



Postphenomenology Unchained: Rethinking Human-Technology-World Relations as *Enroulement*

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Abstract

Humans experience various phenomena as threats to their biophysical integrity. Airborne viruses, leaking radioactivity, or extreme weather conditions are three examples for this. In these scenarios the focus is not unilaterally directed towards the vulnerable body but also towards a world that can potentially become hazardous and out of balance. At the same time, technology comes into play, enabling us to access such an obtruding world including its activities, forces, and agents but also to shield humans and their vulnerable bodies from potential injuries and harm. The contribution develops an approach to investigate human-technology-world relations based on Merleau-Ponty's concept of *Enroulement* unfolded in *The Visible and the Invisible*. This concept releases a non-linear, dynamic *multi-relationality* in which world, human, and technology become relevant as situating as well as situated co-constitutors of such relations enveloped in a permanent process of coiling. We discuss our approach as an alternative to a linear relational perspective as found in the postphenomenological concept of technological mediation. With the approach of *Enroulement* it becomes evident that the situated-situating world is more than something to be technologically mediated, while technology situated in the world but also co-constituting our world is more than a mediator. First, the article emphasizes the notion of the world based on Merleau-Ponty's phenomenology and in a critical examination of postphenomenological approaches. Second, it unfolds the concept of *Enroulement* involving human, world, and technology. Third, it focuses on shielding technologies required by vulnerable bodies and an intervening world. Fourth, it illustrates the suggested approach with two examples in which humans and technologies are exposed to extreme forces and material activities: combat flying and dealing with radioactivity.

Keywords Postphenomenology · Phenomenology · World · Technology · Chiasmic relations

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Introduction

Disasters caused by floods and storms, or threats in the context of pandemics and contaminations—with regard to such phenomena the world can seem ‘out of joint’ for us, or to put it in a more general way: In different situations and constellations the world is perceived and technologically communicated as a fragile structure, a confronting phenomenon itself. At the same time, technology continues to play a crucial role in surviving and living in a world that sometimes does not constitute a ‘cozy corner’ or a stable background but rather challenges us and further accelerates the need for technology.

As postphenomenological approaches have emphasized in the first place, technologies visualize, measure, signal, and generally communicate ‘what is going on’ in the world—even when the world seems to be no longer situated in the background of our everyday life. Postphenomenology is based on the assumption that we always access the world including its things and objects through technology (Ihde, 1990, 2009; Verbeek, 2005; Rosenberger & Verbeek, 2015) even in its moral implications (Verbeek, 2008b, 2011). Therefore, it may be stated that postphenomenology *centers* technology as a predominant mediator in human-world relations such as Bas de Boer and Peter-Paul Verbeek (2022: 190) argue with regard to Don Ihde (1990): “One of the central ideas of postphenomenology is that we encounter the world and the objects existing in it only in relation to the technologies we use”. While technology here is reevaluated as a mediator *between* human and world and human-technology relations are in the main focus of postphenomenological thinking, the notion of the world is narrowed down as something that mostly operates in the background.

In our contribution, we argue that this concept of technological mediation is based on a *linear relationality* in which the world is reduced to the last link (the mediatable) connected with technology (the mediator) as the centered link, and human (for whom to be mediated) as the first link of a chain. Such a centered state of technology (centered link) combined with a primacy of humans (first link) leads to the consequence that the attention is primarily directed to human-technology relations while the world (last link) *as something to be mediated* often seems to remain quite unspecified and marginalized—or to put it even more sharply: The world itself is devaluated. Against this background, we aim to develop an approach that reevaluates the notion of the world and at the same time questions the position of technology in *human-technology-world relations*. Particularly with regard to phenomena unfolding their own dynamics with the potential to change our perception of the world and our technologies including their features and characteristics in a significant way, we suggest an approach that enables a shift: From the question of how humans bodily and/or hermeneutically enter into a technologically mediated world to the question of *how the world including its activities, agents, and forces situates, embeds, envelopes, co-constitutes humans and their technologies*.

For this purpose, we refer to Maurice Merleau-Ponty’s phenomenology in order to understand humans and technology as being *coiled up by the world*.

In his later phenomenological and ontological treatises published postmortem in the book *The Visible and the Invisible* Merleau-Ponty (1968) develops the concept of a chiasmic relation between perceivers and perceived, human beings and the world described in the notion of *Enroulement* (coiling up): The world in the sense of a perceived, sensible world coils up the sentient sensible body and vice versa. Perceiver and perceived are enveloped by one another. While this chiasmic intertwining, which Merleau-Ponty also expresses in his notion of the *flesh*, has been discussed broadly (e.g., among many others Aarø, 2010; Apostolopoulos, 2016; Bannon, 2011; Gilliam, 2017; Toadvine & Lawlor, 2017), we focus particularly on the concept of *Enroulement* and its implications of motion and dynamics in order to emphasize a relational perspective based on an ongoing process of coiling. Therefore, the aim of the paper is to provide an alternative approach for postphenomenology and phenomenology (hereinafter referred to as post-/phenomenology), which replaces the *linear-relational chain-perspective* based on the idea of technological mediation with a *multi-relational coiling-perspective* that understands world, human, and technology as situated-situating co-constitutors. Such an approach enables us to investigate not only how humans access the world by and through technology but also how the world situates and co-constitutes us and our technologies.

Our article develops its argumentation as follows: First, we reflect on the notion of world in Merleau-Ponty's phenomenology as well as in postphenomenological approaches. Second, we elaborate on the concept of *Enroulement* in Merleau-Ponty's phenomenology of the flesh in order to argue for a stronger consideration of the world in technologically co-constituted relations. Third, we characterize shielding relations in the *Enroulement* of human-technology-world as relations in which the world and its activities, agents, and forces co-constitute vulnerable human bodies as well as shielding technologies. Fourth, we discuss our conceptual insights against the background of two exemplary cases in which such shielding relations become evident: The first example relates to the realm of combat aviation in airspace, which presupposes unruly and even hostile forces outside the cockpit; the second example examines the handling of radioactive material in hot cells where research is carried out as part of the development of repositories. In our conclusion, we discuss the proposed multi-relational approach in its potential for post-/phenomenological thinking.

