Doctoral Thesis in Human Computer Interaction

Doing, being, thinking HCI otherwise at the end of the world as we know it

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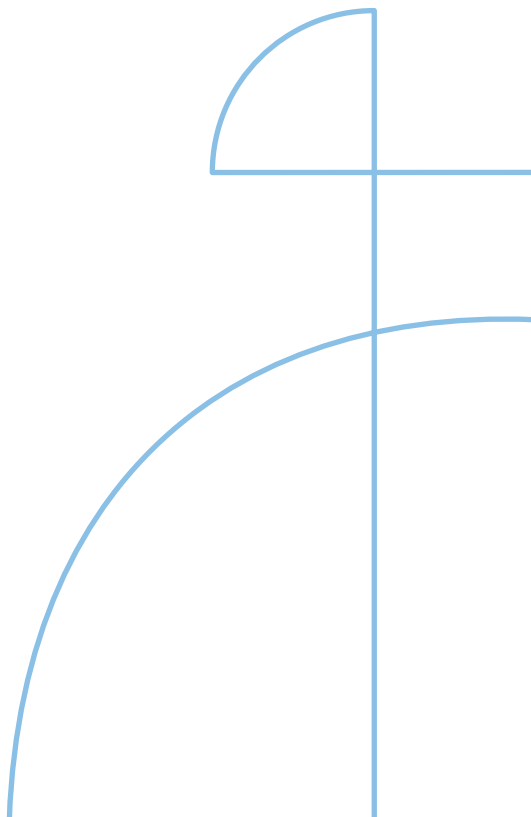
KTH ROYAL INSTITUTE OF TECHNOLOGY



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MINNA LAURELL THORSLUND

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For Mårten, Noma and Line,
and our shared futures

I Abstract

The global environmental crises continue to worsen, approaching irreversible thresholds. While much sustainability research focuses on policy, technological solutions and behaviour change interventions, the role of professionals—the people actually doing the work—remains largely unexplored as potential actors in sustainability transitions. This thesis addresses this gap by asking: how can Human-Computer Interaction (HCI) be practiced otherwise at the end of the world as we know it, to enable liveable futures?

Rather than asking what HCI as a field should do, I centre on HCI professionals themselves—researchers, practitioners, designers, educators, students—and our potential for agency in responding to what I term the socio-environmental predicament. This predicament encompasses interconnected environmental and social crises that cannot be "solved" but require thoughtful, situated responses. I have explored this question through first-person research grounded in my own experiences as a PhD student practicing HCI otherwise.

Through six papers, this thesis makes three contributions. First, I demonstrate the value of centring HCI professionals rather than HCI as a field, shifting from abstract calls for change to concrete possibilities for individual agency and responsibility. Second, I provide two practical resources: a framework for surfacing assumptions about sustainability in our work, and an application of the Two Loops model that identifies multiple sites of agency within both dominant and emerging systems. Third, I show what action-oriented second-order transition research can look like in HCI, demonstrating how such research can support transformations towards liveable futures.

My exploration reveals that meaningful responses include: 1) learning from communities that are already living with the knowledge and/or experience of collapse; 2) using and designing speculative methods to support desirable futuring; 3) engaging in action-oriented community-led work; and 4) paying attention to, promoting and hosting emotions and care in your interactions with others, in the face of uncertainty, complexity and loss. Ultimately, this thesis argues that the transition ahead requires us as HCI professionals to engage in critical reflexivity about our assumptions, values, and practices, and to find new ways of using our skills and positions in service of life and the living.

II Sammanfattning

Att göra, vara, tänka *om* MDI i slutet av världen såsom vi känner den

De globala miljökriserna blir alltmer akuta, och närmar sig ett oåterkalleligt tillstånd. Hållbarhetsforskningen i stort fokuserar i huvudsak på lagstiftning, tekniska lösningar och beteendeförändringar. Förhållandevis lite uppmärksamhet har emellertid riktats mot yrkesutövare som potentiella aktörer i hållbarhetsomställningar. Denna avhandling bidrar till att öka kunskapen om deras potential genom att fråga: hur kan människa-datorinteraktion (MDI) praktiseras på andra sätt vid världens slut som vi känner den, för att möjliggöra framtider som vi kan leva i.

I stället för att fråga vad MDI som fält borde göra fokuserar denna avhandling på dem som utövar MDI som yrke–forskare, praktiker, designers, pedagoger, studenter–och vår möjlighet till konkret handling i förhållande till det sociala och miljömässiga predikamentet. Detta predikament består av sammanlänkade miljömässiga och sociala kriser som inte kan ”lösas”, utan kräver välgrundade och situationsspecifika gensvar. Jag har utforskat denna frågeställning genom vad som kallas första-person-metoder, baserat på mina egna erfarenheter som doktorand av att praktisera MDI med ett nytt förhållningssätt.

Genom sex artiklar ger denna sammanläggningsavhandling tre bidrag. För det första visar jag på värdet av att skifta fokus från MDI som fält till yrkesverksamma inom MDI, ett skifte från abstrakta upprop om förändring till konkreta möjligheter för individuell agens och ansvarstagande. För det andra bidrar jag med två praktiska resurser: ett ramverk för att synliggöra antaganden om hållbarhet i vårt arbete, och en tillämpning av Two Loops-modellen som identifierar ett stort handlingsutrymme inom både dominanta och emergenta system. För det tredje visar jag hur handlingsorienterad andra gradens omställningsforskning kan se ut i MDI, och hur sådan forskning kan stödja transformationer mot levande framtider.

Min forskning visar att meningsfulla sätt att svara an på predikamentet innefattar: 1) att lära från människor som redan lever i eller med kunskap om social eller ekologisk kollaps; 2) att använda och utforma spekulativa metoder för att stödja processer som syftar till önskvärda framtider; 3) att engagera sig i handlingsorienterade och behovsdrivna samarbeten med samhället; och 4) att uppmärksamma känslor–både våra egna och andras–i mötet med osäkerhet, komplexitet och förluster. Ytterst gör jag gällande att den omställning vi står inför kräver av oss som är yrkesverksamma inom MDI att vi kritiskt reflekterar över våra antaganden, värderingar och praktiker, och hittar nya vägar att använda våra förmågor och positioner, i tjänst av livet och det levande.

III List of papers and my contributions

Paper 1 [Assumptions]

Minna Laurell Thorslund and Ola Leifler. 2025. Exploring assumptions about sustainability: Towards a constructive framework for action in Sustainable HCI. In CHI Conference on Human Factors in Computing Systems (CHI '25), April 26-May 1, 2025, Yokohama, Japan. ACM, New York, NY, USA, 13 pages. https://doi.org/10.1145/3706598.3714001

This paper is an essay, of which I am the originator and first author. It argues that several assumptions underpin what people mean by "sustainability", which influence what is considered meaningful and important areas of sustainability research in HCI. I formulated the design of the paper, wrote the first drafts of most of its content, which Ola Leifler and I both edited, and then I edited the final paper.

Paper 2 [Pastcasting]

Minna Laurell Thorslund, Elina Eriksson, Daniel Pargman, Pella Thiel, Martin Hedberg, and Amanda Martling, 2025. Pastcasting: engaging with seemingly unreachable futures. Futures, 2025. https://doi.org/10.1016/j.futures.2025.103609

This paper describes the process and result of a project where, inspired by action research, we developed a workshop method using pastcasting to help an NGO increase engagement in local sustainability transitions. The original research was conceptualised by co-authors Elina Eriksson and

Daniel Pargman. I was an integral part of the research throughout the project, both in terms of practical work and conceptual developments. As the first author, I have been involved in all aspects of writing the paper, including its design, data collection, analysis and discussion.

Paper 3 [Interviews]

Minna Laurell Thorslund, Elina Eriksson, and Daniel Pargman. Principles and pragmatism in local energy transitions: A Swedish case study of the Transition Network. *Manuscript submitted to npj Climate Action.*

This paper reports on an interview study conducted with members of our action research partner organisation, Omställningsnätverket (the Swedish Transition Network). I wrote the interview questions, recruited participants and conducted the interviews. They were analysed by all three authors, who designed, wrote and edited the paper together.

Paper 4 [Eco-anxiety]

Elina Eriksson, Anne-Kathrin Peters, Daniel Pargman, Björn Hedin, **Minna Laurell-Thorslund**, and Sandra Sjöö, 2022. Addressing Students' Eco-anxiety when Teaching Sustainability in Higher Education. In Proceedings of the 2022 International Conference on ICT for Sustainability (ICT4S), 2022. 88–98. https://doi.org/10.1109/ict4s55073.2022.00020

This paper describes a research and development project in a higher education course on sustainability and ICT, where we specifically focused on students' emotions in the face of the environmental crises. My main contribution to the paper is that I was part of designing the project and doing the actual research, and I did a minor part of editing the paper.

Paper 5 [Dread]

Anne-Kathrin Peters, **Minna Laurell-Thorslund**, Elina Eriksson, Daniel Pargman and Michalinos Zembylas, 2025. Dread, hope and the politics of emotion in engineering education. *Manuscript reviewed by and resubmitted to the European Journal of Engineering Education.*

This paper was conceptualised by Anne-Kathrin Peters and describes a study on sustainability education in the field of engineering and computing,

focusing on dread and hope in students and teachers. I participated in the workshops from which data was gathered from the analysis, where we all simultaneously collected data; I did one part of the analysis, of which I wrote a first draft; I wrote parts of the discussion and edited the paper in full with my co-authors.

Paper 6 [Two Loops]

Minna Laurell Thorslund, Oliver Bates, Elina Eriksson, Daniel Pargman, Aksel Biørn Hansen, Fatemeh Bakshoudeh, and Arjun Rajendran Menon, 2025. Meta-crisis computing and you: Finding agency through the Two Loops model of change. *Proceedings of the Sixth Decennial Aarhus Conference: Computing X Crisis,* 127–139. https://doi.org/10.1145/3744169.3744178

This paper is an essay, of which I am the originator and first author. It applies the Two Loops model of change to the HCI and IT community to allow its members to find agency in a changing and uncertain world. The paper's design was formulated with my co-authors, and the thinking within it is the result of our collaboration. I wrote the first drafts of several sections of the paper, and was responsible for editing and preparing the paper for publication.

Publications not included in this thesis

The following publications have been part of my research as a PhD student, but are not part of this thesis:

Daniel Pargman, Elina Eriksson, Arjun Rajendran Menon, **Minna Laurell Thorslund**, Aksel Biørn-Hansen, Emilia Rekestad, Isabel Chender, and Markus Schneider. 2018. Navigating Complexity and Embracing Uncertainty: Teaching Participatory Leadership in Engineering Education. Proceedings of the 12th EESD Conference (EESD 2025).

Aksel Biørn-Hansen, Elina Eriksson, **Minna Laurell Thorslund**, and Daniel Pargman. 2023. Using counterfactual scenarios to envision low-flying academia. In DIY Methods Conference Proceedings, 2023. https://doi.org/10.17613/6hj0-5w42

Ian Brooks, **Minna Laurell Thorslund**, and Aksel Biørn-Hansen. 2023. Tech4Bad in the Oil and Gas Industry: Exploring Choices for ICT

Professionals. In Proceedings of the 2023 International Conference on ICT for Sustainability (ICT4S), 2023. 142–153. https://doi.org/10.1109/ict4s58814.2023.00023

Sahra Svensson-Höglund, **Minna Laurell Thorslund**, Jessika Luth Richter, Anna Richter Olsson, Charlotte Louise Jensen, Jaco Quist, Jennifer Russell, and Carl Dalhammar. 2022. Futures of Fixing: Exploring the life of product users in circular economy repair society scenarios. International Institute for Industrial Environmental Economics, Lund University. https://lup.lub.lu.se/record/25fb635d-7815-4382-bf3d-93f9caff641e

Minna Laurell Thorslund, Sahra Svensson-Hoglund, Daniel Pargman, and Elina Eriksson. 2022. From (e-)wasteland to Repair Society: Exploring ICT repair through speculative scenarios. In 2022 International Conference on ICT for Sustainability (ICT4S), 2022. 179–189. IEEE. https://doi.org/10.1109/ict4s55073.2022.00029

IV Acknowledgements

The five and some years it has taken me to arrive here, with my name on this book, have been the most challenging in my life. At 40+, being an apprentice and a beginner once again, going through the outer and inner work of *becoming*, is in itself a humbling experience. Moreover, the first half of this passage unfolded as a million things that so many of us had taken for granted about the world unravelled or were suspended, as the COVID-19 pandemic swept through the world. Together with my husband and children, we have moved from our hometown to an entirely new context, and my youngest daughter has had health problems. But hardest of all have been the many sudden losses of loved ones that I have endured during this period. I lost my mother, my father, my beloved grandmother, a very close friend and a dear colleague–all of whom were in good health prior to 2020. In other words: for me, the world is a different place now. And had it not been for the kindness, humanity and humour of my colleagues at the MID Sustainable Futures Lab and others who I met along the way, I would not have made it here.

So, first of all, to my supervisors Daniel Pargman and Elina Eriksson: thank you, for *everything*. The LAUGHS! Your intellectual, emotional and human curiosity. For your courage to dare to think and be differently. Daniel (who has read ALL THE BOOKS!), for all your wild thoughts and very silly jokes. Elina, for the tears (both mine and yours), and for knowing exactly when to push me outside my comfort zone and when to give me a hug. Thank you both for believing in me, and, ultimately, for being such good friends and excellent humans.

To my doctoral sisters and brothers Annika, Aksel, Arjun, Yann, Sofie, Fatemeh, Remy and Andreas. I'm happy we got to walk alongside each other for a bit. You are awesome people, and I wish you the best in life. Rob Comber for your advanced reading of this thesis, and your precise, caring and

encouraging feedback. I admire you for being someone who knows all the things about the mess we're in AND still finds ways of thinking of and doing technology for good. Thank you also to Lisa Nathan for an engaging conversation and constructive feedback during my pre-final seminar, and Jonas Löwgren for a half-way seminar that boosted my confidence.

During these past years, I have been lucky to meet many people who are both brave and kind: Ola Leifler, Ian Brooks, Anne-Kathrin Peters, Ann Light, Maria Wolrath Söderberg, Katka Çerna, to name a few. Thank you all, for being such an inspiration. Thank you, Roy Bendor, Mia Hesselgren and Jarmo Laaksolahti, for encouraging me on the sidelines, and Sandra Sjöö for an excellent collaboration. Amanda Martling, Pella Thiel, Emilia Rekestad, Markus Schneider, Isabel Chender for showing me other ways of being in the world.

Oliver Bates, what a treasure of a colleague and friend! Thank you Anna, for everything, always. Jessica, who helped me keep trusting that this was possible. Lisa and Niklas for embodying how care and community is done – thank you for your support. And ILOB! Specifically Hanos for keeping me on track, and Maaike for the beautiful sleeve.

And finally: thank you my dearest Mårten, Noma and Line, for filling my life with love and meaning, and for helping me past the finishing line.

Prologue

For as long as I can remember, I have felt that there was something fundamental about the world that I alone did not understand. I have thought that there must be a good reason, albeit unknown to me, why things are the way they are, and that if something can be done about things like climate change and poverty, someone, somewhere, is currently tasked with doing their very best to address them. To this end, journalists and scientists, among others, keep relentlessly digging for important problems that remain to be solved. The issues uncovered are then gently handed over to our institutions, who are grateful for the opportunity to check one more thing off their list of things to do in humanity's shared journey towards a better world. And because of this beautiful ecosystem of detective work and institutional efforts, the rest of us can just cast our votes once in a while, and then get on with whatever happens to be our jobs, duties and passions. Which is what I, together with so many others, did. Sometimes I'd lie awake at night after some fact nugget had reached me, wondering how on Earth a thing like peak oil was not on everyone's lips and our decision makers' top priorities. I remember thinking, "Should I stock up on toothpaste for when there is no more oil?" after reading about all the essentials of modern life derived from oil. Then I remembered that this is what our institutions are for, and that therefore I had nothing to worry about.

In my early 40s, after a BSc in Psychology (where I learnt little about humans or life, and a lot about Positivist Science), an MSc in Human-Computer Interaction with Ergonomics (which I thought would allow my desire to make people's lives better to flourish), 20+ years of work experience in startups, global corporations and public authorities, and after having become the mother of two daughters, I burnt out. My brain was broken: I was sleepless and depressed, could not tolerate noise or lively conversations, nor

could I do the most straightforward arithmetic. I spent an entire year lying on the sofa with our cat, thinking about all the years I had spent working so, so hard. And I no longer knew what for. How did what I had poured almost all my energy into in *any* way contribute to fixing *any* of the serious problems that kept gathering on the horizon, and which seemed never to end (in fact, they had gotten worse since I last checked!)? During that year on the sofa, I remember feeling like I had fallen off a wagon and was sitting on the side of the road, watching the world spin faster and faster, and very few things made sense to me anymore.

The summer of that year, 2018, was also one of unprecedented heatwaves in Sweden, with major forest fires and drought, emergency slaughter of cattle, and days and days on end with over 30°C, even at night. The air stood still. The bees that had not died from thirst were desperately looking for flowers with nectar, to no avail. People were resorting to beaches late at night to get some cool before trying to sleep. That summer was a time of awakening for many Swedes to the fact that the long-predicted devastating effects of climate change were here. This collective awakening, combined with my personal crisis and training as a coach in Spring 2019, led me to re-evaluate the idea of work, careers and professions completely. I came to see them as the investment that they are: while not everyone is born with money, we are all born with time (even if we do not know how much we have at our disposal) which we must invest wisely. Many of us spend between 1,500-2,000 hours per year doing paid work (see Figure 1). That is, we give our time to someone else to pursue *their* goals, in exchange for money, so that we can pursue our own in our free time. Few of us make time investments of similar magnitude in anything else during our lifetimes.

For some time now, many of us in the industrialised world have enjoyed the privilege and luxury of being able to choose careers based on individual values such as pleasure, curiosity and status–something that our culture has both encouraged and rewarded. In and of itself, working to fulfil individual values does not have to be a problem. However, on closer inspection, we see that many organisations we choose to work for are causing irreparable damage to life on Earth. Building on Hannah Arendt's term "Schreibtischtäter", author Dan Gretton writes about so-called "desk killers"[1], i.e. people in white-collar jobs in institutions or large corporations who, by making executive decisions that are "necessary" for the organisation, can cause massive damage to humans and ecosystems, and who still lovingly kiss their children goodnight at home. While the effects of "desk killers" represent the extreme end of the spectrum of harm caused by much of modern work,

[1] Gretton, D. (2019). I you we them: Journeys beyond evil: The desk killer in history and today. Random House. See also en.wikipedia.org/wiki/Desk_murderer

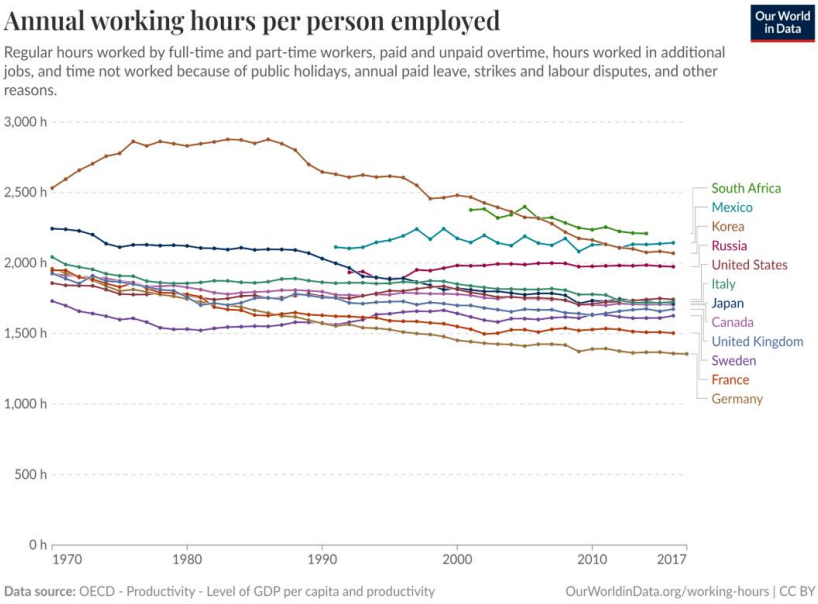

Figure 1. Out of the 8,760 hours in a year, many of us work between 1,500 and 2,000 hours. During a 40-year career, this amounts to well over 50,000 hours.

stepping over the threshold of our workplaces and into our job roles or titles *does* things to how we act in the world, whether we realise it or not.

