

# From human-centred to life-centred design: Considering environmental and ethical concerns in the design of interactive products

Madeleine Borthwick<sup>a,1</sup>, Martin Tomitsch<sup>a,1,\*</sup>, Melinda Gaughwin<sup>a</sup>

<sup>a</sup> Design Lab, School of Architecture, Design and Planning, The University of Sydney, Sydney, NSW, Australia

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## ABSTRACT

Over the past decades, the field of interaction design has shaped how people interact with digital technology, both through research and practice. Interaction designers adopted human-centred design to ensure that the interactive products they design meet the needs and desires of end consumers. However, there is surmounting evidence that placing the end consumer at the centre of the design process creates unintended consequences, damaging global systems that are essential to human well-being. This article reviews emerging paradigms that provide a more holistic perspective, such as value-sensitive design, more-than-human participation and life-centred design. Based on this review, the article introduces a practical framework for life-centred design consisting of principles, actionable methods and a model for responsible innovation. The article discusses how interaction designers can use the framework to balance human-centred considerations with environmental and ethical concerns when designing interactive products.

## 1. Introduction

Since the beginning of the industrial revolution, technology has significantly transformed the relationship between people and the environment. Technological innovations enabled people to travel longer distances on the ground and in the air, to construct denser cities and higher buildings, and to generally live more comfortable lives. Technology dominates all aspects of human life (Jirotko & Stahl, 2020). This is also true for information and communication technology, which transformed and impacted almost every industry over the past decades. Spurred by the digital revolution, the application of information and communication technology quickly spread beyond the boundaries of office and work settings in the form of interactive products (Bødker, 2006).

The field of interaction design emerged in response to this transformation, adopting human-centred design as a framework to address the struggles that people faced when using interactive products (Cooper, 1999). Users or consumers were placed firmly at the centre of the design process using an array of approaches and methods that were intentionally human-centred. Over time, this human-centred focus became fundamental to designing how people interact with digital technology, with the interaction designer's work focusing on users'

goals and the design of the tasks needed to achieve them (Kolko, 2011; Saffer, 2010). The success of design solutions was "judged based on the relevance to the individual who ultimately must use the creation" (Kolko, 2011).

In the past few years, the interaction design community has begun to question this explicit prioritisation of people and their needs and desires due to the damage wreaked upon the global systems essential to human well-being. Scholars argue that it is necessary to shift to a new design paradigm for creating interactive products by augmenting the focus that human-centred design places on the user or consumer with explicit consideration of global well-being within the design process (Nardi, 2019). This shift is urgently needed as global well-being is intrinsically linked to the health of global systems, and technology use has caused environmental impacts on those systems (Praskievicz, 2021).

The impact of design practice on the environment has been recognised for a long time in other design sectors. For example, Papanek, in his 1972 book, wrote, "There are professions more harmful than industrial design, but only a very few of them" (Papanek, 1972, p.18). The industrial design sector has responded to these concerns, resulting in various approaches and reference terms, such as eco-design, sustainable product-service systems and the circular economy (Bhamra & Hernandez, 2021). The field of interaction design has built upon and

\* Corresponding author.

E-mail address: [martin.tomitsch@sydney.edu.au](mailto:martin.tomitsch@sydney.edu.au) (M. Tomitsch).

<sup>1</sup> The first two authors contributed equally to this article and are listed in alphabetical order.

contributed to these movements through exploring its role in encouraging more sustainable behaviours (Blevis, 2007; Paulos et al., 2008). However, as DiSalvo, Sengers and Brynjarsdóttir (2010) observed, most of these efforts focus on individual rather than collective action. Building on this observation, Dourish (2010) argued for a shift “from fostering environmental consumers to shaping environmental movements”.

In this article, we review how this kind of environmental movement could be facilitated through a paradigm shift in how the role of humans as end-users is promoted in interaction design. We argue that introducing this shift into the interaction design process is critical to achieving a systemic effect by adapting the inputs that drive how digital products are designed. To support this shift, we review principles from the field of environmental policy and discuss how they can be applied in interaction design practice. Linking these principles to established frameworks from other domains, we make a case that interaction design, as an inherently multi-disciplinary practice, is uniquely positioned to advocate for planetary well-being, akin to how interaction designers have embraced the role of advocating for the user in the design of interactive products. We conclude by proposing a model for responsible innovation in which usability and desirability as human-centred considerations are balanced with environmental and ethical concerns. Within the broader field of responsible technology, the article specifically focuses on the design of interactive products and interaction design practice. While the article discusses the impact of interaction design on the planet and its ecosystems, these concerns are intrinsically linked with the well-being of people and communities and the potential harmful side effects caused by interactive products. Drawing on relevant previous work, the proposed model thus aims to capture the consideration of both ecological and social systems.

## 2. The evolution and impact of human-centred design

The practice of placing people at the centre of the interaction design process, referred to as human-centred design, emerged in response to the pace of technological development toward the end of the 20th century. With digital technology leaving the office desk and entering people's homes and lifeworlds (Bødker, 2006), the array of digital solutions for everyday problems grew rapidly, spurred by the mass adoption of personal computers, the declining cost of electronics and advances in information and communication technology. However, the new products that emerged were often difficult and frustrating to use. Human-centred design was seen as a way to remedy the technology industry's lack of focus on the people it was designing for, placing users and other stakeholders firmly at the centre of the design process (Cooper, 1999). As Owens (2019) argues, the human-centred design approach has been highly successful in achieving these aims; he states, “There have been incredible changes made in multiple fields from medical care to grocery shopping. The way we operate in our world now is fundamentally different than just a few decades ago, and this is largely thanks to human-centred design”.