The Notion of World in Merleau-Ponty's Phenomenology and Postphenomenology

In their article *The Three Worlds of Merleau-Ponty* Hubert Dreyfus and Samuel Todes (1962) discuss the importance and relevance of the world in Merleau-Ponty's *Phenomenology of Perception* (2002). They distinguish three notions of the world as not being isolated from each other but rather as related in a *stratified* way: The first one is—what they call—the “*fundierende*, pre-personal world” (Dreyfus & Todes, 1962: 564) with a primordial character. The second one is, with regard to Husserl, the “*Lebenswelt*” (lifeworld, *monde vécu*) as an ambiguous world. The *Lebenswelt*

is integrated into the mundane, primordial *fundierende* world but is not limited or equated to it. Furthermore, it becomes relevant as a subjective experienceable world that situates our everyday lives. Therefore, the *Lebenswelt* assumes “an intermediate position” (Dreyfus & Todes, 1962: 564) between the *fundierende* world in its primordial and original state and a third notion of world as the “objective, scientific world” (Dreyfus & Todes, 1962: 563). The authors conclude with the following appreciative comment: “Merleau-Ponty’s achievement is rather to have traced the phenomenological genesis of the *Lebenswelt* and, more sketchily, of the scientific world from the primordial *fundierende* world”. In their perspective on Merleau-Ponty’s concept of the world, there is a stratification of three worlds that are mutually dependent and overlap.

We propose to transform such a stratifying perspective on the world into an *integrative, multi-relational* perspective that understands the world in Merleau-Ponty’s phenomenology as *situated-situating*. In the field of Science Studies, various studies convincingly demonstrate that the so-called scientific world is permeated by technologically driven epistemic cultures (e.g., Karin Knorr Cetina, 1999; Latour & Woolgar, 1986; Pickering, 1995). These cultures are highly interspersed with *lebensweltlichen* practices, while *lebensweltliche* practices are intensively permeated with mundane, primordial, and in this sense *fundierende* practices (e.g., Engert, 2022): *fundierend*, *lebensweltlich*, and scientific are situated in the world, in one notion of world. Against this background it can be stated: The world situates us and our bodies practically and is perceived by us as situating including its practices inside and outside science. With regard to the notion of the world in the *Phenomenology of Perception* the world is not only something differentiated but also something that is integrative in the sense of “the world as perceived” (Merleau-Ponty, 2002: 235ff.) be it in everyday life or in everyday life of science while perceiving is not a pure, brute act. Rather it is embedded in cultural and social practices.

In *The Visible and the Invisible* Merleau-Ponty substantiated the social and cultural infiltration of seeing the world and the world as something *that is seen*: “It is at the same time true that the world is what we see and that, nonetheless, we must learn to see it” (Merleau-Ponty, 1968: 4). In this intertwining of vision and visible his approach enters into a relational argumentation interrelating body and thing, body and world in the way that seeing the world from a certain perspective and position is always situated in a seeable the world:

Without assuming anything from what the science of the body of the other can teach me, I must acknowledge that the table before me sustains a singular relation with my eyes and my body: I see it only if it is within their radius of action; above it there is the dark mass of my forehead, beneath it the more indecisive contour of my cheeks—both of these visible at the limit and capable of hiding the table, as if my vision of the world itself were formed from a certain point of the world. (Merleau-Ponty, 1968: 7)

Hereafter, the world is accessed from a particular point of view that itself is not situated outside the bodily perception, on the contrary: “And it is this unjustifiable certitude of a sensible world common to us that is the seat of truth within us” (Merleau-Ponty, 1968: 11). Hence, the world is neither something solely external to

the subject nor a representation internal to it. At the same time, it is not reduced to a pure object that appears in front of a perceiving subject. It is “visible and relatively continuous” (Merleau-Ponty, 1968: 12) and therefore something that permanently offers something visible, positions and situates us via perception: “Because perception gives us faith in a world” (Merleau-Ponty, 1968: 26). Following Merleau-Ponty’s phenomenological approach *the world is something being perceived and making us perceive by offering us something perceivable, something visible*.

In *Technology and the Lifeworld* Ihde develops his postphenomenological approach in which technology is argued to be a central mediator *between* humans and the world in everyday situations such as looking at a thermometer to decide what to wear but also with regard to advanced scientific situations such as satellite-based technologies in the field of astronomy. In order to emphasize this mediating role of technology in human-world relations Ihde isolates such dimensions and situations in which technology is not included, for instance, “walking barefoot under the moon on a desert beach” (Ihde, 1990: 15) as an example of a romanticized *face-to-face* relation *between* humans and world, what Ihde calls “Garden” (Ihde, 1990). He also refers to examples such as “a fall into a boiling geyser or the icy water of a near frozen lake” (Ihde, 1990: 16) as negative or even destructive examples of “naked face-to-face” (Ihde, 1990: 16) relations *between* humans and world characterized by the absence of technology. For Ihde (1990: 23) this naked human-world relation is expressed as:

I—relation—World.

This non-technological and in his words “simple” (Ihde, 1990: 23) relation is differentiated from “technologically mediated [...] experiences of the world” (Ihde, 1990: 16). Referring to Husserl’s notions of *Lebenswelt* Ihde adopts this concept as a mundane experienceable human world that surrounds us, that embeds us, and that is *for us*. At the same time the world becomes relevant as a bodily perceivable environment that is consistent and pervasive (Ihde, 1990: 17). Both the experienceable human lifeworld as well as what is perceived as brute environment can be technologically mediated and thus convert the Garden situation into a non-Garden situation:

In a cold environment, I could tactilely experience the wind and chill; but I have ‘chosen’ to mediate that cold by wearing down clothing [...]. The technology (clothing), however, transforms this immediately experienced environment; and it is that transformation which must be investigated. (Ihde, 1990: 17)

The postphenomenological focus argues for a shift from investigating human-world relations to specifically human-technology relations: “What remains for [...] a phenomenology of human-technology relations, is to reinsert the role of technologies in all the dimensions of the lifeworld” (Ihde, 1990: 41). In such a perspective the world (lifeworld and/or environment) turns into something that is technologically mediated, or in other words: Technology is positioned *between* human and world. Ihde differentiates between various possibilities of basic relations between human,

technology, and world: The embodiment relations characterize relations in which humans and technology are bodily connected in order to access the world such as wearing glasses, using a hearing aid, or walking with a prosthesis (Ihde, 1990: 72f.; Ihde, 2009: 42). Here, the world is something encountered by an entangled human-technology structure. The hermeneutic relations mediate the world or conditions of an environment via signs or texts, respectively, and require the ability to read such signs or texts in order to be able to interpret the technologically mediated world and its properties. In this relation the world itself can have qualities of a black box that is opened in a specific hermeneutic way through or by technologies (Ihde, 1990: 85). A further relation is described as background relation with regard to technologies running in the background (of our perception) from cooling or lighting systems in buildings up to technologically created environments such as the inside of a space shuttle, for instance (Ihde, 1990: 108). In such relationships, the world and technology merge into one another—technology can be perceived as part of a human living environment, or the living environment is located in technology as an immediate environment. One last relation that Ihde examines is the alterity relation in which the “world [...] may remain context and background, and the technology may emerge as the foreground [...]” (Ihde, 1990: 107). Humanoid robots or game automata might work as examples for entering into alterity relations with technology as interactant. It can be noted: In this approach, humans are not in the world, but rather *face* a kind of natural environment, which becomes habitable for them through and by inventing a technologically enriched and mediated lifeworld.

