DISSERTATIONES
SEMIOTICAE
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UNIVERSITY OF TARTU
Press
1632

Department of Semiotics, Institute of Philosophy and Semiotics, University of Tartu, Estonia

The council of the Institute of Philosophy and Semiotics of the University of Tartu, on January 21, 2026, accepted this dissertation for the defense for the Degree of Doctor of Philosophy (in Semiotics and Culture Studies).

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The thesis will be defended at the University of Tartu, Estonia, on March 16, 2026, at 14.15 University Senate Hall/online.

This study has been supported by the Graduate School of Linguistics, Philosophy and Semiotics; funded by the European Regional Development Fund (University of Tartu ASTRA Project PER ASPERA).

ISSN 1406-6033 (print)
ISBN 978-9908-57-134-8 (print)
ISSN 2806-2582 (pdf)
ISBN 978-9908-57-135-5 (pdf)

University of Tartu Press
www.tyk.ee

ACKNOWLEDGEMENTS

I want to thank my parents for being representatives that took their time explaining to people back home what semiotics is. Same goes for my brother who thoughtfully listened to my theoretical rants over these years.

I very much appreciate José introducing me to semiotics in my undergrad degree and for orienting my passion towards Tartu University. I thank Kalevi and Tiit for the engaging conversations in their offices that helped to sharpen my ability of writing academically. I am also thankful for the research by Farouk that very much helped bring semiotic theory close to my heart.

I am grateful to all my friends for the deep conversations about their interests and their plans, and for understanding why I would say "affordances" within various contexts. It was lovely having colleagues within the department that each had such unique research interests and to feel the shared passion on why we individually chose to study semiotics at Tartu. To Krista and Aleks for our overlapping interests in inner speech and for moving forward with our inner speech research group.

Lastly, since the thesis focuses on living spaces it is fitting to acknowledge the Gildi house, the flatmates, and everyone who stepped foot in it. The Gildi house was where the content of this research first came to light, it was the semiotic lab that provided the grounds for co-imagination and co-creation.

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LIST OF PUBLICATIONS

1. Kozicki, Alec 2021. A semiotic model for smart home affordances: Trajecting semiotic components in a technological living environment. In: Suárez-Puerta, Bianca; Merkoulova, Inna (eds.), *Reflections on Paths, Scenarios and Semiotic Methodology Routes*. IASS-AIS, 204–226.

2. Kozicki, Alec 2023. Umwelt in an umwelt: Co-developing within immersive virtual environments and the paradoxical nature of reality and hyperreality. *Sign Systems Studies* 51(1): 73–100. https://doi.org/10.12697/SSS.2023.51.1.03

3. Kozicki, Alec 2023. Affordance and Ton: The meaning-carriers of semiosis. In: Kõvamees, Erik; Miyamoto, Oscar; Randviir, Anti (eds.), *Concepts for Semiotics II*. Tartu Semiotics Library 24. Tartu: University of Tartu Press, 149–165.

4. Kozicki, Alec 2025. Earthships as a de-sign process to harmonize with the environment. *Semiotica* 267: 135–161. https://doi.org/10.1515/sem-2024-0191

0. INTRODUCTION

"In my beginning is my end. In succession
Houses rise and fall, crumble, are extended,
Are removed, destroyed, restored, or in their place
Is an open field, or a factory, or a by-pass.
Old stone to new building, old timber to new fires,
Old fires to ashes, and ashes to the earth
Which is already flesh, fur and faeces,
Bone of man and beast, cornstalk and leaf.
Houses live and die: there is a time for building
And a time for living and for generation
And a time for the wind to break the loosened pane
And to shake the wainscot where the field-mouse trots
And to shake the tattered arras woven with a silent motto."

– T.S. Eliot (From "East Coker" in *Four Quartets* 1943)

The passage above by Eliot helps to begin this research with a poetic sense to elude that houses live and die, how the materials and space of a home can transform, and how a home offers meaning beyond the centrality of human inhabitation. This thesis examines the living spaces of humans, this is a place where habits form and where countless meaning-making events emerge, such as where we eat, sleep, experience leisure, raise offspring, make memories, earn a living, learn hobbies, fantasize on aspirations, and other acts of semiosis relative to the place we inhabit.

This dissertation topic on "*The De-sign process of inhabiting techno-living spaces*" was influenced by three real-world scenarios that impact how human inhabitants co-develop with the space lived within. It should be mentioned that this research does not directly address a response, or solution, for these three aspects, contrarily, these aspects served an important role in formulating the research questions mentioned later in the introduction. The three aspects that influenced this research topic consists of the COVID-19 pandemic, the Anthropocene, and the growing world age population.

The first aspect that influenced this thesis topic was the COVID-19 pandemic lockdowns that abruptly induced a state of isolation for several people to be confined within their living space. Living spaces transformed for individuals during the pandemic lockdown, for instance, into a classroom, an office, and even into places for socialisation. Much of this transformative process of our living space was due to the technological artefacts appropriated within the physical space for our meaning-making experiences. "From a global perspective, we have collectively experienced a technological schism due to the COVID-19 pandemic

that affected various meaning-making events related to how we work, play, learn, and ultimately grow as individuals" (Kozicki 2023a: 76). Individuals could use smartphones, social media platforms, and virtual reality (VR), to interact with other individuals throughout the world, students could participate in virtual classrooms, and a variety of professions could work remotely rather than in an office. The responses to the pandemic lockdown were indeed a cultural process, but the phenomenological experience of being isolated within our living spaces emerged as a moment in time when technologies altered meaning-making events for inhabitants within living spaces.

The second aspect that influenced this thesis topic is the current epoch of the Anthropocene. As identified by researchers at the *Stockholm Resilience Centre* (Rockström et al. 2009; Steffen et al. 2015; Richardson et al. 2023), the unexpected outcomes that may arise due to the irreversible conditions of the Anthropocene can impact the entire planet. Additionally, the thesis supports the stance of the *European Environment Agency* that nature should be respected for its inherent value, rather than viewed as a source of capital[1]. Minimising the risks and challenges of the Anthropocene is a global, collective effort, but we must harness our abilities as individuals within a localised system to better understand how each of us can contribute towards a trajectory for a future moment. As individuals, becoming aware and learning how to strengthen and sustain meaning-making processes within the inhabited local environment can support the process of co-developing with the physical space lived within.

The third aspect that influenced this thesis topic is the world's growing age population. The *United Nations* 2019 projections for world population prospects[2] indicates that the global life expectancy is living longer, from 72.6 years in 2019 to an estimated 77.1 years in 2050. Their projections also indicate that by 2050 an estimated one in six people will be over 65 years old, compared to one in 11 people being over 65 years in 2019. These two future projections of the global age population could potentially impact meaning-making processes within living spaces for cultures with a growing age population. This could open new opportunities for household technologies to provide at-home caregiving and can potentially reform how communities and amenities are designed to suit the needs for the growing age population. Again, just like the responses for the COVID pandemic lockdowns and for the irreversible outcomes of the Anthropocene, a response to global events require action from local, cultural perspectives.

These three aspects that influenced this dissertation topic helps set the stage on the general problem that the research focuses on. Describing these aspects intend to highlight how design processes not only impact the present state of meaning-making events with a living space, but how the present actions orient the trajectory of inhabitation for a future state that is yet to come.

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1 https://www.eea.europa.eu/en/analysis/publications/exiting-the-anthropocene [accessed on September 23, 2025]

2 https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_kf_wpp2019_10keyfindings.pdf [accessed on September 23, 2025]

In times of the Anthropocene, we are unaware of the irreversible, unexpected outcomes that can impact the entirety of life on earth. Within the context of novel technologies, we do not know how technologies integrated into our living spaces impact our daily lives and habitual meaning-making processes. When novel technologies are appropriated as household goods, we, as consumers, are not fully aware on the repercussions of using novel technologies has on users and to the environment.

The research aims to deliver a semiotic toolbox that can be used by stakeholders of techno-living spaces as a type of designer-artefact-user (DAU) system. As shown within the thesis, this research intends to help navigate through the linear and non-linear processes that we experience as inhabitants co-developing with our unique living spaces. The content of this dissertation focuses on providing relevance for the perspectives of designers, artefacts, and users, related to the concept of techno-living spaces. The novelty of this research is not entirely intended for researchers, but also for stakeholders active in a) the design ideation process and b) the implementation of artefacts within techno-living spaces.

The thesis is intended for two groups of readers, the first group is semioticians with an interest in design processes, and the second group focuses on stakeholders related to techno-living spaces within the context of a DAU system. The broadness of stakeholders in the second group relates to: a) inhabitants (users) within a living space, b) creators (designers) of living spaces and for the designed artefacts within the built environment, and c) the artefacts utilised and appropriated within living spaces. I believe that by reflecting on the places you lived, where you live now, and the place(s) where you envision yourself inhabiting in the future can strengthen your interpretation for the content of this thesis.

As shown in this research, Farouk Seif's (2019) concept of *De-sign* establishes the grounding for individuals to enact the role of being a *de-signer*. The concept of de-sign, as the fusion that combines the idea of design and the action of signs (ibid.: 261), is utilised within this thesis as a navigational compass for the linear and non-linear process of human inhabitants co-developing with techno-living spaces. Seif's notion of de-sign is largely influenced from the work of Charles Peirce, Jakob von Uexküll, and John Deely. However, the content within this thesis intends to not be a deep dive into the relations that Seif has rigorously established throughout his publications, rather, the thesis approaches de-sign as a viable process that can be harnessed through the means of a semiotic toolbox. Seif's de-sign serves as a process in this thesis for creators and users of techno-living spaces to invoke characteristics of agency, imagination, transparency, playfulness, common and *uncommon sense*, paradoxical thinking, perseverance, and wholeness. Harnessing Seif's de-sign process to navigate the co-developing process with a techno-living space is cultivated within this research by constructing a semiotic toolbox that can be enacted by stakeholders within a DAU system.

The scholarly contributions of Seif over the years has brought together how architecture and design processes are interconnected with semiotics. Particularly, his research on eco-humanistic metamorphosis of nature and culture (2010),

semiotic paradoxes of new media (2012), the concept of de-sign (2019), the role of pragmatism in de-sign (2020a), and trajectories toward cultural sensitivity and environmental sensibility (2022), were integral resources for shaping this thesis. What began for Seif (1990) as his PhD dissertation examining the physical and metaphysical aspects of reality within the context of ancient Egyptian architecture established a foundation of semiotic theory that is prevalent in his book titled *"De-sign" in the Transmodern World: Envisioning Reality Beyond Absoluteness* (2019). Seif (ibid.: 17) mentions that his graduate research interest in ancient Egyptian architecture "initially developed as a moral obligation to my ancestors, the ancient Egyptians, it was also a search for continuity between my birthplace, which I left in 1977, and my adopted home, the United States (Seif 1990)." This statement holds much weight for myself, as a researcher, because my journey into semiotics of the living space is a quest to better understand how inhabitants can grow with the lived-in built environment.

My interest in modelling techno-living spaces emerged from hearing the experiences of my grandparents that have lived in the same home for over five decades. Also, the global response to the COVID pandemic causing many individuals to pursue various meaning-making events digitally within the confinement of their unique living spaces was significant in orienting my research interest. From my perspective as an inhabitant of living spaces, I have been able to grow creatively over the years within the places I lived. Within various living spaces, I was able to learn how to design and produce baseball fielding gloves and other leather goods, how to play and improvise on the piano to resonate with the current emotions felt, and to learn how to push myself as a writer to translate and express what I perceived as non-translatable. Pursuing these creative outlets were something unimagined at a younger age, they were unexpected acts of creativity, but the various living spaces I inhabited were incubators that oriented and provided resources to develop in these creative endeavours. As a researcher, my personal interest in design processes was inspired by stories and experiences of others, and from my experience of learning creative outlets that gave a first-hand glimpse on how semiotics is intertwined with acts of creativity. This was the start of my unexpected journey to explore how designers and inhabitants of living spaces can harness the role of a de-signer to support acts of creativity and imagination.

The thesis aims at two research questions as targets to utilise paradoxical thinking relative to de-sign. Examining these two research questions intends to deepen our understanding for the process of inhabitants co-developing with techno-living spaces.

The two research questions for the thesis are:

1. How do technologies within the living space orient co-development processes?
2. How can de-sign be utilised as a navigational compass for human inhabitants co-developing with their techno-living space?

With the de-sign process as the foundation of this research, the thesis devises a semiotic toolbox as an apparatus for orienting co-development processes that researchers, design practitioners, and users, can harness from their own perspectives. Creating a semiotic toolbox is an approach to bring semiotic theory beyond the discipline of semiotics and into real-world scenarios pursued by various stakeholders. Inhabiting a living space is a creative process, and in terms of the Peirce's *synechism*, there is a continuous unfolding process of semiosis (*CP* 7.567). The thesis considers imagination as an important component for co-developing with the inhabited space to enjoy the amusement of uncommon sense, the modelling of both-and for paradoxical thinking, and the dialogue of self and others, which these three aspects relate to Seif's (2019) de-sign process. The content of this research intends to formulate a stance that imagination is an interpretation process to orient, more specifically, establish a trajectory that the user can potentially develop into more of a role as a de-signer within the techno-living space. Users within techno-living spaces that enact the role of de-signers can utilise Kalevi Kull's (1998) degrees of semiotic ecology to strengthen the perceptual and effectual process an inhabitant has with a particular space. Additionally, engaging with the semiotic components of an inhabited space can lead to harnessing the applicability of semiotics by transforming how an object is described and functions within the environment of a techno-living space. The research considers the theories of semiotic ecology (Kull 1998), semiotic components (Campbell et al. 2019), and the formula of *trajectionalism* (Berque 2019) as practical methods for a semiotic toolbox.

