextualise notable situations, disagreements, and other moments that became pertinent to our analysis of friction.

Workshop One: Introductions. Initially, we organised a one-day workshop (July 2023) where the different members of the research team were introduced, and expectations for the project were discussed. During this workshop, we explored a number of different robots that could be used for the project. These included Spot, the Quadruped Robot from Boston Dynamics[1], a Double 2 Telepresence Robot from Double Robotics[2], two Franka Emika Robotic Arms[3] and a LoCoBot WidowX-250 6 DOF (Kobuki) Mobile Manipulator from Trossen Robotics (Interbotix)[4]. We purposefully chose a selection of non-anthropomorphic and machine-like robotic systems [1, 57], that were not designed to look like a normative human body.

Workshop Two: Dance Practice. The second three-day workshop (October 2023) focused on bodywork to establish a collective understanding of the research space. This was an important aspect

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[1]Boston Dynamics Spot
[2]Double Telepresence Robot
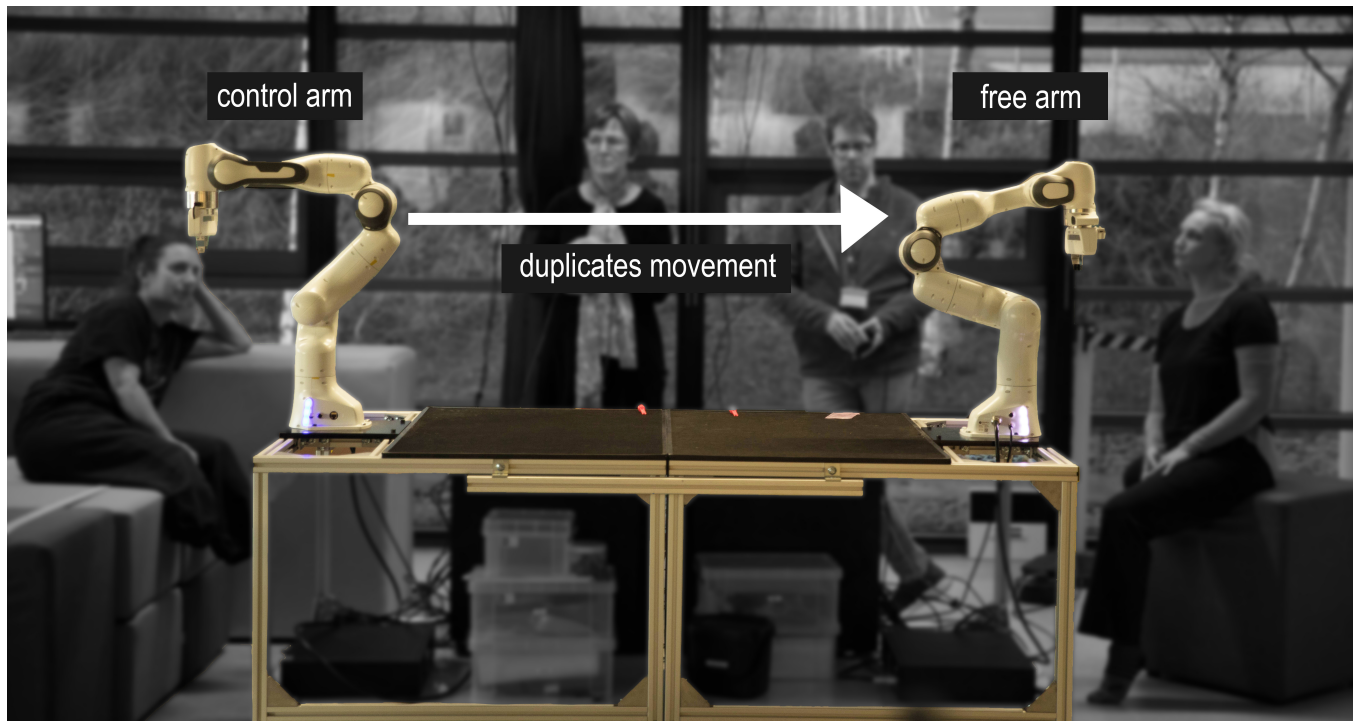[3]Franka Arm Robot
[4]LoCoBot Mobile Manipulator

Figure 3: The robot duplication setup: the robot on the left is the control arm. The free arm on the right duplicates the movements made by the control arm. As the robots are placed back-to-back, this has the effect of mirroring the movement.

of the process as only the dancers (as expert practitioners) would physically dance with the robots. Therefore, we needed a common somatic experience to relate to in order to collectively approach the research. Kate, a dancer and researcher (also referred to as a somatic connoisseur [58]), led the team through a series of bodily explorations and dance activities intended to foster this shared somatic understanding. This began by somatically sensitising ourselves towards our own and each others' bodies. We practiced holding space for each other without touching, and then experimented with contact improvisation to carefully explore the felt experiences of responsibility and trust in the physical contact between bodies. As a group, we explored how to physically negotiate and establish points of contact while moving together in the space. These exercises helped to problematise (akin to defamiliarisation [3, 74]) our habitual enactments of ethics and allow us to articulate our perspectives and lived experiences. This activity was familiar to the dancers on our team who supported the rest of the team by asking questions that helped us articulate our experiences.