While in Merleau-Ponty’s phenomenology the world is more than a vanishing point for human perception, in this postphenomenological approach it seems to be the last link of a chain, a foil for predominant technologies that are centered *between* human and world by following a logic of *linearity*:

Human (I)—Technology—World.

In this approach including its linear visualization or formalization the human body accesses the world through or by technological mediation, while the world becomes either a physical environment humans face (Garden situation) or a lifeworld that surrounds humans technologically related to their bodies but outside of their bodies themselves, outside the human being, the “I”. We would like to point out that this *linear relationality* entails a simplification or even a reduction with regard to human-technology-world relations. This simplification of *thinking relationality in terms of linearity* becomes apparent when we refer back to Merleau-Ponty’s phenomenological concept of the world as a relational one. His notion of the world does not follow a linear structure. In Merleau-Ponty’s phenomenological and also relational argumentation the perceiving human body is situated in a situating world via perception—a world that provides something perceivable. Apart from linearity and a conceptualization of human-world relations as face-to-face or chain-structured relations in which the human being (“I”) is the first, technology is the second, and the world is the third and therefore the last link or component, respectively, Merleau-Ponty’s phenomenology provides an opportunity to tackle a more complex form of *multi-relationality*. This relationality offers more than one-way-investigations of

human-technology-world relations by emphasizing dynamic ongoings of *coiling*. Hereafter, humans and their technologies are not only related to the world but *coiled upon and in the world*. That leads us to the next chapter in which we will deepen our argumentation by discussing Merleau-Ponty's concept of *Enroulement* in his later phenomenology of the flesh.

The Concept of *Enroulement* in Merleau-Ponty's Phenomenology of the Flesh

In *The Visible and the Invisible* Merleau-Ponty develops a relationality that is organized in the form of a *coil*. In this context he introduces the concept of the *flesh* as an approach to argue for an intertwining of perceiving and perceived as a kind of plasticity—he writes:

What makes the weight, the thickness, the flesh of each color, of each sound, of each tactile texture, of the present, and of the world is the fact that he who grasps them feels himself emerge from them by a sort of coiling up or redoubling, fundamentally homogeneous with them; he feels that he is the sensible itself coming to itself and that in return the sensible is in his eyes as it were his double or an extension of his own flesh. (Merleau-Ponty, 1968: 113f.)

Human and world, perceiver and perceived are not only linked to each other, or interlinked, respectively, in a linear logic or in a dialectical manner. Beyond that, they are folded into each other permanently in a chiasmic way (Merleau-Ponty, 1968: 130ff.). With such a concept Merleau-Ponty's phenomenology argues for a plasticity that intertwines human and world, perceiver and perceived in the sense of coiling upon each other: The perceiver is coiled upon and in the perceived world and the perceived world is coiled upon and in the perceiver. This never-ending coiling motion is captured as *Enroulement* (Merleau-Ponty, 1968: 113) in the sense of a relationality that finds its foundation in the constant envelopment of humans and the world. Referring to this relationality in terms of *Enroulement* we note: *The world coils upon and in humans while humans coil upon and in the world*.

The concept of the *flesh* has already been transferred into postphenomenology by de Boer's and Verbeek's (2022) idea of *techno-flesh* which places non-human beings—such as a virus—and human bodies in a cross-over relation: “the virus actively senses the human body, simultaneously constituting the human body as actively sensing its being affected by the virus” (de Boer & Verbeek, 2022: 199). From a postphenomenological perspective including its interest in emphasizing the state of technology, their contribution proclaims that the relationship *between* the virus and the human body can change fundamentally through technology invented by humans in order to mitigate their vulnerability. This is illustrated by the example of wearing a facemask that is largely impermeable to viruses:

Facemasks, therefore, become an intrinsic part of the flesh. Rather than being neutral additions to it they are constitutive elements of it. This ‘techno-flesh’

is not just an addition of technology to the flesh: facemasks re-flesh the world, in the sense that they reorganize the shared material field within which entities can mutually sense one another. (de Boer & Verbeek, 2022: 202f.)

Here, the focus lies on an artefact, a facemask characterized as technology with intervening potential while the world just remains a “shared material field,” a physical environment that has to be technologically manipulated, mediated. Human-technology relations are at the center of such a perspective. With the aim to emphasize the notion of the world with regard to human-technology-world relations, we suggest integrating the world not only as something to be mediated but rather as something that intervenes, as something that *co-constitutes*. In de Boer’s and Verbeek’s argumentation, the body sensed by the virus is related to a human body, and the facemask is related to technology. From a multi-relational perspective human bodies and also facemasks are coiled up by a world inhabiting viruses in the sense of active agents affecting us and infecting our bodies based on activities that can become experienceable and perceivable *for us*, *for* our bodies in the form of symptoms (fever, for instance), *for* our interpretations of technology (tests, for instance) in the form of indicators. At first glance this perspective might challenge an anthropocentric view in which the world is always based on humans’ experiences as Verbeek suggests: “The ‘world in itself’ is inaccessible by definition, since every attempt to grasp it makes it a ‘world for us,’ as disclosed in terms of our specific ways of understanding and encountering it” (Verbeek, 2008a: 388; see also Verbeek, 2005). The argument here is that the world is always experienceable *for* humans, *for us*. Referring to Merleau-Ponty’s phenomenology a thing is perceivable *for us*, but—and this is the shift we take into account—we *perceive it not only as a thing for us*: The thing is also *perceived by us as a thing in itself*.

One cannot, as we have said, conceive any perceived thing without someone to perceive it. But the fact remains that the thing itself to the person who perceives it as a thing in itself, and thus poses the problem of a genuine in-itself-for-us. (Merleau-Ponty, 2002: 375)

Hereafter “it does not make much sense to speak of ‘the world in itself’” (Verbeek, 2008a: 388), but of a *world in-itself-for-us* in the way that the world is not only perceived as a world for us by us but also perceived as a world in itself by us. A *world in-itself-for-us* does not mean that we access the world and are entangled with it in a harmonious and melting, in a hybrid or fusing way, as Merleau-Ponty put it with respect to the world as preceding us:

When I find again the actual world such as it is, under my hands, under my eyes, up against my body, I find much more than an object: a Being of which my vision is a part, a visibility older than my operations or my acts. But this does not mean that there was a fusion or coinciding of me with it: on the contrary, this occurs because a sort of dehiscence opens my body in two, and because between my body looked at and my body looking, my body touched and my body touching, there is overlapping or encroachment, so that we must

say that the things pass into us as well as we into the things. (Merleau-Ponty, 1968: 123).¹