Now that the true cost to humans and the natural world of our spending spree on natural resources is critically threatening more and more life, I feel that it is time for those of us who *can* to become wiser about how we engage in work, and in service of what. That is why I have chosen to write *this* particular thesis, not another one.

Contents

[2] The end of the world as we know it is sometimes referred to by its acronym TEOTWAWKI, which I use here due to lack of space.

On doing, being, thinking otherwise

Throughout the thesis, I have included autobiographical vignettes to share and reflect on what it like to find myself in this space: in between worlds.

1. Introduction

The global environmental crises keep worsening, fast approaching irreversible thresholds (Steffen et al., 2015; IPCC, 2023). Much is being said about the need for the world, or some part of it, to transition or transform in one way or another, in response to the climate crisis and the many other crises we face. Some say the transformation is already ongoing–we are no longer at the drawing board, thinking about what should be done before launching into it. And an increasing number of scientists and intellectuals have started approaching the possibility that "sustainability won't work out" (e.g. Tomlinson et al., 2012; Bendell, 2020; Hagens, n.d.). Either way, a rapid transformation of the world, from today's unsustainability to something more sustainable, is likely to need action of some form on all levels of society. What is required is a sustainability transition on a global scale (Köhler et al., 2019) with millions and millions of macro and micro reconfigurations of people, processes and technologies to mitigate environmental damage *and* adapt to a radically altered world. Yet also, hopefully, allowing as many humans and other forms of life on Earth as possible to continue living well.

To this end, significant resources are being spent both within academia and outside to understand how various societal actors can be mobilised and supported with knowledge and technology. Which actor one focuses on in such efforts depends on one's theory of change—that is, which actor one believes must be leveraged to achieve the necessary changes in how the globalised world operates. One such actor is global institutions and national governments, whose agency and power lie in their authority to legislate and devise policy instruments to effect top-down change. This theory of change has been questioned in relation to climate change, as evidenced by the global track record for lowering greenhouse gas emissions in the past three decades: emissions have instead continued to rise and are now 60% higher than they

were in 1990 (Stoddard et al., 2021). Another suggested important actor is the consumer, who can supposedly "vote with their dollars/wallets"[3]. According to this theory, producers of goods and services can and will only produce what consumers ask for. When consumers demand sustainable goods and services by paying for them instead of their unsustainable equivalents, the incentives to produce the latter disappear. However, since sustainable (and ethical) goods are often more expensive than those that are not, such "votes" are only truly available to the more affluent. While informed consumer choices may well make dents in some companies' profits, they have not been proven to be a transformational force at scale, likely because many more factors are at play in the mechanisms of the free market. Furthermore, the consumer perspective of individual agency ignores that, in addition to being consumers, people's social roles extend further to being members of families and communities, citizens as well as professionals (Hampton & Whitmarsh, 2023). Each social role and context brings its own affordances for and barriers to environmental action and agency.

Sustainability transition studies is an interdisciplinary field of research dedicated to examining the long-term, radical, structural, and systemic changes needed to address sustainability challenges. Interestingly, the role of professionals—used here to mean anyone who works, regardless of education level, employment status or rank—is a relatively neglected research frontier in the field (e.g. Moilanen & Alasoini, 2023). The exception is top-level managers with formal power to improve their organizations' environmental performance (so called regime actors, in the language of sustainability transition studies), or people in inherently "environmental" positions. In fact, the field has given considerable attention to occupations whose explicit task is to improve environmental performance. Such studies include building professionals (Janda & Parag, 2013), engineers, architects and energy managers (Parag & Janda, 2014), and a range of other occupations acting in an intermediary capacity (another term from the field, see Kivimaa et al., 2019). Research with a similar focus also exists in HCI, where studies on "environmental" professionals include Bremer and colleagues' (2025) studies of energy professionals to understand the opportunities and challenges they face; Biggs and colleagues' (Biggs 2021) study of how small farmers are challenging unsustainable large-scale agricultural practices; and Fischer and colleagues' (2017) work on designing and evaluating tools to support energy advisors.

In her TED talk, Jamie Alexander (2020) from Project Drawdown famously says that "every job is a climate job now", pointing to the need for everyone to find a way to channel their occupational skills, resources and

[3] Source: en.wikipedia.org/wiki/Dollar_voting

power towards sustainable futures. In HCI (as defined in section 1.1), there are undoubtedly environmentally conscious professionals who work primarily or exclusively on environmental projects, or for companies whose core mission is environmental. And in SHCI, i.e. HCI's academic subfield dedicated to sustainability (see section 2.2), environmentally literate HCI academics have channelled their concerns through research for almost two decades now. But what about the rest of the professional sphere of HCI (however loosely defined)? The central argument of this thesis is that a sober reality check should call all workers and professionals, including those of us who work in the broader field of HCI, to stop and rethink what we are doing, why, how and for whom. If we did just that, what might the contribution of HCI as a professional community be, moving forward?

The sustainability transitions research community has asked itself three pertinent questions in a paper co-authored by 28 of the field's high-profile names (Köhler et al., 2019): 1. How can sustainability transitions research address situations in which time is running out so quickly?; 2. How can we support the acceleration of sustainability transitions?; and 3. How can sustainability transitions researchers react to the lack of progress towards sustainability?. In the field of Sustainable HCI, a similar question has been asked by Knowles and colleagues (2018): "What role is/are SHCI as a community and SHCI researchers individually going to play in ushering in the change that is required?" (p.49). And in their book *Speculative Everything*, designers Dunne and Raby (2013) write

> alternatives are exactly what we need. We need to dream new dreams for the twenty-first century as those of the twentieth century rapidly fade. But what role can design play? (p.2)

One difference in applying HCI skills to this transition as opposed to products and services typical of the present moment is that we orient our efforts towards emergent or yet unknown futures, socio-material landscapes and practices. Yet, the fundamental ethos of HCI may remain the same: helping humans interact well with the technologies, systems and infrastructures that surround them, whether we have been part of designing them–or not (Baumer & Silberman, 2011). Such a reorientation requires us to explore alternative ways of practicing HCI that are perhaps less focused on helping people make sense of data and information, and more on, for instance, what the design, undesign (Pierce, 2012) or (re)configuration of systems, tools and work can entail under both short and long-term future conditions of scarcity, intermittency and disruptions (e.g. Chen, 2016).

1.1Aim and research question

The aim of this thesis is to explore how HCI professionals, in our various manifestations and practices, can find ways to support the transition towards more sustainable ways of doing, being, thinking otherwise in a time of endings. It seeks to inspire HCI professionals to find the courage and agency needed to question the unsustainable status quo and carve out new ways to use our skills and positions in service of life and the living.

The overarching research question that has guided my research is: *how can HCI be practised otherwise at the end of the world as we know it, to enable liveable futures?* I have examined this question through a first-person approach, i.e. as a situated–and ultimately existential–exploration of what doing, being and thinking otherwise in response to the socio-environmental predicament (see chapter Research context) has meant for me as an HCI professional during my time as a PhD student, in the context of academic research and teaching. Below, I elaborate on the research question and clarify its scope.

HCI and UX, professionals and practitioners

In this thesis, the acronym *HCI* is used to denote both the more academic *Human-Computer Interaction* and its commercial offshoot, *User Experience (UX)*, encompassing all their activities, practices, roles and professional titles. Given the aim of this thesis and as someone who has practiced HCI/UX both in academia and outside for many years, I see no need to separate between them here by only speaking of one and not the other: professionals working within HCI and UX in whatever capacity face the exact same mounting existential challenges (see section 2.1). *HCI professionals*, then, includes–but is not limited to–researchers and designers, educators and students, policymakers and both legal professionals and scholars. By *professionals*, I loosely mean people working in the field, in academia and outside, rather than being members of a formally institutionalised profession. As HCI professionals, we may call ourselves UX and interface designers, information architects, UX researchers, content strategists, micro copywriters, service and product designers, professors and researchers—or even students, still becoming. I sometimes also use the term *practitioners*, mostly as a synonym for HCI professionals, but also to highlight that HCI professionals actively engage in *HCI practice* through the hands-on application of skills, knowledge, and techniques. That is, I use it at times to draw closer to the doing, being, and thinking of working with HCI, which *can* be done otherwise.

I use this broad definition of HCI professionals not to describe my research context or sample, but to convey for whom my argument and explorations are relevant. My hope is that this thesis speaks to anyone who identifies as working in the space of understanding, making, and improving relationships and interactions between technology, humans, and society—however they choose to refer to themselves.

The end of the world as we know it (TEOTWAWKI)

The story of modern progress, the promises of infinite growth and the always-on global supply chain have all defined the context within which I and many others in the global north were born and grew up. They have shaped our stories of the past, our understandings of the present and our expectations about the future. This era is powered by the continuous availability and extraction of cheap energy and raw materials, and an assumption that any harm done in the process is minor, often "justified" and "probably"(?) fixable. As it turns out, many of the harms caused by business-as-usual are none of those things, and we now make claims on Earth beyond its carrying capacity, pushing its ecosystems outside humanity's safe operating space in the process. While certain developments may still be reversible, the window for radical global action is narrowing rapidly, increasing the likelihood of major disruptions to life on Earth with each passing year of insufficient action. These disruptions will mark the ending of some centuries of relative stability and prosperity, enjoyed by many–but not all. As such, my inquiry is situated in a position of privilege, as someone who has benefitted greatly from the riches of industrial modernity, and has only recently started noticing and experiencing traces of what may be to come. Others across the world have not been so lucky, and have already experienced decades and centuries of endings and upheaval.

I first came across the phrase "*the end of the world as we know it is not the end of the world full stop*" through the work of writer Dougald Hine. I use it in this thesis to acknowledge that, due to the socio-environmental predicament, *we are all* approaching endings of various kinds, of which we can know some things and speculate about others. For me, this framing opens up multiple possibilities for constructive action in preparation for that which may come to pass, rather than just engaging in damage control, or giving up.

Liveable futures

Finally, *liveable futures* is a nod to the field of Futures Studies, which acknowledges that *the future is open, but not empty*. It is not empty, as past events continue to shape the future and certain consequences are irreversible.

And since the future is not predetermined, the future remains open, with many possible paths—hence the importance of being deliberate about the futures we pursue. While some of the more desirable futures may no longer be available, multiple liveable futures remain, i.e. futures in which life is not only possible, but also valued and fulfilling.

1.2 Thesis overview

This being a compilation thesis, it consists of two parts: a cover essay and a set of appended research papers. The cover essay is structured as follows: this Introduction chapter outlines the topic of the thesis, its rationale and aim, and the research question. In the Research context chapter, I describe firstly, how the challenge to be addressed is neither climate change alone nor how to achieve the UN's Sustainable Development Goals, but how to respond to a socio-environmental predicament that threatens our very existence, and secondly, how HCI has grappled with sustainability/unsustainability to date. Next, in the chapter Conceptual points of entry, I describe three perspectives that have guided my research: *Futures studies, Reflection and reflexivity in professional practice* and *Action-oriented and second-order transitions research*. The chapter Research approach outlines the methodology and methods I have worked with to explore ways of doing, being, thinking of HCI otherwise, clustered into three themes: *Doing design and research, Being a teacher* and *Thinking about the work*. In Findings, I summarise the results of Papers 1-6 in relation to the research questions, organised into four themes: *Why do we do what we do in Sustainable HCI?; What can it mean to do Sustainable HCI at the end of the world as we know it?; How to find agency as an HCI professional;* and *Doing action-oriented second-order transition research*. Finally, in the Discussion, I revisit the research question and describe my contributions as well as my methodological choices and their limitations. Throughout the thesis, I have included autobiographical vignettes prefixed *On doing, being, thinking otherwise*, to both share and reflect on what it is and has been like to find myself in this space: in between worlds.

2. Research context

In this chapter, I set the context for my research by first describing the fundamental premise of this thesis, which is that we do not have a "sustainability problem" that we must "fix": we are at the end of a story, and the many environmental and social crises that are building momentum are interlinked, forming an unsolvable predicament. This section on sustainability can usefully be understood as a "sustainability positionality statement", as proposed by Ola Leifler and myself in Paper 1 [Assumptions], to facilitate evaluation, comparison and review of work in SHCI.
I then briefly summarise how HCI as a field has addressed the crises to date.

2.1 Sustainability and the end of the world as we know it

> Will Modern humans remain bystanders, as if outside the earth systems,
> and attached to our cultural entitlement?
> (Robertson, 2022, p.69)

Today, much of public environmental discourse frames its goals using the term *sustainability*. The word stems from the word sustain, which can mean[4]:

1. to provide enough of what somebody/*something* needs in order to live or exist
2. to make *something* continue for some time without becoming less
3. [for *something*] to support a weight without breaking or falling

[4] Source: oxfordlearnersdictionaries.com/definition/english/sustain

To sustain is a transitive verb, meaning that it needs an object, i.e. a noun or a *something* that receives the action of the verb. Regarding environmental goals, efforts can be made to sustain things like healthy levels of fish stock in an ocean or the quality of water and air in the Earth's ecosystem. To sustain such things is an ongoing process of tending to and caring for living systems, not an end goal that can be done and checked off a list of things to do.

The word sustainability, the derivative noun of sustain, escapes the need for an object. As such an objectless "-ability", sustainability has, over the recent decades, come to mean any and all efforts aimed at doing purportedly good things *for something*, without offering clarity about what is being sustained. Sustainability, as commonly used in the global North, is associated with lowering carbon emissions, owning an electric car, opting for paper instead of plastic drinking straws, producing and buying clothes made of recycled fibres, investing in solar panels, avoiding bovine products by drinking soy milk, eating avocados and chia seeds, flying less often, increasing energy efficiency, investing in sustainable companies, producing "green" steel, recycling, using rechargeable batteries, investing in renewable energy sources such as hydropower etc. etc. Through these actions, *something* goes (or at least can go) from being unsustainable to "sustainable", as an end goal. This apparent simplicity has transformed sustainability into a powerful USP, i.e. a Unique Selling Point, and a corporate value, in the market economy. It allows some consumer choices and companies to seem sustainable (check!), and others not.

This way of relating to sustainability obfuscates how all our actions are nested in a complex ecosystem of life governed by equally complex dynamics that may be invisible to us and unfold over vast expanses of space and time. In other words, it lacks a systems perspective and represents a simplified and reductionistic view of a thin sliver of the world. It reduces complex situations such as the climate crisis into problems that can be solved through innovation, creating opportunities for selling solutions, ideas, products, services and even careers to people. An example of such a reductionistic idea that is dominant at the time of writing this thesis is that most of the world's current environmental problems are due to climate change, which is caused by fossil fuel emissions. That is, if we manage to drastically reduce fossil fuel emissions, however grand and urgent a challenge, we solve those problems and return to stability. Below, I explain why this understanding of climate change as being our one and only–and fixable–environmental problem simply does not hold up against the facts.

An early definition of sustainability was provided in the 1987 *Brundtland Report*, which defined it as development that "meets the needs of the present without compromising the ability of future generations to meet their own

needs" (United Nations General Assembly, 1987, p.39). This definition has been criticised, among other things, for being too vague to guide behaviour, for being anthropocentric and for ignoring biophysical and social limits (see e.g. Pargman & Raghavan, 2014 for a summary). Slightly less vague, the *Triple Bottom Line* model of sustainability (Purvis et al., 2019) includes environmental, social and economic sustainability, often represented as three overlapping circles or pillars, where compromises are needed to satisfy all three, sometimes inevitably at the expense of each other. Critics of this model point out that the economy and the social sphere cannot be seen as external to the biophysical environment (e.g. Becker, 2023), and instead propose a model where the three circles are nested (see Figure 2a).

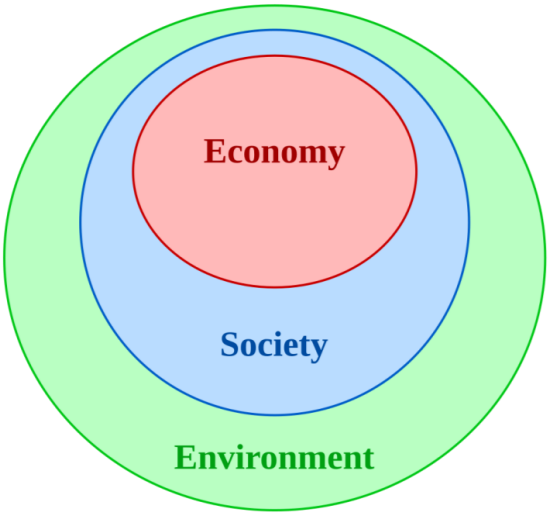

Figure 2a. The diagram with three nested ellipses indicates a hierarchy between the three dimensions of sustainability: both economy and society are constrained by environmental limits. By KTucker, CC BY-SA 3.0, from commons.wikimedia.org/w/index.php?curid=17030898

A third and perhaps more complete model of sustainability has been proposed by Kate Raworth (2012): *The Doughnut Model of Economics*. This model, popularly referred to as *the doughnut*, combines the planetary boundaries framework for the biophysical upper limits of our existence (Richardson et al., 2023) with the United Nations Sustainable Development Goals (SDG) framework (United Nations, n.d.) as the social foundations for it (see Figure 2b). While no framework is ever perfect, the planetary boundaries and the SDG frameworks are both based on quantifiable goals, which go

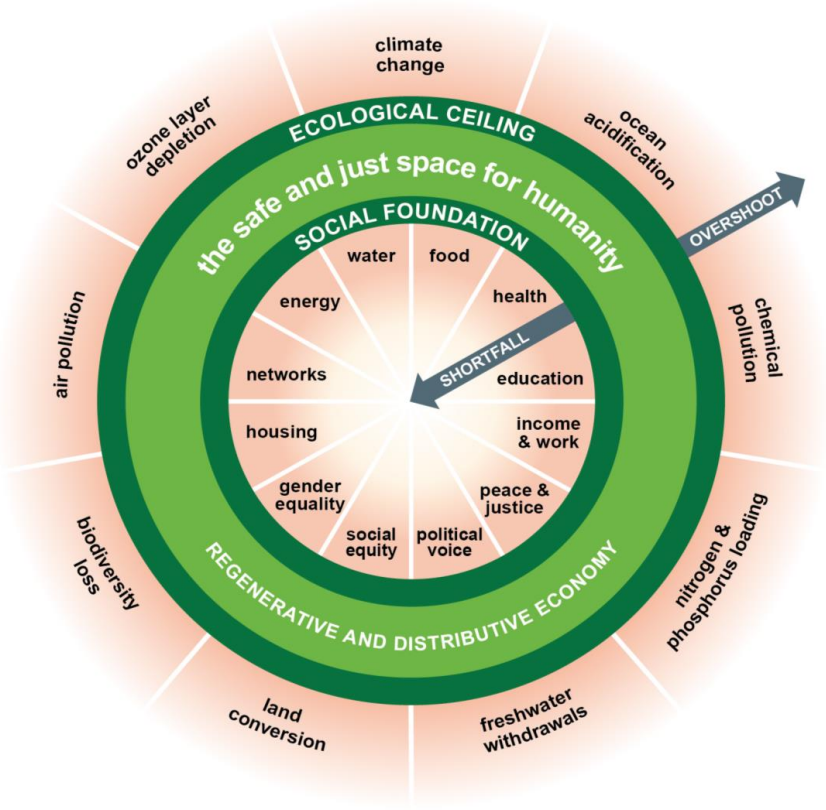

Figure 2b. The Doughnut Model of Economics by Kate Raworth. By DoughnutEconomics, CC BY-SA 4.0, from commons.wikimedia.org/w/index.php?curid=75695171.

some way towards remedying the vagueness of the Brundtland definition outlined above. The doughnut also implicitly reveals how sustainability is inevitably a process without end, filled with goal conflicts that depend on value judgements and compromises. This position is aptly captured in the following quote by Joseph Tainter (2003):

> Directing sustainability efforts in productive directions, then, requires understanding that it is a matter of values, not invariant biophysical processes. Some people and some ecosystems benefit from sustainability efforts, while others don't. When confronted with the term "sustainability," therefore, one should always ask: Sustain what, for whom, for how long, and at what cost? (p.214-215).