Workshop Three: Dancing with Robots. During the third three-day workshop (December 2023), we narrowed our focus to an industrial Franka arm robot. We chose this robot as the dancers indicated it was the most aesthetically and experientially interesting for dance practice. Additionally, these robots offered us the opportunity to work with multiple robots and dancers together. In particular, we envisioned a novel setup where one dancer would operate one robot (the control arm), and a second robot (the free arm) would duplicate those movements. A second dancer would then improvise

with the second moving arm (See Figure 3). We found this setup interesting because it allowed us to explore real-time dance improvisation without the need for extensively programming or training the robots.

Before we could begin dancing, there was an extended discussion amongst the research team concerning how to best organise the space to keep the dancers as safe as possible. In response, we reconfigured the research space by assigning different roles to different team members who would be responsible for different aspects of the setup. Once the setup was established, Kat and Welly each took turns individually practicing with the control arm. Then, they worked together, each taking turns to operate the control arm and improvise with the free arm. Then, we began a series of dance improvisations where Kat and Welly each experimented with their individual styles of moving with and responding to the robot arms. We probed different ways of prompting the improvisations, for example, by asking Kat to move the robot in ways that Welly could respond to, or by asking Welly to improvise and Kat to move the robot in response.

Workshop Four: Provocative and Performative Explorations. The fourth three-day workshop (February 2024) continued these dance-led explorations. Having now developed a stronger feel for how to move with the robot arms, Kat and Welly began to more provocatively explore ways of moving and improvising with the robots. We slowly but purposefully introduced more elements to directly probe conceptions of vulnerability, risk, and control.

Workshop Five: Reflection and Discussion. Before the workshop, one team member processed the raw data to create video clips of each individual dance improvisation, as well as grouping together video clips that recorded each dance sequence from multiple angles. They compiled these video and their metadata into a structured database as well as preparing playlists that covered different aspects of the workshop. We then assembled a wide representation across the team, including dancers and roboticists, so that we could consider each video from multiple perspectives. We made a first pass of all these videos together, and collectively marked which were of interest. We selected 13 video which we watched several times together. These videos were collectively selected by the research team because they were considered interesting from multiple different perspectives, for example, there was something in the video that sparked the collective interest of the dancers, roboticists, and designers. We then closely watched each video multiple times, from multiple angles where possible, while taking notes, discussing in depth, and recording our discussions.

3.4 Data Collection and Analysis

Throughout the process, we gathered a total of 3.25 hours of footage of our dancers practicing and testing the robot arms, 1.25 hours of performance footage (45 dance improvisations) and 2.5 hours of reflection and discussion. Further, we recorded another 10 hours of plenary discussions concerning the project and another 1 hour of miscellaneous group activities. Finally, the first author, whose involvement in the project centred on examining ethics within the evolution of the research process, also kept a field journal. She participated actively in the process, and detailed in the journal her first-person experiences of the group activities as well as observations of moments of interest, for example, when ethical positions where explicitly articulated, alternative perspectives on the research were offered, or different ways of continuing the research were discussed. This resulted in an additional 8000 words of transcribed field notes and reflections.

With the intention of examining the evolution of the process, the data from the first four workshops (July 2023 to February 2024) was organised chronologically. The first author structured the data gathered during each workshop – field notes, video recordings, and audio transcriptions – in the order that activities, dance improvisations, and discussions occurred. In the case of the fifth workshop, where we collectively discussed 13 video clips captured earlier during the process, the transcribed discussions were stored alongside the relevant video clips in the earlier workshops.

The first author, in discussion with the wider research team, conducted an interpretative analysis [64] of the overarching research process from the perspective of processual ethics [23]. Her aim was to make sense of the quality of *friction*, by examining how disagreements were expressed and experienced throughout the processes. She looked for both candid disagreement (e.g., *actually, I disagree...*) or finer-grained differences-in-perspective (e.g., *that's one option, but alternatively...*) that emerged during the research process. These frictions could pertain to ethics directly (e.g., *that could be unsafe...*), but also implicitly (e.g., *this would be a better approach for dancers with disabilities...*). Drawing on the work of Mol [49], she examined the boundaries between opinions (i.e., the

similarities and differences between positions), whether there were any changes to the research process in light of those frictions, and if so, how that change was coordinated. In line with other interpretive approaches [64], she compiled rich descriptions around each moment of friction, examining each context including what occurred before each friction and what – if anything – happened after each friction. She then examined the role that such frictions played in the evolution of the entire research process, which culminated in "The Predator Dance". This was one of the final dance explorations, which the research team identified as the most ethically provocative and challenging. Finally, she identified a series of moments which highlighted how the dancers' embodied expertise and lived experiences of disability ethically challenged established research practices. Her approach adopts the non-dualistic position that we are bodies shaped by our lived experiences, academic training, and professional expertise [23].