In Merleau-Ponty's phenomenological approach, the perceived and experienced world is part of the flesh and therefore of the *Enroulement*, which is always interwoven with the flesh of the embodied human as perceiver while technology is part of the flesh as well. Up to this point, it should be noted:

- 1) *The world is something being perceived by us and making us perceive by offering us something perceivable, something visible: The world coils upon and in humans while humans coil upon and in the world.*
- 2) *The world is something being textured and detected by our technologies by offering our technologies something texturizable and detectable: The world coils upon and in technology while technology coils upon and in the world.*

What kind of relationality is released with this approach? The world becomes relevant in its multiple, dynamic, and active qualities in the sense of a world that sets us and our technologies in motion and that we and our technologies set in motion, that co-constitutes us and our technologies, and that we and our technologies co-constitute.² The world binds, envelops, holds, and encloses us, but it also repels us, throws us down, traps us, and constricts us and our technological interventions and developments. Such a dynamic relationality is accompanied by an *ambiguity* of human-technology-world relations: It does not entail a unilateral human-based access to a technologically mediated world in a linear sense, but it rather unfolds a multi-relational perspective of an ongoing process of coiling humans, technology, and world into one another. The following figure (Fig. 1) visualizes this coiling of human-technology-world relations:

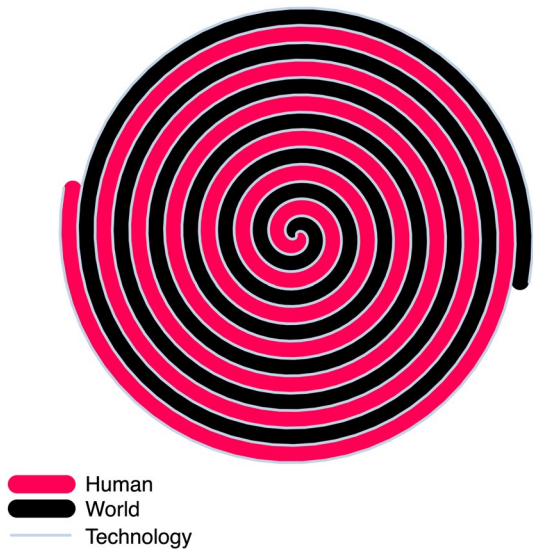
Human, technology, and world are interwoven in a coil. This coil is not static, but rather dynamic as a process of *coiling* engaged in an ongoing motion in which human, technology, and world are continuously enveloped in one another, folded in one another. The one is the space between the others, constitutes the others, and is constituted by the others.³ Technology appears in the midst of humans and the world

¹ Merleau-Ponty (1968: 123) here addresses the “natural world” with regard to the “resistance of things” (Toadvine, 2009: 50ff.) intertwined in a chiasmic relation to humans. Even if nature is examined in a primordial and foundational sense in Merleau-Ponty's phenomenological approach (Rotundo, 2023) from a post-/phenomenological standpoint we suggest arguing such a chiasmic notion of the world beyond any ontological differentiation between a natural and a technological, a natural and a cultural world.

² The mutual co-constitution of something is made relevant in Karen Barad's (2007: 136f) agential realism in another way. Her approach pre-assumes an active or agentively effective matter in an ontological and epistemological way: “Relations do not follow *relata*, but the other way round”. The post-/phenomenological perspective adopted here assumes, on the other hand, the embodied perceptibility and technical accessibility of the world in-itself-for-us.

³ An ontology radically oriented towards intertwinement, dynamic, and process is further expanded in Donna Haraway's later developed post-anthropocentric approach and her concept of worlding (Haraway, 2008, 2016). Here, the perspective from subjects being-in the world shifts to the question of their becoming: “Natures, cultures, subjects and objects do not pre-exist their intertwined worldings” (Haraway, 2016: 13).

Fig. 1 The coil (Copyright
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as connecting but also as contouring both. In this way, technology becomes unifying and at the same time separating: The world is shaped by technologies for us and humans perceive the world through or with technologies while at the same time, humans and their technologies are coiled up by and in the world in its activities, agents, and forces. Therefore, the chiasm is conceptualized in a radical relational way. This relationality is not based on a linear chain or a cross-over structure,⁴ but on a dynamic twisting and curling motion. What enables such a dynamic relationality or coiling perspective? One first answer is that this coiling-perspective comes along with a gesture of deconstructing any primacy of human-technology relations. Human-technology relations are always to the world, are situated in the world, and are co-constituted by the world. In such an *Enroulement*, there is no instance that is prior to the others, that precedes the others. Humans, the world, and technology are intertwined in a non-linear way. From such a perspective not only the questions of how humans perceive and access the world, how humans develop and use technologies, and how technology shapes the world for humans are posed. Rather alternative questions arise: How does the world provide perceptible and experienceable phenomena for humans and detectable and measurable phenomena for technologies? How do technologies co-constitute what kind of world for us and what world situates what kind of technologies? Therefore, instead of asking for the perception of a technologically mediated world, we shift our focus to the presence and co-constitution of the world in-itself-for human-technology-world relations.

⁴ Studies such as de Boer's and Verbeek's (2022: 204) reformulate Merleau-Ponty's concept of chiasm as an intersecting structure between two entities. However, when considering the accompanying concept of *Enroulement* as well as its translations as 'coil(ing)' (Engl.) and 'einrollen' (German), the chiasm becomes comprehensible as a dynamic relationality of continuous intertwinement.

As de Boer and Verbeek (2022: 198) have argued in their concept of *techno-flesh* “technologies are co-constitutive of how particular chiasmic relations are constituted”.⁵ Based on Merleau-Ponty’s concept of *Enroulement* we argue that the world is co-constitutive, too, or better: World, human, and technology are co-constitutive to keeping the coiling process going. Such a concept of *Enroulement* does not mean that human, technology, and world are universally related in a symmetric way (see de Boer & Verbeek, 2022: 203 with reference to Irigaray, 1993: 178). We rather suggest assuming a *situatedness* with regard to the question of how each of the three related parts of the coil co-constitutes the others: Sometimes it appears that humans coil upon and in technology and world; sometimes it appears that technology coils upon and in humans and the world; sometimes the world seems to coil upon us and our technologies. Especially when the world appears to be encroaching on us in a certain way, the question of the role of the world in human-technology-world relations becomes obvious: In how far does the world require certain technologies in order to protect and in a more general way *shield* us? In the following, we will focus on those relationships in which humans and technologies react to and in the world and its human perceptibilities as well as its technological capabilities. Therefore, we will examine *shielding relations* as a case for investigating human-technology-world relations through the lens of *Enroulement*.