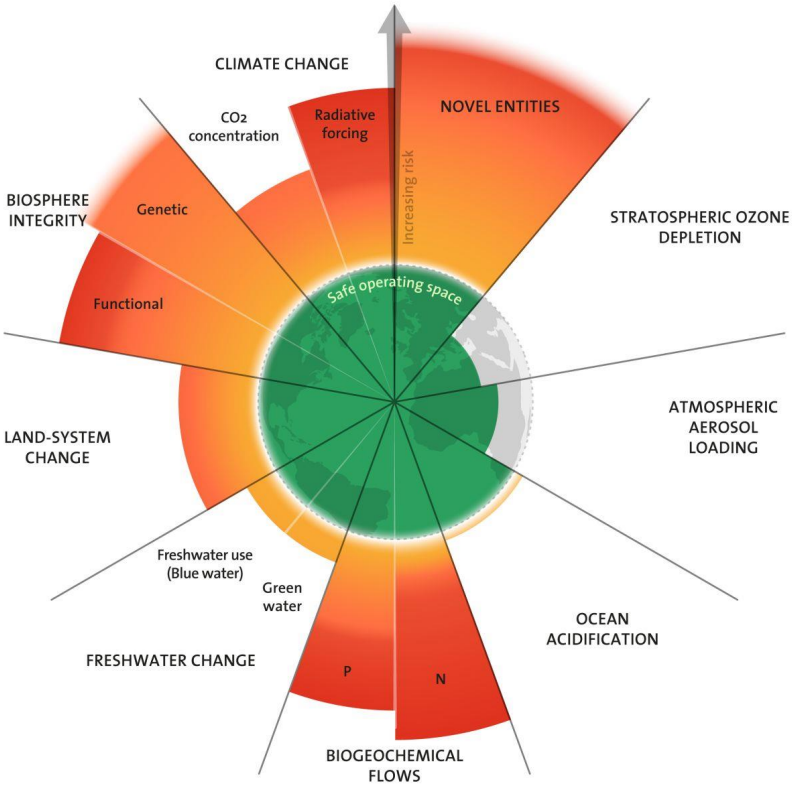

Figure 3. The 2025 update to the Planetary boundaries. Licensed under CC BY-NC-ND 3.0. Credit: "Azote for Stockholm Resilience Centre, based on analysis in Sakschewski and Caesar et al. 2025". Source: stockholmresilience.org/news--events/general-news/2025-09-24-seven-of-nine-planetary-boundaries-now-breached.html

Tainter's framing infinitely complicates what sustainability means, and therefore, how to act, live, work, make, produce, consume, and govern sustainably. If one wishes to be "good" (in a similar way to following Christianity's 10 commandments) by doing sustainable things (or abstaining from unsustainable ones), the task turns out to be nigh on impossible.[5]

Not only is "sustainability" as something we aim for an endlessly complex concept and a moving target: the world's actual state of environmental unsustainability is so much worse than most people realise. A selection: climate change is occurring faster than researchers have predicted, causing

[5] At a conference I attended, a woman shared how her adult daughter had recently called her from the aisles of a supermarket in tears, faced with the impossible task of sustainable food shopping, crying, "Mom, I don't know how to be a good person!".

the IPCC to issue a stark “final warning” in 2023 (IPCC, 2023). The World Wide Fund for Nature’s (WWF) annual Wildlife report 2024 (WWF, 2024) soberingly concludes that in the past 50 years, monitored wildlife populations have shrunk by 73% on average, where freshwater populations have suffered the worst losses by 85%, and that early warning signs indicate that several global ecological tipping points are about to be crossed. And out of the nine established planetary biophysical boundaries (see Figure 3) we have to date crossed seven (Stockholm Resilience Centre, 2025), where “Transgression of these boundaries reflects unprecedented human disruption of Earth system but is associated with large scientific uncertainties” (Richardson et al., 2023, p.3), suggesting that “Earth is now well outside of the safe operating space for humanity” (p.1).

In terms of attempted solutions to this selection of examples, we have failed to reduce CO_2 emissions despite three decades of climate mitigation efforts (Stoddard et al., 2021). Furthermore, there are no available alternatives for fossil energy that can replace them 1:1. When alternatives are used as replacements, they come with their own social and environmental consequences: hydropower destroys aquatic ecosystems, land-based wind power disrupts animal habitats and induces low-frequency noise pollution, crops for biofuels reduce the land available for animal habitats and other societal needs such housing and food, mining for the minerals needed in solar power cells and batteries causes physical and chemical destruction of land and water, and nuclear power waste creates possibly catastrophic risks, however unlikely, for millennia and for all life on Earth. If we were to simply stop using fossil fuels tomorrow, the now globalised, interconnected world of trade would grind to a halt as fossil fuels presently provide 85% of the total energy used (Primary Energy, 2025), with worldwide famine as a result. Similarly, if we were to stop using phosphate and nitrogen as fertilisers in industrial agriculture tomorrow to revert below the planetary boundary Biochemical flow, famine would also result.

I use the above examples to argue that what we face is not a “sustainability problem”, but a much larger global *predicament* that is "made up of a set of interconnected and, at times, contradictory goals that span environmental, social, and economic sustainability" (Hansson et al., 2021, p.4), and is “by definition not ‘solvable’: it can only be constructively addressed in ways that are situated in time, space and context, based on information that is incomplete, contradictory and changing” (Thorslund & Leifler, 2025, p.4). Furthermore, this predicament is not the result of bad luck: it is the direct result of the underlying worldview of Western modernity, a failing cultural and social system that has been a dominant global force for the past centuries. Western modernity, or *the house that modernity built* (Machado

de Oliveira, 2021), is founded on the impossible assumption of infinite growth (Meadows et al., 2004, Hickel, 2020) and on the public acceptance of violence as a necessity, through domination, colonialism, extractivism, expropriation and pollution. What is considered a normal state of the world actually rests on exploiting those with less power.

All of this is to say that humanity as a species is beyond solutions such as carbon budgets and "sustainable" consumer choices, and that what we are facing is "the end of the world as we know it, [which] is not the end of the world full stop" (Kingsnorth & Hine, 2009). In addition to mitigating the ongoing harms, what remains for us as a space for action is how we respond to and prepare for the unfolding events associated with the socio-environmental predicament outlined above.

2.2 Sustainability in HCI

> Have We Taken On Too Much?
> (Bremer et al., 2022, p.1)

The development of HCI over time is typically described in terms of three waves. One such conceptualisation outlines an initial technical paradigm, followed by a cognitive and then an ethnographic paradigm (Harrison et al., 2007). While the characteristics of each wave differ between conceptualisations, what can, however, be observed at a higher level is a "gradual and considerable expansion of HCI's concerns, methodologies, and application areas" (Filimowicz & Tzankova, 2018, p.3). HCI currently being "in the middle of a chaos of multiplicity in terms of technologies, use situations, methods, and concepts" (Bødker, 2015, p.31), it has recently been argued that the discipline is entering–or is already in–a fourth wave. Eli Blevis and colleagues (2014) characterise the fourth wave in terms of HCI's turn towards transdisciplinary design, where "being thoughtful about what to make and the implications of making are central concerns", thereby "avoid[ing] the centrality of teleological, positivist notions of interaction design" (p.40). The authors further argue that "transdisciplinary design is distinguished from the other paradigms by its primary focus on politics and values and ethics" (p.37). More recently, Ashby and colleagues (2019) insist

> that a fourth wave must push harder for actual (e.g. institutional) change–it must go beyond measured criticism and a shift in 'focus' to embrace activism at all levels, from questioning corporate sponsorship to increasing true accessibility and diversity and addressing urgent existential threats such as climate change. (p.1)

If a fourth wave of HCI that seriously takes urgent existential threats into account is indeed in the making, it is still very much at the fringe of what HCI

as a whole is about. At the CHI conference in 2007, a special interest group (SIG) for sustainability in HCI (SHCI) was founded as a response to a budding interest in sustainability-related concerns within the HCI field (Mankoff et al., 2007). The goal of this SIG was to raise awareness of environmental sustainability in the HCI community and to "start a conversation about the possibilities and responsibilities we have to address issues of sustainability" (ibid., p.2121). In another paper published the same year, Eli Blevis (one of the people behind the SIG) wrote that "sustainability can and should be a central focus of interaction design" (Blevis, 2007, p. 503). The SIG identified two ways in which HCI professionals might address the "problem of sustainability" (Mankoff et al., 2007):

> 1. Sustainability *in* Design, or "how to take account of sustainability as part of the material design of products" (p.2122), exemplified with energy use, device re-use, reduction of waste, enabling sharing of devices or energy resources; and
>
> 2. Sustainability *through* Design, or "how to support sustainable lifestyles and decision-making through the design of technology" (p.2123), at individual, group and societal levels.

Many IT-related fields have seen similar developments, such as the birth of Environmental Informatics, Computational Sustainability, Green IT/ICT and ICT for Sustainability, all with slightly different but overlapping contributions. The unique contribution of concerns and methods typical of "traditional" SHCI lies in prolonging the longevity of devices, supporting sustainable lifestyles and promoting sustainable behaviour (Hilty & Aebischer, 2015). A review of papers published in the field during 2010-2019 (Hansson et al., 2021) confirms this scope, where a significant portion of the literature was found to centre on the development and evaluation of eco-feedback and eco-visualisation systems, alongside assessments of the environmental implications of digital infrastructure, including energy inefficiencies. The reviewed body of papers exhibited a pronounced orientation towards advancing the aims of the UN Sustainable Development Goal 12 (United Nations, n.d.), which emphasises responsible consumption and production. In other words, a large proportion of SHCI has historically focused on behavioural interventions to promote sustainable behaviour and support sustainable lifestyles aimed at mitigating environmental costs. However, such interventions are often ineffective in creating long-term change (Brynjarsdottir et al., 2012) and fail to address the systemic nature of our socio-environmental predicament, where the impact of our individual

habits and daily consumer choices has little bearing on the magnitude of what is at stake.

Outside of mainstream HCI/SHCI, calls for "doing HCI/design/technology differently" are on the rise, with manifestos, calls to action and provocations under labels such as feminist HCI (Bardzell, 2010), anarchist HCI (Keyes et al., 2019), post-growth HCI (Sharma et al., 2023, 2025), radical SHCI (Knowles et al., 2018), HCI and more-than-human design (Giaccardi et al., 2024), more-than-human design for existential crisis (Light et al., 2017), existential HCI (Kaptelinin, 2018), regenerative computing (Forsyth, et al., 2018), designing for longer time perspectives, such as multiple life-spans (Friedman & Nathan, 2010) and deep time (Rahm-Skågeby & Rahm, 2021), and social justice-oriented interaction design (Dombrowski et al., 2016), to name a few. Most recently, (Sharma & Kumar, 2025) have argued for broadening the SHCI agenda to encompass both social justice and environmental sustainability, in close collaboration with the HCI for Development (HCI4D) community—an approach that could aptly be called "doughnut HCI" given its alignment with Raworth's doughnut economics framework (see Figure 2b). A full review of the diverse body of published work in Sustainable HCI, of both mainstream and more radical character, is outside the scope of this thesis, but a range of illustrative examples can be found in both Paper 1 [Assumptions] and Paper 6 [Two Loops].

This apparent broadening of scope over time has led Bremer and colleagues (2022) to ask whether SHCI has "Taken On Too Much?", i.e. far more than SHCI practitioners could reasonably expect to deliver. They conclude that "Our [literature] review is telling a story: technologists cannot be expected to do the work of policymakers" (p.8). There is certainly no lack of demand and applications for HCI/SHCI research and commercial technology ventures with a short-term focus that assumes business-as-usual and no limits to growth or environmental boundaries. But, I wonder, if it is not "the job of HCI" to address the pressing issue of socio-environmental collapse, do we leave "saving the world" to those whose job it is (whoever *that* is)? And where does such an abdication of agency leave our field, and us humans as professionals within it, in terms of purpose, responsibility and meaning? By the same logic, most of today's jobs and professions could revert to their original scope and purpose, and tinker with safe and familiar problems in their professional bubbles, while the world outside is on fire, for some imaginary other to fix.

On doing, being, thinking otherwise

Small talk by the coffee machine

One day in 2024, I met a visiting HCI professor in the kitchen of my KTH department. I said hello and asked what their main research interests were. When they returned the question, I shared that I was a PhD student and that what unites the seemingly odd combination of things that I have researched and written papers about is a question about what it means and what is meaningful to do in HCI at the end of the world as we know it. They raised their eyebrows and said:

"Well, that sounds rather depressing!"

I countered that the world is likely to change drastically in the coming decades, whether we like it or not, due to climate change, among other things. This means, I continued, that we will have to change our behaviours and start challenging what we take for granted, including what is normal and necessary, such as travelling far away for conferences and holidays.

"I'm more of an optimist", they quipped. "I believe that technological innovations will make energy so abundant and cheap that it will not only allow us to continue our lives as usual, but that such lifestyles will soon become available to everyone".

Right, I said, slightly taken aback by this unbounded optimism. And then I couldn't help but ask, out of true curiosity: But have you heard about the nine planetary boundaries, of which we have crossed six, or the biophysical limits to growth?

"No".

We didn't quite know what to say after that exchange, but must have found some way of greeting each other, and then walked off in opposite directions, clasping our mugs of coffee.

I obviously don't expect everyone to engage with the socio-environmental predicament in the exact same way I have for the past five and some years. Nor would I wish for it, as I believe in the need for diverse, context-specific approaches. What this exchange highlighted, though, was that even some of the most academically educated people on this planet, including in my own field, have such limited understanding of the biophysical reality within which we must operate. Equally troubling is their lack of awareness about the extent to which we are failing to do so. This is far from the only exchange of this kind that I have had. Each time is an Alice-in-Wonderland-esque experience—I seem to live in a parallel reality while most others find themselves in a world where everything is, and will be, just fine.

There's a particular kind of cognitive dissonance in this—like seeing a fire in a crowded room where no one else is reacting. Eventually, you start wondering: is the building really burning, or am I the one losing my mind?

3. Conceptual points of entry

Below, I outline three perspectives that have guided my research: *Futures studies, Reflection and reflexivity in professional practice* and *Action-oriented and second-order transitions research*.

3.1 Using the future to think about the present

> Self-conscious futures thinking helps people become more responsible for their actions.
> (Bell, 1998, p.2)

Futures studies and speculative futures in HCI

Futures studies is a future-oriented, interdisciplinary field that studies how the future is understood or imagined, the variety of futures that we might need to consider and maybe even prepare for, and what futures we might want to actively create. Typically, the literature differentiates between three types of futures (e.g. Bell, 2017): *probable*, *possible* and *preferable*, i.e., futures based on predictions and therefore likely to come about, futures based on eventualities that might come about, and futures based on visionary or normative ideas of what we would like to happen (also referred to as *desirable* futures). Figure 4 illustrates an expansion of this taxonomy (Voros, 2017) to include *plausible* and *preposterous* futures, as well as a *projected* future, i.e. futures that could happen, futures that seem entirely impossible, and business-as-usual futures where the present is simply projected into the future.

HCI as a design discipline is, by its very nature, future-oriented (Ilstedt & Wangel, 2014). But much of its future-facing design efforts can be considered mainstream, as they sit within the current short-termist economic paradigm

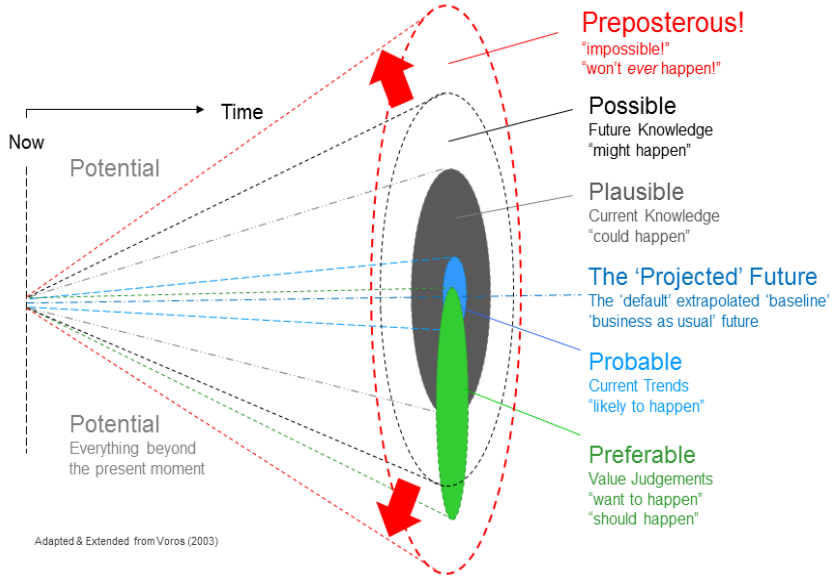

Figure 4. The Futures Cone by Joseph Voros (2017), reprinted with permission.

regarding the future as a probable, projected extension of the past, taking into account neither planetary boundaries (Steffen et al., 2015) nor an increasingly likely environmental collapse. Mainstream design, sometimes also referred to as affirmative (Dunne & Raby, 2013), traditional or normative design, can be contrasted with so-called *discursive* design, which Fox (2018) offers as an umbrella term for various non-normative design approaches such as speculative design, critical design and design fiction, to name a few. Discursive design methods are useful to "provoke conversation and debate about our status quo by explicitly exploring and presenting design provocations that clearly differ from our everyday" (ibid., p.156). In HCI, design fiction is one of the more common discursive design methods used to speculate about futures (Bernhaupt et al., 2020). Compared to other discursive methods, design fiction is explicitly concerned with diegesis (Tanenbaum et al., 2016), i.e. the telling of a story, and the "deliberate use of diegetic prototypes to suspend disbelief about change" (Bosch, 2012). A popular example of a diegetic prototype (Kirby, 2010), i.e. a technology or artefact imagined to exist within a fictional world, includes the computer interface that actor Tom Cruise uses to manipulate data using hand gestures in the film *The Minority Report*. Speculative methods such as design fiction have been proposed as a tool for stimulating and enhancing conversations between different disciplines (Kymäläinen, 2016). In practice, speculative methods have been used in HCI as a method primarily to enhance creativity

in commercial settings for developing products and services such as self-driving cars (Ringfort-Felner et al., 2023); to explore the possible impacts of present policy decisions and societal developments on e.g. sustainability (Pargman et al., 2017), the circular economy (Thorslund et al., 2022) and the relationship between humans and technology (Hassenzahl et al., 2022); and to ask provocative questions about the impacts and ethics of new technologies in contexts such as personal assistants and intimate data (Søndergaard & Hansen, 2013) and animal husbandry (Eklund et al., 2025). In a review of the uses of critical design specifically in SHCI, Soden and colleagues (2021) outline four common arguments for using such speculative methods in the field: to enable discussions of hopeful or optimistic futures, to question values and ethics, to encourage public discourse about climate change and to surface personal narratives about sustainability and the future. Joining others in calling for a reorientation of speculative methods to reach their critical potential, the authors argue that simply doing speculation is not enough in itself; that for speculative design to "contribute to non-incremental change, it too must put things at risk: it should be *dangerous*, both in its process and its implications" (italics in original, p.196).

Furthermore, while these applications of speculative methods in HCI may generate interesting insights, they are typically used to study objects, phenomena and groups of people *outside* the researchers themselves. If used to somehow further sustainability, the agency and underlying theories of change are based on the actions and events beyond those doing the research. That is to say, the intended result of speculative methods as described here is either to stimulate imagination or for *someone else* to start doing something differently. In contrast, some rare examples of speculative work that reflect on and critique the field of HCI itself and its underpinning values and practices include Ben Kirman and colleagues' (2013) fictional paper that troubles HCI's uncritical engagement with automation and robotics; Pargman and colleagues' (2019) use of fictional abstracts to probe into wisdom in computing; and Jones and colleagues' (2014) set of fictional abstracts for papers that could appear in the proceedings of a future CHI 2039 Conference, which enabled reflexivity of the work of HCI in relation to social, political, and cultural trends and events.

Acknowledging the value of speculative methods for HCI, Tanenbaum and colleagues (2016) propose that:

> Fiction, as a research tool, allows us to do several important things with proximal futures: it allows us to adopt a range of different intellectual commitments and values about the future and explore the consequences of those commitments; [...] and it allows us to insulate ourselves from the emotional consequences of perceived proximal dystopias by creating space to "play with" and explore alternative visions of

> the future. [...] Futures studies, in this instance, can be seen primarily as a tool for thinking: it is especially well suited to expanding the possibility space that we address when engaging with imagined futures. Design fiction, as a particular case of futures studies, is ideally suited to several specific modes of imagining that can play important roles within the study of sustainable development in general, and the study of collapse in particular. (p.1-2)

While the authors' argument focuses on speculative methods as a potentially fruitful means for engaging *others* in (potentially dystopian) futures, I argue that the same holds for the HCI community itself. In other words, speculative methods could be used to a greater extent *by* the HCI community *on* the HCI community, as exemplified in the work by Kirman et al. (2013), Jones et al. (2014) and Pargman et al. (2019), to counter the limits of our own imaginations and to reflect on our own agency and direction in such futures.