4 Processual Ethics: How To Dance with Robots?

Here, we present our research process to exemplify the different ways in which we encountered a specific site of friction: how can we dance with robots whilst still facilitating the process safely? Though we encountered many sources of friction, such as ethical tensions between crip perspectives and co-design methodologies (e.g. [8]), and different power relations implied by different research methodologies (e.g. [27]), we focus here on the friction of safely dancing with robots as it is most unique to our project. We encountered this friction repeatedly as we explored how to practice ethics (i.e., enact safety) while purposefully moving beyond the pre-established scope of practicing ethics (i.e., adhering to the existing safety guidelines that established how the robot should be used). We describe how we encountered this friction, and analyse the role that it played, across five stages of our research process; (i) how we intentionally configured the research space to produce uncertainty and uncover potential frictions; (ii) how friction exposed where lived experiences of disability challenged our ethical assumptions; (iii) how friction revealed the ethical differences between professional best practices; (iv) how immovable friction prompted us to reconfigure the research space; and (v) how, through friction, we cultivated our ethical sensibilities. It is important to acknowledge that, in practice, these stages of the process where entangled and unfolded over many hours of collaboration. However, for readability, we have delineated them more distinctly.

4.1 Producing Ethical Uncertainty

We intentionally configured the research space to produce uncertainty and uncover potential frictions. Our aim was to reimagine physical touch with robots as creative, generative, and trustworthy, rather than harmful and a problem to be avoided. This meant that we started with the intention of exploring an interaction generally considered undesirable except under clearly defined use cases. With dance, we wanted to move beyond the pre-established "correct ways" of standing, holding, and moving with the Franka arms. However, that did not mean that every kind of physical contact automatically became desirable. This immediately produced the question of how to best broach the research space.

In this process, we approached this by producing *anticipated uncertainty*. We did this *before* beginning to work intensively with the robots themselves. After our introductory session, we collectively began by engaging in dance exercises. These exercises were designed so that we could experience the uncertainties that we anticipated facing during the process. Within these curated spaces of uncertainty, questions of how to practice ethics began to emerge. For example, one anticipated uncertainty was that of how to approach consent; how to begin re-establishing acceptable and unacceptable forms of physical contact. Kate facilitated group exercises, such as moving and establishing points of contact with each others' bodies, to bring us into a space where we had to question and reflect on our experiences. For example, Steve reflected that, at one point, he saw someone moving towards his dance partner who was dancing with their eyes closed. Anticipating that they would bump into each other, he pre-reflexively put his body in the way, thus preventing them from making contact. Later, he reflected that he did not know why he had made that choice, but that he had instinctively decided that the contact should not happen. This is an example of how the exercise brought our ingrained ethical sensibilities to the forefront; what do we implicitly assume to be a violation of established boundaries? Thus, it enabled us to refocus on consent as a process (e.g., how do we decide what is acceptable?), rather than having pre-defined boundaries of acceptability.

Critically, these exercises did not provide an answer to how consent *should be* practiced in our process. Rather, they served to expose frictions by revealing how consent is not similarly meaningful and enacted by everybody in the same way. The exercises provided embodied points of reference, in relation to which differing conceptions of consent could be articulated. The context of the dance exercise provided permission to feel uncomfortable, i.e., to articulate different experiences of consent that might sit in (explicit or implicit) tension with others. Allowing frictions to begin to emerge in this highly facilitated fashion led us to the beginnings of an ethical process. By articulating these frictions, we challenged each other to question our personal or professional assumptions concerning ethics. This served to destabilise our current ways of understanding ethics, making space to explore something new.

4.2 Challenging Ethical Assumptions

Friction exposed where lived experiences of disability challenged our ethical assumptions. Our project also centred on bringing dancers with disabilities into contact with these robots, as a catalyst for reimagining our approaches to ethics. Friction emerged when the dancers' embodied expertise and lived experiences of disability ethically challenged some of our assumptions about risk and safety. In this case, the friction revealed different attitudes towards ethical change; with many of the academic team's approaches centred on trying to *do things better* and many of the dance team's reflections – particularly those working with crip and feminist perspectives on disability – pointed to the need to *do better things*.

For example, one roboticist explained the importance of designing to support users in building accurate mental models of robots, so that they can make accurate assumptions about their capabilities to predict their behaviours, in order to keep themselves safe. One dancer challenged this perspective, explaining how she confronts multiple harmful assumptions as a dancer in a wheelchair concerning her capabilities. Here, the roboticist approaches ethics as a matter of finding the right model (i.e., improving existing design principles) to prevent the robot doing harm. By contrast, the dancer approaches ethics as a matter of questioning the assumptions implicit in the concept of the model itself (i.e., improving our approach to design).