In response to these shifts, human-centred interaction designers perfected the art of creating products that satisfy people's needs. Saffer (2010), in his book *Designing for Interaction*, postulated that good interaction design is trustworthy, appropriate, smart, responsive, clever, ludic and pleasurable. Bradley (2010) proposed a design hierarchy of needs adapted from Maslow's hierarchy of needs, describing the role of design across the layers of functionality, reliability, usability, proficiency and creativity. There are countless other lists of characteristics and layers still used and taught in interaction design practice and education that primarily focus on the human perspective, neglecting the impact that interaction design has on the broader ecological and social systems. While striving to tackle commercial problems, the interaction design practice movement seems to have lost sight of the bigger picture, and, as a result, the world faces the unintended consequences of these design decisions. The predicament is that human-centred design is increasingly seen and applied to achieve short-term gains for businesses

and investors. This economic focus has diminished the potential of design to serve as a tool that enables deep exploration of decisions before they are made (Dunne & Raby, 2013) to ensure that they are the right decisions. Focusing on short-term gains has also drawn attention away from genuine global problems, future generations and the health of the planet—in many cases, human-centred design has even contributed to these problems. It appears that the majority of emerging technology and applications, such as robotics, wearables, smart cities and ubiquitous computing, have not arisen as “thoughtful responses to the problems of life on a finite planet” but as the result of commercial opportunities driven by growth (Nardi, 2019).

A striking example is the infinite scroll feature that is used widely on social media platforms. In 2019, Raskin, the creator of infinite scroll, publicly expressed his regret about the addictive behaviour resulting from his invention and has since established the centre for Humane Technology, an organisation that advocates for the ethical use of technology (Widdicks et al., 2020). As another example, Wang (2021) outlines how human-centred innovation can lead to unintended consequences and damaging societal effects, such as increased smoking in young adults.

The problems with these economically-driven approaches are not only specific to design but extend to the political and economic systems within which design operates. The current neoliberal economic system gives little reward to those addressing systemic problems, instead emphasising “growth to the exclusion of all other factors” (Friedman, 2019). Governments continue to use the gross domestic product as the key measure of social progress rather than embracing post-growth political approaches that offer potential alternatives to neoliberalism (Nardi, 2019). With an underlying political model that is based on competition, there is little incentive to embrace collaboration and cooperation (Owens, 2019). As Leonard, founder of the community movement the “Story of Stuff”, argues, developed countries are playing a game where the goal is “more”, not “better” (The Story of Stuff, 2013).

The problem of “more”, not “better”—growth above all else—is particularly relevant to interaction design due to the way that its practice is intertwined with the technology industry. The technology industry carried much influence in the decades preceding 2020, inextricably linked with society and politics due to the omnipresent internet, rise of social media and mass uptake of smartphones (Fjord, 2019). The assumption underpinning technological development is that it is always a form of progress. However, the direct results of this technological development tell a less than rosy story. For example, the rise of populist politicians and political division on social media and the destabilisation of work through the gig economy enabled by online platforms indicate that interaction designers may have underestimated their social and political influence (Foth, Tomitsch, Satchell, & Haeusler, 2015; Trittin-Ulbrich, Scherer, Munro & Whelan, 2021; Graham & Lehdonvirta, 2017). A number of voices question designers' lack of awareness of design's contribution to the shaping of the global world beyond the designed artefact itself (Willis, 2006). As Monteiro (2019) states, “The world is working exactly as designed. And it's not working very well. Which means we need to do a better job of designing it”.

There is surmounting pressure, evidenced through large-scale natural disasters, to recalibrate interaction design's contribution to society beyond consumption and towards sustainment (Blevis & Stolterman, 2009). In doing so, it is critical not to fall back on old habits; there is a risk that the application of human-centred approaches to solving these problems will lead to equally anthropocentric solutions. That is, solutions that may benefit people in the short term while failing to consider the long-term impact on ecological and social systems.

## 3. Emerging post-anthropocentric design approaches

Interaction design practice, since its inception, has focused on delivering outcomes quickly and at pace with technological advancements. Motivated by this observation, a number of approaches have

emerged in the academic literature that aim to bring a more holistic and considered approach to designing interactive products. Specifically, within interaction design, value-sensitive design has emerged as an approach to “the design of technology that accounts for human values in a principled and comprehensive manner” (Himma, Tavani, Friedman, Kahn & Borning, 2008). Value-sensitive design advances traditional human-centred design by considering how a design impacts not only direct but also indirect stakeholders (Borning & Muller, 2012). To provide an example of value-sensitive design, Friedman et al., 2013 describe a project that addressed the issue of user data tracking on web browsers and informed consent. As demonstrated through this example, ownership and property, privacy, trust, and informed consent are some of the values that should be considered when designing technologies. However, the authors also identify other factors such as human welfare and environmental sustainability as important values with ethical import. Value-sensitive design further advances traditional human-centred design by considering how a design impacts not only direct but also indirect stakeholders (Borning & Muller, 2012).