One common way of speculating and elaborating on different futures is to design scenarios, which essentially consist of stories about how the world could develop in the future (Heijden, 2005). There are three types of scenarios in futures studies: predictive scenarios (what will happen?), explorative scenarios (what could happen?) and normative scenarios (how can a specific target be met?). Scenarios are particularly effective as the basis of deliberation in the context of participatory futuring efforts aimed at societal change (Ramos et al., 2019). In 2013, Mankoff and colleagues (2013) established that scenario methodologies originating from the field of futures studies had not been extensively used within HCI.

Futures scenarios as tools for thinking

> To not prepare for a life beyond 1.5°C
> is a reckless disregard for humanity.
> (Zadek, 2023)

Currently, mainstream HCI is based on a future scenario of business-as-usual, which assumes that tomorrow's world will look much the same as yesterday (the projected future in Figure 4). As a field that works with design, novelty and creation of artefacts, we may think that in order to reflect on the present and future of HCI within the predicament described in the Research context, we must first *create* scenarios to work from. While using creative and entirely speculative scenarios in such an exercise might be interesting and worthwhile, the existing IPCC climate scenarios of +1.5, 2, 3 and 4°C Earths, each with its own calculated likelihood, represent a viable and already existing starting point. These scenarios, which correspond to plausible or possible futures in Figure 4, have been fleshed out, e.g. by the journalist Mark

Lynas in his book *Six Degrees: Our Future on a Hotter Planet* (Lynas, 2008). The book's publisher, National Geographic, has also dramatised Lynas' book in a full-length film called *Six Degrees Could Change the World* (Bowman, 2007). For each degree of warming, Lynas' descriptions allow for rather visceral explorations of what life on Earth might look like in each of them.

On doing, being, thinking otherwise

Looking for friends to think with

In Spring 2023, I travelled to Hamburg to attend a CHI workshop called *HCI for Climate Change: Imagining Sustainable Futures*[6]. I figured that in a workshop with such a name, which aimed to "discuss the different angles from which the problem of climate change has been addressed by the CHI community so far", I would find colleagues who, just like me, lie awake at night thinking the unthinkable, and are trying to find ways to cut ties with business-as-usual.

For most of the workshop, we worked in groups on different topics sourced from the attendees, and I joined the one called "From behaviour change to collective action". Before exploring the topic, our group did a round of presentations on who we were and what we were particularly interested in. When it was my turn, I said I would be keen to explore together what some of the least optimistic IPCC climate scenarios might mean for HCI. What might we want to do differently today? How might we be of service when the impacts of climate change start disrupting the business-as-usual?

This request was first met with silence, and then with outright objections about the usefulness of such scenarios of doom. One participant pointed out that

"The idea of the apocalypse has been around for hundreds or even thousands of years!"

(and could therefore be dismissed as an archetypal mental construct). And then the conversation moved on. I realised that the topic of the workshop was not about imagining truly sustainable futures, but to "fix" climate change. I later noted that the organisers based their understanding of sustainability on the Triple Bottom Line model, described in Chapter 2.

That afternoon, I left Hamburg feeling embarrassed and ashamed. I don't know which was worse: that I had brought up such a personal, existential question that was met with such resistance, or that I had travelled all the way to Germany to find "friends" and found none.

[6] The topic and purpose of the workshop can be found here: sites.google.com/fbk.eu/hci-climate-change/home

While such scenarios can help us prepare for what is more or less likely to come due to climate related collapse, they may also evoke strong emotions such as fear, dread and grief (Pihkala, 2020), which in turn can lead to various maladaptive responses (Hoggett, 2022) such as denial (pretending that or acting as if everything is fine), disassociation (disconnecting from one's experiences), nihilism (since everything is too late already, we keep doing what we do) or panic (frantic action and ultimately burnout). Simply knowing about the trouble we are in is unlikely to provide anyone with a healthy, meaningful sense of direction. Here, speculative scenarios about *desirable* futures have an essential role to play. Desirable futures are based on value judgements on what could or should happen given what is probable, plausible, and possible. They can be used to generate hopeful but realistic alternative imaginaries of the future for which to aim.

The ability to actively "use the future" for different purposes and in different contexts, and to take notice of the assumptions from which future visions, goals, and strategies derive, is called *futures literacy* (Miller, 2018). With the globalised world's increased complexity and volatility, the UN has recognised this ability as a key human capability. Since 2012, UNESCO, i.e. the UN's special agency for promoting world peace and security through international cooperation in education, arts, sciences and culture, has championed and worked to promote futures literacy in several ways. As Riel Miller, the UNESCO's Head of Foresight and Futures Literacy between 2012-2022, has put it: futures literacy "as a capability has the potential to change the way human agency is conceived and exercised, opening up new opportunities for humanity to take advantage of complexity and emergence in all its forms" (ibid., p.9). As such, it is a capability anyone can build, which opens up both the future and the present for new, desirable possibilities, even in the face of likely losses and destruction. It allows us to consciously use the future to generate alternative possible paths through imagination, thereby creating new possibilities for action. By using futures to become more open and creative in the face of the unknown and open up to new futures, people can become "more competent, effective, and responsible actors" (Bell, 1998, p.328), both in our personal lives as well as our professional and societal roles.

As such, the purpose of deliberating over future scenarios in relation to HCI would ultimately be to use them as tools for thinking (Tanenbaum et al., 2016), to reflect on one's own space for agency in these perilous times. At the very least, HCI professionals could aim for basing their work and professional practice on a realistic understanding of the IPCC's possible and probable climate scenarios, and on their personal ideas of what a possible *and*

desirable, future for themselves, their children[7] and grandchildren might look like, based on those scenarios.

3.2 Reflection and reflexivity for sustainable HCI practice

> The daunting challenge is to become disillusioned with the glamorous wonders of techno-sphere–it's [sic] power, dominance, control, and apparent mastery–to regain delight in the earthly wonder of the biosphere. This is a two-fold process involving a letting go of power and the privilege modernity bestows, along with a letting come of the humbling splendour in reconnection to our terrestrial home.
> (Robertson, 2022, p.74)

Alternatives for action

Many of us, who have been struck by the knowledge about what might lie ahead, already try in our private lives to make more sustainable (or at least less unsustainable) choices, in an effort to lessen the social and environmental impact of our lifestyles. Such choices are, of course, and in fairness, only required and realistic for people living in relative privilege and wealth (Oxfam, 2015). Furthermore, research has shown that while the poorest 50% of the world's population are responsible for only around 10% of global carbon emissions, the wealthiest 10% emit around 50% of global emissions. Most HCI professionals likely belong to the wealthiest deciles[8], making efforts to decrease one's own emissions worthwhile pursuing. Many people also vote for ostensibly "green" parties and policies, in the hope that they will manage to steer us away from the worst of potential outcomes. And yet some resort to various kinds of activism, which in its most radical forms has been shown to also pave the way for more moderate activist groups, through the so-called *positive radical flank effect* (Ostarek et al., 2024). However, limiting our own source of agency to the personal domain through "sustainable" consumption[9] is problematic. This includes investments in highly contested ways of offsetting carbon emissions (Lakhani, 2023) and donations to ostensibly sustainable initiatives. Such approaches ignore the most significant investment most of us ever make: the amount of hours we spend at work over a lifetime. This time investment means that where we choose to work and in service of what represents an essential source of

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[7] In his book *Parents For A Future: how loving our children can prevent climate collapse* from 2021, philosopher Rupert Read points out that the children whose futures he argues are worth fighting for do not have to be one's own: they can be someone else's children who you know and care about, or children of other people who you love.

[8] If you don't know how rich you are relative to the global population, this calculator is worth a go: givingwhatwecan.org/how-rich-am-i

[9] "At worst, this 'buy something!' craze tries to use the problem to solve the problem" (Price, 2021, p.42)

On doing, being, thinking otherwise

But why? Being difficult at work

Before starting a PhD, I worked as a senior content strategist (yet another specialism that has emerged in the HCI field over the years) at a small digital content consultancy. It was the best job and employer I had ever had: I did work that I enjoyed and was good at, and my employer and colleagues were a bunch of both fun and friendly people. As individual consultants, we were allowed to turn down potential contracts that didn't sit right with us, and there were some clients that the consultancy owners wouldn't even consider, such as actors in the defence industry. I felt I worked in a company that genuinely cared about its employees, clients, and the world around us.

So it was a complete surprise to me when I found out, in my fifth year with the company, that we had just landed a contract with a large oil company. Not only was it an oil company, but it had literally just won a greenwashing award in Sweden–and my consultancy had signed a contract to help the company with its communications. Astonished, I later asked one of the owners what led them to take on such work, especially given that we already had more requests for work than we could meet. I also offered that I might have understood it if we had been in a recession and our priority was to avoid laying people off. One of the owners replied:

"We discussed it at length, but concluded that we would accept the request from this client. If we drew the line here, what would we do if an airline asked for our services?"

Well, I said, that's precisely the kind of things that owners of a company have the mandate and responsibility to decide, and I would have hoped (and thought) that you all would draw the line on this side of working for oil companies.

This event and subsequent exchange changed how I felt about my employer, and some months later, I quit the company, in a move of *conscious quitting* that is becoming more frequent among employees (Polman, 2023). I became uncomfortable with the discrepancy between who I thought my employers and colleagues were, and who they revealed themselves to be. As someone for whom authenticity matters, I was too disillusioned to stay.

Later, as a PhD student, I revisited this experience when writing the paper *Tech4Bad in the Oil and Gas Industry: Exploring Choices for ICT Professionals* with Ian Brooks and Aksel Biørn Hansen (Brooks et al., 2023) about how ICT professionals such as ourselves need to start saying no to work that directly or indirectly supports the fossil fuel industry. Earlier versions of the paper were desk rejected as irrelevant by two conferences, before it was finally published in the ICT4S 2023 proceedings. This was my first experience of trying to publicly reflect on the action space professionals in HCI and IT in relation to the climate crisis and as such it was not particularly encouraging.

In response to the comments in the first round of ICT4S reviews, we decided to

include our positionality concerning sustainability, acknowledging the historical social and economic privileges that the fossil economy has granted us, and shared the following:

"In the interest of transparency, the first author [Ian Brooks] has previously been in a consulting role for fossil fuel companies, and the second author [me] has been employed at an energy company with large investments in coal power plants. Both have since chosen to decline any such work, for the reasons outlined in the present paper" (p.4).

As authors, we discussed and reflected on including our past professional engagement quite a bit. We ultimately agreed that it felt like a valuable addition as it shows that we did not write the paper from a place of moral superiority with the intention of cancelling or shaming anyone. By bringing our personal career histories from the fossil sector into the picture, we tried to show that while many of us have done work to support the fossil fuel sector, it is never too late to stop.

After this addition, one of the reviewers commented:

"It has been revealing to discover that both authors have severed ties with the oil and gas industry after working for that sector in the past. It becomes clear that this topic touches their heart. They now mention this in the paper, which I think is an act of transparency and it might make the work more compelling for other practitioners having second thoughts about their support to the sector."

This time, I found the exchange with the reviewers constructive. I felt proud that we had persisted despite the earlier rejections, and that I had dared to break from my academic training, which had taught me to avoid normative stances and keep myself out of the work. The experience showed me how authenticity and transparency can help convey a challenging message more effectively.

power—and therefore, of agency (Price, 2021). Yet social roles such as occupations have been largely overlooked in the sustainability transitions literature as potentially important actors (Moilanen & Alasoini, 2023).

Acknowledging that some jobs directly or indirectly contribute to making things worse, an increasing number of people are also finding ways to change roles or employers for more "sustainable" ones, or even choose to leave their present careers and retrain, in order to forge careers in "sustainability" (e.g. in so called *green-collar jobs* (2025). In relation to climate change, Scientists for Global Responsibility have released a helpful albeit now somewhat dated framework for identifying engineering career choices that may have a positive or negative impact (Parkinson, 2003). The report proposes five paths: careers that 1) help further our understanding, 2) work towards technological improvements, 3) help to develop new, alternative technologies, 4) promote economic solutions, or 5) promote social or political solutions. Other available alternatives in the domain of work include trying to change an

organisation from within, e.g. by becoming a *tempered radical* (Meyerson, 2004) and pushing for change from inside, or by refusing to do certain kinds of work, e.g. to work on contracts that support the oil industry (Brooks et al., 2023; Watterson, 2023). Both moves require the courage to be demanding and risk creating uncomfortable situations at work and, ultimately, a loss of employment.

So what, then, are the options available for HCI professionals who find themselves doomscrolling during coffee breaks from working on the user interface of robotic lawnmowers? One is, of course, to leave their career in HCI altogether to find a job in "sustainability". Another option is to find opportunities to work on projects, products and services that explicitly work towards "sustainability", however that is defined in that context (Thorslund & Leifler, 2025). A third path—explored in this thesis—focuses on discovering new ways of doing, being, and thinking in HCI. This exploration joins and learns from ongoing efforts by many colleagues in the field who have been working towards such transformation for years.

The reflective-reflexive practitioner

Modern society's ways of thinking, relating to and acting in and on the world are at the root of why we have ended up in such a dire situation (Machado de Oliveira, 2021; Hollway et al., 2022; Hine, 2023). Trying to apply the same ideas about how the world is constituted, and therefore how we can and must act in it, will lead to more of the same[10]. Put differently, in order to change the catastrophic trajectory upon which some parts of humanity have set Earth's ecosystem over the past centuries, we all need to learn to do, be and think differently—in all facets of our lives, including our professional work. In his influential book *The Reflective Practitioner: How Professionals Think in Action* (Schön, 1995), organisational theorist and philosopher Donald A. Schön argues that professionals *reflect*, i.e. think critically, about their actions, decisions and experiences, both *in action* as it happens, and *on action* after the event, to learn from and adapt their practice. According to Schön, this reflectiveness may be triggered when there is uncertainty, instability, uniqueness and conflict, conditions that aptly describe the socio-environmental predicament. Under such conditions, Schön argues, professionals can engage in *frame analysis* as a type of "reflective research" into their own professional practice. Frame analysis is the study of how people understand situations and activities, i.e. the mental models and assumptions they bring to their work. When used to reflect on one's own

[10] This is echoed in a quote frequently attributed to Albert Einstein: "We cannot solve our problems with the same thinking we used when we created them".

professional practice, it can "help practitioners to become aware of and criticize their tacit schemes" (ibid., p.309), i.e. to discover their underlying and often unconscious understandings of the world. Such awareness is key both for unlearning outdated and maladaptive understandings, and for learning new ways of doing, being and thinking:

> When practitioners are unaware of their frames for roles or problems, they do not experience the need to choose among them. They do not attend to the ways in which they *construct* the reality in which they function; for them, it is simply the given reality. (ibid., p. 310)

This kind of unawareness is clearly observable in the often unfounded assumptions of advancement in technological innovation (Becker, 2023), where novelty in and of itself is considered as progress (The Consilience Project, 2024). Practices of active reflection on how we understand the context, function and meaning of our work can help loosen the grip of such assumptions:

> When a practitioner becomes aware of his frames, he also becomes aware of the possibility of alternative ways of framing the reality of his practice. He takes note of the values and norms to which he has given priority, and those he has given less importance, or left out of account altogether. Frame awareness tends to entertain awareness of dilemmas. (Schön, 1995, p. 310)

Recognising such dilemmas—i.e. the impossibility of fully reconciling systemic issues—is one of the most sobering aspects of the socio-environmental predicament. Schön further writes:

> Once practitioners notice that they actively construct the reality of their practice and become aware of the variety of frames available to them, they begin to see the need to reflect-in-action on their previous schemes" (ibid. p.311).

In more recent literature on reflection, the kind of internal interrogation Schön evokes through frame analysis is called *reflexivity*. Ann L Cunliffe, a professor of organisation studies, argues for the importance of critical reflexivity in professional practice thus:

> Whereas reflective analysis is concerned with a systematic searching for patterns, logic, and order, critically reflexive questioning opens up our own practices and assumptions as a basis for working toward more critical, responsive, and ethical action (Cunliffe, 2016, p.755)

It seems, then, that to do HCI otherwise in response to the socio-environmental predicament, HCI professionals need to be critically reflexive practitioners, to catch sight of the impact of our assumptions, values and actions on the world.

This kind of internal change as key for constructive action in the context of sustainability transitions has been conceptualised in the field of Transition Design as *mindsets* and *postures*, which result from learning about the interconnectedness of the world and therefore the crises we face:

> Transition Design argues that living in and through transitional times calls for self-reflection and a new way of 'being' in the world. This change must be based upon a new mindset or worldview and posture (internal) that lead to different ways of interacting with others (external) that informs problem solving and design. All of these are mutually influencing. (Irwin, 2015, p.235)

In Transition Design, mindset refers to a person's internal constructs, such as values, beliefs and assumptions, and posture is used to describe how their mindset is applied in a specific context, i.e. their external stance or behavioural orientation, notably in relation to others. In the global, non-academic field of sustainable development, a similar notion is evoked with the *inner development goals* (IDGs), a framework that "simplifies a complex field of human development to help us better identify/ understand/ communicate/ develop/ integrate the inner skills needed for sustainable development"[11]. Many capacities listed under the Being and Thinking dimensions of the framework, such as Self-awareness and Critical thinking, also point towards reflexivity as a key skill. Finally, in the sphere of NGOs, the Transition Network (i.e. the research partner described in Paper 3 [Interviews] and Paper 2 [Pastcasting]) explicitly differentiates between *outer* and *inner transition*, where the former refers to practical actions in the world such as improving local food resilience and energy efficiency, and the latter to the emotional and psychological inner work needed to "[support] the effectiveness of our work and in resourcing us to meet the feelings and sense of helplessness that often goes hand in hand with the reality of what is unfolding in our world today"[12]. As such, it includes becoming aware of values, worldviews and culture, among other things, to be able to act differently from that knowledge. Such reflexivity in relation to one's own assumptions and practices is the very goal of Paper 1 [Assumptions].

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[11] From innerdevelopmentgoals.org/framework/. The words "identity" etc. appeared one after another in the top banner of the website.

[12] From archive.transitionnetwork.org/do-transition/inner/inner-transition-framing/.

On doing, being, thinking otherwise

Offering spaces for critical reflexivity and eco-emotions

During my time as a PhD student in HCI, I have facilitated gatherings on three occasions where the purpose has been to offer the participants spaces for critical reflexivity and for acknowledging emotions. Together with my supervisors Elina Eriksson and Daniel Pargman, we have become increasingly aware over time of the need for providing such spaces, both to colleagues in the field of sustainable HCI/IT and to the engineering students that we meet when teaching sustainability (Paper 4 [Eco-anxiety] and Paper 5 [Dread] are both about emotions and sustainability teaching).

In 2022, we applied for and received an internal educational development grant to explore how emotions manifested in the context of a course on sustainability for media technology students, and how we could support students with their experiences of difficult emotions as they deepen their knowledge about the state of the world. The grant allowed us to devise a side activity that ran alongside the course in four sessions. A handful of students volunteered to participate in the side activity, which we designed by applying many of the possibilities and tasks for environmental educators suggested by Panu Pihkala (2020). One of the most impactful sessions was held outdoors, where we went for a *silent walk* in a beautiful nearby park, for the students to experience being fully present in nature and learn some accessible techniques to recreate it in their own lives. It was followed by a mini-lecture about *The Work That Reconnects* from Joanna Macy and Chris Johnstone's book *Active Hope* (2012), to learn about the role of gratitude and grief as important forces for good. We finished by silently building a *cairn of mourning* with the stones we had picked during the walk, a ritual that "allows people to express more personally their grief for what is happening to the world. In knowing the depth of this sorrow, they can know the depth of their belonging, from which comes the power to endure hardship and to act for the well-being of all"[13].