Similarly, the dance team also challenged some ethical assumptions expressed by team members who practiced co-design. At one point in our early workshops, the co-designers discussed whether we were doing enough to empower the dancers and enable them to dance safely with the robots. However, members of the dance team pointed to a tension between this approach and a more crip position on disability, which seeks to resist positioning people with disabilities as being disempowered in the first place. Here, the co-designers approach ethics as a matter of empowering their participants (i.e., counteracting a power imbalance). By contrast, the crip perspective to doing ethics is a matter of challenging the notion of empowerment itself (i.e., finding a way to approach power imbalance that does not simply reinforce the existing hierarchy of power).

These assumptions even permeated different methodological options. For example, a designer raised the idea of removing the potentially dangerous robots from the process entirely, and instead utilising a Wizard-of-Oz style approach where a human could play the role of the robot. A member of the dance team expressed their ethical discomfort, stating that the idea of replacing the robots felt like "blindfolding an able-bodied person" and advocated for continuing to explore how to work within the constraints of the robot. Here, the designer approaches ethics as a matter of removing the risk posed by the robot, and finding a safer approach (i.e., removing the constraint to the process). Conversely, the dance team approaches ethics as a matter of finding a safe way to work within those constraints (i.e., troubling our assumption that constraints are a problem needing to be removed).

From the perspective of processual ethics, our habitual ways of doing ethics were destabilised and challenged by engaging with different perspectives and lived experiences.

4.3 Misaligned Professional Ethics

Friction revealed the ethical differences between professional best practices. As a starting point, we all agreed on the need to facilitate the process safely. Our different robots came with different levels of associated risk. Some robots came with relatively low-levels of risk, for example, one of our smaller robots could bump into someone without causing harm. Other robots came with more severe risks, but ones that would only be encountered if we tried to interact with them in a highly specific way, for example, deliberately placing body parts inside the robot's outer shell where the internal machinery was housed.

Despite a collective recognition of the different risks, we held multiple professional perspectives concerning how safety should be facilitated. Friction arose when we attempted to facilitate a safety induction to the Franka arm, largely due to the different approaches to establishing risk. For example, our roboticists established what was unsafe to do with the robots by outlining the *unknown risks*,
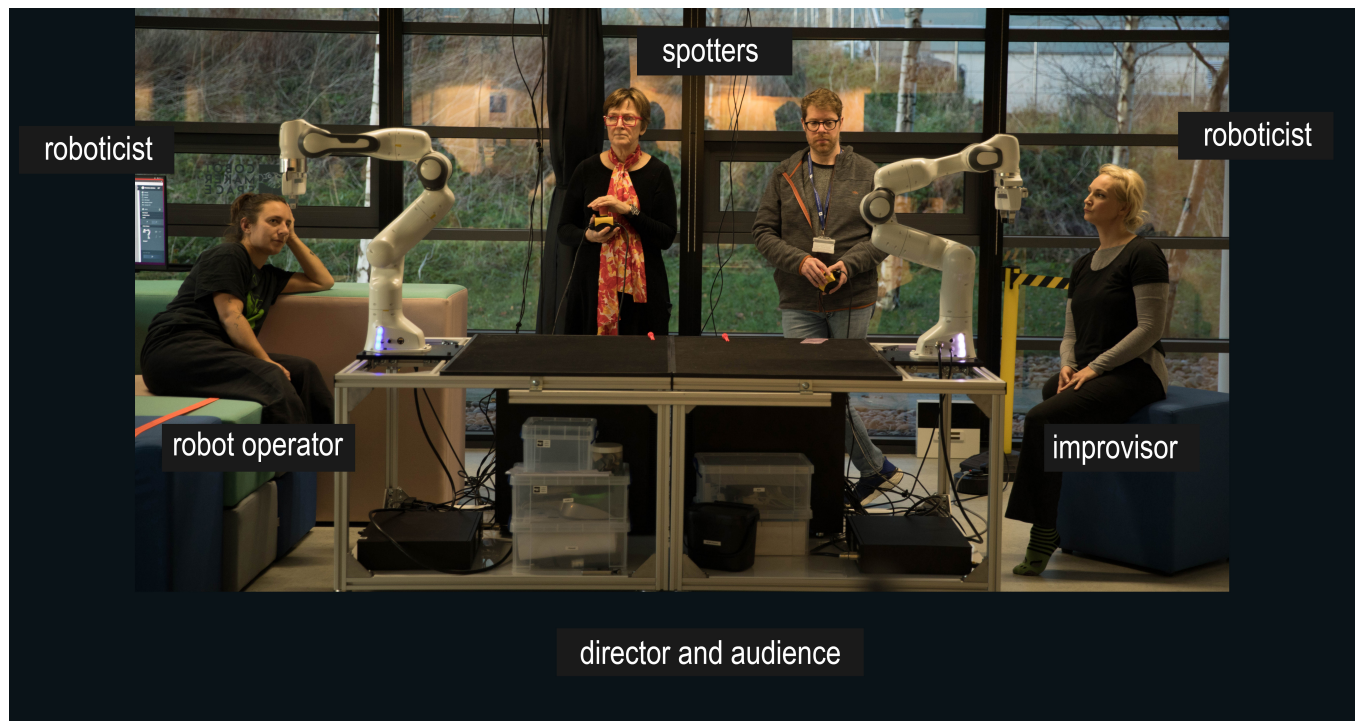
Figure 4: The safety setup: the dancer on the left operates the control arm while the dancer on the right improvises with the free arm. Each dancer is monitored by a roboticist near them. Two team members hold emergency stop buttons. The director and the audience are positioned behind the camera.