As shown in this overview and in the listed publications of the thesis, the theories utilised can help go beyond problem-solving strategies and to pursue acts of paradoxical thinking. Much of this process revolves around Seif's concept of de-sign, which is elaborated more in the first section, and the second section examines the theories relevant for the semiotic toolbox. Ultimately, the semiotic toolbox can be invoked by the stakeholders previously mentioned, this can lead to strengthening agency within the inhabited space during the continuously unfolding co-development process of inhabitant(s) and the environment lived within.

0.1. Description of key terms for research topic

I will introduce and describe two key terms that are significant for the thesis: de-sign and techno-living spaces. It should be mentioned that these two terms are further elaborated throughout this overview text.

0.1.1. De-sign

De-sign differs from traditional design disciplines due to de-sign navigating towards qualities or attributes as outcomes, while at the same time, incorporating design practices to produce physical things as deliverables (Seif 2019: 198). The

core definition of de-sign can be understood as the fusion that combines the idea of design and the doctrine of signs (ibid.: 261). The thesis utilises de-sign as a guiding navigational process that can assist in orienting how human inhabitation co-develops with the surrounding environment.

Qualities are navigated towards in the de-sign process through what is considered as *de-sign outcomes* and *de-sign deliverables* (Seif 2022: 292). De-sign outcomes relate to the qualitative characteristics that are ideated and intended to reveal variant aspects for "the unfolding process of continuous wholeness" (Seif 2019: 330). De-sign deliverables are the concretised tangible objects that could not be explicitly communicated (ibid.: 294). As Seif summarises the relation of de-sign outcomes and de-sign deliverables[3], "qualia are the emergent qualitative attributes in de-sign outcomes, but are manifested in de-sign deliverables" (Seif 2020b: 192). Furthermore, "qualities are not things at which to aim but, instead, require intentional navigation toward imagining them" (Seif 2022: 292).

De-sign entails a reiterative process encompassing linear and non-linear acts that aim to go beyond the boundaries of absolutizing reality. The linear, deliberate acts orient how "to find the missing thing or to fix what is broken" (Seif 2022: 291) and is considered as a "utilitarian process appropriate for problem-solving strategies" (Seif 2020a: 116). Intentionality, as the non-linear act, requires constant adjustment of feedback and feedforward reiterations during the navigation "through unknown territories for the purpose of seeking qualia" (Seif 2020b: 197). Intentionality also involves tolerating ambiguity during the unexpected outcomes that emerge (Seif 2020a: 116). Intentionality is a journey, not a destination (Seif 2022: 286).

As a brief example of the linear and non-linear processes that unfold in a de-sign process, the fourth publication of the dissertation (Kozicki 2025) examined the inhabitation of Earthships as a living space intended to harmonise with the environment. Constructing an Earthship requires planning, modelling, and gathering physical substances as resources for building a homestead to meet the specifications of being an Earthship (an example of a linear process). The process of inhabiting an Earthship aiming to live in harmony with the environment requires adjusting user behaviour and resource consumption to ensure the effectiveness of self-sufficient practices (an example of a non-linear process).

De-sign not only provides the mechanics for problem-solving activities but also supports the process for de-signers to go beyond the fixation of solving a problem. As conveyed by Seif (2015: 331), a paradox is something that is not meant to be framed as a problem to solve but should be understood as something to persevere and navigate through. Distinguishing common sense from *uncommon sense* is identified for the linear and non-linear processes of de-sign, the

[3] A couple publications in recent years utilised Seif's de-sign (2019) to structure their research. Baranna Baker (2020) discussed de-sign outcomes as imaginative states within a viewer's mind pertaining to fictional subjects in cinematic texts. Seema Khanwalkar (2020) explored a user's perception of artefacts designed in post-war periods relate to a mimesis and trajectory of user behaviour with the materialised patterns of built environments.

former is expected for solving problems, while the latter is needed for persevering through paradoxes (Seif 2019: 218); recognising "the subtle difference between paradoxes and problems is to go beyond common sense" (ibid.: 237). The content of this thesis is in line with Seif's (2020a: 123) stance that paradoxical thinking is the most significant skill needed to engage in the de-sign process. The notion of paradoxical thinking is significant for the dissertation, because it allows for the research to aim at the research questions not entirely as problems to solve, but as a process to persevere and navigate through.

We will shortly return to elaborate on de-sign in the first section for more of a context in the research. To summarise this subsection, de-sign navigates toward imagining qualities as de-sign outcomes that are concretised in tangible objects as de-sign deliverables, de-sign is a reiterative process of linear and non-linear acts, and paradoxical thinking assists in going beyond problem-solving strategies.

0.1.2. Techno-living space

The object examined in this research is what I introduce as a techno-living space. The research refrains from using the notion of home[4], as this is a culturally embedded object that varies per cultural and sociological system. A techno-living space is considered as a built environment that is a type of habitat, which Almo Farina and Andrea Belgrano (2006: 11) express from an ecosemiotic perspective that a habitat "is the environmental box in which a species is living." From my perspective as the researcher introducing the notion of techno-living space, I consider a living space as a constructed habitat intended for the nurturing and development of life. Attaching "techno" to this description of living space is to stress the potential ability of inhabitants being in more of a position as designers to invoke creative acts with the physical substances in relation to the inhabited space. In a broad sense relevant for the content in this thesis, techno-living spaces are modelled as a type of built habitat filled with technological resources that inhabitants can discover opportunities to develop pursuits of learning, creativity, and imagination.

At the root of word technology is *techné*, which etymologically refers to the art of making (Seif 2015: 330). As expressed within the publications of this dissertation (Kozicki 2023a; 2025), a technological artefact is considered as a cultural artefact within the spatial-temporal context of a techno-living space. Thus, the substance perceived as a technological artefact is a part of a "cultural system that the individuals are a part of has an underlying role of the scaffolding process on how technology can be used within the space" (Kozicki 2023a: 93).

[4] Within a home there emerges a sociological hierarchical formation that derives from the dynamics of modelling systems. This can include the socio-cultural conventions, such as the research by Mary Douglas (1991) who examined the conventional UK household in to identify the significance of social roles and encoded non-verbal signs to signify/reinforce hierarchical processes within the home.

From a contemporary perspective, a narrow description of techno-living spaces can be directly associated to the integration of electronic devices, digital artefacts, and smart technologies that are integrated within living spaces. After all, these are common household commodities of the 21st century that many of us interact with. However, the digital and electronic artefacts created within the current era are just one of the ways to understand the technologies of a living space.

We can take in account how fictitious texts orient our understanding of a techno-living space. Take for instance the cartoon shows from the 1960s of *The Jetsons* that portrays a family in the future with flying cars and a robotic maid. Along with *The Flintstones* which depicts humans in the stone age using vehicles with wheels made from stone, and using a bird attached a string as the whistle to signify the end of a work shift. Within our present time, there are shows such as *Black Mirror* (2011–2025) and *Cassandra* (2025) that portray a dystopian perspective of unexpected outcomes when humans put too much reliance on technologies in the contemporary age. Although these shows are fictional, what the viewers perceive as technologies within the context of living spaces is influenced by the interpretation of texts.

Reflecting on prior built living spaces for a deeper understanding on the technologies utilised for the process of inhabiting a space. As an example, I will briefly discuss the system of cave dwellings and monastery located in Vardzia, Georgia. Although this example is not included within the articles in this thesis, I find it to be a unique example of how a living space was intricately designed using the physical substances and characteristics of a specific environment. The history, origin, and cultural significance of the Vardzia caves as a heritage site is dense with information that is beyond the scope of this research. However, the purpose of discussing this example is to highlight how a system of living spaces, and even still operating as an active monastery, were constructed in a layer of volcanic tuff in the 12th century (Okrostsvaridze et al. 2016: 104) that served as a natural camouflage (Maisuradze et al. 2021: 93). I experienced a tour of Vardzia during the summer of 2025 and saw firsthand various caves that functioned as a monastery, for storing spring water, for baking bread, and for sleeping quarters. The image below (Fig. 1) is from my trip to Vardzia.

What is shown in this image, and while experiencing Vardzia in person, is an unexpected outcome of an earthquake in 1283 that exposed the series of caves within the cliffside (Okrostsvaridze et al. 2016: 102). Researchers point out that the volcanic tuff suffers from constant weathering and destruction, and the rocks could be carved out with an iron knife, which is considered as a reason for building the cave system at this location (ibid.: 104). This example of a techno-living space is to highlight how the development and preservation process continually unfolds through time, and how non-linear processes unexpectedly emerge, such as the earthquake in 1283.

Figure 1. Image of Vardzia, Georgia (image by author, 2025).

Returning to the research at hand, let us take a moment to identify what this research does not focus on. Starting off, the thesis does not examine the form on what a techno-living space represents, such as architectural styles or the interior design of a living space. Additionally, the research does not focus on spatial modelling of living spaces to analyse optimal locations to integrate a technological artefact, such as examining where in the living space is optimal for installing a television. The research does not focus on the semiotics of architecture, such as Eco's (1973) denotative and connotative functions of substance and form in architecture. Lastly, the research does not examine cultural conventions, behaviours, and rituals with technological artefacts within the context of living spaces. On the contrary, the research focuses on how the stakeholders' agency (relative to the subsystems of designers, artefacts, and users) can navigate towards pursuits of learning, imagination, and creativity by utilising a semiotic toolbox for the process of inhabitants co-developing with techno-living spaces. As shown in this research, the applicability of invoking a semiotic toolbox is grounded in the de-sign process that can be pursued by an individual who takes on the role of a de-signer.

The publications within the thesis have examined the following aspects of techno-living spaces, and the third section of this overview article goes into further detail on the findings related to meaning-making processes within techno-living spaces. The first publication (Kozicki 2021a) examines the interrelations of semiotic components when modelling smart home systems as a form of DAU system. The second publication (Kozicki 2023a) discusses a user's agency when interacting with VR technology, which orients meaning-making processes for both physical reality and hyperreality. The third publication (Kozicki 2023b) elaborates on how the concept of affordances is utilised both from an engineering

and semiotic perspective within the context of common household objects. The fourth publication (Kozicki 2025) analyses the concept of Earthship as a living space to examine how self-sustainable processes are oriented for human inhabitation and ecological relations. The publications within this thesis focus on unique instances of techno-living spaces, which is intended to illustrate various meaning-making processes that can occur within an inhabited space.

0.2. Historiography of design and semiotics

The purpose of this subsection is to highlight how design processes and semiotics are utilised for this research. This subsection examines design as a process, the relevancy of semiotics for design processes, the importance of DAU systems for modelling techno-living spaces, and the role of affordances within the context of this research to bridge design practices and semiotics.

Design is a process for problem-solving activities (Alexander 1964). However, design processes can go beyond problem-solving strategies and assist in the paradoxical nuances of reality, which have been previously depicted as ill-defined problems (Simon 1973) and wicked problems (Rittel, Webber 1973). The following statement brings us closer to the relevancy of paradoxes for this research, "paradoxes are not necessarily contradictions, rather, they contradict the immediate perception, predetermined expectation, and belief of what is and what is not" (Seif 2019: 239). Elaborating further on the prior quote, contradictions are intrinsically linked to paradoxes, "and how we persevere through them is at the very core of design thinking and semiotic interpretation (ibid.: 232). The importance of initially describing paradoxes in this subsection is to lay the foundation on how the thesis aims at examining the navigational process of inhabitants co-developing with a techno-living space.

Various semioticians have uniquely expressed the relevancy of semiotics and design processes. For instance, Mihai Nadin (2022: 13) expresses that design is an activity to create realities for our various activities, and that "design principles are semiotic by nature" (ibid.: 21). Additionally, Alvise Mattozzi (2010: 48) states how semiotics in relation to design can be considered as "a practice that tells how to produce and use descriptive tools that affect design practice." In line with Seif's utterance of persevering through paradoxes, Tiziano Manna details how "semiotics could also be defined as the science of transformations, because the use of signs – of artefacts – modifies the knowledge, values and beliefs of a culture" (Manna 2024: 110). These descriptions offer various perspectives to indicate how semiotics is relevant for design thinking processes and as a theoretical tool for design practices. Section two of the thesis goes into detail on the theoretical tools within a semiotic toolbox that can be utilised by individuals, albeit designers or users, to assist in the navigational process of inhabitants co-developing with their techno-living space.

Techno-living spaces within the thesis are modelled as a type of designer-artefact-user (DAU) system. This approach to model techno-living spaces as

DAU systems was influenced by the engineering research of Jonathan Maier and Georges Fadel who have written about the complexity of DAU systems (2003; 2006) and modelling affordances for design processes (Maier, Fadel 2009; Maier et al. 2009). The thesis extends Maier and Fadel's contributions by examining how semiotics can assist with the interrelations of designers, artefacts, and users of techno-living spaces. As Maier and Fadel (2003: 5) indicate, every design has at least three major subsystems of: the designer(s) of the artefact, 2) the artefact(s) being designed, and 3) the user(s) of the artefact – thus, forming a DAU system.

Their research (Maier, Fadel 2003) examines how DAU systems are a form of complex systems, which was largely researched at the Santa Fe Institute in the 1990s, such as the anthological book titled "*Complexity: Metaphors, Models, and Reality*" (Cowan et al. 1994). Maier and Fadel (2003:2) describe a complex system as "a collection of a large group of strongly interacting parts" capable of being classified as adaptive or non-adaptive systems, and with many complex systems organised as a hierarchical structure consisting of varying temporal and spatial scales on each level of the system (ibid.: 3).

The figure below is a visual to showcase the interrelations of designers, artefacts, and users, along with depicting the external pressures that exist outside of the DAU system itself. The dashed lines of the five external pressures (natural environment, parent company, economy, manufacturer(s), and law) are intended to stress the relations that are beyond the DAU system at hand. It is important to note that this thesis does not focus on the external pressures within this figure, as this would require additional methodological structure to examine the impact of external relations. Specifically for this thesis, the research focuses on the solid lines that interrelate the subsystems of designers, artefacts, and users.