I later reused this format in Summer 2024 at the Information Technology 4 Sustainability (ICT4S) conference in Stockholm. It was offered as a social activity one morning, called *the Mourning walk*, for which four conference attendees registered and three turned up. At that conference, we also spontaneously offered an opportunity to share and discuss eco-emotions in response to one of the keynotes, which was quite heavy. Several topics were planned for three rounds of discussions in smaller groups after the keynote. However, in response to its content and the ensuing sentiment in the audience, we decided to add a group for a debriefing on the emotions evoked for anyone who felt the need, which I facilitated with a senior conference organiser. For each of the three rounds, our group was filled with more than a handful of conference attendees who engaged in vivid, personal conversations, suggesting this novel addition to discussion topics was

[13] From workthatreconnects.org/resources/cairn-of-mourning.

appreciated.

On each occasion described above, I felt very nervous about facilitating the session, as its framing and content were so vastly different to what is usually said and done in these contexts, steeped in engineering culture and norms. I was afraid that I would be perceived as too "out there" and at the same time not grounded enough in being "out there". This ambivalence, I think, comes from being fairly new at this myself. That is, I am new at acknowledging the many, often difficult emotions accompanying the knowledge about the "mess we're in" and inviting others I don't know to explore them together. This invitation is even more challenging in a professional setting. As a teacher in a higher education institution, there are norms around teachers' authority, experience and professionalism, and the culture within engineering is oriented explicitly towards rational thinking and logic (see Paper 5 [Dread]). Furthermore, as a junior, aspiring academic research community member, doing something so outside the norm felt risky and uncomfortable.

However, this newness at the magnitude and depth of what lies ahead and is already unfolding has been usefully described by psychotherapists as a collective ongoing trauma (Woodbury, 2019): no one knows precisely where we are heading or what must be done. The need to explore our thoughts and feelings in response to it, together with others, was apparent in the presence and engagement of all the people I met during the activities I describe here.

I share these experiences here to highlight that one of the ways in which any HCI professional can choose to respond to the socio-environmental predicament is to look out for situations and contexts where this kind of attention to emotions is called for. By training, many of us have the skills to facilitate group conversations, listen carefully to what is being said and ensure that everyone's voices are heard. What our professional training does *not* prepare us for, however, is having the confidence to invite and host such conversations, and the courage and skills to be constructively present with the pain and confusion of others (Balaam et al., 2019).

3.3 Action-oriented and second-order transitions research

> This [situation] raises a critical question for humanity: how can rapid and transformational societal change be achieved to prevent dangerous levels of global warming? While science has so far excelled at understanding the climate problem and identifying technocentric solutions, it has so far largely failed to seriously engage with the critical question of how to make transformational change happen.
> (Fazey et al., 2018, p.54).

Decades of largely non-normative research into climate change mitigation and adaptation have yet to result in the kinds of radical change necessary to curb global carbon emissions (Stoddard et al., 2021). In response, sustainability transformation scholar Ioan Fazey and colleagues (2018)

propose *ten essentials for researchers to guide action-oriented transitions research*, which I will use later in this thesis to frame my research (see Findings). At this point, it is worth noting that while Fazey and colleagues' propositions are made in response to the challenge of climate change, I extend the problem space to the *socio-environmental predicament* outlined in Chapter 2. By premising my work on the socio-environmental predicament, I argue that working towards "sustainability" in the 2020s and beyond is no longer a question of "solving" climate change; instead, it means exploring and experimenting with how to *respond* to the predicament, which is unsolvable by definition. In a similar vein, in the book *The PhD at the End of the World: Provocations for the Doctorate and a Future Contested*, Susan D Porter (2021) writes:

> In these postnormal times, the necessary thinking processes also include ones that are more creative, reflexive, intuitive, relativistic, systems-oriented, and dialectical (in which issues are approached from multiple perspectives or logics). These thinking processes have also been conceptualized as a 'higher order of consciousness that involves changes in epistemology and ways of making meaning more inclusive, integrative, and complex. (p.69)

Fazey and colleagues' ten essentials are based on the understanding that research in general–and sustainability research in particular–is inherently *normative*, and that researchers arguably also *intervene* in the matters they study. The term *second-order science* from the field of cybernetics is used to acknowledge that the researcher is not independent of what is being studied, and to stress the importance of reflexivity. By necessity, given the situation we find ourselves in, the goal of the kind of research that both Fazey and colleagues and Porter refer to is not necessarily about generalisability, replicability or even building theory, but to promote other types of knowing and knowledge that may (or may not) push us in the direction of liveable futures.

In Table 1 I describe my understanding of the ten essentials, i.e. the assumptions underpinning them and what it means for research that aims to support transitions. In Findings, I return to these essentials to describe how the work I have engaged in during my time as a PhD student has lived up to them.

Table 1. The ten guiding essentials for new types of knowledge production by Fazey et al (2018).

Essential	Assumption	Description
1. Focus on transformations towards low-carbon, resilient living	Assumes that significant and transformative societal change is needed to respond to the socio-economic predicament, which is a symptom of how modern society is organised.	Research and practice that aims to address the predicament must explicitly examine and challenge structures, systems, mindsets and cultures, and focus on transformational change and how it is created.
2. Focus on solution processes	Assumes that fewer resources need to be spent on understanding problems, and should instead be used to learn how to bring about change.	The goal of research should be to generate actionable knowledge, where creating an understanding of the problem is a means to an end, and not the end result of the research. By focusing on change, such research also addresses aspired outcomes and the processes that lead to such outcomes.
3. Focus on "how to" practical knowledge	Assumes that transitions research needs to focus less on descriptive and abstract forms of knowledge, and more on practical contributions that elucidate how to implement change in practice.	Practical knowledge consists of both *techne*, i.e. concrete knowledge and skill of how to do something, and ı, which is the context dependent ability to know what is the right thing to do, and the morally defensible way to achieve it (Aristotle, 2004, in ibid.), sometimes called "practical wisdom", or "how to-knowledge". Three directions in practice research can be discerned: research *into* practice, where the practices are studied and described; research *for/as* practice, "where practices are the intended outcome and researchers work with practice or as practitioners to develop knowledge, such as a when developing a new process of change or new technologies through experimentation and iteration (Hope, 2016)" (in ibid., p.62); and research *through* practice, where the practice itself is the research.
4. Approach research as occurring from within	Assumes that putting the researcher within the research as opposed to outside is a necessary shift for developing practical knowledge.	This shift implies acknowledging that research is an actor in the process of promoting change (Umpleby, 2010, in ibid.), enabling research to aim for social betterment, elevates the status of applied work within science, and demands that researchers acknowledge and reflect on their assumptions and impact on the research and change.
5. Work with normative aspects	Assumes that science is inherently normative and that second-order transitions research is intrinsically political.	This essential implies that researchers need to be transparent and accountable about the research they do, be critical, reflexive and transparent about the values that underpin research choices, and "facilitate dialogue over important concepts such as value, resilience, agency, ideology, knowledge, and power as part of the research process (Moser, 2016)" (ibid., p.63).

Table 1. The ten guiding essentials for new types of knowledge production by Fazey et al (2018).

Essential	Assumption	Description
6. Seek to transcend current thinking and approaches	Assumes that the socio-environmental predicament cannot be addressed by the same ways of knowing and thinking that gave rise to it in the first place.	Fazey and colleagues suggest that transformation aims to innovate and develop previously unimagined possibilities for thinking and action, and that visioning, experimenting and inventing beyond what is assumed probable are key. They further propose that one way to work with the sixth essential is to engage in so-called *re-entry*, "where first-order concepts are applied back on themselves resulting in new meta-concepts and emergence of new questions" (ibid., p.63).
7. Take a multi-faceted approach to understand and shape change	Assumes that truth is not absolute.	There will always be infinite understandings, experiences, theories of change and ideas about what is desirable in addressing complex issues such as the socio-environmental predicament. In line with this essential, Fazey and colleagues argue for the need for future-oriented research, transdisciplinary approaches that include many different perspectives, knowledges and ways of knowing, and democratisation of knowledge.
8. Acknowledge the value of alternative roles of researchers	Assumes that learning about change requires practice and experience.	This assumption means that researchers must get their "hands dirty" and be prepared for and comfortable taking on multiple roles.
9. Encourage second-order experimentation and change	Assumes that learning about change is iterative.	"The implementation of solutions can be challenging and messy" (ibid., p.57), and learning is best done through iterations of experiments, interlaced with reflection.
10. Be reflexive	Assumes that practising second-order transitions research requires reflexivity on behalf of the researchers.	Reflexivity is an approach (or a *posture*, in the language of Transition Design) that supports the other nine essentials, while also enhancing the ethical conduct of transitions researchers, keeping ambitions high and avoiding path dependency.

4. Research approach

The work described in this thesis was conducted as a contribution to the field of *Sustainable Human-Computer Interaction* (SHCI). The explicit aim of any particular domain within sustainability as a field is to support a transition away from "unsustainability" and towards something that is defined as more "sustainable". However, research shows that decades of largely non-normative research into climate change mitigation and adaptation have yet to result in the radical change necessary to curb global carbon emissions (Stoddard et al., 2021). This state of affairs calls for researchers to dare to become normative in their efforts, a questionable stance in the more traditional, positivist view of science.

One of the key premises of the work in this thesis is that working towards "sustainability" in the 2020s means exploring and experimenting with how to respond to the unsolvable socio-environmental predicament outlined in Chapter 2. There, I also describe how HCI has worked with "sustainability" to date. Unusually, however, this thesis focuses neither on the process nor the product of HCI research and design, but *the role of HCI professionals ourselves* in addressing, or living with, the predicament and its constituent crises. Such a move involves revisiting, reevaluating and ultimately revising our posture, mindset and psychological barriers (Knowles & Eriksson, 2015) in the world, which on a collective scale may carry greater potential for leverage for systemic transformation (Meadows, 1997) than designing new systems and services.

During my time as a PhD student, the work and research I have done is this: I have explored how HCI professionals might engage in the work of our field at the end of the world as we know it, by practising HCI otherwise myself, where I stand. Below, I begin by elaborating the ontological, epistemological and methodological positions in the work in this thesis, and

then briefly describe the approaches and methods used in the papers herein, clustered into three themes: *Doing design and research, Being a teacher* and *Thinking about the work*. However, as part of my inquiry has been to do research otherwise, I have also chosen to go even deeper into my research approach in Chapter 5, by describing it as *action-oriented and second-order transitions research* based on Fazey and colleagues (2018) ten essentials described in the previous section, 3.3.

Ontologically, my research acknowledges multiple kinds of reality: material/ecological reality exists independently (realist), social phenomena like professional norms and identities are constructed within bounded groups (constructivist), and lived experience has phenomenological validity (phenomenological). Rather than adopting a single ontological position, I pragmatically treat different aspects of my research according to their nature, focusing on what each perspective illuminates about practicing HCI otherwise in this time of endings. To elaborate on these positions, I consider the socio-environmental predicament as real, as something that exists independently of social construction. Constructivism, on the other hand,

> asserts that social phenomena and their meanings are continually being accomplished by social actors. It implies that social phenomena and categories are not only produced through social interaction but that they are in a constant state of revision. (Bryman, 2016, p.16-18, in Grix, 2002)

Exactly how I practice HCI otherwise is unique to me, but it is shaped or constructed by norms and professional culture. And a phenomenological stance allows me to consider my lived experience is a valid source of knowledge, and that such experiences are real and knowable.

Methodologically, the research described in this thesis is *qualitative*. It acknowledges that the world is *constructed* through our experiences and subject to interpretations, privileging the depth and richness of studying fewer instances of a phenomenon. Furthermore, it acknowledges the *situatedness* of knowledge and meanings, i.e. how we understand the world is inherently shaped by the context within which such an understanding is produced. Denzin and Lincoln (2005) write:

> Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. (p.3, as cited in Alvesson & Sköldberg, 2009)

Both these stances are embedded in so-called *first-person methods*, where a researcher uses their personal experience to capture subtle, pre-reflective, and dynamic aspects of subjective experience from an internal perspective to produce rich data (Lumma & Weger, 2023). First-person methods specifically focus on the researcher's own subjective experience and consciousness, often for understanding psychological or phenomenological processes. Such methods are increasingly used in HCI to probe into researchers' own design processes and experiences: "In first-person research, the line between the personal and the professional gets blurred. Our opinion, point of view, decisions, and mistakes can be seen as a valuable starting point for learning." (Desjardins et al., 2021, p.8).

Specifically, to describe my methodology I have been inspired by the concept of *heuristic inquiry*, originally conceived of by humanistic psychologist Clark E. Moustakas (Moustakas, 1990). According to Lumma and Weger (2023), it is an "open-ended and autobiographical process" used to "explore questions that arise from a personal experience of the researcher", "to immerse into a self-searching process in order to find a deeper meaning and insight about one's personal experiences", and invite "personal growth and transformation of the researcher" (p.10442). Since heuristic inquiry is open-ended, it often accidentally leads to unexpected discoveries. Below, I use Moustaka's (1990) six phases of heuristic inquiry to outline the structure of the process that led to this thesis: initial engagement, immersion to the topic and question, incubation, illumination, explication and synthesis. As will become apparent, the phases tend not to be sequential or discrete.

Initial engagement This phase involves a personal experience of deep interest ,"a passionate concern that [...] holds important social meanings and personal, compelling implications" (ibid., p.27). In my case, the initial engagement with my research question was born during my burnout (described in the Prologue) and in my disappointment at my employer's actions (see But why? Being difficult at work), in the years before I even became a PhD student. During that year, I became acutely aware of the socio-environmental predicament, and started questioning my professional choices and options. As a result, I applied for a PhD position to work on a project to do with design and futuring methods as applied to sustainability transitions in local communities. The beginnings of my research question were with me from the start, but it was not the explicit or official focus of the research that I was engaged in.

Immersion Once the question is discovered, "the researcher lives the question in waking, sleeping, and even dream states. Everything in his or her life becomes crystallized around the question. The immersion process enables the researcher to come to intimate terms with the question–to live it and grow in understanding of it" (ibid., p.28). In this phase, the researcher brings the question to all aspects of life: public, private and professional–all present opportunities for exploring the question. My "under cover" research question was with me throughout the first four years out of five of doctoral studies. In each book and paper I read, in each course that I took, in each podcast I listened to, each conversation I had, I looked for insights on what to do, as an HCI professional (and otherwise), given the mess we are in. I went to conferences, both academic and outside, to find answers. And in the research I did, while not explicitly about this question, I did the same. Papers 1-5 were written during this time. And it was not until after these years had passed (i.e. less than one year ago at the time of writing) that I dared to consciously formulate the research question that ultimately led to this thesis. Moustakas also describes how this phase is about recollecting past experiences and writing about them. In my case, this happened later in the process, i.e. as I started writing this cover essay, when different personal experiences of the things I was writing about started to surface. I felt compelled to type these retrospective autobiographical vignettes into the cover essay as they surfaced, without really knowing why or what I was trying to say with them. This highlights the subconscious dimension of exploratory research, in which intuitions often guide our actions and choices long before we can fully understand their significance.

Incubation This phase involves a distancing from direct involvement with the research question, to allow one's experiences to sink in. During incubation, ideas and thoughts are being processed, but indirectly. Since this thesis has been more than five years in the making, there have been many opportunities for and periods of incubation, both during time off work, and during intense work on specific papers and teaching.

Illumination Here, the researchers' insights are crystallised into insights, allowing for the synthesis of fragmented ideas. New meanings, patterns or connections may appear, and unconscious aspects of experiences can be brought to the fore, in moments of breakthrough moments of clarity that are necessary for a researcher to move forward. Two such experiences include coming up with the idea for and writing Paper 1 [Assumptions] and Paper 6 [Two Loops], and deciding to review my research through the lens of Fazey and colleagues' essentials (see section 3.3) for this cover essay. Working as a

teaching assistant in sustainability (Paper 4 [Eco-anxiety], I came to realise the importance of also working with the emotional dimensions of the predicament. And in doing the data collection for Paper 5 [Dread], I was struck by how important authenticity is to me when I act in my professional role, and how difficult that can be in practice (see e.g. Teaching HCI). Furthermore, at some point I had a realisation that many professional roles create a systematic disconnection from ecological reality and teach us that caring for the living world is neither possible nor desirable.

Explication This phase involves reflection, focusing, and dialogue with the material that has emerged, moving from broad impressions to precise articulation of findings. While each paper herein has involved some aspects of explication, Paper 1 [Assumptions] and Paper 6 [Two Loops] stand out as attempts to do just that. And here, I started to see how my autobiographical vignettes fit into the greater argument that I was drafting.

Synthesis In this final phase, everything is brought together into a cohesive whole that communicates a researcher's newfound understanding of their inquiry. In my case, this cover essay is the synthesis of the first-person research undertaken as described above.

Finally, this thesis is largely based on *exploratory methods,* which are common in HCI and design, as they are useful for studying topics with little prior knowledge and where the research aims to identify new possible patterns or possibilities to better understand what is being studied. The aim when using exploratory methods is thus not to test a hypothesis, but to probe into more or less unknown domains, which means that the methods tend to be more flexible and open-ended, producing hypotheses and tentative generalisations about what is being studied (Stebbins, 2001).

In the remainder of this chapter, I describe the specific methods used in this thesis, organised into three themes: *Doing design and research*, *Being a teacher* and *Thinking about the work*.

4.1 Doing design and research

For Paper 3 [Interviews], I conducted *semi-structured exploratory interviews* with eight people from an NGO (Omställningsnätverket, i.e. the Swedish Transition Network), recruited using *snowball sampling* (Biernacki & Waldorf, 1981). This recruitment method is suitable when studying a phenomenon that is not widely found in the general population, i.e. when the topic of study is of a specific community whose members may be hard to find

"from the outside". The interviews were exploratory as they aimed to understand how the interviewees worked to create change in their local contexts, without previous knowledge about it in the form of, e.g. a theory. The paper is a *case study* of how sustainability transitions are enacted by the active "members" of the NGO to increase our understanding of such transitions. It also informed the design work described in Paper 2 [Pastcasting], as it helped us better understand the needs, goals, challenges and culture of our research partner Omställningsnätverket.

Paper 2 [Pastcasting] is an account of one possible way to do research in line with Fazey and colleagues' (2018) ten guiding essentials for transformational knowledge production. It is also an instantiation of pastcasting as a futuring method to support societal transformation through increased individual agency, using design methods. By combining concepts and methods from the disciplines of *futures studies* and *design*, we developed a scenario-based workshop method to support the work of the NGO Omställningsnätverket. In the workshops, participants engage in *participatory futuring* by exploring and co-creating normative, open-ended, counterfactual scenarios, generated using the affordances of *pastcasting,* which "takes a preferable present as its starting point to consider how past possibilities could have formed paths from the past to a preferable present (and by extension, to a different future)" (Bendor et al., 2021, p.4). The workshop format was developed through a process of *design research*, over multiple iterations of prototyping, evaluation and redesign, to arrive at an end result that fulfilled the project's requirements.

4.2 Being a teacher

Paper 4 [Eco-anxiety] reports on a small-scale research and educational development project that I was involved with as a teaching assistant, where we studied emotional aspects of teaching sustainability in ourselves and our students. Specifically, we wanted to know how to better support our students in the emotions that may arise when learning about the socio-environmental predicament. We immersed ourselves in the literature on emotions and sustainability education, identified gaps in how the course was currently set up and run with respect to the literature, redesigned the course as far as feasible to introduce recommended features from the literature, taught the course and reflected on the experience and outcomes throughout and afterwards. As such, the effort represents an informal *action research* project on our own teaching, as it aimed to study and improve it in relation to an emerging need. To address emotional aspects in our ongoing and future teaching, we employed a *mixed-methods* approach, which included our

On doing, being, thinking otherwise

Teaching HCI

or, What we teach when we try not to teach or think about global warming[14]

For several terms of my time as a PhD student, I have been a teaching assistant in mandatory courses in basic HCI, where I have supervised a group of engineering students through a process of designing a digital tool or service for a given user group and theme. As an example of such a pairing, one year, the students went through the double diamond of design to develop a tool for older people to play and have more fun in the wake of the COVID-19 pandemic. Being an introductory course in HCI, it is steeped in the ontology and epistemology of second-wave HCI and introduces students to heuristic evaluations, Norman's design principles and quantitative measures of success.