for example, a malfunction that could potentially result in an unpredictable behaviour. The roboticists enacted ethics, in accordance with their training, by alerting us to risks arising from unknown factors, i.e., *if we do not know something is safe, then it is a source of risk.* However, when the dancers responded with further questions concerning the robot, they asked for *known risks,* for example, parts of the robot that could be broken if they used too much force. The dancers enacted ethics by asking us to alert them to risks arising from known factors, i.e., *if we know something is not safe, then it is a source of risk.*

In our process, this friction resulted in the team talking across purposes as we tried to establish how to facilitate safety. This reveals different professional attitudes to responsibility. The roboticists approached the safety induction in a fashion akin to when a new researcher joins the lab, and they are responsible for providing training in how to properly operate the equipment. In this best practice, *responsibility is on the technician to ensure care is taken of both the dancer and the equipment. This should be accomplished by showing the dancer how they should use the robot.* The dance team approached the safety induction in a style more akin to beginning to dance with a new partner. They describe how, in this situation, they would usually ask the new partner about body parts (e.g., a sore shoulder, a weak knee) that they should be careful around. The way safety should be facilitated through this best practice is different; *responsibility is on the dancer to ensure care is taken of the robot. The technician should facilitate the dancer's responsible behaviour*

by showing the dancer what not to do to the robot. Thus, we see two slightly different ethical configurations within these professional best practices. As it is impossible to quantify unknown risks, from the roboticists' perspective, they cannot responsibly tell the dancers that anything is safe. However, from the dancers' perspective, the roboticists' position can be interpreted as everything is unsafe. If everything is unsafe, then the dancers cannot act responsibly by avoiding the known risks.

The friction exacerbated existing uncertainties in the process. This uncertainty led to the dancers asking more questions as they tried to establish the (known) risks of dancing with the robot, and the roboticists responded to these questions by trying to give more detail concerning the (unknown) risks of dancing with the robot. Thus, the risks became amplified, which produced more uncertainty, and exacerbated the friction between professional perspectives. This compounded the ongoing miscommunication. From the perspective of processual ethics, we reached a moment of ethical breakdown in the research process where we could no longer move forward together without doing something about the situation.