Worlds and Their Co-Constituting Technologies: Exploring Shielding Relations

Based on Merleau-Ponty’s concept of *Enroulement* it can be stated that the world is always interwoven in human-technology relations. Every human-technology relation is coiled by the world which becomes noticeable in this ongoing relational process. This becomes particularly evident with regard to those relations in which the world including its perceptible and/or texturizable and detectable effects is made relevant by perceiving and interpreting humans. As Ihde has pointed out, humans use shelter technologies to protect themselves from environmental effects such as cold or heat, storm, or water. One extreme example he refers to is a nuclear submarine: “Its crew lives inside, and the vessel is designed to remain at sea for prolonged periods, even underwater for long stretches of time” (Ihde, 1990: 110f.). In Ihde’s approach, the human-technology interdependencies are centered referring to the life inside of the

⁵ Aydin et al. (2019: 322) demonstrate this strong environment-creating impact of technologies in their concept and study of “Active Technological Environments (ATEs)” which are emphasized in the way that they “are not just a mute and stable background for human existence, but they are actively involved with the human beings and material objects for whom and which they form an environment”.

submarine while the sea as a technologically mediated environment being entirely communicated by devices and instruments such as the sonar, for instance, recedes into the background in the sense of a ‘world outside’.⁶

Based on the outlined perspective on coiling the focus shifts from humans accessing the depths of the sea via technology that mediates an environment, or a ‘world outside’ to a situated-situating world including its co-constituting technology and human embodied perception. The world coils up over the submarine and its technological equipment regarding water- and pressure-resisting materials and design as well as up over humans being trained in their bodily and mental conditions to be able to operate and live in such a technological surrounding under water. The world situates humans and technology including its forces and requirements. Under this perspective the sea is no longer a ‘world outside’—instead it becomes relevant as part of the world humans and technology are moving through, are situated in. In such a scenario technology, humans, and world co-constitute each other through *shielding*. This does not only apply to complex technologies such as submarines or spaceships. The facemask, as mentioned above, protects us against viruses while at the same time, it allows us to be in a world potentially populated by viruses by partially shielding our noses and mouths from contaminated air. In this way, we profile *shielding relations* as an important case to investigate human-technology-world relations with regard to the following insights: First, to emphasize the role of the world, according to which the world becomes more than something to be technologically mediated; second, to point out that technologies are more than mediators that put humans and the world in progressive relations. In such a perspective technology is not a mediator between two entities but furthermore a co-constitutor that is massively adapted to the world in its particular conditions, demands, and requirements as well as to humans and their potentially vulnerable bodies in such a world.⁷

Shielding technologies react to specific perceived and/or technologically detected conditions of a world that requires the invention of technologies in order to protect vulnerable human bodies (and often non-human bodies, too). For instance, in a sunny snowy landscape, we do not wear just any kind of glasses—instead, certain glasses and lenses are required that have a light-reducing effect to protect our eyes from snow blindness. Here, being in the world is enabled through being technologically shielded from its forces and conditions: We look through the glasses to see the visible world while at the same time, these special glasses shield our eyes from a harmful light in a bright white world that situates us but that is also present to us as a potentially dangerous alterity. Another example: The ‘rain radar’ shows that extremely heavy rain is expected in the coming hours, so we decide against the bike and opt for the streetcar to get to our appointment reasonably dry. In this case, the

⁶ With regard to Merleau-Ponty’s notion of the world Anderson and Harison (2010: 7f.) state that “Within such an understanding the world is never an ‘out there,’ a meaningless perceptual mess in need of (symbolic) organization, nor is it an inert backdrop of brute things projected upon by our hopes, desires and fears”.

⁷ In this way, shielding technologies thus mark a contrast to cyborg technologies (e.g., Bjørn & Markussen, 2013; Dalibert, 2016; Oudshoorn, 2015; Verbeek, 2008a), which interconnect humans with technology and the world through embodiment relations.

streetcar is not only used as a means of transport but also as a shielding technology to avoid getting wet. In this sense, it can be stated that the ambiguity of shielding relations allows the world to step into the foreground or into the background like a puzzle picture depending on how the world becomes noticeable in the respective situation—or to put it differently: depending on how the world situates us and our technologies and is situated by us and our technologies. Especially when humans recognize an inconsistency between the technological co-creation based on signs and signals and their own perception of what is perceivable in a situation the world emerges from the shadow of its technological production, its technological co-constitution. If, for example, we check the ‘weather app’ on our cell phones during a hike in the mountains and the app indicates that there will be no storm or rain in the next hours and we then look up into the sky and sense that a heavy thunderstorm is about to hit, we leave the comfort zone of technologically provided information and decide to go back to the camp based on our own observations and expectations. While here technology is pushed into the background, the world comes to the fore for our perception and experience, the world coils upon us and our technologies. The camp with its tents provides shelter by *shielding* us from dangerous downpour and strong winds we would have been exposed to in the mountains. With regard to such shielding relations, it can be stated that the world, technology, and our perception strongly co-constitute and co-create human-technology-world relations.

In the following, we would like to discuss this co-constitution of the world, humans, and technology through the lens of the outlined perspective of *Enroulement* by exploring such shielding relations in the context of two examples: the forces in the world of combat aviation and the activities of a nuclear world and their impact on humans and technology.

Investigating *Enroulements*: Challenging Airspaces and Radioactive Hot Cells

What does the concept of *Enroulement* in the sense of a *multi-relational* and *situated-based* approach reveal for the investigation of the relations of world, humans, and technology? Or in other words: How to investigate *Enroulements* in their multi-relational potentials and complexities? First, we propose to base investigations on one initial question: *Who/ what coils upon whom/ what and how?* Further, we suggest a heuristic of questions along the following three entry possibilities to trace the process of coiling:

Coiled-up by the world: What world coils upon what technology and what humans and how?

Coiled-up by technology: What technology coils upon what world and what humans and how?

Coiled up by humans: What humans coil upon what world and what technology and how?

The order of the introductory questions is not fixed but rather follows the respective situatedness of the phenomenon as well as the situatedness of the perspective on this phenomenon: Sometimes a phenomenon is saturated by the world for someone, sometimes it is saturated by the technologies involved, sometimes it is saturated by humans—and sometimes it is saturated with the whole process of coiling in a similar intensity. Referring to these initial questions not only the question of who/what coils upon whom/what but also the question of *how* the various relations of coiling unfold is of interest. Based on two exemplary cases we will briefly illustrate this *multi-relational* approach in its possibilities of application. The cases are taken from current research projects exploring human-technology-world relations. The first example refers to the role of the airspace and its impact on combat flying. This case is based on a sociological-ethnographic study on military training of fighter pilots from 2018 to 2023 (Anders, 2025). From a relational perspective, the study multidimensionally examines the pilots' corporeal-mental training embedded in various technical equipment. Furthermore, it reflects the role of airspace, including its forces, dynamics, and effects (Anders, 2020). The second example focuses on handling a hazardous and "toxic object" (Schürkmann, 2021) —here radioactive materials—in a nuclear laboratory conducting research for the development of repositories (Schürkmann, 2022). It originates from the environmental and scientific-sociological research project *Undergrounds of Disposal: Sociogeological Processes in Nuclear Waste Management* that will run from 2023 to 2026 and is funded by the DFG (German Research Foundation). Based on an ethnographic approach the project investigates how 'repository-relevant' research in scientific laboratories is conducted to develop long-term disposal scenarios.