The figure is modified in this thesis from the format by Maier and Fadel (2003) to emphasise the relations of the external pressures (i.e., the dashed lines), and to provide examples for the types of designers, users, and artefacts of techno-living spaces. Examples within the designer(s) subsystem include architects, builders, designers of artefacts and digital systems, and prosumers – as the producing consumer that generates and expresses content within digital networks (Scolari 2018). The user(s) subsystem identifies two categories of users, potential and actual, and the type of user is further distinguished into three specific roles. Administrative users have full access to configuring functionality with an artefact. Limited users can perform certain functions with artefacts within a living space, such as children or guests given restricted access. Service users perform installation and maintenance processes that may have specialised competencies and resources – Kozicki (2021a) elaborates on these three roles within the context of smart homes as a DAU system. Examples of the artefact(s) subsystem include the tools, materials, physical goods, digital devices, and software that are related to a techno-living space. Approaching the concept of techno-living spaces as a type of DAU system aims to strengthen a viable semiotic toolbox that can be utilised in design activities and the process of inhabitation.

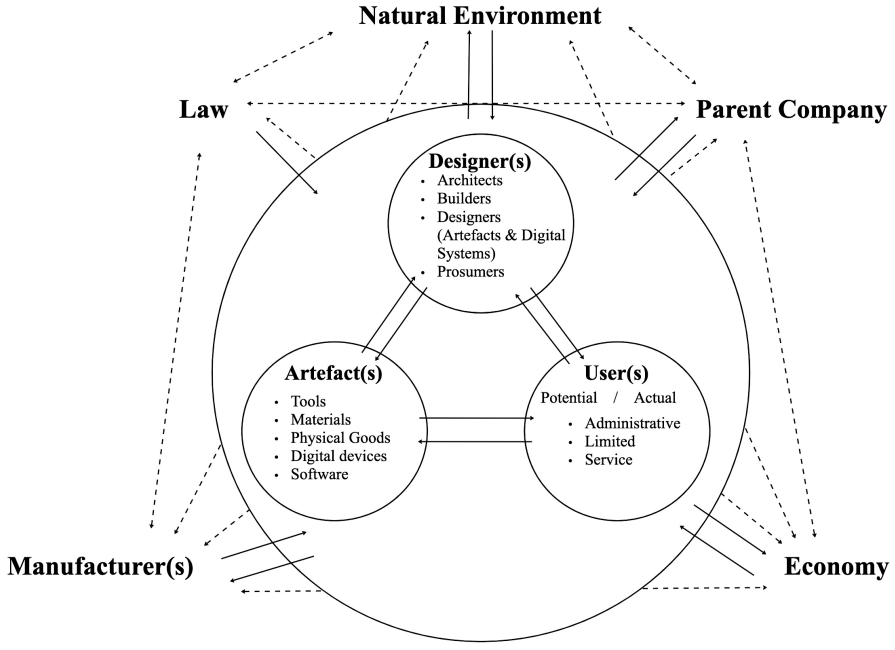

Figure 2. Visual of a DAU system and the external relations (diagram by the author, 2025).

The concept of affordances, which was largely influenced from the research of James Gibson (1986), is considered as a practical notion within this thesis to strengthen the bridge of design and semiotics. The thesis utilises Maier and Fadel's (2003; 2006) research of modelling affordances as a practical method for engineering and design that can be further extended within the context of semiotic processes for inhabiting techno-living spaces. From an engineering perspective relevant for the thesis, an affordance is defined as the "relationship between two subsystems in which a potential behaviour can occur that would not be possible with either subsystem in isolation" (Maier, Fadel 2006: 15). Additionally, the following quote elaborates on the two subsystems of an affordance and the potential emergent behaviours:

> In the context of the designer-artifact-user complex system, artifact-user affordances (AUA) appear as interactions between the artifact and user subsystems, and artifact-artifact affordances (AAA) appear as interactions within the artifact subsystem itself. Interactions between the designer and user subsystems include the information needed to specify which affordances should and should not exist in the artifact under design. Interactions between the designer and artifact subsystems include the specification of the artifact's properties that determine its various affordances internally (i.e., AAA) and externally to the targeted users (i.e., AUA). (Maier, Fadel 2006: 15)

This description of affordances from an engineering perspective serves an important role for modelling the continuously unfolding process of inhabiting a techno-living space. This stance that affordances result as either positive or negative outcomes assists in this research to examine the linear and non-linear processes of de-sign during co-development with a techno-living space. Furthermore, the thesis bridges this engineering approach of affordances with the definition provided by Cary Campbell et al. (2019) from a semiotic perspective. Within their research, affordances are potential action-possibilities that an organism enacts with semiotic resources to channel learning-as-choice in its environment (ibid.: 366–367). Subsection 2.2. of the thesis elaborates more on the significance of affordances as one of the four semiotic components for co-development processes (ibid.). The goal of these descriptions is to highlight the central definitions of affordances from the perspectives of engineering and semiotics relevant for this research, which was the core purpose for one of the articles included in this thesis (cf. Kozicki 2023b). The thesis takes the stance that the role of affordances can strengthen the relations of design and semiotics and is viewed as a practical approach for modelling the qualitative and quantitative characteristics of techno-living spaces.

As a recap, the subsection described how design processes and semiotics are related for this research, how techno-living spaces are modelled as a type of DAU system, and how affordances are utilised as a bridge for design and semiotic processes concerning the interrelations of designers, artefacts, and users within techno-living spaces. Modelling the action-possibilities – using Campbell et al. (2019: 366) definition of affordances – of techno-living spaces as a DAU system provides the opportunity to examine the interrelations of designers, artefacts and users, and to examine the two research questions for the thesis.

0.3. Structure of thesis

Looking ahead towards the proceeding sections in the thesis overview, the following content builds upon the concept of de-sign and elaborates on the semiotic toolbox relevant for the de-sign process of inhabiting techno-living spaces. So far, the general aim, research questions, what influenced me as an inhabitant and as a researcher, the two key terms for the topic, and a historiographical account relevant to this thesis, were addressed in the introduction.

Section 1 describes how de-sign is harnessed as a navigational compass for the continuously unfolding process of inhabitants co-developing with a techno-living space, which relates to RQ2. The section is split into two subsections, the first subsection elaborates on the characteristics and process of de-sign as a transdisciplinary endeavour outside the boundaries of sciences and humanities, and the second subsection discusses how stakeholders within a DAU system can pursue de-sign that take on the role of being a de-signer.

Section 2 addresses the theories utilised to construct a semiotic toolbox that is grounded within the context of a de-sign process. This section consists of four subsections to describe the theories applied in the publications of the thesis. The content in Section 2 serves an important role for establishing a response for RQ2 on how de-sign can be utilised as a navigational compass for human inhabitants co-developing with their techno-living space.

Section 3 analyses meaning-making processes within techno-living spaces related to the listed publications of the thesis. Each subsection within Section 3 discusses aspects that orient the co-development process regarding the technologies within living spaces, along with utilising the components of the semiotic toolbox described in the previous section. The published articles elaborated in this section to relate to RQ1 that examines how technologies within the living space orient co-development processes.

Section 4 is a conclusion to reflect and provide a summative recap on the research questions addressed in the introduction that oriented this research. The conclusion highlights three takeaways related to the semiotic toolbox and these takeaways are considered to benefit researchers, users, and designers to further navigate the process of inhabitants co-developing with techno-living spaces.

1. DE-SIGN AS A NAVIGATIONAL COMPASS FOR ORIENTING CO-DEVELOPMENT PROCESSES WITH TECHNO-LIVING SPACES

> "It is disgraceful and dishonourable not to know one's abode;
> but to know it thoroughly is as praiseworthy as it is honourable.
> Oh, if we try to learn about the places in the country where we are staying, we will understand the fate of the peoples and towns in which we spend our life!
> And then we start wondering about how quickly human affairs and circumstances pass and change!"
>
> – Johannes Claudii Risingh (*Oratio de civitate Dorpatensi* 1637)

Section 1 is split into two subsections. The first subsection discusses the relevance of approaching de-sign as a transdisciplinary endeavour that plays with the boundaries of sciences and humanities, along with the boundaries of construction and inhabitation of living spaces. The second subsection examines the notion of being a de-signer within the context of a techno-living space. The purpose of this section is not to dissect how Seif describes a de-signer, but to utilise the de-sign process (for de-signers) to navigate the trajectories on how meaning-makers can "grow with" the surrounding environment during the continuous process of semiosis.

1.1. De-sign as a transdisciplinary endeavour

Building off the description of de-sign in the introduction, this subsection provides an overview of de-sign as a process towards co-imaginative and co-creative practices within the context of techno-living spaces. The thesis utilises de-sign as a tool for designers and inhabitants to strengthen, and become more aware of, the qualities navigated towards to orient how co-development processes emerge for human inhabitants and the inhabited living space.

Within the context of scientific disciplines, "De-sign is incontestably boundaryless" (Seif 2020b: 194) and "semiotics is undoubtedly a transdisciplinary framework" (Seif 2017: 18). A transdisciplinary approach that goes between, across, and beyond various disciplines (Nicolescu 2002) is significant for the fusion of design thinking and the action of signs (i.e., de-sign) as a process outside the boundaries of the humanities-science schism (Seif 2019). Establishing a transdisciplinary endeavour for this research provides the possibility for scholars

not just within one discipline to utilise de-sign but offers a potential to go beyond (the prefix trans-) the boundaries of a specific discipline.

As Seif (2016: 5) indicates, sciences examine what is true by measuring characteristics, while humanities describe what is real through the means of interpretation. This paradox of true versus real is essential for the boundary-lessness of de-sign, as it allows to go beyond *playing within* boundaries of a particular discipline and to navigate towards the transdisciplinary process of *playing with* boundaries (Seif 2019: 140). Seif conveys that imagination and the ways to attain a desired future requires the integration of factual information (i.e., what is true) and imaginative interpretation (i.e., what is real) that "transcends traditional disciplinary boundaries and the canon of interdisciplinary research" (Seif 2016: 14). Furthermore, Seif elaborates on how the de-sign process navigates toward qualities while tolerating ambiguity and uncertainty:

> In other words, if the quest for qualities is to be pragmatically valued, we must be able to find ways to allow these qualities to be manifested in physical things. This also means that the brilliance and beauty of de-sign outcomes cannot be achieved head-on, by aiming at physical matters or expecting particular results, but necessitate the courage to tolerate ambiguity and the uncertainty of navigation toward that which-is-yet-to-become. (Seif 2022: 297)

This quote describes a central component for de-sign, that is, tolerating ambiguity and navigating towards something which-is-yet-to-become. The thesis utilises de-sign as a transdisciplinary process that can aid designers and users of techno-living spaces to play with boundaries that "navigates through the process for a discovery" (Seif 2020b: 196). The endeavour of navigating[5] towards qualities and tolerating ambiguity (i.e., de-sign process) bridges both sciences and humanities, which is seen as having an impact beyond academia that can be pursued by builders of living spaces and individuals who inhabit the built environment. With this said, the thesis approaches de-sign as a transdisciplinary, navigational process not just outside the boundaries of sciences and humanities, but also for the stakeholders related to designing and inhabiting living spaces.

As mentioned in the introduction section, the modelling of both-and for paradoxical thinking is a significant characteristic to examine the linear and non-linear process of inhabitants co-developing with techno-living spaces. The modelling of both-and is a process to assist with how reality can go beyond the absolutized boundaries of *either-or* relations and shift towards wholeness (Seif 2019: 250). Articles within this thesis, such as examining the paradox of physical reality and hyperreality within techno-living spaces (Kozicki 2023a) and elaborating on Earthships as enduring a harmonious process for both human inhabitants and ecological relations (Kozicki 2025), heavily relied on the modelling of both-and relations. The relevancy of both-and modelling and paradoxical

[5] The notion of aiming at a known target is following a linear direction (Seif 2020b: 196), compared to navigating through unknown territories as a non-linear reiterative process which undergoes constant adjustment from feedback and feedforward processes (ibid.: 197).

thinking for co-development processes of inhabitants and the environment assists with going beyond an anthropocentric perspective. We can notice a both-and stance when reflecting on Murray Bookchin's statement that "it is not only we who 'tame' nature but also nature that 'tames' us" (Bookchin 1982: 32). The cultivated trajectory of humanity co-developing with the environment cannot afford to lose its ecological direction (Kozicki 2025), and the co-development process can be strengthened when the modelling of both-and is embraced.

Transparency is an integral characteristic of de-sign, as it allows the perseverance through paradoxical boundaries and to integrate Jean Gebser's (1985[1949]) diaphanous perception and aperspectival consciousness (Seif 2019: 43). Factoring in transparency for how inhabitants co-develop with techno-living spaces provide designers a process to engage with imaginative and creative acts towards what-is-not-yet-known. As Seif explains the purpose of transparency for de-sign:

> Hybridization and transparency resonate with the Peircean synechism and the Gebserian diaphaneity, supporting the belief that the lifeworld exists as a continual whole, with no part being separated or absolute. Yet, transparency does not necessarily imply mixing, because it can be attained by integration; nor does continuity mean sameness. Since diaphaneity does not mean mixing and dissolving differences, signs reveal the transparency which are intrinsic to the sense of wholeness. (Seif 2019: 261–262)

Integrating transparency for how the surrounding environment is imagined, perceived, described and altered, as individuals and a collective, enhances the ecological awareness and sensitivity that can go beyond the perception of viewing and interacting with the environment as a raw material (Kozicki 2025). Overall, transparency is an integral characteristic for a de-sign process of techno-living spaces, because although humans can be at the centre of complex design processes, what is in the surrounding periphery that goes beyond our own existence must not be out of mind (ibid.). Invoking transparency can benefit sociological relations from the inhabitants' perspectives, and transparency offers de-signers to play with boundaries intended for navigating beyond a human-centred focus and to strengthen the environmental relations surrounding the place of inhabitation.