4.4 Reconfiguring Ethical Breakdown

Immovable friction prompted us to reconfigure the research space. To recover from the ethical breakdown, a team leader took charge and made executive decisions concerning the research process. This leader employed their authority to interrupt the compounding misunderstanding, and suggest a way forward that was a compromise
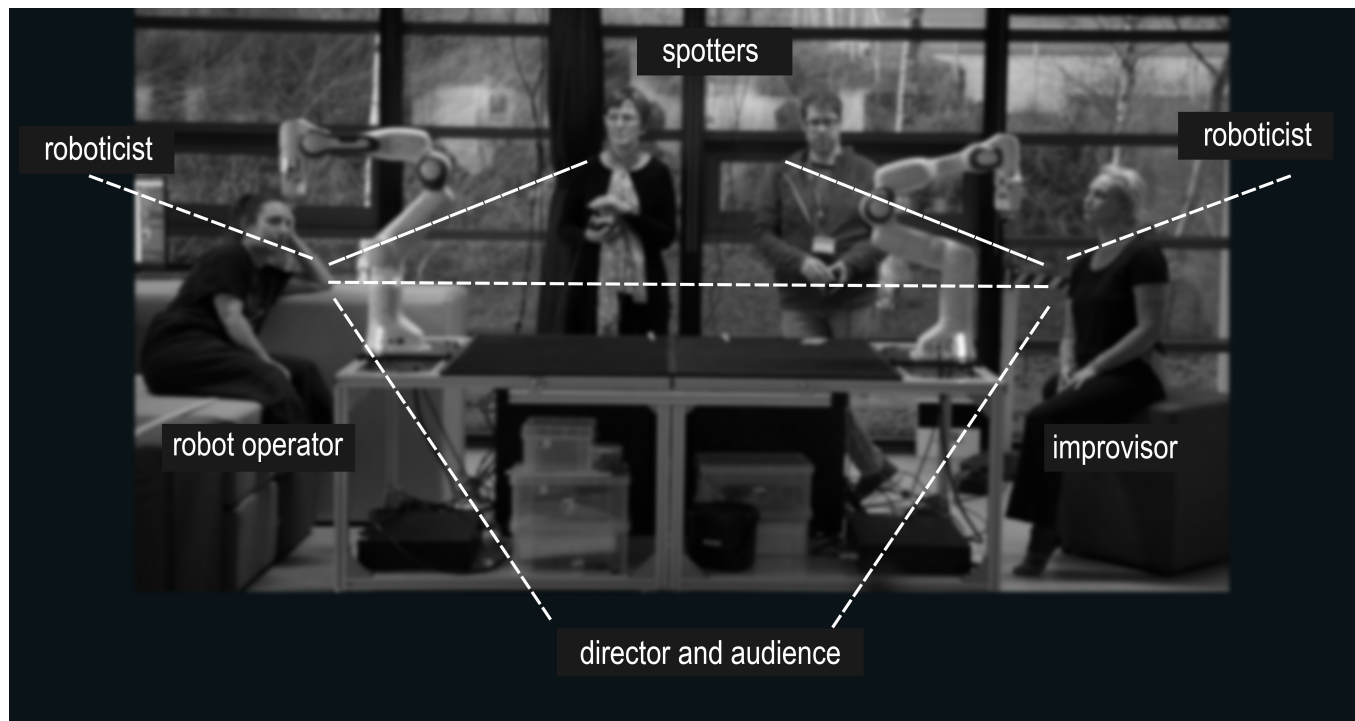
Figure 5: Ethical relations: the safety setup places each of us – the roboticists, the Spotters, the director and the audience – in a specific relation to the dancers

between the concerns of the dancers and roboticists. With everyone's permission, they assigned roles to different team members in order to balance the different safety concerns being voiced. This led to a number of changes to the setup; one team member would monitor each dancer-robot pair with an emergency stop button (similar to how Spotters are employed in gymnastics); Simon, a roboticist, was responsible for ensuring the operation of the robots, and Feng was responsible for monitoring the computer from which the robots were running; Kate, the director, was responsible for taking care of the dancers – Kat and Welly – and coordinating the dance improvisations (See Figure 4). An order was also established for each improvisation. The Spotters would need to be in place, and Simon and Feng would both confirm that the robots were ready to operate *before* the dancers could move into proximity with them. Kate was given final control over when each improvisation began and ended (unless the robot needed to be shut down in an emergency). Once an improvisation was over, the dancer would move out of proximity with the robot, so that Simon and Feng could return them to start position. The rest of the research team formed "an audience for the performance" and were encouraged to speak out if they felt something was off.

This setup had the effect of the boundaries between different roles in the space (i.e., artist/researcher/observer) and instead placed each body in a specific ethical relationship to the dancers (See Figure 5). (i) The dancers were ethically responsible for each other and their robots, (ii) the director was ethically responsible for the dancers, (iii) the roboticists were ethically responsible for the dancers, through

keeping the robot safe, (iv) the Spotters were ethically responsible for the dancers, through stopping the robot if it becomes unsafe, and (v) the audience also had an ethical responsibility to the dancers, in their role as observers. In essence, to overcome the breakdown, we established a temporary ethical protocol. This reconfiguration meant that ethicality was no longer contingent on adhering to one set of pre-established procedures – or even reaching an agreement between contrary professional perspectives. Rather, the ethical responsibility for facilitating safety has been distributed into specific roles within a hierarchy of responsibility. Thus, the ethical continuation of the research process became coordinated among the group, despite our differing professional approaches to safety.

From the perspective of processual ethics, we reached a point of breakdown where we could no longer continue working within the ethical configurations established by our different areas of professional expertise. We overcame this by purposefully reconfiguring the ethical relationships in the space. This reconfiguration enabled us to move forward again, by creating new ethical relationships. Thus, we were shifted out of our ingrained approaches to ethics, and we had to relearn how to practice ethics in our provisional roles.