Forces, Cockpits, and Trained Pilots: Combat Flying in Unruly Heights

Fallout shelters, submarines, and spaceships—these are three examples of highly sophisticated and complex technological systems invented and designed to protect vulnerable inhabitants or passengers from uninhabitably up to deadly environmental conditions—holding the world at bay. This, at least, is the postphenomenological perspective on these technologies. As mentioned above Ihde (1990:110) refers to nuclear submarines and spaceships to emphasize the characteristics of shelter technologies in their extremes. These "technological cocoon[s]" offer shelter by being "autonomous and enclosed" (Ihde, 1990: 110). With the focus on the demarcation qualities of these technologies constituting a technological boundary between human and world a dichotomy of worlds is introduced. On the one hand, a technologically controlled immediate environment for humans and their corporeality as well as sensuality and perception—the world inside; on the other hand, an environment with harmful and threatening qualities to humans and technology—the world outside. As a consequence, in this linear-relational perspective, shelter technologies become relevant exclusively as mediators of a hermeneutic relation to the world and as a context for human perception, while disregarding the relation of these technologies, as well as the humans embedded inside these technologies,

with the so-called worlds ‘outside’. With the concept of *Enroulement* we shift the focus on the *multi-relationality* and *ambiguity* of human-technology-world relations without introducing a dichotomy of worlds, without assuming technology as solely mediating, without reducing human experience to hermeneutical analysis. Examined under this premise instead of ‘autonomy’ and ‘enclosurement,’ dependence and exposure, amplification and containment, vulnerability, and enhancement become apparent.

In the case of combat flying, we would like to take a closer look at the complex ambiguous multi-relationality of such scenarios. In combat aviation, specially designed aircraft are exposed to enormous forces, while the pilots are equipped and trained to endure the effects of these confrontational situations. Based on the initial questions formulated above, we would like to examine flying under these conditions, in terms of an *Enroulement* in the following:

- a) *Coiled-up by the world permeated with technologically amplified demanding forces:* The dynamic process of coiling can be unfolded regarding the world perceived as a world-in-itself that co-constitutes technology as well as humans. Fighter jets and even airplanes are exposed to high altitudes, low temperatures, thermic forces, and atmospheric phenomena that seem to confront and challenge technology as well as human physiology. Furthermore, the technologically induced movement amplifies and therefore co-constitutes the world experienceable as an intrusive and immersive field of acceleration, gravitational- and centrifugal forces that challenges the technological integrity and co-constitutes humans in their vulnerability (→c). Shielding technology, such as the pressurized cockpit and the pilots’ equipment, is made to fit these specific worldly conditions which must be studied and investigated in the process of developing, designing, and constructing these technological settings and artefacts (see Law, 2002). In short: World seen as world-in-itself coils up and into technology, constitutes technology, and is constituted by technology. However, simultaneously, the world appears to offer conditions that aircrafts are not only exposed to but rather depend on. Atmospheric phenomena, air density, and air mass as well as thermic forces are technologically utilized to generate propulsion and thrust but also as sensible and detectable conditions to which technology (→b) as well as trained humans (→c) relate.
- b) *Coiled-up by shielding technology appropriating, sensing, and mimicking world:* In this ambiguous coiling of technology and world in combat aviation, airspace is experienced as an antagonistic force that exerts powerful impacts on both technology (→a) and the human physiology (→c). Simultaneously, these same forces are coiled-up by technology: Utilizing airflows, which in turn co-constitute the needed lift and propulsion, the cooling of heated electronics, and the shielding properties of the pressurized cockpit mimicking harmless environmental conditions. Furthermore, aircraft technology, such as sensors and probes but also antennas and transmitters, are oriented towards what the sensible world offers. Sensing, detecting, and collecting data that is processed in two ways: As electronic information to deploy countermeasures in order to shield humans from recognized forces and to be communicated through signs and signals on instru-

ments and displays that co-constitute the world as it is communicated, seen, and experienced (\rightarrow c).

- c) *Coiled up by technologically shielded humans trained in their corporeal experience of the world:* Pilots are situated in a situating world, a world experienced as forceful and demanding as the following statement by a fighter pilot illustrates: *It's like, I experience seven to nine times my body weight within a second, that's incredibly extreme. Without proper preparation, it can quickly become a critical situation.*

(Statement in the context of an ethnographic interview conducted by Lisa Anders)

This extreme experience of the world co-constitutes the human as incompatible with this world and vulnerable within it.⁸ The world becomes relevant as a forceful permeating world that requires “proper preparation,” which means two things: Technological equipment and systematic education and training.⁹ Pilots’ bodies are equipped with various technologies which restrain (ejection seat) and protect (helmet) the body, or enhance (breathing mask, anti-g flight suit) the physiological tolerance of the body in order to cope with such demanding experiences, such as the impact of gravitational forces. Enhancement technologies are adapted to the particular needs and requirements of the human body in a challenging human-technology-world relation (such as high oxygen saturation or continuous blood flow), yet these technologies also focus on the world to detect, mitigate, and counteract the effects of harmful influences (such as gravitational forces). Pilots, for their part, must embody this technology through physical practices (such as special breathing techniques and tensing muscle groups in synchronization with the compression of the flight suit). In this way, the equipment, which is embodied by the pilots to shield against gravitational forces, depends on the detection of these same forces in order to work in the first place. With regard to this example, the world does not only become a co-constitutor of human-technology-world relation in the sense of an antagonistic force (\rightarrow a) and the technologically detectable (\rightarrow b), but also in the sense of the bodily-technologically bearable. Furthermore, pilots are trained to use both their corporeal experience as an introspective non-representational approach to the world (Dreyfus, 2002; Dreyfus & Dreyfus, 1980; McDonough, 2019) and to perceive, read, and interpret the signs and signals depicted on instruments and displays (\rightarrow b) in order to confirm and supplement but also to question their perception of the world against the other.

⁸ As part of his cultural-scientific analysis of aviation as a spatial revolution, Asendorf (2013) describes in detail the development of technological measures to protect vulnerable bodies for high-altitude flight.