To advocate for moving beyond human-centredness in interaction design, the umbrella term “life-centred design” has been adopted in interaction design, drawing on Thackara’s (2006) work in the area of designing for all life, not just human life. Life-centred design, as a framework, is able to encompass and operate alongside other emerging terms while being distinguished by its objective to augment human-centredness in design rather than replacing it. In the context of this article we consider life-centred design as being complementary but different from “more-than-human” centred design, which has its foundation in ecological philosophy (Abram, 1996). In the interaction design literature, examples of more-than-human centred design refer to designing experiences for non-human species in cities (Clarke et al., 2019), the home (Robinson and Torjussen, 2020) or the zoo (French et al., 2020) and designing with and for artificial intelligence and automated agents (Nicenboim et al., 2020). In other words, more-than-human designs consider non-human stakeholders as the primary user or subject in a design process. Though in some cases, the term is also used to critically question the impact of human-centred interventions on non-human species (Foth & Caldwell, 2018). Specifically, within the context of collaborative city-making, Forlano (2016) argues for de-centring humans, suggesting that designers are well-placed to operate as advocates for non-human stakeholders. Davidová and Zavoleas (2020) discuss three projects that redefine architectural design practice through the lens of post-human-centred design by focusing on eco-social parameters, highlighting that human activity should not be treated as if it were at the epicentre of global existence. Light et al. (2017) challenge the use of “human” in human-computer interaction design, highlighting that “All entities on the planet have to deal with (human-made) technology”.

Life-centred design, as an approach, has also been highlighted and discussed beyond academia in recent years. For example, the 2020 trend report from Fjord, one of the biggest information technology consulting firms and a Fortune 500 company, indicates that life-centred design is the most important trend to affect businesses in the coming years (Fjord, 2019). They observe “an evolution in design from user-centred to human-centred and now life-centred design ... starting to edge away from designing for one to designing for collective—i.e. the entire planet” and suggest that “as this [trend] accelerates, user-centred design will feel increasingly selfish and design’s emphasis will make a switch in favour of design for all life” (Fjord, 2019).

The Davos Manifesto, a set of ethical principles put forward by the World Economic Forum to guide companies, was also updated in 2020 to explicitly include a more life-centred outlook. According to the Davos Manifesto, the new definition of a company postulates that “A company ... acts as a steward of the environmental and material universe for future generations. It consciously protects our biosphere and champions a circular, shared and regenerative economy” (Schwab, 2020). A number of interaction design practitioners have made similar observations,

contributing perspectives from within interaction design practice and sharing their views via online platforms (Owens, 2019; Robinson, 2019; Sznel, 2020; Lutz, 2021).

Perhaps the most interesting piece of evidence is that globally, societies are already engaging in life-centred design, albeit in an anti-theoretical way. For the past two years, the largest and most disruptive stakeholder involved in all design efforts has been a microscopic virus. Out of necessity, people and organisations have redesigned their lives, work, public spaces and social activities to accommodate a non-human entity (Sznel, 2020). This is a clear indicator that it is possible to achieve large-scale systemic change when there is will and impetus to do so.

To illustrate the benefits of a life-centred design approach and its application in practice, we turn to a design proposal for a high-rise building in New York City designed by Terreform ONE (Joachim and Aiolova, 2019). Being the publicly visible face of a building, the design of its external facade plays an important role. Besides technical feasibility and economic viability, architectural designers need to consider both the desires of the building owner (e.g., what kind of messaging the building’s exterior should communicate) as well as the usability from an occupant perspective (e.g., the ingress of light and what kind of shading it provides to improve occupants’ comfort). Sustainability is increasingly considered when it comes to designing a building’s facade to raise the building’s sustainability rating, making it more attractive for tenants and meeting building regulation codes. This includes, for example, what kind of glazing and shading to use but does not typically involve the consideration of the local natural environment or ecosystem. Terreform ONE went beyond previous norms of sustainability considerations by designing the building facade so that it also functions as a natural habitat for the Monarch butterfly—a species that used to be native to the building site but is at the cusp of distinction due to urban development. By integrating biomaterials, the facade provides an environment for butterflies to nest while at the same time offering a green outlook for building occupants. That way, the proposed facade is designed to improve the experience of both human and non-human stakeholders. Although the project represents an architectural design, it includes interaction design considerations as the facade features interactive media screens located at the bottom and top end of the building. Live images of caterpillars and butterflies nesting in the biofacade are captured and amplified on those screens to raise awareness about the extinction of local species to passers-by.

#### 4. Shifting practices and perspectives in interaction design

The broader impact of design decisions is not a new topic for researchers and practitioners, and much essential work precedes this article. For example, in the industrial design domain, the materiality of design outcomes has made the harmful effects of design more tangible. The design phase of a physical product accounts for 80 per cent of its environmental impact, which implies that the decisions made in the early phases of a design process have a significant long-term impact in terms of how people will engage with the product before, during and after its useful life (Thackara, 2007). These questions also extend to funded research projects, in which decisions are made that may have impacts that go beyond the immediate questions addressed in the research, for example, when investigating emerging technologies such as nanomedicine (Kwee, Yaghmaei & Flipse, 2021). Stahl et al. (2021) argue for a responsibility by design approach to ensure the “ethical sustainability and desirability of science and innovation outcomes”.

The field of interaction design is uniquely positioned to contribute to the conservation and restoration of the Earth’s biosphere and to play an important role given the increasing digitalisation of all aspects of human life. In a world with scarce resources, there are fewer constraints in the realm of digital products and designs that exist in the form of interactions between people (Fjord, 2019). Though it is important not to overlook the environmental impact of digital interactions caused by server farms, network infrastructure and the manufacturing of physical

devices (Tomitsch, 2021). Thus, interaction design decisions span both software and hardware, either directly or indirectly. The design of interactive products, whether they have a physical manifestation or appear solely as a digital application running on the consumer's computer or mobile device, determines the decisions consumers make and how they use those interactive products. The example of infinite scroll encourages consumers to keep scrolling through their social media feeds, exacerbating the negative impacts of social media use. Another often-cited example is the habit of listening to music on video streaming services like YouTube, which requires significantly more energy compared to audio streaming, negatively impacting the biosphere by contributing to greenhouse emissions.