4.5 Cultivating Ethical Sensibilities

Through friction, we cultivated our ethical sensibilities. As the final part of our analysis, we focus on "The Predator Dance" (See Figure 6). In this particular scenario, Welly was asked to operate the control arm with her eyes closed. To ominous music, Welly smoothly moved

Figure 6: The Predator Dance (left to right). (1) Welly begins to control the robot. (2) Kat begins to improvise. (3-5) Kat weaves in and out of the space around the robot. (6) Kat assesses how to approach the robot. (7) Kat ducks beneath the robot. (8) Kat rises up again.

the control arm while Kat improvised with the free arm in a bold and subversive fashion, expertly weaving in-between the robot's movements in a manner that purposefully built suspense in the rest of the research team. At one point in the dance, Kat ducked beneath the robot as Welly moved it downwards, which led to an extended and dramatic moment where the robot appeared to threaten Kat from above, before they finally dropped to the floor and out of the robot's range of motion (See Figure 6). The research team visibly reacted to this moment, however, the Spotter, Rachael, chose not to press the emergency stop button. When reflecting on this improvisation, the dancers expressed great satisfaction with this performance (referring to it as the best one of the process so far), while the rest of team revealed that this was also the most nervous they had felt during the entire process. When this moment was later reviewed, the team decided that not shutting down the robot was the correct decision; stopping the robot in that position would have potentially put Kat at greater risk, either trapping them on the floor or causing a collision when they tried to rise up again. This video is included in the supplementary material for this paper.

After the dance, Kat reflected on how they intentionally put themselves into a precarious situation, but that they sensed how the robot was moving and knew they had to drop to the ground to avoid it. They likened it to receiving a clear lead from a dance partner. After watching the video be replayed, Rachael described her discomfort with the situation, explaining that she felt close to pressing the button in the moment before Kat dropped to the floor beyond the robot's range of motion. To her, those few seconds lasted for an excruciatingly long time. When asked why she had not pressed the emergency stop button, Rachael explained that she knew that Kat had acted intentionally. She saw Kat's style of dancing as purposefully provocative, and that despite feeling uncomfortable, she was reluctant to act on that discomfort and put a stop to the dance.

We see two frictional perspectives in the situation: Kat's comfort and Rachael's discomfort. However, in this case, the friction reveals a shift in how they are practicing ethics. In our setup, Kat is placed in an ethical relationship to the robot with the responsibility to ensure, as much as possible, that neither their body nor the robot come to harm. To facilitate this, the dancers asked for known risks at the start of the process. Now, Kat explored the borders of those risks. Their reflections indicate that they developed a somatic understanding of the robot's body and an embodied sense of the limits of its movement: *It was one of the nicest moments I've had with [the robot.] I felt 'okay, I have to go to my knee.' It's like when you're dancing with a human and the lead is so clear like 'okay, you want me to go there. So I will go there.' [Simon: did you feel it on your back?] Just. I felt more the movement continuing down than physical pressure on my back. I knew it was coming down.* This enabled Kat to flirt with risk, choosing to duck beneath the robot, without compromising their ethical responsibility to keep themselves and the robot as safe as possible. Here, *Kay challenges our pre-conceived notions of risk through her embodied expertise.* Rachael is placed in an ethical relationship to Kat with the responsibility to respond to anything unexpected and dangerous that might happen. Kat's sudden ducking beneath the robot shifted the improvisation into the space of unknown risk – to which it was Rachael's role to respond. However, her reflections indicate that she had developed an appreciation of Kat's body and

their dancing style. She considered her ethical responsibility in relation to potentially infringing on Kat's professional expertise: "*I felt that Kat had done this intentionally. And throughout, I feel Kat's style of dancing with the robot has been purposefully provocative and subversive. Because that's... Which is great, I love that. So I was like, this is just Kat dancing. And I'm uncomfortable... But then should I act on that, should I make the decision to shut it down...* Her ethical sensibility towards safety was challenged, but she chose not to act while Kat appeared to be comfortable with the risk. Here, *Rachael challenges her pre-conceived notions of risk through not contesting Kat's embodied expertise.*

From the perspective of processual ethics, this reveals a shift in how ethics were being practiced within the research process. Within the reconfigured space, we – the Spotters, audience, and other team members – were put into a relationship of ethical responsibility with the dancers. Our roles facilitated safety, but they also laid the groundwork to cultivate ethical sensibility towards the dancers' bodies. It required us to engage with the dancers more closely and, in turn, we developed a deeper appreciation of their practice. Through opening ourselves up in this way, we developed a richer understanding of the ethical differences that exist between practices. We did not reach a consensus on how to best practice ethics in this process, but rather, we reached a space where we could "hang together" despite our discomfort and differing perspectives. In this way, the Predator Dance was a space of ethical generativity where alternative ways of practicing ethics could be explored.

5 Discussion: Productively Engaging with Friction

It is important that the ethics of our research processes are rendered visible for the purposes of critique within the HCI community. This contributes to greater honesty and integrity in our research reporting practices, as well as fostering reflection and critique regarding our ways of practicing ethics in research [23, 36]. It is equally important to be attentive to where new ethical configurations failed to emerge in our research or where ethical misalignments were so deeply implicit that they failed to even manifest as friction within the process. In our analysis, we identified some moments – such as our reactions to failures and breakdowns concerning the robot – that might have provoked some deeper reflection and critique. These deeper and more implicit ethical misalignments are discussed in depth in [21].