While I have loved being a teacher during this time, teaching this particular course feels like a strange exercise in make-believe. It has asked of me to entirely compartmentalise what I know about the world outside of KTH and some of the likely futures ahead. It has asked me to pretend that I don't believe that "Every piece of infrastructure, every home, every community, every business, every industry, was built to work in a world that no longer exists" (Gell, 2025). It bothers me, as I am uncomfortable being inauthentic. But I also don't quite know what an alternative would look like, or how it would come about. As teaching assistants, some of us PhD students have argued for including ethics in the teaching, but the suggestion was dismissed due to a lack of time. I assume that the same would hold for including sustainability in the course. It would, however, feel worthwhile to have the students design for any one of the crises that form the socio-environmental predicament, instead of coming up with yet another variation of an app that already exists in the world of business-as-usual. But I suppose that is what prepares them best for the current labour market? And speaking of ethics, is it even ethical for us as teachers to hint at the end of the world as we know it to the students, as many of them are already bereft of hope for the future (Hickman et al., 2021) and working hard to forge a career for themselves?

reflections as teachers, our literature readings, a collaborative research diary, a small ethnographic study and a quantitative course evaluation.

In Paper 5 [Dread], we revisit the educational development project described in Paper 4 [Eco-anxiety] to ask how dread and hope manifest in sustainability education for engineers, and how we as teachers and our students navigate these emotions. For the purposes of the paper, we conducted workshops to bring together and analyse our own experiences,

[14] This heading is, of course, a paraphrasing of Per Espen Stoknes' book "What We Think About When We Try Not To Think About Global Warming" from 2015, where he describes psychological barriers to and strategies for climate action.

views and meta-emotion reflections from the project as educators and education researchers, based on the field notes from the ethnographic study that was part of the project and diary entries from diaries that we kept during the project. As such, the paper is based on four sources of researcher reflections: 1) Reflections in diary entries, 2) Reflections in ethnography field notes, 3) Reflections in workshops on diary entries and field notes, and 4) Meta-emotion reflections in workshops on 1, 2 and 3. The reflections on our experiences as educators were explored using a theoretical framework where emotions were understood as being socio-political, i.e. as maintaining or challenging the status quo. In psychologist Linda Finlay's (2003) map of reflexivities in social science research we, as authors of the paper, engaged in reflexivity as introspection, as intersubjective reflection, as mutual collaboration, and as social critique. Firstly, *reflexivity as introspection* provided data about our own social/emotional worlds during the teaching experience. Secondly, *reflexivity as intersubjective reflection* provided data about how unconscious processes structure the relationship between us as researchers and teachers, the students and our colleagues. Thirdly, we engaged in *reflexivity as mutual collaboration* through co-operative inquiry, where three of the five authors were simultaneously both researchers and subjects of the research. Such collaborative reflexivity allows for multiple voices and conflicting positions to be taken into account. Finally, we engaged in *reflexivity as social critique* by using our experiences to understand the socio-political nature of hope and dread in relation to the climate crisis.

4.3 Thinking about the work

Papers 1 [Assumptions] and 6 [Two Loops] originated from my personal attempts at making sense of the current landscape of SHCI/HCI and at trying to identify the kinds of work that may be meaningful to engage in moving forward, given "the mess that we are in" (Macy & Johnstone, 2012). While Paper 1 [Assumptions] is descriptive and therefore looks backwards, Paper 6 [Two Loops] is explorative and forward-looking.

Paper 1 [Assumptions], where we describe a set of assumptions that impact how "sustainability" is defined and operationalised in SHCI, is the result of *abductive reasoning*, a complement to its inductive or deductive counterparts. In abductive reasoning, or abduction, "a single case is interpreted from a hypothesis overarching pattern, which, if it were true, explains the case in question" (Alvesson & Sköldberg, 2009, p.4). Alvesson and Sköldberg argue that what differentiates abduction from the more well-known inductive and deductive reasoning is that, in addition to observation, it also includes understanding. As such, abduction is at the core of e.g. diagnosing medical conditions and errors in technical systems, and involves

iterative cycles of making observations and formulating theory (i.e. describing an overarching pattern), refining both the theory and the empirical area of application. Furthermore, according to Danermark, and colleagues (2018), abduction is not only possible but *necessary* in social science research aimed at seeking knowledge about structures and mechanisms, and making claims about how something *might* be. Abduction thus involves looking for relationships in empirical material that are not immediately obvious and is, therefore, also *interpretive* and unable to claim definitive truths.

Paper 6 [Two Loops], on the other hand, is *forward-looking*, and takes a known model for understanding organisational change, the Berkana Two Loops model (Wheatley & Frieze, 2006), and applies it to the work of HCI and IT professionals in the context of the socio-environmental predicament. The paper is the result of *collaborative interpretive research*, where all seven authors moved back and forth between co-constructing the model's application to the socio-environmental predicament on the one hand and to HCI and IT professionals on the other, over more than ten combined research and writing sessions that resulted in the paper.

Finally, the totality of work in this cover essay, including the reflections on doing, being and thinking otherwise that I have woven in throughout, represents both the process and product of a *first-person methodology*. In addition to using myself and my experiences as the object of research, I have also immersed myself in contexts and communities who think about and live based on a sober acknowledgement of the socio-environmental predicament, or some version of it. Throughout, I have used reflexivity, not as a way of turning away from the world, but to carve out space for action and agency for change, from my situated experience of being an HCI professional myself. By being reflexive about our experiences, we can

> explore how we might contribute to the construction of social and organizational realities, how we relate with others, and how we construct our ways of being in the world. Critically reflexive questioning also means exposing contradictions, doubts, dilemmas, and possibilities [...] This means highlighting ideologies and tacit assumptions—exploring how our own actions, conversational practices, and ways of making sense create our sense of reality. (Cunliffe, 2016, p.754-755)

5. Findings

In this chapter I describe key insights and findings from the papers included in this thesis, organised into four themes: Why do we do what we do in Sustainable HCI?; What can it mean to do Sustainable HCI at the end of the world as we know it?; How to find agency as an HCI professional; and Doing action-oriented second-order transition research.

5.1 Why do we do what we do in Sustainable HCI?

Paper 1 [Assumptions] is backwards-looking and begins with the observation that the variety of work done under the umbrella of Sustainable HCI (SHCI) is extensive, and that it can be hard to understand the relationship between sustainability and the highly diverse set of topics being researched in HCI/SHCI. The paper uses assumptions as a lens and aims to shed light on different understandings of sustainability problems in the SHCI field, and how such understandings underpin different directions of research and design in SHCI. The paper is grounded in observations made by my co-author and me through our engagement in the field over time. Through abductive reasoning, these observations led us to assumptions organised along four dimensions: 1) the depth and nature of the sustainability challenges; 2) the role of technological innovation in relation to those challenges; 3) what is included in a design or system and what gets defined as "externalities"; and 4) the time perspective used to consider sustainability. Furthermore, we argue that:

> What one assumes–knowingly or unknowingly–within each of these dimensions directly influences what is meant by the term "sustainability", which is then reflected in the questions that are asked, the methods that are chosen, the solutions that are

> proposed and the systems that are developed (i.e. in one's actions and theories of change). (p.2)

For each assumption, we outline actions that can be seen as commensurate with it and, when possible, give examples of such work in the field of SHCI, HCI or the broader field of IT. For instance, when considering sustainability from a short-term perspective (dimension 4), regardless of how the environmental crisis is understood (dimension 1), it makes sense to focus on innovations for substitution of e.g. energy sources, on optimisation through e.g. increased energy efficiency and decreased consumption through behaviour change, and on designing with materials that are non-toxic and fit within a paradigm of circularity. For assumptions that demand more radical shifts in how to think and act, away from immediate and measurable solutions to well-defined problems, we point to any work known to us that is aligned with them, but we also found some gaps (e.g. HCI and SHCI for the long-term or deep time). For such gaps, we propose frameworks that may help the field generate interesting and important strands of new work.

The framework reveals that assumptions such as the ones we have observed in the field are all examples of values-based boundary judgments (Ulrich & Reynolds, 2010) about what is considered important and not in SHCI/HCI, made knowingly or unknowingly. Interestingly, and as observed elsewhere, values are often only recognised as such when they challenge the norm (e.g. Becker, 2023). Furthermore, it shows how the assumptions relate to worldviews, dispositions, and systems of values about how technology operates, and should operate, in the world; and how central technology is and should be in a changing world. Finally, the framework highlights how all assumptions are linked to time frames in one way or another, e.g., urgency, presentism, or short-term definitions of externalities.

We propose that the SHCI/HCI community could use the framework in several ways: to identify one's own assumptions to reveal any biases and knowledge gaps; as a tool to surface differences in how sustainability is understood within a team and to agree on a shared definition; to do an inventory of the current body of SHCI work so as to reveal any biases and gaps, allowing for more strategic decisions about future research; to formulate one's own position or profile in SHCI in CVs and publications; as inspiration for someone in HCI who is looking to redirect their work to SHCI, or someone already within SHCI who wishes to change focus; and to help make explicit underlying assumptions in SHCI work to better discussions and critique within the community. For the last suggested use of the framework, we propose a practice for work in SHCI to include a kind of "sustainability positionality statement", and as authors, we conclude the paper by providing our own statement as an example.

On doing, being, thinking otherwise

Daring to (maybe) have something to say

An early version of the framework outlined in Paper 1 [Assumptions] came to me about two-thirds into my time as a PhD student. By then, I had read many papers and attended several academic conferences on technology and sustainability in person and online.

In any other context, reading proceedings or going to a conference that exhibits a wide variety of perspectives and domains of application can feel inspiring. There is an underlying assumption that most people there are on a shared quest for knowledge to enrich the world that needs it. There is further an implicit understanding that while this quest may be pursued in a variety of ways, the research questions asked are pertinent to the community for/by whom the conference is organised.

This was, however, not my experience from engaging with most of the research in the field of technology and sustainability. Given what I know about the state of the world and the urgency with which we must act to mitigate the worst impacts (see the Section 2.1), much of the research made little sense to me. Specifically, I asked myself why this focus on efficiency, optimisation and novelty, or on intricate, slow explorations of our co-existence with the living world, when the world is on fire? Either I was missing something–i.e. that I didn't know enough to understand that what I was hearing and reading about did indeed represent radical steps towards societal transformation–or our assumptions about the world, i.e. our ontologies, were simply not aligned. I concluded the latter and started trying to understand the assumptions a given research piece was based on.

The thinking and writing behind Paper 1 [Assumptions] represent an exercise in abductive sensemaking from being a practitioner in the field. It is offered to the SHCI community as a hand-drawn map based on having listened carefully to what is being said between the lines in our work as a community.

Being thoroughly steeped in my undergraduate environment's empirical and positivist tradition, writing Paper 1 [Assumptions] (and this cover essay too, for that matter!) represented an intense internal conflict. On the one hand, there was my present lived experience of having observed or at least gauged something meaningful and important that I wanted to share with my professional community, and, on the other, my training of *never* counting my own experiences as valid, unless backed up by empirical, statistically validated data.

We submitted the essay to the CHI subcommittee "Critical Computing, Sustainability, and Social Justice"[15]. It came back with "Revise and resubmit", where

[15] That is in itself interesting in the context of this thesis, that this cluster of topics is on a par with 18 others that supposedly (and legitimately!) do not concern themselves with critical

one of the key concerns raised was that it lacked a clear method, accompanied by suggestions of how the proposed framework could or should be validated instead of being "prematurely" shared with the community. Even though the manuscript explicitly stated that it was an essay, not a research paper, I had to remind the reviewers of the subcommittee's commitment of being

> epistemologically pluralistic, welcoming of a range of perspectives, approaches, and contributions that might take interpretivist, empirical, activist, political, ethical, critical, and/or pragmatic approaches to both societal challenges and how HCI research frames itself in relation to them. As a part of that commitment, we also champion diverse forms of scholarly expression in the CHI community, such as critical essays, research through design, practice-based research, design fictions, and commentaries[16].

Not only did the subcommittee's name suggest that this essay would fit; its official epistemological commitments were also aligned with mine. And still, the essay's knowledge contribution was initially met with suspicion, before the reviewers were reminded of the counter-cultural stance the subcommittee is attempting to adopt.

As such, I see writing it as one of many exercises for me (and the reviewers!) to unlearn some of the workings of modernity and positivism, in having the courage to use my own experience to make sense of a phenomenon together with a colleague and then share it with my community, however tentative. This was, in essence, yet another unsettling experience of trying and daring to think without knowing for sure, or to "know" something without thinking in "the right way".

In relation to the aim of this thesis, the paper provides a high-level description of how the body of research in SHCI/HCI currently understands the crises that we face, and how the field is trying to be a force for good in the face of them. As a framework, it may help some SHCI professionals better position themselves and their work, allowing them to be more strategic about their choice of work moving forward. It may also help HCI/SHCI professionals who feel stuck in their current niche to find other, and potentially more systemic and/or underexplored points of departure for their work.

thinking about technology, ecological realities and questions of justice between people, generations and species. The full list of committees can be found here: https://chi2025.acm.org/subcommittees/selecting-a-subcommittee/

[16] Excerpt from the description of the Critical Computing, Sustainability, and Social Justice subcommittee on the CHI 2025 website https://chi2025.acm.org/subcommittees/selecting-a-subcommittee/#critical_computing

5.2 What can it mean to do Sustainable HCI at the end of the world as we know it?

Papers 2 [Pastcasting], 3 [Interviews], 4 [Eco-anxiety] and 5 [Dread] represent situated inquiries as to how I, as an HCI professional, have tried to use my skills and power to do, be and think otherwise, based on the opportunities that I have had as a PhD student.

Paper 2 [Pastcasting]

In Paper 2 [Pastcasting], my co-authors and I describe the context, process and product of Event Horizon, the main research project I was part of between 2020-2023 as a PhD student at KTH. The project was founded on the normative premise that for the 2015 Paris Agreement to be fulfilled, global CO_2 emissions must be reduced by 50% every decade until 2050 for a 75% chance of maintaining Earth below the 2°C target, as operationalised by the "carbon law" (Rockström et al., 2017). In practice, drastically curbing carbon emissions represents an "urgent and unprecedented transformation" (Stoddard et al., 2021, p.654) that is all but failing to materialise, due to several reasons that may ultimately be rooted in issues of power. In the face of such a massive, existential challenge where true political leadership and action appear to be missing, helplessness and powerlessness as facets of eco-anxiety (Pihkala, 2024) are common experiences (e.g. Hickman et al., 2021). Since feelings of helplessness and powerlessness may prevent people from constructively engaging with climate change (Hmielowski et al., 2019, in Ojala et al., 2021), addressing the gap between what "must be done" and what feels possible represents an important area for research. In Event Horizon, we used participatory research through design methods and pastcasting from futures studies to devise a workshop format aimed at decreasing the gap between "must be done" and what feels possible for the participants. In the project, "we" were a team of both academic researchers and members of the NGO Omställningsnätverket (the Swedish Transition Network). It is a global environmental network that acts based on climate change and peak oil being real and already here, and aims to support people in increasing local adaptation and resilience through hands-on, practical action.

Paper 2 [Pastcasting] had the dual aim of describing how we set up and conducted a close collaboration with a civil society organisation in line with Fazey and colleagues' (2018) ten guiding essentials for transformational knowledge production, and of instantiating pastcasting as a futuring method to support societal transformation through agency, using design methods. The end product of the collaboration was a pastcasting-based workshop method package, consisting of a workshop manuscript and a supporting

process board for both online and physical settings. These were handed over to Omställningsnätverket under a Creative Commons license, for anyone to use in their local contexts. The materials were specifically designed for people who "long for conversations with different stakeholders in their community about what a local sustainability transition to a regenerative low-carbon society could look like and how it could work"[17].

In relation to this thesis, the work underpinning Paper 2 [Pastcasting] provides valuable insights in three areas. Firstly, it demonstrates how a close, issue-oriented research collaboration (Fazey et al., 2018) with a civil society organisation can be set up and conducted to provide its members with actionable insights and tools to support their efforts using research through design methods (see Table 3 in the paper for a complete summary of how the project aligned with Fazey and colleagues' ten guiding essentials). In the paper, we describe how this action-oriented research project was born organically out of two of the authors engaging with people in their personal networks, who were active in Omställningsnätverket. Their shared interest in peak oil, climate change, and imagination as key to unlocking human agency ultimately resulted in a successful research funding application. This collaboration shows how sources for meaningful and important work where HCI can have an impact can be found outside of our professional spheres, and that each encounter with people engaged in some aspect of our predicament can carry opportunities for collaboration. Another learning from the project that is not elaborated on in the paper is that research collaborations between academia and NGOs often end up being lopsided: the academics, who get paid for their time, extract knowledge, time and resources from unpaid NGO workers, thus reducing the time available for their NGO work, for the sole benefit of the academics themselves. Multiple aspects of how Event Horizon was set up and run for the partnership to be as equal as possible, from its definition and the practical work that was involved throughout, to how the project outputs were defined to provide value to both parties.

Secondly, the work described in Paper 2 [Pastcasting] shows how futures studies methods can be used to support participatory futuring towards societal transformation through agency. While speculative and critical HCI do make use of futures-oriented methods, mainstream HCI typically studies existing phenomena using empirical methods for data collection. Adding scenario-based futures studies methods, such as pastcasting, to the HCI toolbox allows the design space to open up for other trajectories than business-as-usual. Such an opening could serve not only to criticise the current system or to creatively speculate about other worlds and beings, but

[17] From Omställningsnätverket's website, omstallning.net/bhp.

also to essentially generate "proto design requirements" of alternative pathways for desirable futures and worlds.

Thirdly, it shows how HCI skills such as iterative prototyping and facilitation can be used not to generate user insights or design products and services, but to bring local communities together around shared issues of concern, to explore their nature and find ways forward. Further methods, techniques and knowledge used in the project from HCI's constituent fields include speculative artefacts from design, as well as framing, priming, social safety, breathing and mental exercises from psychology.

Paper 3 [Interviews]

The interviews in this exploratory study were conducted early on in the Event Horizon research project. The aim was to get to know the partner NGO Omställningsnätverket better. Omställningsnätverket, as part of the global Transition Network, assumes that climate collapse and peak oil are a given, and therefore engages in local *practivism* (i.e. "activism that is based on changing one's own practices rather than changing those of others", in Hoff et al., 2020, p.6) as a response to an energy transition that is already here. Preparing for the interviews, I attended a two-day course organised by Omställningsverket to learn more about its "holistic, grassroots approach to social, economic, and environmental transformation"[18]. The aim was to understand, through participation and observation, what kinds of people were drawn to the network and why, and to find potential participants for the interview study. We later decided against recruiting interviewees from the course, as we wanted to study more experienced transitioners.

In the interview study, we were particularly interested in understanding what people who identify as transitioners have tried to achieve in their local contexts, what strategies they have found to be effective and which ones have failed to have an impact. Furthermore, we sought to conceptualise the work that the transitioners did in their local contexts using *the middle-out perspective* (Parag & Janda, 2014; Janda et al., 2019), to highlight the multidimensional and multidirectional nature of their efforts.

Through our analysis of the interviews, we found four key strategies for supporting local sustainability transitions: 1) to focus on concrete, practical action (practivism) 2) that is situated in a specific place (situatedness), and 3) is aimed at fixing broken social contracts, increasing trust and aiding local economies (regeneration) 4) without demanding affiliation or allegiance to a specific course of action, movement or worldview (nonpartisanship). We also

[18] https://transitionnetwork.org/do-transition/training/trainings/

saw that the interviewed transitioners' actions could be usefully described using the middle-out perspective: their efforts had impacts downstream (to fellow inhabitants), upstream (to local authorities and governing bodies) and sideways (on aligned interests and organisations) from their own positions, and that they contributed to all three modes of influence, i.e. aggregation, mediation and enabling.

The study in this paper is an example of how common HCI methods such as interviews and observation can be used to approach and learn from communities that are already living, or learning to live, in ways that are based on an unevenly[19] unfolding socio-environmental collapse. While the paper focused on the transitioners' strategies, our research also gave us insights into how their experience, values and priorities impacted their life choices and everyday practices. Learnings from studies such as this one can seed ideas for further action-oriented research collaborations aimed at generating both tools and knowledge to support the work of community organisations. They can also be used to proactively gather user requirements and define scenarios of use for systems that can be built from scratch, or configured from existing technology, in the abundant present while preparing a future of scarcity and intermittence. Finally, the middle-out perspective provides a useful framework for tracing both the direct and indirect effects of Omställningsnätverket's practivists actions to capture a richer picture of their work, and thereby their tasks and needs.

Paper 4 [Eco-anxiety]

As a PhD student in HCI at KTH, I have also had teaching duties in my department. One of the courses in which I have assisted with teaching is a mandatory course in sustainability for engineers, specifically for media engineering students. Together with the other teachers in the course, we had been asking ourselves whether and how to respond to distress in students as they learn about the true state of the natural world. This distress, or *eco-anxiety*, can be experienced in many ways, including grief, anger and fear (Pihkala, 2020). Since such negative emotions can be debilitating, leading to hopelessness and ultimately inaction, they present an important area to address for anyone working in the sustainability space.