As a recap for this subsection, de-sign is utilised as a transdisciplinary process for playing with the boundaries to navigate through the paradox of what is true versus what is real. This transdisciplinary process is impactful for researchers within sciences and humanities and can also be harnessed by stakeholders related to the construction and inhabitation of living spaces. De-sign entails the modelling of both-and to navigate through contradictions and to tolerate ambiguity, along with revealing transparency and diaphanous boundaries oriented towards a sense of wholeness. The following subsection elaborates on how de-sign is embraced by an individual who takes on the role of being a de-signer within the context of their techno-living space.

1.2. Being in the role of a de-signer

This subsection conveys how the de-sign process is pursued by an individual's agency that takes on the role of being a de-signer. The subsection focuses on how stakeholders related to the DAU system of a techno-living space can become in more of a role as a de-signer. Elaborating on Seif's de-sign process from the perspective of an individual intends to provide a designer(s) an approach to strengthen their meaning-making relations with the user(s), and for a user(s) to transform into more of a position of being designers within their unique techno-living space. Being in the role of a de-signer can assist with the navigation of co-development processes for inhabitants and the environment of their living space.

Being a de-signer entails a pursuit of acting on behalf of others with a sense of integrity as a navigational process towards a desired future (Seif 2022: 288), which Seif expresses as *de-sign agency*. A de-signer navigating the co-development process with a techno-living space is in line with Seif's (ibid.: 304) stance that de-sign agency is an important concept for co-evolutionary and co-metamorphosis of nature and culture. De-sign agency encapsulates the both-and modelling for cultural and ecological relations during the navigational act of co-development processes.

The qualities navigated towards while co-developing with a techno-living space can go beyond the semiosis generated (in terms of de-sign outcomes and de-sign deliverables) for the centrality of the human inhabitant and into the periphery of what surrounds the habitat. The co-metamorphosis of nature and culture was initially described by Seif (2010) as an *eco-humanistic metamorphosis*. This notion of eco-humanistic metamorphosis intends to transcend the understanding of sustainability to go beyond reducing ecology as environmentalism, and humanism "which while assumes the goodness of humans it emphasises their existence as autonomous beings" (ibid.: 244). This concept is further addressed for techno-living spaces in the fourth article within the thesis (Kozicki 2025) and is elaborated more in the second section.

The following passage by Seif outlines the role of a de-signer and contextualises what has been described in the previous sections about the de-sign process:

> De-signers can create the appropriate de-sign contexts within which others become aware of meaningful ways of being-in-the-world. So, de-signers are not the forgers of intentionality; rather, they are the midwives of palingenesia[6] who can assist others through the navigational process of bringing into being qualities manifested in unexpected outcomes. It is through De-sign that de-signers, as agents of

[6] The use of palingenesia, as a continual recreation and regeneration, relates to the de-sign outcomes that emerge from the continuously unfold process of synechism. Seif (2019: 262) states, "every de-sign situation offers a unique experience of infinite possibilities and choices for reconstructing reality. And because of this experience, de-sign outcomes are only invariant aspects of the unfolding process of continuous wholeness. This unfolding process can be best perceived as the recurrence of birth, continual recreation, regeneration, or palingenesia."

> intentional change, become envoys of a meaningfulness that has the potential for integrating cultural sensitivity and environmental sensibility. (Seif 2022: 301)

This quotation describes the role of de-signers as agents of intentional change, and how the agency of de-signers integrates cultural sensitivity and environmental sensibility, which this thesis should be understood as an extension of Seif's (2010) eco-humanistic metamorphosis. The following quote emphasises how the eco-humanistic metamorphosis of de-sign agency can navigate through the qualities of sustainability and aim towards a state of *thriveability*:

> Trajectories innate to the de-sign process transform us into not only lifelong-learners, competent of questioning absolute knowledge, but also agents of change, capable of moving beyond merely being inquisitive about information, into becoming reflective, contemplative knowers who integrate all aspects of biosemiotics. This is precisely why the concept of stigmergy can be transferred from the collective insect nest building to the idea of De-sign agency in order to intentionally transform our ways of understanding and caring for the built environment. Once the idea of De-sign agency as the envoy of intentionality develops the stigmergic process will manifest itself as a paradigm shift from mere sustainability to a broader sense of thriveability that hinges on the integration of cultural sensitivity and environmental sensibility. Embracing the stigmergic, de-sign process will render human beings to become co-creators of the metamorphosis of culture and nature. (Seif 2022: 303)

This thesis views inhabiting a built environment as a continually unfolding process of learning. An individual can live their entire life within one living space or move to a new place for whatever reason, but an individual as an inhabitant is able to continuously learn more about what is within and what surrounds their living space. For instance, the unexpected outcomes of a natural disaster can alter an inhabitant's meaning-making relations with an inhabited space, the results of an unexpected outcome can orient an inhabitant's decision to move to a new place or implement solutions within the inhabited space to reduce potential negative outcomes in future unexpected scenarios. Within the context of this thesis, there is an aim on how to harness our ability of being life-long learners concerning the technologies related to living spaces. This aim intends to lead inhabitants to reflect on questions such as, how do we learn about what technologies within the living space afford (as an action-possibility)? How do we learn and discover functions of an artefact? How do we learn about the impact of users interacting with certain technologies?

To further contextualise how stakeholders of a techno-living space as a DAU system can harness the process of de-sign, the following statements focus on how imagination contributes to the semiosis relative to technologies within living spaces.

- Designer(s) imagining who the user is and if user competency is sufficient to positively engage with the designed artefact.

- Designer(s) of an artefact imagining potential user experience and envisioning how a user would interact with the artefact's interface.
- Designer(s) imagining what other artefacts may exist within a potential user's living space.
- User(s) imagining opportunities to utilise an artefact when its intended function reaches a point of obsolesce.
- User(s) imagining what positive and negative outcomes may unexpectedly emerge when appropriating a new technology within the living space.

The purpose of these example statements is to show how imagination from the perspectives of designers and users entail a dialogical relation, which reinforces the statement that, "dialogues reach for imaginative possibilities of that which is yet-to-be" (Seif 2019: 271). Bringing in these examples emphasise that "de-signing and dialoguing are inextricably isomorphic processes of imagination" and that "de-sign thrives on initiating meaningful dialogue" (ibid.). The notion of dialogue for the role of a de-signer allows design thinking and semiotic interpretation to invoke transparency between the relations of self and other, and to harness de-sign agency to act on behalf of others. As Seif (ibid.: 310) states, "there is no sense of reality for Self without Others."

The role of being a de-signer is significant for navigating through paradoxes that exist within techno-living spaces, such as the paradox of physical and hyperreal environments, the paradox of technology and teleology, paradox of real and true, and paradox of visual and virtual. Seif (2012: 57) elaborates on these four distinct paradoxes as being paradoxes of new media, which are relevant to the publications included in this thesis. The paradox of visual and virtual, along with the paradox of reality and hyperreality, is central to the article (Kozicki 2023a) that introduces the notion of *umwelt in an umwelt* for modelling immersive virtual environments. The article (Kozicki 2023b) discusses the paradox of real and true in the topic of affordances and Uexküll's *Ton* (Uexküll 1982). The paradox of technology and teleology is utilised in the article (Kozicki 2025) to discuss how Earthships repurpose objects perceived as waste used as building materials. We will return to these publications in section three of the overview.

To review the content discussed in this subsection, a de-signer utilises de-sign agency to act on behalf of others which navigates toward an eco-humanistic metamorphosis. De-signers, as agents of intentional change, aim their agency towards a state of thriveability that integrates cultural sensitivity and environmental sensibility. Being agents of a de-sign process transforms us as life-long learners to engage in dialogical relations that reach for imaginative possibilities. Lastly, being in the role of a de-signer assists in navigating through the contradictions and paradoxes that emerge within techno-living spaces. The next section of the thesis offers individuals, a semiotic toolbox to strengthen their potential ability of being a de-signer to assist the navigational process of co-developing with techno-living spaces.

2. DE-SIGNING WITH THE SEMIOTIC TOOLBOX FOR TECHNO-LIVING SPACES

> "Preliterate humans did not have to 'love' nature; they lived in a kinship relationship with it, a relationship more primary than our use of the term love. They would not distinguish between our 'esthetic' sense on this score and their own functional approach to the natural world, because natural beauty is there to begin with-in the very cradle of the individual's experience."
>
> – Murray Bookchin (1982: 49)

This section describes the theories related to what is considered as the semiotic toolbox. This toolbox is intended to be a resource that can be utilised by stakeholders of a DAU system within the context of techno-living spaces. Building off the prior section that focused on de-sign as a navigational compass, the toolbox serves a function to engage with the meaning-making that impacts the process of co-development for human inhabitants and the built environment lived within. With this said, the applicability of the semiotic toolbox not only impacts the individual's self, but for the others in relation to what surrounds the individual. The following theories are discussed in this section as tools that de-signers can enact during the process of inhabiting a techno-living space: 2.1. the umwelt and lifeworld (*lebenswelt*), 2.2. semiotic components as an apparatus, 2.3. semiotic ecology as a process to frame the environment, and 2.4. the notion of milieu and *trajectionalism* during the continuous flow of reality.

2.1. The umwelt and lifeworld

Starting first with the umwelt theory, the umwelt theory serves as an important role to establish a grounding for user experience and behaviours that emerge within the context of species-specific living spaces. The umwelt theory was introduced by Jakob von Uexküll (1992[1934]) and can be understood as the "distinctions the organisms themselves make, the ways organisms themselves see the world" (Lindström et al. 2014: 123). Furthermore, an umwelt is "any organism's 'model' of all that it can understand as existing, the way that it uses its senses to apprehend semiosis as well as the way that it produces its own semiosis" (Cobley 2022: 30).

The thesis content focuses on the human umwelt and how the meaning generated by a human inhabitant undergoes a co-development process with a techno-living space. With this said, the human umwelt is a central point for a de-sign

process, and the thesis shows how the de-sign process can go beyond the human subjective as the point of centrality. Going beyond this centrality intends to navigate co-development processes of techno-living spaces to encompass ecological relations outside of our own subjective umwelt. Persevering through the centrality of human experience resonates with the distinction how the umwelt theory provides scholars the ability to distinguish between the environment (*Umgebung*) as "as a raw universal datum" and the umwelt as "a singular, concrete reality, valid only from the view of the being concerned" (Berque 2019: 2). The umwelt serves as a theoretical grounding for additional theoretical tools to support the co-development process of inhabiting a techno-living space, such as the lifeworld, semiotic components, semiotic ecology, and milieu, which are all discussed within this section.

The concept of lifeworld (*lebenswelt*) introduced by Edmund Husserl (1970) relates to the ontological development of "ongoing events" (Seif 2019: 295) that an organism experiences during their lifecycle. The umwelt and lifeworld are paired within this subsection due to the stance of how "an umwelt is an at times species-specific lifeworld" (Lindström, Tønnessen 2010: 259), which underlines that an umwelt represents what can be experienced by any specimen, and a lifeworld relates to what has been experienced through a specimen's actual life history (ibid.). The lifeworld of inhabitants is an important factor since inhabiting a space is a continuous ongoing process. A living space is an object that inhabitants develop within, ontologically speaking, and the inhabitants' lifeworld orients the perception if the property fits into the imaginative desires and expectations sought after (cf. Kozicki 2025). As inhabitants experience various stages of life, biomechanical processes alter in relation to the characteristics of the living space (Kozicki 2023b), such as how someone perceives and engages with a flight of stairs[7].

Inhabiting a space not only aims to cater the needs of an inhabitant in the present moment but inhabitation is also oriented towards future meaning-making events that have yet to come. For instance, an individual renting or purchasing a living space must interpret the living space during a present moment, but the interpretation process entails that the individual envisions potential actions in a future moment that could emerge within and surrounding the living space. As a few examples of invoking imagination related to potential future events, a buyer could imagine the living space filled with their personal possessions, imagine if the space is sufficient for raising offspring, and to imagine any potential negative outcomes that may impact the wellbeing of inhabitants in future moments of their life.

[7] Research by Warren (1984) examined the oxygen consumption of human mobility and various staircase sizes, which focused on the thresholds of optimal and critical biomechanical affordances.

2.2. Semiotic components as an apparatus

A significant model for the semiotic toolbox is the four semiotic components consisting of semiotic resources, competence, affordances, and semiotic scaffolding that an organism enacts during the co-development process with a given environment (Campbell et al. 2019). Additionally, the notions of learning, memory, and knowing are considered as the three semiotic substances embedded in the semiosis individually and culturally experienced (ibid.). Campbell et al. (2019: 353) mentions that "semiosis as the fundamental process of meaning-making implies, as its central aspects, learning, memory, and knowing; and that semiosic activity assumes and is framed by resources, competence, affordances, and scaffolding." In reference to their statement, the thesis utilises semiotic components as an apparatus to strengthen and orient the relations between designer(s) and user(s), user(s) and artefact(s), and designer(s) and artefact(s). These three interrelated orientations of semiosis are used for modelling the co-development process with techno-living spaces as DAU systems. Publications within the thesis examined how semiotic components are relevant for the interrelations of designers, artefacts and users for smart homes (Kozicki 2021a), immersive virtual environments (Kozicki 2023a), and Earthships as self-sustainable living spaces (Kozicki 2025). I will briefly discuss each of the four semiotic components within this subsection to show their relevancy as theoretical tools.