Importantly, interaction design and its related branches (e.g., service design and user experience design) are inherently multi-disciplinary (Blevis & Stolterman, 2009). The incorporation of anthropology underpins interaction design research practices to enable successful research engagement with end users (Forlizzi, Zimmerman & Evenson, 2008). Interaction designers are able to contend with complexity and offer facilitation between disciplines in problems that are best solved by uniting stakeholders and experts from different areas. To revisit the building facade example introduced in Section 3, interaction design offers methods and tools for engaging stakeholders and experts that can represent the human (building occupants, building owner) as well as non-human (Monarch butterfly) perspectives. For example, this could be achieved in practice by creating human and non-human personas capturing their needs, frustrations and issues (Tomitsch, Fredericks, Vo, Frawley & Foth, 2021b). Personas are a widely used method and tool in interaction design to make sense of and synthesise research data and to keep the perspectives of relevant stakeholders at the forefront throughout the design process (Adlin & Pruitt, 2010). While they are aggregate narrative representations, they are based on primary or secondary data. Interaction designers can use a middle-out approach that brings together bodies from the top (e.g. government agencies that drive policy and regulatory requirements) and bottom (e.g. conservationists, animal welfare groups, wildlife carers and Indigenous peoples) to form a coalition that can speak on behalf of the non-human stakeholder (Tomitsch et al., 2021b).

This ability to learn from diverse disciplines is key to successfully addressing the challenge of moving toward a new life-centred design approach by taking a "post-disciplinary stance" that evolves practices and empowers practitioners (Wilde, 2020). There are many sectors outside of design that have learned to address complex problems in different ways that could potentially be used to scaffold this new approach. In the following section, we review and draw on principles and frameworks emerging from these sectors with the aim to establish a foundation for adopting a life-centred approach in the design of interactive products.

## 5. Principles to support life-centred interaction design practice

Acknowledging and building on the work that has been carried out in other fields, we draw on environmental policy research as a starting point for developing principles for life-centred interaction design. The area of environmental policy has for a long time dealt with the challenge of how to appropriately articulate goals and criteria and was paramount in first bringing the notion of "wicked" problems into the broader discourse (Rittel & Webber, 1973). Historically, decision-making criteria for environmental policy have often been framed around a "three pillars" framework (Purvis, Mao & Robinson, 2019) that places society, ecology and economy as the main underpinning principles (also referred to as people, planet and profit). While this helps with emphasising and maintaining a focus on different areas of concern, the pillars approach has its limitations as it implies that different pillars are naturally at odds with one another, downplaying their inherent interconnectedness (Gibson, 2001). In addressing this issue, Gibson (2001) suggests a broader and less simplified set of principles as "key changes

needed in human arrangements and activities if we are to move towards long term viability and well-being".

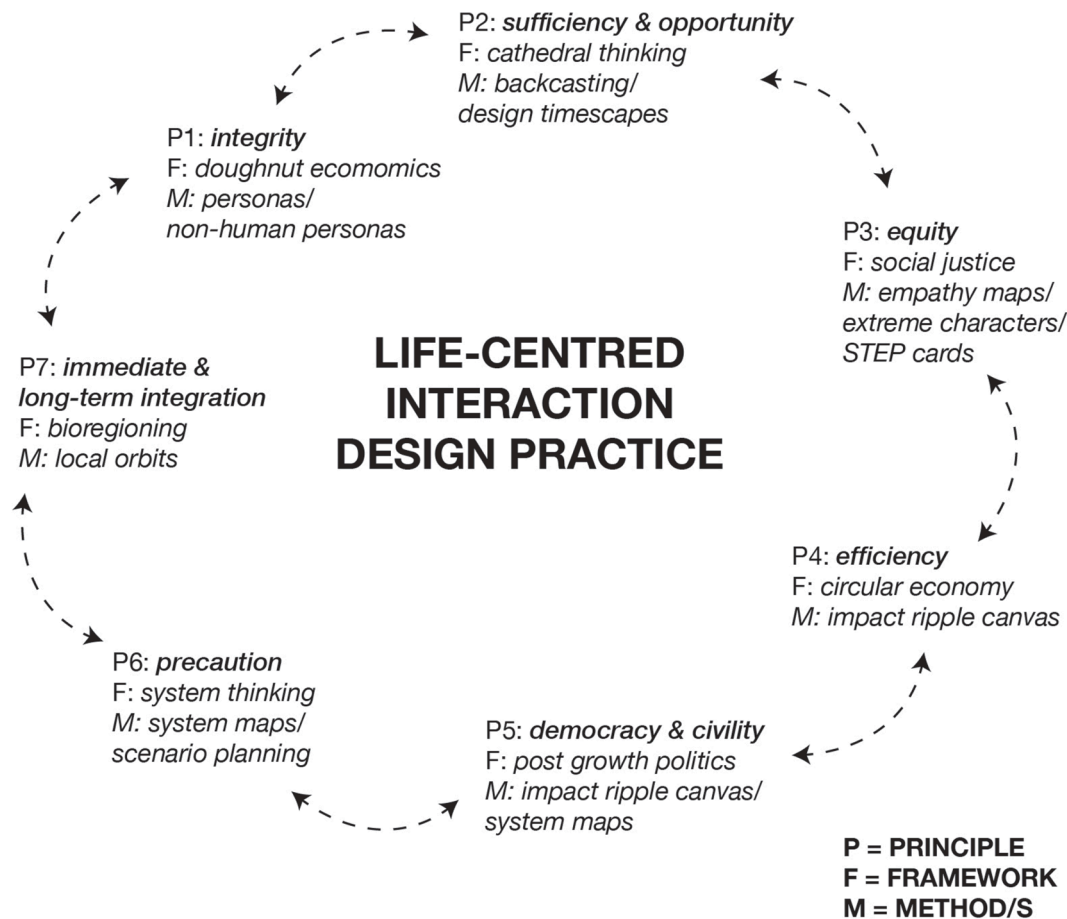
The principles bear resemblance to the Sustainable Development Goals (SDGs) articulated by the United Nations, which have been discussed in the context of specific interaction design projects and as a way of framing problems in human-computer interaction research more broadly (Barbareschi et al., 2021; Birch & Harrigan, 2015; Pathak et al., 2019; Fredericks et al., 2019; Eriksson et al., 2016). The increasing attention that the SDGs have received in the human-computer interaction design literature is reflective of the broader global agenda to ensure a path forward for development that is sustainable and also recognises social, environmental and economic issues that need addressing on both a local and global level (Bhamra & Hernandez, 2021). The SDGs offer a way to set priorities in interaction design research, to reflect on the contribution that interaction design can make to each of the SDGs and to highlight opportunities for further research (Hansson, Cerratto Pargman & Pargman, 2021).