This paper explored how eco-anxiety was communicated by students and teachers in the course in 2021 and what kinds of support students received from us teachers to deal with it, based on a list of suggested teacher activities by Pihkala (2020):

[19] This is a reference to the quote "The future is already here—It's just not very evenly distributed", by American speculative fiction author William Gibson.

1. Self-reflection and inner work by the educator himself/herself
2. Validating various ecological emotions and experiences of eco-anxiety among the students
3. Admitting that the educators themselves feel difficult emotions
4. Providing information about coping with eco-anxiety
5. Offering students chances to discuss their emotions
6. If possible, offering students chances for embodied activities
7. Collective action
8. Maintaining balance, remembering joy and upholding meaningfulness

Based on our reflections as teachers, guided by literature, a small-scale ethnographic study and a course evaluation, we found that both teachers and students expressed eco-anxiety at times throughout the course. We also found that we already used a variety of Pihkala's suggestions in our teaching activities, openly acknowledging that the course is likely to lead to or increase eco-anxiety, also in ourselves, to act as role models for how to live with the knowledge of existentially dangerous ecological breakdown, and provide safe spaces for the students to express their own emotions throughout the course, if they want to.

In relation to this thesis, this paper argues for the importance of tending to eco-emotions in oneself and the people we engage with to support resilience and agency in the face of distressing facts about environmental collapse. It also provides examples of how this can be done in practice. Emotions will occur, in this case in the classroom, in our students and ourselves, although not in everyone and not at the same time. If, as HCI professionals, we reorient our work to be based on the biophysical reality of accelerating ecosystem collapse, we need to be prepared to meet difficult emotions in ourselves and others, in repeated cycles over time (Macy & Johnstone, 2012; Pihkala, 2022).

Paper 5 [Dread]

In this paper, we revisited the teaching setting described in Paper 4 [Eco-anxiety]. We were guided by our experiences as teachers, feeling the need to deepen our understanding of how emotions manifest in sustainability teaching in an engineering context, in both students and teachers. Specifically, we were interested in investigating dread and hope, which we theorised as *socio-political*, i.e. socially constructed in power relations.

We found that both students and teachers expressed and/or experienced emotions throughout the duration of the sustainability course, and that dread was more commonly expressed (or avoided) than hope. By being authentic as

teachers, i.e. not sugarcoating the story we tell, we open a mental door to the unsustainability and implausibility of infinite growth, business-as-usual, techno-optimism and techno-solutionism, realisations that may understandably evoke dread. We argue that by allowing expressions of dread in our interactions with students as a response to non-mainstream "truths" about the socio-environmental predicament, we as teachers challenge dominant emotional norms typical of both STEM and society in general. Furthermore, by being open about our own experiences of absorbing such "truths", we act as role models for students of how one might live with and beyond dread. Dread, we argue, "should not be dismissed as paralyzing or counterproductive; rather, it can serve as a catalyst for critical hope" (p.24) and, ultimately, action.

5.3 How to find agency as an HCI professional

The final paper in this thesis, Paper 6 [Two Loops], is forward-looking and aims to help HCI researchers, practitioners, designers, educators and students to find agency in the unfolding events, towards liveable futures. The paper uses the *Berkana Institute's Two Loops model of change* (Wheatley & Frieze, 2006; Corrigan, 2024) which is used to understand and work with change in living systems, such as organisations and societies. The model captures the movement and relationship between dominant and emerging systems (or paradigms), helping people make sense of the turbulence they may be witnessing, and suggests meaningful ways for people to respond to an ongoing transition. Notably, the model brings attention to how transitions are marked by loss, grief and uncertainty, which is an under-recognised aspect of working with innovation, transitions and transformation.

The paper was written as a collaborative effort of discovery and reflection by all authors, ranging from early and late PhD students to senior, tenured academics. It is the result of a series of conversations and workshops with the authors to work through the Two Loops model of change, making sense of it together and asking the model what each of its concepts and phases might mean for our professional community. We identified aspects of the model that are already part of the current practices and ideas of HCI, such as innovation, prototyping, exploration and networking. We also noticed gaps, i.e. work that is currently rare or non-existent, such as stewarding existing systems and tending to emotions related to loss (e.g. of what has been, privileges, dreams about the future). The model further revealed how HCI's (and IT's) focus on solutions to simplified problems ignores the reality of what is at stake.

In relation to this thesis, the paper shows that Two Loops is a useful visual device for communicating, firstly, that anyone can meaningfully and equally

importantly work either with the dominant, dying System or with the emergent System(s); and, secondly, that the times ahead require that we learn to stand and act with one foot in each of the two Systems. Furthermore, we argue that "by showing different ways of engaging in the transition, the model can help us spend our energy wisely, in the present as well as over time, in service of something we believe in and feel drawn to" (p.15).

5.4 Doing action-oriented second-order sustainability transition research

The previous sections in this chapter have summarised the results of my exploration of how to practice HCI at the end of the world as we know it. Below, I present how the explorations in the six appended papers constitute a "portfolio" of action-oriented second-order sustainability transition research, as defined by Fazey and colleagues (2018) and described in Section 3.3.

Essential 1. Focus on transformations towards low-carbon, resilient living

> *Assumes that significant and transformative societal change is needed to respond to the socio-economic predicament, which is a symptom of how modern society is organised.*

For Paper 3 [Interviews], we studied so-called transitioners, i.e. people who enact various kinds of sustainability transitions in their local context, based on present and likely future realities of climate change and peak oil, to learn about their strategies for achieving them. Paper 2 [Pastcasting] describes how we developed a scenario-based method for helping local communities reflect on pathways towards low-carbon carbon. Paper 1 [Assumptions] is an essay that suggests a framework for interrogating assumptions about sustainability in one's own work and that of others within SHCI, in order to hopefully guide colleagues towards more systemic and therefore transformational ventures. And the exploratory Paper 6 [Two Loops] addresses worldviews by identifying the current ideological paradigm or "loop" as stagnant and ultimately dying, and acknowledging the emergence of new possible paradigms of influence, while pointing to spaces and opportunities for action in both.

Essential 2. Focus on solution processes

> *Assumes that fewer resources need to be spent on understanding problems, and should instead be used to learn how to bring about change.*

While it does not study the solutions themselves, Paper 6 [Two Loops] describes and concretises the process of change from a malfunctioning and

dying paradigm to other emergent possible paradigms of influence, and the various roles that people can take in that process, suggesting spaces for action for change. The scenario method developed in the study described in Paper 2 [Pastcasting] allows its participants to deliberate on possible pathways for arriving at alternative and more sustainable states of their local contexts to inspire action along those pathways. The entire aim of Paper 3 [Interviews] was to learn about how individual members of Omställningsnätvkerket (the Swedish Transition Network) tried and managed or failed to make change happen in their local contexts.

Papers 1 [Assumptions], 4 [Eco-anxiety] and 5 [Dread] address change indirectly, by considering how people's internal constructs and emotional states affect their relationship to what is meant by "sustainability", to the work that is needed and to undesirable but possible futures. The first paper concerns assumptions about sustainability in the SHCI/HCI community, and the latter two papers concern emotional responses and considerations in both students and teachers of sustainability.

Essential 3. Focus on 'how to' practical knowledge

> *Assumes that transitions research needs to focus less on descriptive and abstract forms of knowledge, and more on practical contributions that elucidate how to implement change in practice.*

Practical knowledge consists of both *techne*, i.e. concrete knowledge and skill of how to do something, and *phronesis*, which is the context-dependent ability to know what is the right thing to do, and the morally defensible way to achieve it (Bornemark, 2020), sometimes called "practical wisdom", or "how to knowledge". Three directions in practice research can be discerned: *research into practice*, where the practices are studied and described; *research for/as practice*, where "where practices are the intended outcome and researchers work with practice or as practitioners to develop knowledge, such as a when developing a new process of change" (Fazey et al., 2018, p.62); and *research through practice*, where the practice itself is the research.

For Paper 3 [Interviews], an example of *research into practice*, we interviewed active members of Omställningsnätverket, whom we refer to as *practivists*, about their practices, or strategies, for creating change in their local contexts. The research project described in Paper 2 [Pastcasting] is an example of *research for/as practice*. Inspired by action research and using participatory design research methods, we co-created a workshop format for our research partners to use and spread beyond the project. Finally, Paper 4 [Eco-anxiety] represents *research through practice*, as it reports on our

experiences of applying a set of ideas for environmental educators suggested by Panu Pihkala (2020) in our own practice. The aim of trying out his ideas in our own teaching was to better handle eco-emotions in students, to prevent difficult emotions from holding students back in constructively handling the socio-environmental predicament. In addition to the formal outputs of my research, i.e. the papers, I consider my time as a PhD student and the various roles, tasks and contexts that I have taken on during it, as embodied—in the sense of lived and performed—and situated research through practice. My practice during the doctoral study years has been guided by this thesis' overarching question of how to practice HCI otherwise as called for by the socio-environmental predicament.

Essential 4. Approach research as occurring from within

> *Assumes that putting the researcher within the research as opposed to outside is a necessary shift for developing practical knowledge.*

Paper 1 [Assumptions] is an essay based on the personal experiences of being part of the SHCI community about the assumptions held within it regarding what sustainability means. The paper proposes including a sustainability positionality statement in academic papers and exemplifies it by describing the authors' own positionality. Paper 6 [Two Loops] is also work from within in that it is the result of a group of SHCI researchers reflecting on and applying the Two Loops model of change (Wheatley & Frieze, 2006) to our own field and its opportunities for agency in the current and emerging paradigms.

As for the two papers that resulted from the research project Event Horizon, i.e. Paper 3 [Interviews] and Paper 2 [Pastcasting], my colleagues and I were and became actively situated within the research in several ways. I did this first by attending a two-day training organised by Omställnings-nätverket at the project's onset. The training was an introduction to transition, which I attended foremost as a participant rather than a researcher. As the research project progressed, I also attended several of Omställningsnätverket's annual conferences, online and in person, both as a researcher presenting our work and co-facilitating workshops, and as a regular participant. Inspired by their aims and methods, I founded a local transition group where I lived using Facebook, and organised meetups with people I met that way (as best we could, as this was during the early years of the COVID-19 pandemic). Finally, inspired by action research, the aim of the Event Horizon research project was always to work with Omställnings-nätverket as a research partner to contribute to social betterment.

In Papers 4 [Eco-anxiety] and 5 [Dread], what is being researched and, as a result, developed, are the teaching practices of the authors, i.e. ourselves.

Essential 5. Work with normative aspects

> *Assumes that science is inherently normative and that second-order transitions research is intrinsically political.*

Normative considerations are elaborated on in Paper 2 [Pastcasting], where we describe the collaboration with Omställningsnätverket in the research project Event Horizon in terms of how the project was conceived, funded, scoped and run. In Paper 1 [Assumptions], my coauthor and I are openly reflexive about the values we bring to the paper ourselves. The aim of the paper is to facilitate critical reflexivity about assumptions and, ultimately, values upon which work in "sustainability" is based, by proposing a framework for such reflections for our colleagues in the field. Paper 6 [Two Loops] is explicitly based on an understanding of the socio-environmental predicament as being the result of a set of values that have been conceptualised as "modernity" by, e.g. Vanessa Machado De Oliveira (Andreotti) (2021). It outlines spaces for agency, both within the current System of influence, i.e. paradigm, and in emergent Systems, based on alternative values to those of modernity. In both Papers 4 [Eco-anxiety] and 5 [Dread], where we study eco-emotions in our own teaching and interactions with students, we interrogate our own values and norms and those of the context of engineering, and how they interact. Finally, while not included in this thesis, the paper *Tech4Bad in the Oil and Gas Industry: Exploring Choices for ICT Professionals*, which I wrote together with Ian Brooks and Aksel Biørn Hansen (Brooks et al., 2023), is deeply normative about ICT professionals needing to be brave and stop supporting the fossil fuel industry through their work.

Essential 6. Seek to transcend current thinking and approaches

> *Assumes that the socio-environmental predicament cannot be addressed by the same ways of knowing and thinking that gave rise to it in the first place.*

The ideas that the socio-environmental predicament cannot be addressed by the same ways of knowing and thinking that gave rise to it in the first place, and that visioning, experimenting and inventing beyond what is assumed probable, are central to second-order transition research. Essential 6 can be applied both to the research itself and the action-oriented contexts within which transitions research takes place. Papers 6 [Two Loops] and 2 [Pastcasting] both aim to help people, HCI professionals in the former and

local communities in the latter, to imagine and concretise ways to support transitions.

Furthermore, two of the papers included in this thesis engage in what Fazey and colleagues call *re-entry*: Paper 1 [Assumptions], which asks "What is the sustainability in sustainable HCI about?", and Paper 5 [Dread], which asks "What emotions do emotions evoke in us as teachers, and how do we deal with them in ourselves and in our students?"

Essential 7. Take a multi-faceted approach to understand and shape change

Assumes that truth is not absolute, and that future-oriented research based on many different perspectives, knowledges and ways of knowing is needed.

Papers 1 [Assumptions] and 6 [Two Loops] both aim to help colleagues within SHCI/HCI to consider various paths for agency, by adopting different lenses on how to understand the world and the crises we face. Paper 2 [Pastcasting] is future-oriented. While it is normative about the need to reduce CO_2 emissions, the developed workshop method is entirely open-ended about the images of alternative, more sustainable presents that the workshop participants collaboratively create. As such, the actual research in these papers may not meet Essential 7, but the frameworks and methods offered aim to encourage and support HCI professionals, including ourselves, to align with it. However, the totality of work during my time as a PhD student, including papers that I have authored that are not appended to this thesis, is arguably both future oriented, transdisciplinary and pluralistic, where the objective of the latter "is not to unify multiple lenses, which can reduce diversity, but to mesh or link different ways of understanding the world." (Fazey et al., 2018, p.65)

Essential 8. Acknowledge the value of alternative roles of researchers

Assumes that learning about change requires practice and experience.

During my PhD studies, in addition to being a *researcher*, I have also been a *participant* in action research in Paper 4 [Eco-anxiety], where I, as a teacher in sustainability in engineering, was also the *object of analysis*, just as I was in Paper 5 [Dread]. In Papers 1 [Assumptions] and 6 [Two Loops], I was *indirectly an object of analysis*, as the studied assumptions and suggested paths for transformation were based on observations and experiences from my lived experiences of being an HCI professional. And in Paper 2 [Pastcasting], I was a *co-designer* with our research partner Omställnings-nätverket of the developed scenario method.

Essential 9. Encourage second-order experimentation and change

Assumes that learning about change is iterative.

The clearest example of research where I have been part of such iterative experimentation and learning is the work described in Paper 2 [Pastcasting]. While the research project Event Horizon did not aim to evaluate the results of the change it was designed to support, the results of the project, i.e. the workshop method and associated materials, were prototyped, designed and evaluated in multiple iterations to ensure that they best represented what our research partner needed.

Essential 10. Be reflexive

Assumes that practising second-order transitions research requires reflexivity on behalf of the researchers.

Papers 1 [Assumptions] and 6 [Two Loops] are based on deep reflections on our observations and experiences in the field of SHCI/HCI, and they aim to encourage and support others to do the same to support transformations for liveable futures. For Paper 4 [Eco-anxiety], we wrote reflective diaries as tools for educational development, focusing on how emotions manifested in us teachers and the students. These were later used as data for Paper 5 [Dread], for meta-emotion reflections on our experiences. Here, they were used to critically reflect on how hope and dread as sociopolitical emotions manifest in sustainability teaching in engineering. In Paper 2 [Pastcasting], the close research collaboration with Omställningsnätverket meant that we continually reflected together on both the research process and product, not least in order to be sensitive to any asymmetries of power in the project.

Finally, referring to work by Davis and Klaes (2003), Fazey and colleagues (2018) write that:

> Transcendent forms of reflexivity [...] may involve the researcher critically reflecting on how they may need to undergo their own transformations in order to be in a better position to understand or shape transformative change in the systems in which they are embedded. (p.66)

This concept of transcendent reflexivity aptly describes the inner work, both conscious and unconscious, that I have engaged in ever since my burnout in 2018, which I describe in the Prologue, which has ultimately led to this thesis.

6. Discussion

This thesis is based on the following premises:

1. The Earth's ecosystems provide us with clean water, air and food
2. If Earth's ecosystems die, we die
3. Modernity as a system of ideas and practices has undermined the Earth's material and cultural ecosystems for centuries, creating an unsolvable socio-environmental predicament
4. As a result, massive, life-threatening changes to the conditions of all life on Earth, including that of humans, are already unfolding
5. Many of these changes are irreversible and will continue to unfold throughout our lifetimes, and those of our children

Some of us are lucky enough not to have been affected by such changes yet, allowing us to imagine that things will be fine and that we don't need to do anything. Others have woken up to one or several of the issues that comprise the socio-environmental predicament and are now doing their best to find ways of living with that knowledge and of being more a part of the solution than the problem. And yet some have already lived for generations with the destruction caused by modernity, as expressed through acts of e.g. domination, colonialism, extractivism, expropriation and pollution.

Initiatives exist at all levels of both public and private sectors, in academia and outside, in major institutions and startups, to address one or several of the social and environmental problems included in the Doughnut model of economics (see Section 2.1), in which climate change is one. Privately, some people recycle, try to eat the ”right” things, buy fewer or the ”right” things, travel less, or invest money, time or care in various causes. Interestingly, however, the potential role of people's occupations in addressing

environmental issues has been largely overlooked in research on sustainability transitions (Moilanen & Alasoini, 2023).

My research is motivated by three things: knowledge of the ever-increasing likelihood of collapse of the very things that our lives and livelihoods depend upon (described in Section 2.1); the mismatch between that knowledge and the way our institutions and professional communities, including that of HCI, are responding to it (see Section 2.2); and the power of imagining alternative, desirable futures, and how such imaginaries can foster personal agency (see Section 3.1).

With this backdrop, this thesis has aimed to find *one* possible answer to *how HCI can be practised otherwise at the end of the world as we know it, to enable liveable futures*. I have done this by framing my research and teaching as a doctoral student in HCI as one of many possible manifestations of roles within the larger field of HCI. In other words, my work during the past five years exemplifies how practicing HCI otherwise can be done, in the specific context of academia. As such, it has included:

1. Studying and learning from communities that are already living with the knowledge and/or experience of collapse
2. Designing/using speculative methods, experiences and artefacts to help communities imagine desirable futures
3. Engaging in action-oriented community-led work
4. Paying attention to, promoting and hosting emotions and care in your interactions with others

In the remainder of this chapter, I reflect on my research and discuss its contribution to the field, its implications for our field and professional practice and the limitations of my research approach.

6.1 Centring HCI professionals, not the field

The first contribution of my work is to put HCI *professionals* and not the field of HCI at the centre of my inquiry. By switching the focus from HCI as an anonymous field of knowledge and practice (someone, somewhere) to its practitioners, we come closer to the concrete doings rather than the abstract thinkings of the field. Importantly, doings have doers, and doers have identities and relationships; they have roots and lives, fears and hopes, pasts and futures. I argue that calls for ”HCI to do things differently” (e.g. Keyes et al., 2019; Sharma et al., 2023) inadvertently result in a distance between the call and individual practitioners of HCI: I feel no ownership of and have no power over the field as a whole. But as someone who is trained in and practices HCI, I am an HCI practitioner who can make choices about what to

do, and not. Addressing professionals and not the field, then, may counteract the diffusion of responsibility often noted in social contexts where it is unclear if someone should act on a situation (Darley & Latane, 1968).