⁹ For comprehensive technical-historical insights into the design of military aircraft technology and the experience of military pilots see Kehrt (2006).

High Activities, Shielding Lead, and Educated Scientists: Operating Radioactive Materials in Hot Cells

We are in a world in which nuclear industries have produced artificially or, in other words, technologically produced radioactivity that can potentially harm and injure bodies even into the structures of their DNA. Persisting in such a world requires special technologies. For instance, various studies concerning nuclear sites and scenarios demonstrate the importance of communicating technologies in order to warn and alert humans about the dose of radioactivity—so their senses are not able to perceive radioactivity even if there might be “physical awareness of the morphology and topography of radiation” (Parr, 2006: 820) with experienced scientists who are familiar with this.¹⁰ Only technology is able to measure and therefore communicate its intensity, while further “predictive technology” (Sugawara, 2023) is used to communicate any risks in the case of nuclear incidents or even accidents (e.g., Ishigaki & Tanaka, 2021; Perrow, 1999; Rossignol & van Oudheusden, 2017). By using the example of the incident in the nuclear power plant *Three Mile Island* near Harrisburg, Pennsylvania that took place on March 28, 1979, Ihde (1990: 85) illustrates a situation in which our understanding and interpretation of ‘the world’ completely depends on hermeneutic relations: “I now clearly have to know how to read the instrumentation and from this reading knowledge get hold of the ‘world’ being referred to. [...] In the Three Mile Island incident, the nuclear power system was observed only through instrumentation”. What is called “the ‘world’” here is described as technologically mediated to the engineers. This argumentation is based on the linear relational chain structure as outlined before: “I-technology-world,” or more concretely “engineer-instruments-pile” (Ihde, 1990: 85). To put it in a nutshell: From such a linear relational chain-perspective, ‘the world’ is reduced to the inside of a pile, technology is reduced to a mediator of signs and signals, and humans are reduced to their ability to interpret such signs and signals in the sense of someone for whom the world is technologically mediated.

With the approach of *Enroulement* other and more complex relations come into the focus of investigation of nuclear settings. To illustrate this, we will zoom into a nuclear facility where radioactive substances are dealt with for research purposes, more concretely the *hot cell* (Figs. 2 and 3).¹¹

The photographs show such a hot cell including boxes in which, inter alia, nuclear fuel from spent fuel rods is removed from the cladding tubes and processed into samples for further experiments (Figs. 2 and 3). Mechanical grippers attached to the boxes function as extended arms and hands for the scientists working in front of these boxes. The pressure of the scientists’ hands operating the grippers outside the box including the movements of the arms are transferred to the grippers inside the box. A thick pane of leaded glass and leaded walls separate the area inside the boxes from the space in front of them, where the scientists carry out their work. The

¹⁰ With respect to the role of technology in cases of imperceptibilities regarding phenomena in the context of climate change see Ihde (2016).

¹¹ A hot cell is a heavily shielded room in which highly radioactive materials are handled.

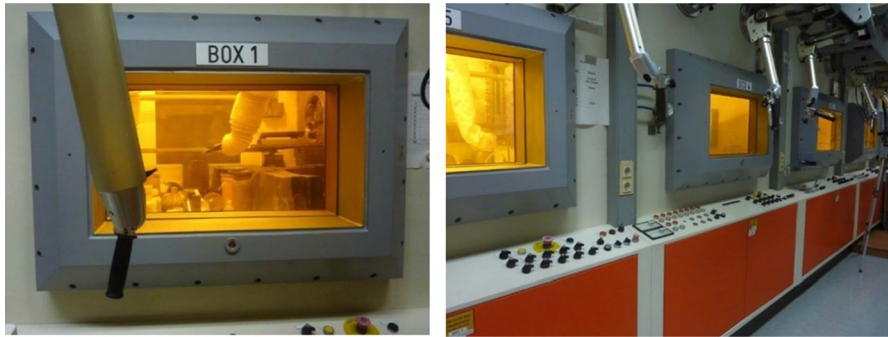


Fig. 2 and 3 Hot cell (Copyright Christiane Schürkmann)

scientists can look inside the box and see the materials, artefacts, and operations through a fifty-centimeter-thick lead glass layer. With a camera inside the box, it is possible to take close-up pictures of the cut-open cladding tubes filled with nuclear fuel—of course, it is not possible for the scientists to view and observe the highly radioactive materials up close with their eyes. The lead glass enables the scientists to perceive the inner life of the box, while it simultaneously shields the scientists' bodies from radioactive contamination and the radionuclides from the sphere outside the box. Based on the initial questions, dealing with radioactivity in hot cells can be unfolded as follows through the lens of *Enroulement*:

- a) *Coiled up by the world saturated with technologically produced radioactivity*: Viewed through the lens of *Enroulement* it can be stated that the world which becomes relevant here for us and our technologies is saturated with a technologically produced activity, or in other words: a world we and our technologies share with artificially radioactive substances that are potentially able to harm us as well as our technologies. Such a world might appear as hazardous and risky to us based on our knowledge of radiotoxic effects on our bodies. Therefore, it is seen by us as radioactive *in itself* based on our knowledge of how to interpret the units of measurement on display of the dosimeter, on how to behave in such a setting, on how to handle these materials—here in the context of a laboratory conducting research about spent fuel cladding tubes in a hot cell. In this way, we and our technology are coiled up by a world that requires particular communicating and shielding technologies (\rightarrow b) but also particular humans who are educated and trained in special ways so that they are able to work under such conditions, to operate its activities by working with grippers, interpreting measured values, evaluating images (\rightarrow c). At the same time such a world situating such a hot cell including its radioactive materials is co-constituted by humans (\rightarrow c) and their invented methods and technologies (\rightarrow b) that artificially produce radioactive materials released in the world.
- b) *Coiled up by producing, communicating, and shielding technology*: The hot cell is preceded by technology that is capable of producing such highly radioactive substances in the first place. Besides communication technologies such as the

camera producing pictures, or the dosimeter producing signals and signs the hot cell and further, the whole nuclear facility consist of various shielding technologies which move into the focus of the analysis: The walls are finished with lead and special paints in order to prevent radionuclides from passing through; lead is incorporated into the glass; mechanical equipment is preferred to electronic equipment, as the former is not as susceptible to such ionizing radiation. Therefore, the scientists' bodies but also all human and non-human bodies outside the hot cell and the research institute are technologically co-constituted in their vulnerability, their inability to bear direct contact with such radiation (\rightarrow c). In this way, technology becomes relevant not only in the sense of communicating something (for instance the dose of radiation) but also in its shielding qualities, its resistances, its longevity to enable humans and further technologies to persist in such a world that imposes certain requirements on everyone and everything that is situated within it (\rightarrow a).