For the purpose of proposing a set of principles for life-centred interaction design practice, we now turn to a discussion of Gibson's principles, linking them to established frameworks from other domains and post-anthropocentric design approaches introduced earlier in this article (Fig. 1). As Forlano (2016) argues, human-centred design strategies can merge and evolve with frameworks from other disciplines for dealing with socio-technical complexity and ethical considerations. In this way, Gibson's principles, despite coming from another domain, can be used as a foundation upon which we can build concrete methods for implementing these principles in interaction design practice.

We acknowledge that both the principles and the frameworks considered here may be incomplete. The principles have yet to be validated in the context of interaction design and may require adaptation based on empirical data. There are likely other frameworks that play an important role in achieving the objectives of life-centred design that are not included here. Rather than offering a systematic literature review of established frameworks, our intent is to respond to the observations outlined in the previous sections in a way that we hope can contribute towards the shift from human-centred to life-centred interaction design practice. For each of the principles, we highlight methods that interaction designers could use to put the principle into practice. These methods were selected from a recently published collection of 80 design methods (Tomitsch et al., 2021a).

The first principle, *integrity*, recognises "the interdependencies between human systems and ecological systems and maintaining the integrity of these irreplaceable biophysical systems" (Gibson, 2001). To implement this principle, interaction designers can draw on doughnut economics, which is a framework used, for example, by urban planners, policymakers and civil societies (Raworth, 2017). Drawing on the SDGs, the doughnut economics framework provides a visual guide for finding a balance between ecological and social concerns and identifying a safe zone in which both are able to be fulfilled. The principle of *integrity* is aligned with recent work on more-than-human participation, which offers a framework for interaction designers to consider non-human stakeholders (Clarke et al., 2019). The *personas* and *non-human personas* methods can be used to help understand those interdependencies between human and natural systems. Within human-computer interaction, "ecosystemas" were also proposed as a way to represent entire ecosystems in a persona-like format (Tomlinson, Nardi, Stokols & Raturi, 2021).

The second principle, *sufficiency and opportunity*, ensures "a decent quality life for all people, with opportunities to seek improvements to this quality of life but without compromising future generations" (Gibson, 2001). The first part of this principle is strongly aligned with human-centred design, particularly when it is augmented with plural design as an approach to allow multiple worlds to flourish and to consider those that may have been pushed to the "margins" due to colonisation (Leitão, 2020). To address the second part of the principle, interaction designers can draw on cathedral thinking, which is based on



**Fig. 1.** The principles for implementing a life-centred design approach interaction design—adopted from the field of environmental policy (Gibson, 2001)—with links to supporting frameworks and actionable methods.

the observation that architects who designed medieval cathedrals had to do so knowing they would not be alive to witness the completion of their work. Nonetheless, they had to plan cathedrals as artefacts to be enjoyed by future generations (Rogers, 1994). Cathedral thinking encourages designers to think beyond present needs and instead focus on inter-generational concerns. A challenge in applying cathedral thinking within interaction design is the lack of feedback implicit in a discipline that works in a highly iterative way. Conversely, long-term actions either “lead to future consequences that cannot be seen today, or they lead to consequences that seem to take place elsewhere” (Friedman, 2019). Methods that can be used to map out actions and their consequences over time include *backcasting* and *design timescapes*. These methods can reveal unintended consequences caused by the mechanisms designed into digital products, such as the spread of misinformation on social media that may lead to political instability, negatively impacting the quality of life of future generations.

The third principle, *equity*, reduces “dangerous social gaps in sufficiency and opportunity in aspects of health, security, social recognition and political influence between rich and poor” (Gibson, 2001). Interaction designers can turn to the social justice approach when implementing this principle, which embraces conflict, participation and politics as a means to achieving socially preferable outcomes. There are several arguments behind the effectiveness of this approach in relation to achieving life-centred design outcomes. Firstly, where environmental degradation occurs, it is frequently entangled with existing social inequalities. Secondly, explicit engagement with social justice guards against the tendency of interaction design practices to start from existing needs and wants and re-entrenching these existing inequalities and power relations through their design activities (Dombrowski, Harmon &

Fox, 2016). The social justice approach provides a loose set of guidelines and mindsets: the intentions to design for transformation, recognition, reciprocity, enablement, distribution and accountability. Bringing this orientation to interaction design would help to “explicitly direct attention to the ways that sustainability is inextricably tied up in, rather than isolated from, the politics of class, race, labour, economy and geography” (Dombrowski et al., 2016). These considerations align with value-sensitive design as an approach to considering the moral and ethical values of direct and indirect stakeholders in interaction design (Doorn et al., 2013). In practice, equity can be considered during the design process through *empathy maps* and *extreme characters* to better understand the perspectives of others and *STEP cards* to uncover the social, technological, economic, political and other factors at play.