We were able to collectively arrive at a generative ethical outcome. In many ways, we were at a considerable advantage; the framing of our research created space to analyse and consider different approaches to ethics, and our team – although interdisciplinary and diverse – entered the project agreeing and expecting to broach the ethical uncertainty this would create. Though we encountered moments of ethical breakdown, our team did not ultimately have to deal with insurmountable challenges or resistance to the process in general. Such ethically generative outcomes to frictional research processes are far from guaranteed. Further, it is difficult to offer practical and applicable guidelines regarding how to productively engage with friction. Friction arises from a multitude of factors that have shaped our ethical sensibilities [23, 46]; lived experiences, professional expertise, and academic training. Further, we

encounter friction in processes that are themselves highly situated and contextual [6, 51]; shaped by funding obligations, institutional requirements, and expected deliverables and research outcomes.

In our analysis, considering various disagreements in terms of their implicit ethics allowed us to more clearly trace the process by which we established a way of collectively practicing ethics together. There are five ways in which we arrived at a generative ethical outcome, which may be helpful in productively engaging with friction in other interdisciplinary collaborations: (1) Space can be created early on in the research process, in which different ethical perspectives can be articulated, especially in projects where different perspectives and approaches to ethics are anticipated. (2) Contrary perspectives on ethics and desirable research outcomes can be considered, not only in terms of established procedures and knowledge structures, but also in relation to how they position different bodies in relation to the research process. (3) Disagreements concerning methodological choices can be considered, not only in terms of practicality or similar merits, but in terms of the ethics or values that are implicit in that way of approaching the research. (4) Different professional approaches to ethics can be considered in terms of the ethical relationships and responsibilities they create between different bodies in the research process. (5) Redistributing the ethical relationships and responsibilities can be a way of moving forward, when it is difficult to agree on a single ethical approach to the research. In practice, these approaches will look different in every process, however, they may act as a starting point for cultivating a kind of collective ethical sensibility regarding the best ways to approach collaborative research.

Our contribution both extends and combines existing inquiries into ethical practices within the HCI community. Recent research has provided strategies for incorporating ethics into existing practices [45], however, our approach here has been to examine the values already implicit in our practices by approaching ethics in terms of sensibilities. The cultivation of ethical sensibility has been examined as an individual process [23], which here we instead consider from the perspective of an interdisciplinary team who have different sensibilities towards ethics and professional best practices. Whereas such disciplinary tensions have been outlined in the case of obtaining formal ethical purview [6], we take a fine-grained approach by examining how such frictions unfold in practice[53]. Such fine-grained, situational, and contextual approaches to ethics are increasingly important in messy and complex research processes [20, 51, 65], and we offer a processual analysis which examines the role of friction in the research process as a whole. Our contribution offers a nuanced analysis that reveals how different professional training and practices contain implicit ethical positions which can result in friction. However, we argue that such friction can be engaged productively which can foster an ethical process that cultivates our ways of relating ethically towards one another. This contribution is relevant for interdisciplinary collaboration in both academia and industry settings [46].

Even while we have attempted to present our frictional process in as much detail as possible, our account still does not capture the full nuance and complexity of our own collaboration. Towards the very end of the project, one roboticist confessed to us that they had access to a third emergency stop button throughout the entire process, which they had not shared with anyone else on the research team. Their reasoning was that they did not want the designated safety persons to become complacent, knowing there was an extra layer of protection. While writing this paper, they reflected that this decision might be indicative of their habitual sensibilities about technical safety measures. This was an act taken out of care towards the rest of us, and one that reflects how deeply ingrained our attitudes towards ethics can be.

6 Conclusion: Towards Generative Ethics

Frictions are inevitable in the interdisciplinary field of HCI and will become even more so as we broach new technologies that pose increasingly interdisciplinary challenges. We are a community characterised by our differences [68]. Rather than solely a challenge to work with, differences also contribute to the generativity of our research domain. Indeed, they only become undesirable when they prevent us from relating to each other and moving forward together. Our aim with this work is to motivate others to engage, or seek ways to engage, productively with friction. In doing so, new ethical understandings could emerge across epistemic, ontological, methodological, and conceptual boundaries. Finally, and most fundamentally, we advocate for cultivating an attitude of openness in research. Our habitual ways of knowing and doing ethics become deeply ingrained in our academic bodies. In each stage of our process, encountering friction destabilised our habitual ways of approaching research and allowed for new ethical configurations between us. However, this can only happen if we are willing to let ourselves be moved – have our academic bodies reshaped – by those who know differently [22]. We see this as underlying all attempts to cultivate more ethical research practices: our capacity for ethical understanding or action-taking begins in letting our ethical sensibilities be challenged, questioning the partiality of our ethical knowledge, and being open to ethical change [22]. The generative potential of ethics, ultimately, lies in the process of becoming.

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