- c) *Coiled up by vulnerable educated humans involved in routinized practices:* Such a radioactive world does not only require special technologies—it also requires professionally trained and educated persons who are able to operate in such a world with its special equipment, who are able to protect their bodies, who are able to deal with radioactive materials, or radiation, respectively (\rightarrow a). Thus, scientists and engineers have to be educated to handle the grippers (such an education can last up to two years!), to insert and work with radioactive materials in the hot cell, to incorporate various practices regarding safety and security, for instance putting on protective clothing before entering the control area, wearing a dosimeter, routinely adhering to rules such as not eating and not drinking, to interpret signs up to model and calculate scenarios in the context of doing research (\rightarrow b). Situated in such a world, permeated with producing, communicating, and, last but not least, shielding technologies humans maintain such a technologically saturated world that hosts artificial radioactivity.

In summary, the following can be stated for this chapter: From the perspective of *Enroulement* human-technology-world relations are investigated in order to emphasize *multiple case-based relations*. Hereafter, the world is more than something to be mediated—it becomes relevant as something that requires something, that restricts us and our bodies. At the same time, technology is more than a mediator—it is a communicator, a separator, a co-constituter. Last but not least, humans are more than embodiments for whom the world is technologically mediated—they are trained and educated knowledge producers but also vulnerable co-constituters of the world they are situated in. Hereafter, the *world in-itself-for-our-technology-for-us* in its states, activities, agents, and forces coils upon us and our technology. Therefore, the two examples focusing on different phenomena illustrate that human-technology-world relations are always coiled by one another, releasing various relations in a field of tension between connecting and shielding, enabling, and restricting.

Conclusion

The aim of the paper was to develop an approach based on a dynamic multi-relationality of world, human, and technology in the sense of an ongoing process of coiling. Referring to Merleau-Ponty's later notion of *Enroulement* chiasmic human-technology-world relations are not solely based on cross-over structures but rather as a concentric spiral motion. Hereafter, the world coils upon humans and technologies, technologies coil upon the world and us and humans coil upon the world via perception and technologies developed by them in the world that requires particular technologies as well as trained and educated embodied humans. This requirement was argued with respect to shielding relations that impressively demonstrated the ambiguity of human-technology-world relations in a field of tension between being situated and situating one another, being constituted, and constituting one another, belonging to each other, and altering each other. Based on three initial questions the investigation of *Enroulements* of humans, world, and technology was briefly illustrated by two examples in which beyond communication technologies shielding technologies play a crucial role in order to enable such challenging human-technology-world relations. Furthermore, the approach of *Enroulement* was discussed in its potentials for replacing a linear-relational chain-perspective as it could be found in the postphenomenological concept of technological mediation after which technology is positioned between human ("I") and the world while the world is reduced to something to be technologically mediated, or to a kind of natural environment we have to face before we invent proper technologies that mediate the world for us. In which ways does the proposed approach unfold potentials for analyzing and investigating human-technology-world relations? In order to answer this question, we discuss the following three aspects in more detail:

Revaluing the notion of world: With such a perspective we reclaim a notion of world that is taken into account as being perceived as powerful, active, saturated with activities, forces, and therefore requirements in the sense of a world we and our technologies are situated in while at the same time we and our technologies co-constitute the world. The world is therefore not only perceived and interpreted by us as a world for us. To put it another way, the world is not perceived and viewed by us per se as a world that we can mediate and dominate technologically or that can be mediated and dominated by technology. In this way, we argue beyond a perspective that implicitly assumes a *linear progress* of our, of humans' relationship to the world: from naked humans in an untechnologized garden to a technologized lifeworld created for us by us to a highly scientized earth mediated by complex technologies for hermeneutic interpreting humans. Against the perspective of *Enroulement* the world rather becomes relevant as a world in-itself-for-us and in-itself-for-our-technologies: a world that is perceived in its requirements and dynamics by us and that is detected by our technologies having to bear and react towards its forces, activities, and agents. Against this background, the statement "we make things which in turn make us" (Ihde & Malafouris, 2019) is put from the head on its feet by referring to Merleau-Ponty's

argument that “the things pass into us as well as we into the things” (Merleau-Ponty, 1968: 123): *The world passes into us and our technologies as well we and our technologies into the world*. In short: This multi-relational approach reevaluates the notion of the world as situating and at the same time situated, as constituting, and constituted in-itself-for-us.

Reevaluating the notion of technology: Second, the approach of *Enroulement* allows us to adopt a perspective on technology that decenters technology without devaluing it. Hereafter, technology is not per se a mediator positioned between human and world. Moreover, it is situated in the world that is technologically co-constituted in-itself-for-us at the same time. This notion of technology is accompanied by the gesture of criticizing an implicit pre-assumed technological fix in postphenomenological thinking. The perspective of coiling does not celebrate human-technology relations as a linear story of progress (from Garden to Earth), but as a permanent process of negotiation, of enabling and restriction in the sense of a continuous concentric spiral motion. In this way, such an approach does not follow the idea of technological enhancement as a story of human enhancement. Rather, technology becomes relevant as multi-relational in the sense of communicating, producing, operating but also as shielding and therefore in the sense of unfolding various relations to us and our world in the world. This approach neither glorifies technology nor condemns it, but revalues it as a multi-relational co-constitutor.

Reevaluating the notion of human (perception): Third, the approach of *Enroulement* opposes a presupposed human primacy in the sense of ruling a technologically moldable world, a world that is universally perceived, experienced, and technologically mediated as a world for us. Referring to Merleau-Ponty’s argument that we perceive and experience the world not per se as a world-for-us but also as a world-in-itself humans are reevaluated in their embodied perception and practices—not in the context of a naked face-to-face relation but situated in a world that is technologically shaped by them but that also shapes them and their technologies. In this way, humans perceive and experience themselves not universally in a world technologically mediated for them, but as potentially being coiled up by forces, agents, activities they cannot (technologically) control at all times and in every respect.

All three insights demonstrate the ambiguity of human-technology-world relations in their co-constituted-constituting and situated-situating potentials. By taking into account this ambiguity, we gain an openness to return to the phenomena without imposing a predetermined linear scheme on them. Thus, investigating *Enroulements* of the world, human, and technology in a multi-relational sense means considering our being to the world in the world as well as to technology in the world. Especially in times in which humans technologically identify and bodily experience multiple socioecological crises, such a perspective forwards the insight not only to take into account the vulnerability of humans and their bodies as well as of our technologies and their components but also the perceivable

and detectable efficacy of the vulnerability of the world-in-itself-for-us—a world that is exposed and exposes us and our technological inventions, creations, and co-constitutions. In summary, it can be stated that the approach of *Enroulement* allows us to gain a post-/phenomenological perspective on human-technology-world relations that breaks the chains of a linear-relational thinking.

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