The fourth principle, *efficiency*, reduces “demand for energy, materials and other stressors of socio-ecological systems” (Gibson, 2001). Research carried out under the umbrella term “sustainable human-computer interaction” offers a plethora of examples of how human-centred design can be adopted to reduce the consumption of energy and materials in and through design (DiSalvo et al., 2010). To implement the principle, interaction designers can also turn to the circular economy as a framework, which “replaces the ‘end-of-life’ concept with restoration”, “shifts towards the use of renewable energy”, and “aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models” (Ellen MacArthur Foundation, 2012). In collaboration with the Ellen MacArthur Foundation, design and consulting firm IDEO developed the Circular Design Guide (IDEO & Ellen MacArthur Foundation, 2017), which offers methods to support the transition to a circular economy. However, there is value in considering *efficiency* beyond the design of

physical products. Similar concerns extend to digital products, although in less obvious ways. Adopting this approach assists interaction designers' attentiveness to the hidden impacts of their designs on socio-ecological systems. Methods like the *impact ripple canvas* can help to facilitate consideration of the direct, indirect and big-picture impacts of a design. An example of an unintended stressor in interaction design is the reliance of interactive streaming services, social media platforms and other digital applications on large-scale server farms, significantly contributing to the world's use of electricity (Beardmore, 2020).

The fifth principle, *democracy and civility*, increases "the capacity for authoritative, market, customary and individual entities to be better informed when applying sustainability principles in decision making" (Gibson, 2001). Post-growth politics offers a starting point for implementing this principle. It postulates an alternative view of economics to counter the explosive growth that has defined capitalism since the industrial revolution and significantly since 1950. The main critique of the growth-based model of politics is that it does not take into account the natural limitations of a planet that is finite. Advocates of post-growth politics, such as Nardi (2019), propose that we need a "fundamental change in how we relate to production, consumption, and the natural world" in order to avert disaster. Possible proposed alternatives to growth-based politics include steady-state economics, voluntary simplicity and commons-based approaches. From a design perspective, there is an acknowledgement that designers cannot remain apolitical; they must explore frameworks for political engagement using the design mindset in order to address the world's severe problems (Gibson, 2001). In practical terms, empowering users and consumers to make better-informed decisions is a key perspective emerging from *democracy and civility* as a principle. For example, this may include exposing underlying ethical practices for products offered through online shopping sites. These considerations that are often hidden and unintended can be exposed through the *ripple impact canvas* or *systems maps*.

The sixth principle, *precaution*, acknowledges "uncertainty by managing for adaptation, and by avoiding poorly understood risks that could potentially cause irreversible damage to complex and poorly-understood systems" (Gibson, 2001). Interaction designers can turn to systems thinking to identify those poorly understood risks embedded within entangled systems. As a framework, systems thinking offers a language, perspective and set of tools that recognise the non-linear and integrated nature of complex problems and provides an antidote to reductionist thinking (Monat & Gannon, 2015). It assists with making sense of the dynamics and interdependencies that drive complex problems by visually representing the interplay of different factors such as politics, ecology, economy and ethics. To bring this into practice, interaction designers can use *systems maps* to visualise and comprehend these complexities. *Scenario planning* can be used to deal with uncertainty by exploring four potential futures mapped out against local and global drivers.

The seventh principle, *immediate and long-term integration*, acknowledges "interdependencies through the application of multiple sustainable principles at once, to identify and seek areas of potentially mutual benefit" (Gibson, 2001). To support life-centred design practice, the implementation of this principle in interaction design can draw on the bioregioning framework, which embraces biodiversity as a key indicator of urban health (Thackara, 2019). Bioregioning advocates a search for ways to address common goals between human beings and other entities to create value that is not limited to financial terms (Friedman, 2019). This involves looking for local solutions, resources and community buy-in as a way of creating improvement. The bioregioning framework matches the interaction designer's skillset in that a designer in this context can fulfil a role that is "as much connective as it is creative" through the creation of artefacts that enable collaboration between a broad variety of different disciplinary parties involved in the process (Thackara, 2019). Depending on the situation, it might be beneficial or even necessary to investigate multiple scales in order to reconcile the contradictory requirements of urban architecture, humans and

socio-technical systems (Forlano, 2016). The *local orbits* method can be employed to record the resources, relationships and histories of spaces; *systems maps* can help with identifying interdependencies and areas of potential mutual benefit.

As Gibson highlights, these principles are interconnected and cannot be separated from one another. The frameworks discussed for each principle may also lend themselves as an approach towards implementing other principles. Certain frameworks may further be more conducive to specific design situations than others, and we are certainly not suggesting that interaction designers need to always draw on all frameworks. It is important, however, not to be selective in regard to the principles. There is a risk that the designer's bias might lead them to favour certain principles over others. Thus, all the principles should be at least considered from the outset.