Semiotic resources are "something that can be used to represent; that can be engaged with semiotically and, as such, leads to the generation (or discovery) of (more) meaning" (Campbell et al. 2019: 358). As an example, an instruction manual, a FAQ webpage, and a troubleshooting webpage can assist users in problem-solving strategies to generate meaning with an artefact. Semiotic resources can exist as something within the physical environment, such as clay to create an artefact, and even the instruction manual that came with the artefact, but resources can also exist within digital environments, as in the case of FAQs, tutorials, and support webpages (cf. Kozicki 2021a). Campbell et al. (2019: 359) further elaborate that "semiotic resources are subjective, depending on (1) what the organism, given its embodied morphology and its relation to the environment, can use and (2) what the organism chooses to use." As a contextual example to emphasise this statement regarding semiotic resources, we can imagine the situation of a child deciding to stand on a chair to reach something inside a kitchen shelf. We will shortly return to this example to discuss how competence relates to semiotic resources.

Competence refers to the capability of discovering resources and recombining the meaning within a new pragmatic function (Campbell et al. 2019: 359). The researchers further elaborate that "semiotic competences are employed to scaffold knowledge, which is to say, to develop models of (aspects of) their environment, which result in a capacity to navigate in the environment" (ibid.). Returning to the prior example of a child using a chair to reach something in the shelf, engaging with the chair not as something to sit on, but as a resource to stand on provides the child the capability to pursue an action that could not be otherwise

pursued due to their height. Furthermore, the child enacts additional degrees of competence during this meaning-making process, such as understanding how and where to move the chair, or having the competence to make sure there are not any adults around that may criticise their actions.

As previously described in the introduction, affordances from the semiotic perspective are action-possibilities (Campbell et al. 2019: 366). Their research future extends the definition of affordances "as potential semiotic resources that an organism enacts (detects, reads, uses, engages) to channel learning-as-choice in its environment" (ibid.: 367). To support this stance of affordances as potential semiotic resources, one of the included publications expresses that:

> [J]ust as learning about how a meaning for an object can change over time, one may also learn that expressions such as affordance or to afford can transform from not only representing a change in consumption (e.g., paying the check, sharing the remaining amount of water while stranded, putting another piece of wood in the kitchen fire), but to represent the various relationships that potentially exist for a user's interpretive process in constructing a desired behaviour with an object. (Kozicki 2023b: 150)

To synthesise the notion of affordances with the previous example of the child using a chair to stand on, the possible action of standing on a chair can lead to positive or negative outcomes. For instance, a positive outcome for the child standing on a chair can be how the chair supported their weight (+AUA), and negative affordances can relate to how the legs of the chair are unstable that causes the child to fall while standing on the chair (-AUA) or scratching the floors when the chair is moved near the shelf (-AAA).

Semiotic scaffolding is how organisms continually seek and extract meanings through their interactions within their umwelt (Campbell et al. 2019: 368). The following block quote details how an organism's semiotic scaffolding can lead to environmental changes:

> A scaffolding is similar to what it aims to grasp, being deemed a model, because, following this metaphor for learning, it moulds onto it. The erection of new scaffoldings, thus, leads to environmental changes that evoke new semiotic resources. In the scaffolding process, not only organisms change – their environments change, too. Thus, as new semiotic resources become available and are used, organisms and environments co-develop. (Campbell et al. 2019: 359–60)

This description of semiotic scaffolding indicates how engaging with semiotic resources and competences can lead to discovering new resources within the environment. We can take eco-friendly living spaces, as an example, that aim to reduce carbon emissions and relations to global supply chains as a type of semiotic scaffolding. This example of self-sustainable living spaces relates to the publication concerning Earthships (Kozicki 2025) that highlights how resources within the surrounding environment can be utilised as building materials to construct a living space, such as using natural substances or end-of-life commodities.

Using objects that would normally be perceived as waste as building materials can alter the semiotic relations with end-of-life commodities. This example is elaborated in subsection 3.4. of the research, but for now it is worth mentioning how an object is described (e.g., being waste that should go to a landfill) can transform as a semiotic resource suitable for learning and discovering new semiotic processes within the given environment.

The subsection described how each of the four semiotic components are inter-related to one another for the co-development process of a subject with an environment. The thesis considers that designers and users engaging with the four semiotic components as "building blocks" for semiosis serves as a practical theoretical tool to develop as life-long learners.

2.3. Framing the environment with semiotic ecology

The next resource in the semiotic toolbox for techno-living spaces is Kull's (1998) model of semiotic ecology. Kull's model of semiotic ecology consists of four degrees of nature that relates to how the human umwelt interprets, alters, and produces within the contextualised environment (ibid.). Publications included this thesis have shown that semiotic ecology is a practical method for meaning-making processes in physical environments (Kozicki 2025) and for immersive virtual environments (Kozicki 2023a).

A brief overview of Kull's (1998) four degrees of nature for semiotic ecology is provided. The 0^{th} degree nature is the "absolute wilderness" and "the objective nature itself" (ibid.: 355). I have previously described the 0^{th} degree as the imagi-native nature that exists beyond what is currently experienced in an environment as being real or true (Kozicki 2023a: 84). The 1^{st} degree nature is what I describe as the exhibitive nature (ibid.), this degree relates to what is seen, described, and interpreted (Kull 1998: 355). The 2^{nd} degree I categorise as the manipulative nature (Kozicki 2023a) due to the alteration and manipulation of an environment, for instance, building a living space on a piece of land. Kull indicates the 2^{nd} degree as "the materially translated nature" (Kull 1998: 355). The 3^{rd} degree is the "interpretation of interpretation, the translation of translation, the image of image of nature" (ibid.), and I have expressed that the 3^{rd} degree is a reproductive nature emerging as a hyperreal nature from the mind of a human interpreter (Kozicki 2023a: 88).

Semiotic ecology leads designers, specifically in this thesis "de-signers", towards a reiterative design process to learn how an environment is imagined, exhibited, manipulated, and reproduced – respectively, the descriptions for the four degrees of nature (Kozicki 2023a). Semiotic ecology for a DAU system design process provides a framing on the continual development of semiosis for designers' and users' meaning-making activities and their perception of the sur-rounding environment. The framing of semiotic ecology assists with the transi-tion from what the potential users are expected to understand and perceive within

an environment, into strengthening the semiotic relations on what and how the actual users are altering and reproducing within the environment.

Overall, semiotic ecology assists in the navigational process of de-sign during the linear and non-linear paths that not only impact the inhabitant's semiosis, but also with the environmental characteristics that are potentially impacted due to human semiosis. Modelling the semiotic ecology of techno-living spaces also provides insight on how co-development processes are paradoxically oriented by physical and hyperreal environments, which is revisited in subsection 3.3. to address what I describe as the umwelt in an umwelt (Kozicki 2023a). Semiotic ecology offers de-signers a tool within the semiotic toolbox for the linear and non-linear process during the continuous unfolding semiosis that impacts the co-development process of inhabitants and the environment (Kozicki 2025).

2.4. Milieu in the continuous unfolding flow of reality

The last tool within the semiotic toolbox is the notion of milieu and Augustine Berque's (2019) formula of trajectionalism. The subsection describes how the notion of milieu is used in this research, the role of Berque's formula of trajectionalism within the semiotic toolbox, how the distinction of things and objects relate to the trajectionalism formula, and ends with describing the relevancy of the co-development process for both the inhabitants and the inhabited space.

The concept of mesology was introduced as the science of *milieux* (environments; milieu as a singular environment) by the French biologist Charles Robin during the 1848 inaugural meeting of *Société de biologie* (Canguilhem 1968: 71). The notion of milieu entails "both a centre or focus and what surrounds this focus" (Berque 2019: 3) that is "always at the same time elsewhere and in me" (Lestel 2018: 432). The centrality and periphery of milieu serve an important role for the both-and modelling for paradoxical thinking in a de-sign process, and for the co-development of inhabitant(s) and the inhabited space. With this said, the thesis frames human inhabitation as the centre and the surrounding environment as the periphery.

Incorporating the notion of milieu within the semiotic toolbox assists in the process to go beyond the point of centrality and to encompass more on what is in the surrounding of human inhabitation. As shown in the article (Kozicki 2025) about Earthships as a self-sustainable living space, it is possible to orient the notion of self-sustainability to fulfil the needs of the human inhabitants, while also strengthening the semiotic relations with the surrounding ecological system. This process to enhance ecological awareness and sensitivity requires our social understanding of self-sustainability to go beyond a point of centrality, which relates back to Seif's (2010) eco-humanistic metamorphosis.

The mesological research by Berque (2016; 2019) has contributed towards the formulation of reality as a *trajective* process, rather than reality as purely subjective or objective (Berque 2019: 9). Bringing in Berque's research on the *trajectivity* of reality offers insight to de-signers for the trajectory of co-development

processes with techno-living spaces. This thesis takes the stance that Seif's design process aides in the navigational act which orients co-development processes, and incorporating Berque's trajectivity further strengthens the continuous act of inhabitant(s) co-developing with the technologies and space inhabited. We will take a moment to examine Berque's trajectionalism formula that serves as another resource within the semiotic toolbox for the co-development process with a techno-living space.

In Berque's trajectionalism formula, reality equates to an interpreter's predicates of a logical subject; a logical subject as a physical substance that is living and/or non-living, and predicates as being some form of representation. The following block quote elaborates on the ternary relation of reality comprised of an interpreter, the logical subject, and the predicate(s):

> The idea is to go 'beyond' (trans, tra-) the respective limits of the object and the subject, by way of a logical operation in which the physical object (i.e. the logical subject S: that which the matter is about) is taken as a certain predicate P (i.e. as something) through the senses, action, thought and eventually (in the case of the sole human) speech of a certain interpreter I, in a ternary (not binary) relation S–I–P (i.e. 'S is P for I'). The formula of this trajection is: r = S/P, which reads: 'reality r is the subject S taken as the predicate P' (for graphic simplicity's sake, the interpreter I is here only implied, but concretely, the apparent binarity S/P is in fact always ternary: S–I–P). (Berque 2019: 3)

The trajectionalism formula details that predicates of a substance are perceived and understood "as something" by an interpreter (Berque 2019: 3). The meaning assigned by an interpreter to a substance within the environment is seen as relevant for how semiotic scaffolding describes "how organisms continually seek and extract meanings through their interactions within their umwelt" (Campbell et al. 2019: 368). With this in mind, we can turn to Deely's (2004) distinction of things and objects to further establish a bridge for the ternary relation of trajectionalism and with an interpreter's umwelt.

Distinguishing things and objects provide an opportunity to highlight the ternary relation for reality within Berque's trajectionalism formula. The triadic relation of a sign and an interpreter assigning predicates to physical substances is relevant to bridge trajectionalism with semiotics. As Seif (2019: 54) summarises, "Since thinking is in signs, according to Peirce and reiterated by Deely, thoughts mediate between things in the world and our experience of them as objects in our minds." Things are something in the environment that only needs to exist to be a thing (ibid.), and objects exist within the mind and as known in our awareness (ibid.: 85). This connection is in line with the statement that, "Semiotic resources are very much ingrained into an environment as things, but competence is the recollection of objects within the user's mind that allows them to construct a meaning-making act by recombining the resources that exist for the user" (Kozicki 2023a: 88). In other words, a physical substance in an environment, that exists as a thing, can transform as an object for an interpreter by altering and transforming the predicates assigned to the substance. The process for an

interpreter to orient and scaffold what an object represents can go beyond a human-centric perspective and aim towards assigning predicates intended for what surrounds the periphery relative to human inhabitation. How an interpreter describes and assigns predicates to the objects within the context of techno-living spaces can incorporate peripheral semiotic relations that go beyond the centrality of the human inhabitant, which can lead to considering ecological relations as predicates that exist outside of the human umwelt. Distinguishing things from objects are to indicate how the trajectionalism formula (i.e., Reality = Substance-Interpreter-Predicate(s)) is a resource for an interpreter being in the role of a designer during the trajective process of reality.

To exemplify what has been mentioned within this subsection, the article (Kozicki 2025) about Earthships as a type of self-sustainable techno-living space focuses on the role of milieu and Berque's trajectionalism. This article had an aim to analyse what the notion of self-sustainability represents for the process of inhabiting Earthships. The article elaborated on *what* is self-sustainable about inhabiting Earthships and *how* does this inhabitation process harmonise with the surrounding environment? To explore this what and how, milieu served a role to identify what was at the centre and periphery regarding an Earthship's self-sustainable processes, and the trajectionalism formula detailed how this type of inhabitation process continuously developed within a surrounding environment. The organisation that created the concept of Earthships, *Earthship Biotecture*, describes the fulfilment of six human needs to be considered as an Earthship: food, energy, water, shelter, garbage management, and sewage treatment. With these six needs as predicates of an Earthship, the research considered human inhabitation as the centre, and the surrounding ecological relations as the peripheral relations in relation to self-sustainability of Earthships.

Creating an Earthship requires utilising local, natural resources, such as mud and timber, and the transformation of converting end-of-life commodities, such as glass bottles and tires, into practical building materials. In the case of converting end-of-life commodities into building materials, an interpreter alters the predicates on what the substance represents to discover new meanings on how to engage with something that would otherwise potentially end in a landfill. Altering substances perceived as waste in the environment and engaging with them as resources for the building process of an Earthship transforms the predicates of substances in an environment. This spearheads the statement that "Simply put, we can change objects more than we can change things. This is to say that once we change our habitual thoughts about objects, it is much easier to change our perception of things and change them" (Seif 2019: 86). With this said, my aim to describe the distinction of things and objects is to make Berque's trajectionalism formula more accessible as a resource for the semiotic toolbox. We will return discussing Earthships aiming to harmonise with the environment in subsection 3.4., but this subsection exemplifies the process of trajectionalism and milieu as a resource for the semiotic toolbox for inhabitants co-developing with a techno-living space.

3. ANALYSING MEANING-MAKING PROCESSES WITHIN TECHNO-LIVING SPACES

> "Love is not directed to abstractions but to persons; not to persons we do not know, nor to numbers of people, but to our own dear ones, our family and neighbors. 'Our neighbor,' we remember, is one who we live near, not locally perhaps, but in life and feeling."
>
> – Charles Sanders Peirce (1893: 177–178)

The following section examines various aspects of techno-living spaces analysed within the included publications of the thesis. Additionally, the content of this section utilises the semiotic toolbox to examine RQ1 that focuses on how technologies orient inhabitant(s) co-development process with a living space.