This change of perspective from the field to the professionals also represents a shift in thinking about change within a field such as HCI, from top-down change by committee to bottom-up change, as enacted by individuals. One way such top-down efforts can be expressed is through professional codes of conduct. While the entire global community of HCI professionals may not know of and be guided by it, the ACM Code of Ethics and Professional Conduct (Association for Computing Machinery, 2018) states that its members should avoid doing ”unjustified” harm. Concurring with Green (2018), Brooks and colleagues (2023) argue that the idea of ”justified” harm

> sets the harm in relation to individual and collective judgements of what is justified and not; judgements that are inherently and inescapably situated in terms of both culture and time. In our current paradigm, oil and gas operations are still considered necessary and therefore justified. (p.7)

Such a justification of the harm caused by, e.g., the fossil fuel industry is clearly incommensurate with the premises of this thesis, outlined at the beginning of this chapter, rendering the ACM code rather useless in relation to HCI professionals' environmental dilemmas. This example demonstrates how a top-down measure to ”do good” can become toothless since its signatories represent many different interests, including those tasked with maintaining or stewarding the status quo, to use the language of Paper 6 [Two Loops]. In this sense, we have more power as individuals to enact radical change than most top-down initiatives do. Naturally, this is, not a new thought. It is aptly captured in the viral quote “Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has”[20]. And the SHCI community (including venues such as ICT4S and Computing within Limits) is abound with just that: colleagues who are finding ways to use their skills, knowledge, positions, power and resources to make a difference. While a full review of all of the important and inspiring work in this vibrant field is outside the scope of this thesis, both Paper 1 [Assumptions] and Paper 6 [Two Loops] provide informative, albeit partial, overviews of such research in SHCI. Published research is of course only the formally visible “outputs” of such work: there are numerous people in the field, both known and unknown, who do (and have done for a long

[20] The quote is commonly attributed to the anthropologist Margaret Mead, but does apparently not appear verbatim in any of her works.

time) work to change the field from within, mostly outside of funded research ventures. Many of these people agreed to be interviewed for Sharma and Kumar's recent paper (2025) where they share their experiences of working within SHCI and trying to shape the field. Paraphrasing Paper 6 [Two Loops], there are long sustained efforts of innovating, naming, connecting, nurturing, illuminating, composting and bridging, and some budding strains of hospicing, within the living system of HCI. Much of this work remains unrecognised and invisible to the HCI community at large. I am grateful for and want to name some of these efforts: the people behind the 2007 initiative to establish SHCI as a subfield and the Computing within Limits workshop series; those who lobby for and ultimately chair conference subcommittees or organise workshops that go against the grain of mainstream HCI; those who persist in trying to put the socio-environmental predicament on the mainstream HCI agenda; those who work to find ways to compost resources for potential future use; those who work to spread awareness in our professional community and beyond about the true state of the Earth's ecosystem; those who speak publicly about and help others process the existential and emotional dimensions of living in this time of endings; those who work to put–and keep–ethics on the HCI agenda; those who invite other concerned HCI professionals into networks for knowledge exchange, inspiration and support both within academia and outside; those who enter collaborations with public bodies and policy makers to help communities, towns and regions to mitigate or adapt to environmental deterioration; and those who find or intentionally free up time to make a difference outside of paid work.

In this thesis, I also expand the domain of "sustainability" from any *one* of the environmental or social crises outlined in Section 2.2, to a socio-environmental predicament that we will not be able to solve. For me, this shift is not about alarmism or defeatism, but one of acceptance of *what is*, whence wiser action can emerge. However, in ecosystems, what is sustainable is wholly dependent on the local conditions and state of the system. Therefore, any interventions aimed at improving the health and resilience of that system must be local, i.e. specific to the system and based on a deep understanding of it. So, while some top-down institutional efforts may still be needed with this outlook[21], the socio-environmental predicament invites a much larger share of highly local, bottom-up responses (experiments, artefacts, infrastructures, conversations…), the full results of which we will likely not live to see. In relation to HCI, the predicament framing ultimately puts the onus on each of us to find ways of being of service, right at the sites where our lives unfold, as professionals and as humans.

[21] International legislation against ecocide being one of them, see endecocide.org

6.2 Resources for self-reflection and agency

The second contribution of my work is to have provided two resources to HCI professionals for self-reflection and for finding agency in relation to the socio-environmental predicament and its constituent crises.

The first resource, Paper 1 [Assumptions], describes different assumptions about "sustainability" in sustainable HCI and IT and how they impact the work that is undertaken in the field. While the paper is descriptive about these assumptions and their associated efforts, it is also intended to serve as a tool for surfacing and challenging one's position and to offer hints at how "sustainability" can be approached in HCI from a more systemic and longer-term perspective. By contrast, Hansson and colleagues (2021) and Mann and colleagues (2018) have performed quantitative analyses of the field in order to highlight gaps and avenues for future work, the former using the UN Sustainable Development Goals as a framework and the latter the *Mann-Bates Sustainable HCI Maturity Scale*. While valuable in themselves, they use external criteria for evaluating efforts in sustainable HCI. Paper 1 [Assumptions] complements their work by focusing on the internal assumptions of the researchers (or at least their research). The paper is an essay, so future work could validate and refine the assumptions, e.g., by evaluating the current body of work in sustainable HCI against it.

The second resource, Paper 6 [Two Loops], is based on the Berkana Institute's Two Loops model of change (Wheatley & Frieze, 2006) and places the role of HCI professionals in relation to systems change and uncertainty. The model suggests multiple sites of agency for practitioners within our field, both within the dying dominant System, which includes mainstream computing, and in the already existing seeds of the emergent System(s). As authors, "being introduced to [the Two Loops] [...] model has been encouraging, as it reveals how the current situation, however terrifying, carries endless possibilities for agency, and thereby hope" (p.2), which is why we decided to share our explorations with the HCI community. While calls within HCI to act abound (e.g. Keyes et al., 2019; Sharma et al., 2023), their *who* and *how* typically remain elusive. Six Silberman's (2023) advice for early-stage computing professionals in an "age of consequences" is an exception, as he offers many concrete perspectives on how to understand and navigate career opportunities in the context of climate change and accelerating environmental degradation. However, if considered from the perspective of the Two Loops model, his advice is more about how to navigate and forge a career around the unsustainability of the dominant System. The model, a lens for understanding change in living systems, offers a wider space for action that includes care, attention to emotional aspects of change, community building and emergence. These are all important facets of the

work that is needed for liveable futures, not least to counter fear, doom and a lack of purpose as the dominant System and its comforts and privileges unravel.

6.3 Action-oriented second-order sustainability transition research in HCI

The third contribution of my work is to have framed it in terms of action-oriented second-order sustainability transition research (Fazey et al., 2018), in the context of the socio-environmental predicament. That is, the work in this thesis instantiates what such research may look like in HCI as a field, and as such, how many other kinds of HCI research can be usefully both understood and conceived of through this lens. Fazey and colleagues' essentials (see Section 3.3), both suggest and scaffold work aimed at supporting transitions towards more sustainable ways of life. In Section 5.4 I have mapped the research in the appended papers against each of these essentials. This mapping helped me see how the whole is bigger than the sum of its parts: a single research effort may not be transformational in itself, but a set of research efforts may be, as they represent a pull, however slight, in the same direction. This line of thinking echoes how Johan Redström (2017) builds on Lakatos' and Feyerabend's ideas of research programs.

Furthermore, having spent more than years as a PhD student experimenting with doing, being, thinking HCI otherwise myself, I realise that these experiences may also be considered as second-order transition research, on HCI itself, as a professional practice. This contribution is found not only in the peer-reviewed academic papers herein, but also in my personal experiences and reflections around and between them, found in the autobiographical vignettes strewn throughout this text (a complete list of the vignettes, prefixed "On doing, being, thinking otherwise", is available just after the table of Contents). I demonstrate what such explorations may look like, where such opportunities may lie and what they may ask of us. Four out of Fazey and colleagues' ten essentials seem particularly relevant to these experiences and explorations–below, I comment on each of them.

Essential 6. Seek to transcend current thinking and approaches

The foundation of a meaningful response to the predicament is a re-orientation in how we as individuals–and therefore, as professionals–relate to the world: ourselves, our fellow humans and all other life on Earth. Given that unsustainable exploitation, extraction, and growth are among the causes of our problems, a reorientation calls for reconsidering what we demand of ourselves and others in the name of work, professionalism, and success. This

On doing, being, thinking otherwise

Care at work

I became a PhD student in spring 2020, just as the magnitude of the COVID-19 pandemic was beginning to become apparent. That autumn, I had my first experience teaching in higher education as a teaching assistant in sustainability for mainly media technology engineers. Course directors and teachers everywhere were working all hours of the day trying to translate their curricula to online environments. In my team, we acknowledged that for many of our students, these were difficult times, notably for the ones who had just arrived in Stockholm, or even Sweden, and had no social networks. We decided to begin each seminar by asking everyone, including ourselves, to share how we were doing, probing us all about our mental well-being and any other challenges that this novel, terrifying situation faced us with.

In one of the first seminars where I did this, when it was their turn to share how they were doing, one of the students said:

"Before I do, I have to tell you something. I'm a master's student in my final year, and this is the first time in my five years at KTH that any teacher has ever asked me how I'm doing."

To me, this student's experience says so much about what professional roles do to our way of relating to others and to life. Research by Anne-Kathrin Peters (2018) has shown that engineers often emerge from their academic training bereft of their initial passions and commitments to make a difference in the world. Instead, they learn to favour solvable tasks and problems.

I don't mean to romanticise children, but many toddlers are infinitely fascinated by other living beings and will go to great lengths to care for and save suffering animals. By the time we become adults, many of us have learned, explicitly or implicitly, that we cannot, should not, must not care too much for other living beings, human or otherwise. Instead, we focus on the work to be done.

I doubt this lack of care is a necessary consequence of human adulthood–the existence of wise elders in many cultures suggests otherwise. Rather, it's something people learn, as if by necessity, in order to function and succeed within our work contexts. As such, it can be unlearned.

So while unusual, countercultural, and therefore uncomfortable, I think finding ways to practice care in our professional lives represents a potentially powerful reorientation of how we relate to the world.

includes when, at what rate and at what speed we agree to or ask others to produce work, what we demand of ourselves and others to leave outside work (lives, families, loved ones, life events) to get the work done, and, ultimately, in what we refuse to take part. Such responses are about a return to being in

relation, and therefore about care and collaboration. The need for care has been most apparent in my work as a teacher and colleague, notably in contexts where some aspect of the socio-environmental predicament has just hit someone (including myself) hard. And Paper 6 [Two Loops] shows how the work ahead of us is one where a multitude of efforts and humans must come, and stay, together.

Essential 7. Take a multi-faceted approach to understand and shape change

Finding meaningful ways to respond to the socio-environmental predicament asks us to rethink the role of professional groups in bringing about change. Typically, the skills and authority of professional groups are leveraged to make *others* do something differently. Policy makers and lawyers find ways to incentivise some behaviours and disincentivise others. Teachers impart new knowledge and skills so their students can act based on them. In HCI, we can design tools and services to help others reach their goals and base their actions on better information. We can critique the dominant System and outline ways for others to challenge it. And we can facilitate conversations and experiences that help people imagine other, more desirable futures than those currently on offer, to spur action. I propose three mental shifts that can add to the range of possibilities for HCI professionals. The first is to engage in the kind of self-reflexivity described above, as this is likely to reveal ways of practising HCI otherwise that are different from what is currently the norm, thus changing how we *ourselves* act to create change. The second is to think beyond paid careers, and more about how our acquired skills and knowledge may be of service in the yet abundant present and in preparation for increasingly likely future adversities. The third shift is to think more about what we can do not *with* technology, but *thanks* to it (Jack, 2025).

Essential 9. Encourage second-order experimentation and change

Finding ways to reorient oneself as a professional in response to the predicament must be situated in and specific to one's local circumstances. Therefore, my explorations have taken place in the research and teaching collaborations that I have been part of, in the teaching I have done, in the discussions that I have facilitated and been part of, the space I have created and held for emotions in colleagues, students and myself, in the questions that I have allowed myself to ask, in noticing how I react to being told that my questions and methods are undesirable or unacceptable, and deliberating how to respond to such views. These are local in that what has been an opportunity to do so for me may not provide the same space for exploration for someone else. Also, the potential for impact of my explorations depends on the cultural system within which they have taken place.

Essential 10. Be reflexive

Meaningful responses to the predicament can only be derived from continuous self-reflection on most dimensions of life, including that of our professional choices and actions. We are asked to continuously reflect on questions such as: What resources do I have? Where do I have power or influence? Where am I, knowingly or unknowingly, reproducing the destructive dynamics that have led us here? Where and how can I begin to tease out other, regenerative ways of doing, being, thinking HCI? In Aarhus, when I had presented the paper on Two Loops, a colleague in the audience asked: ”With the dismantling of democracy that is ongoing in my home country, the USA, I have been working really hard lately to save my local library from being shut down. Is that important, or the right thing to do, when viewed through this paper?”. I love libraries. But as an example of the kind of self-reflection we need to engage in, I cannot be sure whether libraries in their current form can simply be ”moved” to or replicated in the emergent System. Libraries depend on funding from currently powerful institutions; their existence is based on a belief that verbal literacy is and has done nothing but good for the world, and they typically favour one medium over others, which is also dependent on the global supply chain for printing and distribution. Maybe what is called for instead is for the *idea* of the library to be composted and reimagined for the emergent System? Put differently, uncertainty about what is ”the right thing” to do will be the norm, and it is even harder to act on without self-reflection.

6.4 Limits, hopes and futures

My exploration of how to do, be and think HCI otherwise is but *one* possible way of approaching this question: there are arguably as many answers to it as there are HCI professionals at any given moment in time–my own answer is likely to be different in ten years. As such, the insights from my work are neither generalisable, universal, nor future proof.

Why this approach?

A different take on my research question could have been to interview and study other HCI professionals than myself. However, this would not have been possible for me for very practical reasons. Firstly, this thesis’s analytical angle on my work came to me very late in the process, and was not the focus of the project that I was hired to work on as a PhD student. Secondly, while finding HCI professionals who work in/for ”sustainability” e.g. by tackling climate change would be relatively easy, finding participants from the HCI community who understand the situation to be an unsolvable socio-

environmental predicament may prove to be quite a challenge in terms of recruitment and population and sample sizes. This difficulty is predicted by Paul Chefurka's (2012) *ladder of awareness*. His model describes a continuum of how people understand the unfolding global crises, which is divided into five rough stages:

1. Dead asleep (unaware)
2. Awareness of one fundamental problem (e.g. climate change)
3. Awareness of many problems (i.e. there are multiple crises)
4. Awareness of the interconnections between the many problems (it is a is a poly- or multicrisis, and a predicament)
5. Awareness that the predicament encompasses all aspects of life (it is existential, a meta-crisis)

Chefurka has further observed two ways for people at stage five to reconcile themselves with their current understanding of the world: an outer path of local adaptation and resilience, and an inner path of reframing the action space as one of consciousness and self-awareness. While the model is both anecdotal and more than 10 years old, he interestingly notes the following:

> From my observations, each successive stage contains roughly a tenth of the number [of] people as the one before it. So while perhaps 90% of humanity is in Stage 1, less than one person in ten thousand will be at Stage 5 (and none of them are likely to be politicians). The number of those who have chosen the inner path in Stage 5 also seems to be an order of magnitude smaller than the number who are on the outer path. (ibid.)

Another way of expressing the challenge of finding participants for a study of multiple HCI professionals navigating the socio-environmental predicament is to use the Two Loops model to frame my work as naming and innovation in the emergent System, and hospicing and bridging in the dominant System. While colleagues do exist in this space, there is as of yet no known HCI sub-community that is wholly committed to it, and from which one could readily recruit people to study.

Having said that, a snowball sampling method combined with careful pre-screening for predicament awareness and ample time for recruitment might well yield a set of participants with whom to probe the question of this thesis further through e.g. interviews, diary studies and ethnographic observations. With the increasing signs of system instability and collapse at the time of

writing this thesis (spring and autumn 2025), such a study is likely more feasible now than it would have been five years ago.[22]

Generalisability vs. transferability

Similar to my work, action research aims to stimulate change in a community and typically faces similar objections about generalisability; here, I find Herr and Anderson's (2005) writings informative. They describe action research as an

> inquiry that is done by or with insiders to an organization or community… [and] is oriented to some action or cycle of actions that the organizational or community members have taken, are taking, or wish to take to address a particular problematic situation. (p.3-4)

As my thesis has aimed to explore ways forward for HCI professionals, I find *transferability*, as defined by Lincoln and Guba (1985) in naturalistic enquiry and used in the action research literature (Herr & Anderson, 2005), a more useful term. With transferability, the aim is not to be able to generalise but to *transfer* findings, as appropriate, to another context, and the onus on establishing transferability lies with those trying to use such insights elsewhere:

> [I]f there is to be transferability, the burden of proof lies less with the original investigator than with the person seeking to make an application elsewhere. The original inquirer cannot know the sites to which transferability might be sought, but the appliers can and do. The best advice to anyone seeking to make a transfer is to accumulate empirical evidence about contextual similarity; the responsibility of the original investigator ends in providing sufficient descriptive data to make such similarity judgments possible. (Lincoln & Guba, 1985, in Herr & Anderson, 2005, p.298)

The theory of change that underpins action research is that

> "*action* is influenced by *internal conviction*, which comes from *voluntarism* and *personal understanding*. This, in turn, is achieved by both *formalistic* and *naturalistic generalization,* the latter being the result of *direct* and *vicarious* experience. In other words, practitioners tend to find traditional research, which is based on formalistic generalizations, less useful than narrative accounts […] that provide them with vicarious experience" (italics in original) (Herr & Anderson, 2005, p.62-63)

My findings, then, do not apply across all contexts or for all HCI professionals at all times. Instead, the work in this thesis seeks to encourage and inspire other HCI professionals, who also find themselves grappling with

[22] Or, come to think of it: if you are an HCI professional and have read this far and think this is important, email me at minna.laurell.thorslund@gmail.com–I would be more than interested to learn about how you are finding your way forward.

how to respond to the crumbling of the very system that gave rise to our field in the first place. My hope is for any of my colleagues within the field who read this thesis to be strengthened in their impulses–however tentative–to question the grossly unsustainable status quo, and for the findings herein to inspire and vicariously inform new and old ways to use our skills and positions in service of liveable futures. Moving forward, a line of questioning that seems central to research: What support is needed for more HCI researchers to reorient their work and competences towards facing and acting on the increasingly destabilised conditions of life on Earth? Such support may include experiences, knowledge, conversations, contexts, models, speculations, skills and many other things. My wish is for more of us to start low-fi prototyping possible answers and sharing them with others.

7. Conclusion

Researchers have established that the Earth's ecosystem is now "well outside the safe operating space for humanity" (Richardson et al., 2023, p.1). As a result, in the coming years and decades, an ever-increasing proportion of the world will experience significant changes, including more frequent and severe disruptions of many kinds. This turn of events marks the end of the Holocene, i.e. the past 10,000 years of stability, during which all of humanity's recorded history has taken place. The many causes behind this perilous situation include a mix of social, historical and cultural factors that have formed a self-reinforcing system of destruction. In this thesis, these interrelated crises and underlying causes are referred to as a *socio-environmental predicament*, to which there is no ultimate solution, only responses.

A myriad of initiatives exist in the commercial, public and academic spheres to better understand, mitigate and face different aspects of this predicament. The actors in such responses are typically either policy makers, citizens, corporations, investors or consumers. Additionally, in our field, Sustainable HCI has done much work to contribute to sustainability *in* and *through* technology. However, to date, the role of *professionals* has received relatively little attention as potential actors in such sustainability transitions.

This thesis puts HCI professionals, in the broadest sense of the term (see Section 1.1), in the centre of inquiry. I have used my own experiences as an HCI professional situated in academia to find an answer to the question *how can HCI be practised otherwise at the end of the world as we know it, to enable liveable futures?* My aim has been to inspire more HCI professionals to find the agency and courage needed to find new ways of using our skills, positions and sites of power in service of such futures. In the process, I have identified critical self-reflection as necessary practice, and provided two

resources (Paper 1 [Assumptions] and Paper 6 [Two Loops]) to support such inner work in HCI professionals. I have also demonstrated how work in this vein can be framed as action-oriented second-order transition research, a useful framework to better understand the transformational power of different research efforts and inspire future ones.

Based on this first-person research endeavour, I propose that some viable ways forward include: 1) studying and learning from populations who are prototyping lives outside the fossil fuel powered norm; 2) using our skills in speculative methods and design to support desirable futuring; 3) engaging in action-oriented community-led work; and 4) tending to emotions in ourselves and others in the face of uncertainty and upheaval. While these findings are based on first-person research and therefore cannot be generalised, they can usefully be *transferred* to the contexts, work and lives of other HCI professionals, as they see fit.

There are no longer any
non-radical pathways ahead of us.

Naomi Klein
interviewed in Salon

We are living in exciting times.

Kimberly Nicholas
in Under the Sky We Make:
How to Be Human in a Warming World

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