## 6. Discussion

### 6.1. A model for responsible innovation

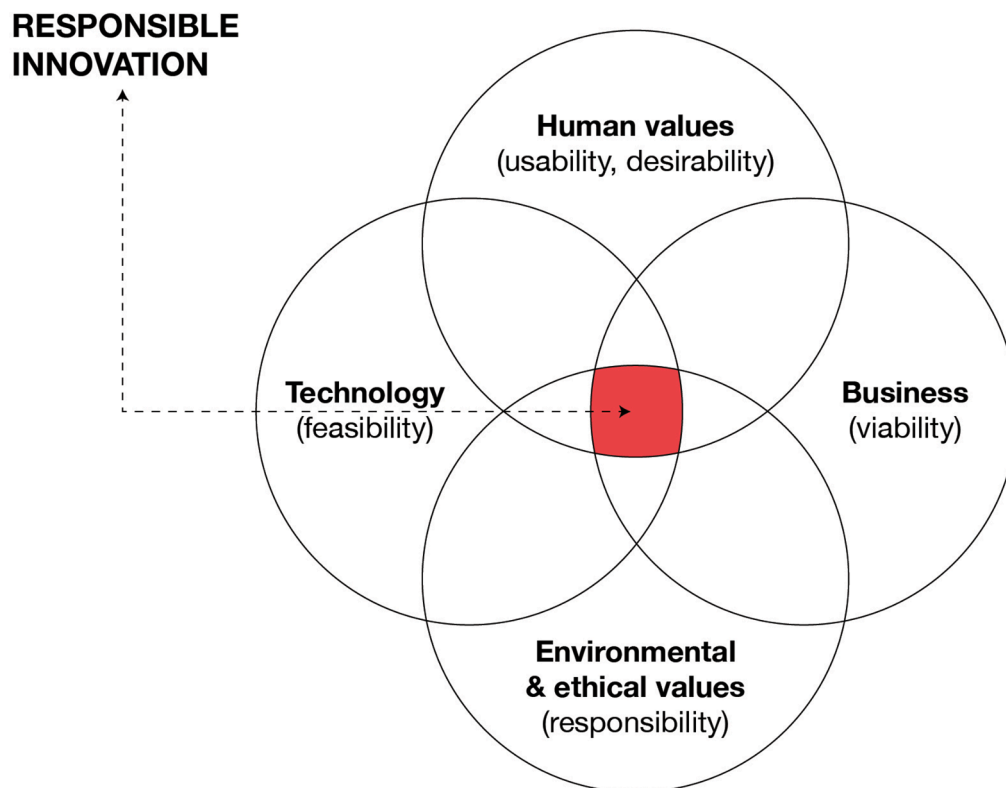
For the past decade, the digital technology industry has largely followed a popular set of guiding perspectives in the form of three lenses that advocate a balance between desirability, viability and feasibility, with financial viability often forming a leading factor when it comes to practical implementation (Shapira, Ketchie, & Nehe, 2017). It is commonly acknowledged that for an innovation to be successful, it has to consider and satisfy all three perspectives (Calabretta, Gemser & Karpen, 2016). We argue that through the lens of life-centred design, it is crucial to take into account not only feasibility, viability and desirability but also the responsibility that comes with designing new products. This includes carefully considering the environmental (i.e., the impact on the planet and ecosystems) and ethical (i.e., the unintended consequences for people and communities) values of design proposals alongside technology, business and human concerns (Fig. 2).

Although it may be argued that the responsibility perspective should be an overarching consideration that underpins technology, business and human concerns, we propose to consider it as a separate, fourth dimension, as depicted in Fig. 2, in order to give it an equal weighting. We acknowledge that the proposed model paints an overly simplified picture of the complex entanglement of issues and concerns that make up the environmental and ethical values. Further, as suggested by Timmermans, Yaghmaei, Stahl and Brem (2017), responsibility ought to be understood as a "network of closely intertwined relationships of existing, novel and emerging responsibilities". As such, the model should be seen as a starting point. Its simplicity and familiarity (by augmenting a widely used model), we hope, will aid its adoption in practice.

The model aims to bring the environmental and ethical concerns front and centre when designing interactive products. It augments current interaction design practice that is still largely driven by the needs and desires of users and consumers as outlined in Section 2. This shift to responsible innovation aligns with research in the field of science and technology studies, defining responsible research and innovation as a "transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products" (von Schomberg, 2012). Questions that have emerged from research on responsible innovation (Stilgoe, Owen & Macnaghten, 2013) are increasingly important to consider when designing interactive products, covering product (e.g., "What other impacts can we anticipate?"), process (e.g., "Who will take responsibility if things go wrong?") and purpose (e.g., "Who will benefit?").

### 6.2. Advocating for non-human stakeholders and ecosystems

We agree with Owen et al.'s (2013) observation that responsible



**Fig. 2.** The lens of life-centred design expands the human-centred model of innovation (as originally published by IDEO) by adding considerations about what is environmentally and ethically responsible.

innovation is “ultimately about being responsible, taking responsibility, and innovating responsibly” and that it is a collective endeavour. We extend this observation by suggesting that when it comes to the design of interactive products, interaction designers are ideally placed to take on custodianship of the responsibility perspective. As custodians, their role is to lead this collective endeavour and to ensure that the relevant concerns are represented during the design process. This includes advocating for non-human stakeholders and ecosystems who would otherwise not have a voice in the design process.

With responsible innovation activities starting to be seen as central to business operations (Kwee and Flipse, 2021), there may be an opportunity for a new kind of profession to emerge (as also suggested by Tomlinson et al. (2021)) or for practitioners trained in environmental sciences to shift into an advocacy role. Whoever takes on the role will undoubtedly face the limits of their own conception and sophistication. While the world is full of complex systems, humans themselves have limited cognitive processing power and the constraints of time and resources (Gibson, 2001). It can be difficult and indeed sometimes impossible to resolve the tensions between all design constraints, including environmental, social and financial concerns (Shapira, Ketchie, & Nehe, 2017). Therein lies the value in translating intertwined principles into approaches and methods, laying the road for further work ahead. This should include an investigation of how impact assessment frameworks could be integrated into interaction design practice as a formalised approach for evaluating the economic, social and environmental impacts of interactive products (Rodrigues and Rituerto, 2022).