The four subsections highlight findings from the included publications of the thesis that relate to how technologies within the living space orient a co-development process. The first subsection describes how the semiotic components within techno-living spaces as a DAU system are interrelated that designers can utilise for design thinking and reiterative design processes. The second subsection distinguishes the roles of narration, interaction, and immersion within techno-living spaces, this subsection highlights how users engaging with various technological artefacts within living spaces can transform meaning-making relations. The third subsection discusses how the co-development process is oriented as a both-and relation when a user is immersed within a virtual environment, while, at the same time, within the physical environment of a living space. The fourth subsection focuses on the centrality and periphery (i.e., milieu) of Earthships as a type of techno-living space that aims to harmonise with the surrounding environment.

3.1. Interrelations of smart home technology as a designer-artefact-user system

The first published article of this dissertation (Kozicki 2021a) derives from the research of my master's thesis on the hierarchical system of affordances in smart homes (Kozicki 2021b). The article explored how the concept of semiotic components (Campbell et al. 2019) for smart homes are interrelated for the meaning-making processes of a DAU system. A smart home is described as a living space with a technological network and system that responds to environmental stimuli to trigger automatic or controlled functionality (Kozicki 2021a). This approach of modelling semiotic components within smart home systems provides design thinking opportunities for designers to enhance their imagination on who the

potential user could be, and to learn about the actualities on how users engage with the artefact. From a designer's perspective, enhancing competence relative to user potentialities and actualities during a design process can lead to strengthening semiotic relations with potential and actual users of smart home technology.

Designers do not always know precisely who the actual user is and how they engage with the designed artefact. During the design ideation process designers utilise imagination to understand who would use this artefact and what sort of characteristics the user(s) may consist of. The potentialities that emerge when imagining future acts of meaning-making resonates with Peirce's term of the rhematic sign, since the rhematic sign is a "sign of qualitative possibility" (*EP* 2:292). The article (Kozicki 2021a) identifies how designers must conceive of a *rhematic user*, which identifies the potential user that can be considered and reevaluated during the design process. To better align with user expectations, design thinking can incorporate characteristics such as biomechanics, cultures, demographics, and user competencies. This provides designers to reflect on the characteristics that a rhematic user is expected to possess.

Users can be modelled as actual users, rather than potential users, when designers gain awareness on who the specific users are and how semiotic activity is contextualised with the designed artefact. The actual user is considered as a *dicent user* (Kozicki 2021a), which relates to Peirce's description of a *dicent sign* as a "sign of actual existence" (*EP* 2:292). Regarding the dicent users of a smart home system, the article (Kozicki 2021a) identified there are various types of users that have certain privileges related to the functions of artefacts within a smart home system – Fig. 2 within the introduction also described the types of users. Distinguishing the types of users can lead to designers understanding that not all the users interact and construct meaning with the technologies as the other users within the living space. For instance, the individuals that take on the role of administrative users, the children or visitors that may have limited access to the smart home system as a user (or even a pet bird that uses mimetic language to interact with a smart home assistant), and service users that perform installation and maintenance processes (Kozicki 2021a). With this said, there is a transformation in the designer's ability to formulate how the perceived potentialities emerge as actualities when modelling user experience. Modelling potential and actual users can lead to strengthening a reiterative design process to embrace the unexpected outcomes that emerge during meaning-making events within a contextualised environment.

Utilising the semiotic components as an apparatus, as described in subsection 2.2., can strengthen the interrelations of designers, artefacts, and users once there is more of an understanding on how a technological artefact is integrated and contextualised within a living space. Semiotic components for a DAU system strengthen the relations for designers with users that transition from the conception of potential, rhematic users to actual, dicent users. Additionally, a designer's semiotic components relative to a user are altered once there is more of an understanding on who the potential user could be versus who the actual user is. This transformation of semiotic components from the designer's perspective

can lead to strengthening their relation to support the co-development process on how the integrated technologies orient meaning-making processes. This is elaborated in the article focused on the semiotic components of smart home systems as a DAU system (Kozicki 2021a), and the thesis takes the stance that this is relevant for the concept of techno-living spaces.

3.2. The roles of narration, interaction, and immersion within techno-living spaces

This subsection identifies the roles of narration, interaction, and immersion on how technologies within the living space can orient meaning-making processes. Incorporating the notions of narration, interaction, and immersion provides the ability to examine how the meaning-making process with a text is contextualised within the living space by a user(s). The content of this subsection is an extension of the article (Kozicki 2023a) to elaborate how communication processes and user interactions have transformed due to the technologies integrated within living spaces.

The aspects of narration, interaction, and immersion are related to a user engaging with a text within the context of a living space. Narration within the living space emerges as messages brought into existence within the space that can orient meaning-making processes. The narrative process also provides the opportunity for the boundaries of the sociological bonds within the living space to become blurred with the cultural relations that go beyond the individual living space. In other words, artefacts that narrate messages bring outside texts into the local system of a living space. This resonates with Cecelia Tichi's (1991) description of the television as being modelled as an "electronic hearth" while this artefact was entering the US market in the late 1940s as a household commodity (Gaines 2006). The radio is another example of inhabitants gaining awareness of events that are happening beyond the local system of a living space. Both the radio and television altered the way information is disseminated within the living space, which impacts the inhabitants' semiotic relations with the surrounding environment and the habitual behaviours of the inhabitants. With respect to certain cultural norms and architectural layouts, a hearth can offer inhabitants warmth, relaxation, and a place to share ideas, experiences, and stories; the television commodified as an electronic hearth emerged as the new centre piece that could be integrated into living rooms. As Elliot Gaines (2006: 179) reiterates, "Ultimately, spatial aspects of things in the world have a profound impact on the way we interpret things in our daily lives." With this said, technologies providing inhabitants the ability to perceive and interpret texts establishes a narration that is expressed from beyond the localised system of a living space.

The notion of interaction is significant for user experience (UX) and user interface (UI) for a user performing a meaning-making process with an artefact. Within the scope of digital technologies, interaction largely relates to an artefact

consisting of screen technology, for example, televisions, computers, smartphones, and smartwatches. Kristian Bankov mentions, "The screen, after all, becomes the key to a new, revolutionary phase in the representation of narrative, since its reality effect is beyond compare" (Bankov 2022: 52). Think of how the habitual actions of watching television has changed over time, for decades it was only possible to watch certain content aired at specific times, this led spectators having to alter their actions in relation to the time of the television program. Now, think of how interacting with the television has changed over the recent decades. Innovative technologies such as the remote, digital video recorder (DVR), and streaming services have altered user interactions in terms of time and space. Video streaming services on transportable artefacts (e.g., a laptop or smartphone) gives users the opportunity to watch video content wherever and whenever it fits their schedule, it removes the constraint of structured programming and opens into the infinite potentiality of a user binge watching. Expanding on the prior paragraph's example of the narrative role of watching TV, the various interactions with a TV is no longer fixed in a specific place with a set schedule of when certain programs will be aired. Overall, the means in which a user interacts with an artefact within the living space orients meaning-making processes[8].

Immersion, within the context of this thesis, entails a form of digital environment that the user can perceive and interact in various semiotic activity. An immersed user experiences co-development processes with both the physical and hyperreal environments, which is elaborated in subsection 3.3. Although this both-and relation of being immersed is discussed in the next subsection, it is important to emphasise that, while being immersed, the user's agency is oriented by both the physical and hyperreal environments (Kozicki 2023a). This both-and relation of agency can lead to the alteration of physical spatial characteristics in the living space intended to generate more positive outcomes while being immersed (e.g., not breaking or running into things in the physical environment). Immersive technologies, such as VR and augmented reality (AR), can alter users' perceptual process of stimuli within the living space (ibid.). We can return to the example of watching TV used to describe narration and interaction, within the online virtual world platform *VRChat*, first released in 2014, it is possible to watch visual media in VR as if you are a spectator in a theatre. Experiencing a movie within one of the many virtual worlds in VRChat transforms the user experience of watching visual content. Although the user may physically be somewhere in the living space using the VR headset, the immersive environment is where the user perceives the visual content, and this immersive experience is oriented by the stimuli in both the physical and hyperreal environments.

The purpose of describing the roles of narration, interaction, and immersion is to make explicit how a user can generate meaning with an artefact within the

[8] A unique example of perceptual affordances for an umwelt is how interacting with the Delboeuf illusion, formed by two or more concentric circles, can impact how a user perceives and interacts with circular dinnerware (e.g., plates and bowls) which may lead to overserving or underserving a portion of food (cf. Kozicki 2023b: 156).

living space. These three roles are important to provide a deeper understanding on how technologies within living spaces can orient meaning-making processes, albeit through means of narration, interaction, and immersion. Additionally, describing these three roles intends to engage with the paradoxicality that orients how inhabitants co-develop with their techno-living space by both the physical environment and the digital environment(s) integrated within the living space.

3.3. Co-developing in immersive virtual environments as epitome of 'both-and' modelling

To begin this subsection, what does it mean for an individual's meaning-making process to be in two places at the same time? This question relates to the experience of being immersed, which I find to be a topic that has not been extensively explored within semiotic discourse. Technologies associated with the metaverse, VR headsets, and AR glasses, are examples of contemporary digital artefacts for how hyperreality is impacting the contemporary understanding of reality. Seif (2012: 60) expresses that the paradox of physical reality and hyperreality is paramount with the engagement of new media as a hyperreal transcendental reality. To examine Seif's statement, the article (Kozicki 2023a) introduces the term umwelt in an umwelt[9] to show how Kull's (1998) semiotic ecology becomes paradoxical when an individual is mediated simultaneously within a physical and digital environment.

To model the paradoxicality of immersion there requires a grounding of both-and, because an individual's umwelt is situated within a physical environment, while also engaging with signs emerging from hyperreal environments. Being immersed within immersive virtual environments (IVE) does not substitute the physical environment, however, an individual's meaning-making process becomes dually oriented towards the perceptual process for both physical and hyperreal environments. The significance of the umwelt in an umwelt (Kozicki 2023a) has been recently utilised by other publications, such as examining users' kinetic movement while experiencing a cinematic text in VR (Fawzy, ElSamadoni 2024), and the phenomenological impact of digital environments for museums as a form of virtual tourism (Palmer 2023). As Catherine Palmer (2023: 5) conveys the relevancy of the umwelt in an umwelt for virtual museums, "the virtual-tourism-world is not an alternative to the physical world but one that merges and overlays the physical with simulated images of the physical."

The article (Kozicki 2023a) expresses that immersion emerges from four aspects experienced by a human umwelt. The four aspects include the grounding of both-and, textuality, agency, and environmental mapping. I will briefly elabo-

[9] The article (Kozicki 2025[2023]) is a translation in Chinese for the article (Kozicki 2023a) that discusses the notion of umwelt in an umwelt.

rate on how these four aspects are relevant for immersion as a both-and process that orients meaning-making in physical reality and hyperreality.

As mentioned above, being immersed within an IVE is not a substitution of a physical environment, rather, immersed users are situated in both physical and hyperreal environments. The both-and aspect of immersion is fundamental to model user behaviour for co-development processes on how meaning-making processes are oriented when a user engages with an IVE within the context of a living space. Additionally, the both-and modelling is relative to paradoxical thinking in the de-sign process, as described in subsection 1.1., which can assist designers and users in the navigational process of unexpected outcomes that emerge for both physical and hyperreal environments.

The aspect of textuality for immersion predominately focuses on texts within the notion of new media. Seif (2012: 65) conveys that new media represents cultural objects and events and "provides the possibility to meaningfully modify them" and goes onto mention that "consequently, we may need to rethink the nature of reality itself" (ibid.). Textuality within the scope of new media can emerge as imaginative possibilities for a creator, the transformation of a text within immersive environments goes beyond the stance of being a replica, but instead, becomes a meaning-making event perceived as a real experience. For instance, the article (Kozicki 2023a) elaborates that what we understand as a music concert has transformed within the age of new media. The video game *Fortnite* offered players the experience of attending music concerts within the video game platform. Although the spectacle is pre-programmed and does not require the artist to perform live, the spectators perceive this experience as a concert (ibid.: 95). Attendees of the virtual concert can upload videos on web platforms, such as *YouTube*, to share their experience and reactions of attending a music concert within Fortnite. Thus, a unique example of how experiencing a virtual concert in the game Fortnite transforms as a new text within another hyperreal environment when a user's experience is uploaded on YouTube.

The third aspect is the immersed umwelt (i.e., umwelt in an umwelt) having a form of agency that is a two-fold mediation within the physical environment and within an immersive environment. "An immersive experience requires the user to have agency within a text, but also in relation to the things within the physical boundaries" (Kozicki 2023a: 95). Users can decide where within their living space to engage with immersive technology to potentially ensure a positive outcome. For instance, deciding the optimal location within the living space where the user would not injure themselves or damage any household objects. This optimised affordance can vary per type of meaning-making event, such as if the user needs remove any coffee tables or lamps to positively afford physical mobility that impacts an immersive experience. As another example, a user may seek out a quiet area within the living space so the auditory stimulus within the immersive environment becomes more prevalent. These two examples intend to indicate how meaning-making events for immersive environments within the living spaces are a two-fold mediation, and the experienced events requires certain affordances that impact both the physical and hyperreal environments.

Environmental mapping, as the fourth aspect of immersion, relates to a user invoking memory and imagination that models and conceptualises the environmental stimuli and perceived boundaries of a virtual space. Within the case of virtual worlds in VRChat, each virtual world is a one-of-a-kind environmental system filled with characteristics and semiotic relations that become mapped out, mentally speaking, by users. Additionally, environmental mapping relates to users remembering characteristics of the physical space while immersed, such as possessing the memory of what exists within the physical environment to potentially deter from any negative outcomes to emerge. Simply put, the phrase "where is what?" relates to the relevancy of environmental mapping, and immersion entails environmental mapping for both the two-fold mediated environments regarding the paradox of physical and hyperreality. Environmental mapping relates to the statement that "semiotic resources are very much ingrained into an environment as things, but competence is the recollection of objects within the user's mind that allows them to construct a meaning-making act by recombining the resources that exist for the user" (Kozicki 2023a: 88).

3.4. Earthships aiming to harmonise with the environment

The most recent published article (Kozicki 2025) examines the concept of Earthships as a type of self-sustainable living space and utilises a lens of ecosemiotics, as the "semiotic framing and interpretation of real-life processes of nature" (Tønnessen 2020: 91). The concept of Earthships originate in the 1970s by Michael Reynolds, an architect that also established an Earthship community in Taos, New Mexico. Reynolds founded the organisation Earthship Biotecture which allows individuals to purchase blueprints and even attend courses on sustainable building processes for constructing Earthships.

The article (Kozicki 2025) categorises the resources for constructing an Earthship into two forms, local and non-local resources. Categorising local and non-local resources intends to focus on what substances – related to Berque's (2019) trajectionalism formula – are in proximity of the surrounding environment for constructing an Earthship. Local resources are substances in the surrounding environment, and non-local resources exist outside of the local environment that requires a relation to supply chains with stakeholders throughout various environments (Kozicki 2025). For instance, used tires are a common building material for Earthships to create berms that form three sides of an Earthship – the fourth side consisting of glass to let sunlight for an interior greenhouse. Each tire tamped with dirt to increase thermal mass before they are stacked atop one another, this process is labour intensive but provides heating and cooling processes for the Earthship. Interpreting substances as local or non-local resources, such as used tires within or beyond the surrounding environment, provides insight to strengthen ecological awareness. This leads to creators becoming more aware of the substances in the surrounding environment that can be enacted as semiotic resources to learn and discover opportunities to utilise what exists within a local sur-

rounding. The content of this article (ibid.) aimed to elaborate on how substances utilised as semiotic resources within an environment are relevant for the distinction of things and objects, as mentioned in subsection 2.4. This approach is considered in line with how, "the role of design and signs in apprehending the distinction between the real and the true, and the relationship between objects and things, is the only path we have to creating experience that transcends the insistence on absolute reality" (Seif 2019: 284).

A central aspect of this article utilises Seif's (2019) notions of de-signers and de-sign agency to strengthen ecological awareness and sensitivity. The article focuses on the de-sign agency of individuals who navigate in the continually unfolding process of co-developing with the environment while constructing and inhabiting an Earthship. This is in line with Seif's statement that "De-sign agency is a navigational process towards a desired future" and how de-signers as "agents acting-on-behalf-of-others, should be capable of performing with a sense of integrity" (Seif 2022: 288). To bring the concept of de-sign agency more towards a state of applicability for this article I utilised Kull's model of semiotic ecology as one of the tools within the semiotic toolbox. As described in the article, "Kull's model of semiotic ecology can assist the means of self-sustainability towards orienting ecological meaning-making processes that go beyond the centrality relative to the needs of human inhabitation" (Kozicki 2025: 153). Going beyond the centrality of human inhabitation relates to how milieu consists of a centre and a periphery, which the article framed human inhabitation as the centre and the ecological relations as the periphery. This bridge identified in the article for de-sign agency and semiotic ecology reinforces that "as creators that can alter ecological relations surrounding our existence, we can utilize de-sign agency […] to go beyond our subjective needs to orient acts of creation for beings within a shared environment" (ibid.: 158).

Examining the co-development process between the inhabitant and the surrounding environment for this article aimed to go beyond a cultural analysis and focus more on a mesological understanding. Incorporating mesology and the notion of milieu allowed the research to keep in mind the trajectory of what-is-yet-to-come for an inhabitation process to live in balance, a harmony, with the surrounding environment. Taking the trajectionalism formula described earlier in the thesis within the semiotic toolbox, the following statement examines how the formula was applied for Earthships harmonising with the environment:

> [I]f an individual and/or a collective aim to have their reality (r) in balance with the environmental relations for their inhabitation, then what things as substances (S) are understood for self-sustainable purposes? Furthermore, what are the predicates (P) to reinforce the self-sustainable processes beyond the perspective of the human inhabitant? (Kozicki 2025: 158)

Additionally, the following block quote highlights the centrality and periphery for the process of constructing and inhabiting an Earthship as a type of self-sustainable living space:

> The dynamic process to live self-sustainably and in a harmonious balance with the surrounding environment requires an understanding of: a) how self-sustainability is oriented for Earthships, b) how the resources used for self-sustainable processes are reliant on environmental characteristics, and c) how our means to endure self-sustainability is a social and semiotic process that orients the unfolding acts of how we co-develop with the ecological system we, as individuals and a collective, live within. (Kozicki 2025: 138)

Overall, gaining awareness as builders, inhabitants, policy makers, manufacturers, and additional stakeholders, can strengthen our ecological awareness and sensitivity to what it means to live self-sustainably. Design processes aimed towards self-sustainability "can lead to strengthening awareness that our descriptions for what is represented can change, and when we gain more understanding on how to engage with the substances around us in our surrounding there emerges a potentiality to alter the meaning ascribed to the various resources" (Kozicki 2025: 145). The complexity of an inhabitant to live self-sustainably is two-fold. We must ensure our own lifeworld is nurtured to develop, but this requires a semiotic and social awareness of the peripheral ecological relations that the state of inhabitation is mediated within.

4. CONCLUSION AND TAKEAWAYS

> "The very act of dwelling in or inhabiting someplace presupposes an identification with its environment, which makes us feel at home and contributes to the spirit of place, the genius loci. By integrating cultural patterns and environmental characteristics through the de-sign process, the immanently emergent qualities contribute significantly to place-making and animate the spirit of place".
>
> – Farouk Seif (2022: 300)

The quotation above by Seif is a fitting statement to wrap up this research focusing on the de-sign process of inhabiting techno-living spaces. As this overview article outlines, inhabitants taking on the role of a de-signer can utilise the semiotic toolbox for navigating the co-development process with techno-living spaces. This thesis aimed to highlight theoretical resources for humans, as individuals and a collective, to traverse linear and non-linear processes intending to support a) how we live within a technologically rich space, and b) how we co-develop and orient the local environment that surrounds us. Returning to a statement mentioned at the beginning of the research, minimising global risks and challenges that may unexpectedly emerge is a collective effort, but individuals can harness their abilities within a local system to better understand how each of us contribute towards a trajectory for a future moment.

The content within this conclusion section expands upon the two research questions addressed in the thesis. The section also provides three significant takeaway statements related to the semiotic toolbox to support future research and design endeavours regarding co-development processes for inhabitants and their techno-living spaces.

RQ #1: How do technologies within the living space orient co-development processes?

Within this research, technologies in the context of living spaces relate to the construction process of using resources to build a living space and to the wide range of household artefacts appropriated and engaged with by inhabitants. As inhabitants we may not always be involved in a dialogue with a designer during the ideation and construction of a living space, this reinforces the stance that designers do not always know *who* (i.e., as the dicent user) the living space will be inhabited by. When an individual starts moving into a living space, or even imagines the moving in process, an imagination process emerges to model spatial relations, such as interpreting "what goes where" and to mentally arrange objects

within the physical characteristics of the living space – in my case every time I move, I face the question of where will the piano fit? An imaginative process can also invoke modelling temporal relations, to use the example of a piano in a living space, reflecting on "when can I use the piano" can orient the scaffolding of future meaning-making events. The person who plays the piano might perceive it as acceptable to play any time of day. However, imagining how playing the piano at certain times can potentially emerge as negative affordances for others in the surrounding environment can orient how and when an individual would engage with the piano within the living space. As another example on how imagination relates to technologies integrated within a living space, we can think of a parent imagining what their child is doing in their room while interacting with a smartphone, computer, or another digital artefact. This example intends to portray the role of dialogue for the parent and child to strengthen an understanding on the meaning-making events pursued by a child using a digital artefact within their room. Although these examples are outside the scope of the thesis, utilising the de-sign process and the semiotic toolbox within this research is considered to assist in the unique meaning-making events that emerge in our techno-living spaces. Section 3 of this overview article describes how a semiotic toolbox can be enacted as a resource to orient the co-development process of inhabiting techno-living spaces.

The role of affordances is considered to serve two crucial purposes that orient how inhabitants co-develop with techno-living spaces. First, modelling affordances is a process that is applicable for practitioners in both academia and industry. As elaborated in Kozicki (2023b), it is a way for researchers and designers to navigate through the paradox of real versus true within the context of living spaces. This paradox of true versus real concerns the quantifiable characteristics of something within the living space (i.e., what is true) and the qualitative outcomes for what is perceived and described (i.e., what is real). Second, affordances, as one of the four semiotic components (Campbell et al. 2019), allow inhabitants to engage with semiotic resources to discover and learn about unique action-potentialities (affordances) that can emerge in the context of a living space.

Stakeholders of a techno-living space (as a DAU system) can navigate towards what is described as desired affordances within a living space, while aiming to reduce any potential negative affordances that may emerge, to orient how inhabitants can discover ways to engage with semiotic resources in the living space. This is precisely where the four semiotic components as an apparatus (Campbell et. al 2019) can support the co-development process of inhabitants and their techno-living space. The articles within the thesis have analysed the semiotic components related to interactions with smart home systems (Kozicki 2021a), being immersed in VR (Kozicki 2023a), users perceiving and interacting with household objects (Kozicki 2023b), and transforming end-of-life commodities in the environment as building materials (Kozicki 2025).

RQ #2: How can de-sign be utilised as a navigational compass for human inhabitants co-developing with their techno-living space?

This research considers de-sign as a navigational compass that can be harnessed by inhabitants to expand semiotic relations into the periphery of what surrounds their place of inhabitation. The thesis aimed to not concretise an anthropocentric design process, paradoxically, we must understand how we alter the world beyond our subjective experience. This includes how we identify, describe, and transform what the signs represent in the surrounding environment to go beyond our self and our fellow human inhabitants.

As elaborated in Section 1, Seif's (2019) de-sign serves as a process for designers and inhabitants to navigate towards outcomes using linear (deliberate acts) and non-linear (intentionality) processes during the co-development with a techno-living space. The thesis highlights integral characteristics of de-sign for this research, such as the modelling of both-and for paradoxical thinking, the notion of transparency, de-sign agency, "playing with" disciplinary boundaries, eco-humanistic metamorphosis, and the distinction of true versus real. The description of de-sign in Section 1 emphasises how inhabiting techno-living spaces can be further navigated, by taking on the role of a de-signer, to persevere through the paradoxical nuances that an inhabitant may experience.

As described in Section 2 of the thesis, utilising a semiotic toolbox offers a practical approach for researchers, designers, and inhabitants, to strengthen and reinforce semiotic relations for techno-living spaces as a type of DAU system. This thesis utilised three tools within the semiotic toolbox to examine the de-sign process of inhabiting techno-living spaces. The semiotic ecology model (Kull 1998) helps to distinguish the four degrees of nature relative to human semiosis and an environment, whether semiosis emerges within a physical or hyperreal environment (Kozicki 2023a). The four semiotic components (Campbell et al. 2019) consisting of semiotic resources, competence, affordances, and semiotic scaffolding are significant for co-development processes of an inhabitant and their living space, and for strengthening semiotic relations between designer(s) and user(s) (Kozicki 2021a). The formula of trajectionalism (Berque 2019) offers insight on the unfolding process of reality that consists of a ternary relation of physical substances, predicates of substances, and the interpreter who assigns predicates to the substances.

There are three takeaway statements emphasised in bold that emerged from analysing the second research question. The three statements correlate with the significance of the semiotic toolbox that supports de-sign as a navigational compass for inhabiting techno-living spaces. These statements serve as practical takeaways that designers, researchers, and users can take into consideration to further navigate the process of inhabiting techno-living spaces. The three statements are intended to be a recap of what has been previously discussed in the framework article of the thesis and in the included publications.

The four semiotic components and the de-sign process can strengthen the interrelations between the agents in a designer-artefact-user system. This aspect is significant for strengthening feedback and feedforward reiterations in

communication processes that may become constrained once a user implements a technology into their living space. The semiotic components as an apparatus (Campbell et al. 2019) consisting of semiotic resources, competence, affordances, and semiotic scaffolding give insight on how an individual engages with the signs in relation to a living space and its surrounding environment. Utilising the semiotic components can assist designers to discover and learn about unexpected outcomes that emerged for actual (dicent) users, which designers may have been unaware during the modelling of the potential (rhematic) users (Kozicki 2021a). This is significant for designers to gain insight on how their artefact is appropriated and interacted within the context of a living space. Keeping the four semiotic components in mind during the early design stages can establish a wider range on who the rhematic user(s) may consist of, and this allows designers to evoke imagination on aspects such as:

- how a designer's imagined characteristics of an intended user leads to a framing of who could be the potential user of the designed artefact.
- how potential users could potentially engage with the artefact within their contextualised living space.
- what are the needs of the potential user(s) that the designed artefact is expected to fulfil.
- what problems does the designed artefact aim to solve for potential users, and what unexpected outcomes may emerge once the artefact is engaged with by a user.

These bullet points intend to stress how semiotic components can be integrated into a designer's imagination on how user experience is modelled. With this said, invoking the semiotic components while modelling a potential user can lead to new semiotic relations once there is a deeper understanding on how actual users engage with the designed artefact. Subsection 1.2. highlighted additional bullet points to express how imagination relates to designers and users within a DAU system.