### 6.3. Building toward a collective movement

The power with which designers have at times changed things for the worse is a dark testament to their ability to instigate change. Design has a far-reaching impact, and by focusing the designer’s efforts on solving

meaningful problems rather than adding to them, it may be possible to instigate systemic change—building toward the collective movement that DiSalvo et al. (2010) and Dourish (2010) have been calling for. If designers recalibrate their efforts to design for collective as well as personal values and “address people as part of an ecosystem rather than the centre of everything”, then much can be achieved (Fjord, 2019). Designers already come equipped with creative abilities and skills that assist them with gathering and accommodating a range of diverse perspectives on complex problems. It is time to expand on that ability by zooming out from a human-centred to a life-centred framing, which involves assessing the long-term impact of design proposals, planning for intergenerational concerns and considering the perspectives of all living things in the design process.

It would be naive, however, to suggest that the only barrier to achieving such systemic change is the personal impetus of designers. We must acknowledge that much of global society operates within a neoliberal framework, where shareholder primacy dominates corporate policy (Hansmann & Kraakman, 2001). The resulting focus on profits as a measure of success provides a significant barrier to the perception of life-centred design as essential.

Some of the current levers to influence this problem include legislation and voluntary efforts such as corporate social responsibility, although both are potentially problematic. Legislation may be deferred or watered down if not politically expedient. Advocates of corporate social responsibility often promote it as being “good for business”; in other words, it is seen as an indirect means to increase profits (Chaffee, 2017). This motivation is at odds with the idea of responsibility for responsibility’s sake and does not explicitly extend to planetary needs.

Some scholars suggest that this tension can no longer reasonably be navigated, and we need to change the playing field itself. For example, Nardi’s (2019) post-growth politics or Klein’s (2015) justice-based economy, are both dependant upon fundamental social change. Further, Fry (2020) argues that sustainability beholden to economic

development is ontologically unsustainable and argues instead for “sustain-ability ... based on the growth of the ‘development of ecological sustainment’”. This article embraces a more humble aim of “giving people the tools for responding to the crisis in meaningful ways” (Knowles, Bates & Håkansson, 2018). Within the scope of interaction design practice, we contribute to this aim by outlining principles and the suggested methods for implementing life-centred design.

#### 6.4. Limitations

We acknowledge that there are several factors that may have limited and biased the particular framing presented in this article. We (the authors) are interaction designers and social designers, theorising from a frame of reference that might exclude viewpoints that also contribute to this discourse, including critical discussion on what constitutes personhood, society, nature and the relations between those entities. We have attempted to address this limitation by explicitly focusing on perspectives for interaction design practice in the Global North. While some of the observations may be transferable to other design disciplines, we do not claim that our conclusions are generalisable. We draw on knowledge from other fields as a way to stand on the shoulders of those that have grappled with the human–environment interrelationship for longer. While we endeavoured to accurately represent this knowledge, we were still doing so through our own disciplinary lens and may have missed important gaps. We are further constrained in the framing of the perspectives through our cultural and social backgrounds and experiences, which (while spanning multiple countries) we consider as being privileged. Scholars from marginalised communities, the Global South and indigenous backgrounds would likely contribute additional and plural perspectives that should inform life-centred design practice. We hope that future studies will complement the principles and model presented in this article to build a more complete and comprehensive understanding of life-centred design practice and its role in achieving responsible innovation.

#### 7. Conclusion

To reiterate, it is possible to achieve large-scale systemic change with the will and the impetus to do so. Global, nation and state sanctioned responses to the persistent danger of the Covid-19 pandemic have shown this. The Covid-19 pandemic is a continuing crisis and a test run for the wider and far more devastating crisis that is climate change. Where Covid-19 has been acknowledged as an immediate and visceral threat to our species, the changes brought by climate change (and those that will come) are often one step removed from being a present, persistent threat for people in the Global North. The UN Sustainable Development Goal 13, Climate Action, asks all countries to come together to address the urgent work needed to “combat climate change and its impacts” (United Nations 2022). Further, Goal 13 acknowledges the opportunity Covid-19 has presented nations to implement a “systemic shift to ... more sustainable econom[ies]” attendant to both the needs of people and those of the planet (United Nations, n.d.). In proposing a framework for life-centred design for interaction design practice and a model of responsible innovation, we hope to contribute to this call to arms. In doing so, we acknowledge that all design activity is predicated on the inescapable anthropocentrism of our species. As humans, we are the ones with the agency to perpetuate the crisis of the Anthropocene or respond to it, as Fry (2020) suggests, with sustaining ability. As Dilnot argues, “the only way out of the anthropocentric (out of crisis) is through the anthropocentric ... it is only through adopting a strictly anthropocentric perspective that we might overcome the nihilism that has been created. ‘Strictly’ means here to acknowledge and take the consequences of the anthropocentric” (Dilnot, 2021, p.55).

As such, we hope that the framework and model presented in this article provide a starting point for interaction designers to acknowledge their anthropocentricity in the face of the urgent need to respond to the

climate crisis and to critically consider the consequences, change and action their design practice might enact on human and non-human worlds, the planet and the systemic relations between them.

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#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Further reading

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