Semiotic ecology for design processes allows meaning-making to go beyond a human-centred focus. The thesis utilises Kull's (1998) model of semiotic ecology to examine how inhabiting techno-living spaces relates to an inhabitant's imagination, perception, description, and alteration of the environment. As described in the article (Kozicki 2023a) and in subsection 3.3., the four degrees of nature in Kull's (1998) model can be understood as not only being relevant for physical environments, but also in terms of experiencing and constructing meaning within immersive virtual environments.

The article (Kozicki 2025) examines how semiotic ecology is a process that can support the role of being a de-signer. The article conveys how the act of creating and inhabiting an Earthship as a self-sustainable living space entails a both-and process for societal and ecological relations for the predicates described as *what is* self-sustainable. To recap this aspect of the article, a societal perspective

of a self-sustainable process "focuses on empowering an inhabitant to gain more autonomy from societal grid-like dependencies", while the ecological perspective "reinforces the process to strengthen meaning-making relations for the various biological agents within the environment" (ibid.: 156). With this said, the thesis takes the stance that semiotic ecology is a viable resource within the semiotic toolbox for de-signers to go beyond the centrality of human inhabitation and to embrace peripheral semiotic relations with the surrounding environment.

The centre and periphery of milieu encompass a both-and relation for paradoxical thinking that can assist with the contextualisation and orientation of co-development processes. This last takeaway statement relates to the article (Kozicki 2025) that exemplified how objects perceived as waste can transform into building materials to build an Earthship. Subsections 2.4. and 3.4. of the thesis overview described the notion of milieu and the relevance of Berque's (2019) trajectionalism formula. The article (Kozicki 2025) discusses how various end-of-life commodities within the surrounding environment can be utilised as semiotic resources to discover unique meaning-making opportunities, such as used tires and plastic bottles being integral materials for constructing an Earthship. This takeaway can support future research focusing on specific substances within an environment and even community-led workshops to discover new ways to engage with semiotic resources that exist within a local environment. As highlighted in the article about Earthships harmonising with the environment, "the milieu in our environment is oriented by social, cultural, and political narratives that frames our knowledge and dialogue, which can limit the field range of potentiality on how we co-develop with the environment" (Kozicki 2025: 155).

To recap the dissertation in these final paragraphs, the research aimed to utilise semiotics components to examine how the semiotic ecology of human inhabitants orients the co-development process and milieu with environment lived within. Paradoxically, the environment of a techno-living space is not merely physical but can also be grounded in hyperreal environments due to digital technologies (e.g., VR and computers) that an inhabitant engages with semiotic components in both physical and hyperreal environments. To reiterate a statement from subsection 1.1., the cultivated trajectory of humanity co-developing with the environment cannot afford to lose its ecological direction (Kozicki 2025) and the process of co-development can be strengthened by the grounding and pursuit of both-and modelling for paradoxical thinking.

Navigating towards any perceived desired qualities for both the *lived within* and *living with* the environmental context is considered as attainable for de-signers. This both-and process entails that individual stakeholders, albeit the inhabitants or designers, can embrace the central and peripheral emergent outcomes relative to semiosis with techno-living spaces. As described in this thesis, being in the role of a de-signer with a techno-living space is navigated by the semiotic tools of semiotic ecology (Kull 1998), the trajectionalism of milieu (Berque 2019), and semiotic components (Campbell et al. 2019) of resources, affordances, competence, and scaffolding. These theoretical contributions can provide a viable approach, as resources within a semiotic toolbox, for various stakeholders of

DAU systems to engage with the complex and dynamic process of inhabitants co-developing with their surrounding environment.

To conclude, the de-sign process is utilised within this research as a navigational act for the unfolding process of inhabiting a techno-living space to go beyond the centrality of human semiosis. The thesis describes a navigational compass and a semiotic toolbox for individuals to pursue the role of de-signers aiming to strengthen and sustain meaning-making processes on how human inhabitation impacts the physical space lived within.

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SUMMARY

The dissertation introduces the concept of techno-living spaces, and provides a set of applicable concepts, as a semiotic toolbox, for designers and users in the design and inhabitation process of techno-living spaces. The semiotic toolbox is intended to support the development of semiotic relations from our individual perspectives, as meaning-makers, while integrating semiotic relations within the surrounding environmental context of a techno-living space. The concepts applied within the semiotic toolbox include the notion of milieu and its role for the trajectory of reality (Berque 2016; 2019), the four semiotic components as an apparatus for how a subject co-develops with their environment (Campbell et al. 2019), and the concept of semiotic ecology to examine how human semiosis relates to the surrounding environment (Kull 1998). The novelty of this dissertation examines how human inhabitants can orient and navigate meaning-making processes to co-develop with techno-living spaces and for what surrounds an inhabited techno-living space. As shown in this research, Seif's (2019) concept of de-sign is used as a navigational process to assist individuals, who take on the role of de-signers, during the trajectory of inhabiting and co-developing with techno-living spaces. The research method incorporates de-sign and the semiotic toolbox as resources that can strengthen semiotic relations for designers, artefacts, and users related to the concept of techno-living spaces. The aim is to not concretise an anthropocentric design process, paradoxically, we must understand how we alter the world (*Umgebung*) outside of our subjective experience by searching within ourselves to identify, describe, and transcend what the objects represent for our reality (*Umwelt*). Utilising the de-sign process and the semiotic toolbox for design practices involving various stakeholders is seen as beneficial for social and ecological relations during the co-development process with the surrounding environment and the inhabited space. The research outcomes are considered as useable concepts for creators to gain understanding on how users engage with the designed product, while at the same time, providing users with a set of semiotic resources to strengthen the roles of learning, imagination, and creativity to co-develop with techno-living spaces.

Publication I) Kozicki, Alec 2021. A semiotic model for smart home affordances: Trajecting semiotic components in a technological living environment. In: Suárez-Puerta, Bianca; Merkoulova, Inna (eds.), *Reflections on Paths, Scenarios and Semiotic Methodology Routes*. IASS-AIS, 204–226.

The four semiotic components within a smart home examines how the meaning-making process can be strengthened between the designer, the user, and the smart home system. The four semiotic components of resources, affordances, competence, and scaffolding (Campbell et al. 2019) offer an approach to implement how an organism co-develops with their environment. For this thesis, semiotic

components are the building blocks for semiosis and considered as a practical tool for bridging biosemiotic theory and design processes. Each environment will contain its own unique semiotic components that is perceived by a living interpreter, and in the context of smart homes, this ambiguous term allows the interpreter to perform meaning-making activity to construct a smart home system. The process of creating a smart home can vary per the semiotic components of designers and users; someone programming their own smart home system is largely reliant on their competency in programming language, while someone who is paying for a smart home technician for installation is constrained by other unique semiotic components. Semiotic components in the context of smart home technology can lead to designers evoking an imaginative depth on how a user will engage with their designed artifact, while providing users with a means to discover and learn new threads of semiosis on how to engage with the smart home system.

Within the article there is a distinction between a rhematic (potential) and dicent (actual) user. This relates to Peirce's description of rhematic and dicent signs and provides designers with insight on how the semiotic components transition from a generalised potentiality (the rhematic user) and into a peculiar actuality (the dicent user). Modelling user engagement on the level of potentiality and actuality leads the designer to strengthen their relations with the users who engage with the artifact and to learn of the unexpected outcomes that can be reinforced within the continuous design process.

Publication II) Kozicki, Alec 2023. Umwelt in an umwelt: Co-developing within immersive virtual environments and the paradoxical nature of reality and hyperreality. *Sign Systems Studies* 51(1): 73–100.
https://doi.org/10.12697/SSS.2023.51.1.03

The growing industry and collective consumer awareness of virtual reality (VR) technology is a contributor for what is known as Web 3.0 technologies. From a physiological perspective, immersive environment technology can be modelled to orient and alter the basic needs of an individual, such as the effects of owning virtual lang, working in a virtual space, and the means of entertainment within an immersive environment. This paper analyses the distinction and paradoxical relation of physical space with hyperreal space, which are both competing for engagement of an individual's semiotic reality and semiotic components (Campbell et al. 2019).

Virtual reality technology is modelled in the paper as an artifact within the domain of smart home technology since users are known to mediate themselves within the comfort of their living space. Users within an immersive environment perform self-reclusion of the physical living space to transcend as an avatar into a virtual realm. Paradoxically, this paper sheds light on how immersion into a virtual space possesses four degrees of "nature" (Kull 1998), and how habitual use can be seen to contain a level of "realistic nature" due to users being able to engage in reproduceable experiences within a virtual environment.

Publication III) Kozicki, Alec 2023. Affordance and *Ton*: The meaning-carriers of semiosis. In: Kõvamees, Erik; Miyamoto, Oscar; Randviir, Anti (eds.), *Concepts for Semiotics II*. Tartu Semiotics Library 24. Tartu: University of Tartu Press, 149–165.

This article discusses the theoretical boundaries related to affordances and Jakob von Uexküll's (1982) use of *Ton* (tone), the distinction between these two terms relate to the paradox of true versus real (Seif 2012). Theoretically, affordances are integral for objectivity of physical characteristics and are grounded in the notion of 'true'. The modelling of affordances requires a contextualised boundary perceived by an organism within an ecological space, this is where James Gibson's (1986) concept of affordances is viewed not only as an objective nature, but as a subjective process within an ecological setting that enacts the perceptual function. The coupling of the environment and the organism within it become co-developed, and the embodiment of subjective meaning is linked to the umwelt within an ecological realm (Campbell et al. 2019).

A crucial aspect discussed in this article relates to how an affordance and *Ton* (tone) differ. Building from what Uexküll (1982) describes, a tone emerges and exists within an umwelt, and the tone is not inherent to the environment since the organism must know the convention on what the ranked characteristics of the perceived object represent as being a means of a 'meaning-carrier' – in this sense, a tone is 'real' as opposed to affordances fitting into the notion of what is 'true'. This distinction helps to further examine the qualitative aspects on how a subject engages with something that induces a behavioural function within an environment, which provides a theoretical depth to help bridge how design practices and semiotics model affordances.

Publication IV) Kozicki, Alec 2025. Earthships as a de-sign process to harmonize with the environment. *Semiotica* 267: 135–161. https://doi.org/10.1515/sem-2024-0191

This article examines the concept of Earthships and utilises Berque's (2019) trajectionalism to analyse how self-sustainable living spaces can harmonise with the surrounding environment. The theoretical aspect of this research brings together Seif's (2019) de-sign process, Kull's (1998) model of semiotic ecology, and additional insight (Bookchin 1982; Norman 2023) regarding design practices and the ecological system. In sum, this article expresses the process of inhabitants that are aiming for harmonisation with the living space and the surrounding environment.

The technologies associated with an Earthship is the central focus to understand how self-sustainability is being described and implemented, which leads to the intention on providing sustainability beyond the inhabitants' self and into the ecological domain. The reused materials to construct an Earthship, including tires, cans, and bottles, are novel ways to transform the teleology of an object that

would otherwise be perceived at the final stage of their life cycle, but this should be modelled in relation to what is framed as a resource that presently exists in the local environment (Kozicki 2025).

There is a connection made with Seif's (2010) use of eco-humanistic metamorphosis, and this article brings into discussion how the concept of milieu is relative to Seif's (2019) de-sign process and de-sign agency. The contribution of this article intends to show how potential inhabitants orient their process for co-developing with their techno-living space.

KOKKUVÕTE

Tähendusdisaini protsess tehniseeritud elamisruumides

Käesoleva doktoritöö eesmärk on arendada mõningaid semiootilisi vahendeid, mida disainerid saaksid kasutada eluruumide disainiprotsessis. Nende kaudu saab kaasata inimest kui tähenduste kujundajat, võttes samal ajal arvesse ümbritseva keskkonna konteksti seotust disainiprotsessiga. Uurimistööd suunab praegune antropotseeni ajastik, kus rõhk on inimeste suhestumisel erinevate tehnoloogiate kaudu keskkonnaga, milles nad elavad ja millega koos arenevad. Oluline seos biosemiootika ja disaini vahel tugineb Seifi (2019) tähendusdisaini (*de-sign*) kontseptsioonile. Teoreetilise aluse tugevdamiseks on kasutatud ka teisi käsitlusi, sealhulgas mõistet „miljöö“ kui reaalsuse trajektoori kujundajat (Berque 2016, 2019), nelja semiootilist komponenti kui subjekti ja tema keskkonna koosmõju aparaati (Campbell jt 2019), ning semiootilise ökoloogia kontseptsiooni inimese semioosi ja keskkonna vaheliste seoste uurimiseks (Kull 1998). Uurimistöö uudne panus seisneb semiootilises ja disainipõhises lähenemises sellele, kuidas inimene suhestub, kohaneb ja areneb koos keskkonnaga, milles toimub tema tähendusloome – fookuses on tehniseeritud elukeskkonna käsitlemine kui disaineri–artefakti–kasutaja süsteem. Eesmärk ei ole kinnistada antropotsentristlikku disainipraktikat, vaid mõista, kuidas muudetakse ümbrust väljaspool oma subjektiivset kogemust, otsides samas võimalusi mõista, kirjeldada ja ületada objektide tähenduslikkust omailmas. Biosemiootika teooriate rakendamine disainipraktikatesse võimaldab käsitleda disainiprotsessi kui pidevalt avanevat protsessi, mis sünnib subjekti ja keskkonna vastastikusest seotusest. Biosemiootikas olevate kontseptsioonide arendamine erinevaid osapooli kaasavateks saavutatavateks disainipraktikateks võib olla kasulik, et parandada sotsiaalset ja ökoloogilist koostoimet ning pakkuda võimalusi ühiseks arenguks tehniseeritud keskkonnaga, milles elatakse ja mida kujundatakse. On oluline, et loojad ja kasutajad võtaksid omaks tähendusloome käigus ilmnevad ootamatud tulemused. See on loojate jaoks praktiline, et saada parem arusaam sellest, kuidas eeldatav kasutaja disainitud tootega suhtleb, pakkudes samal ajal kasutajatele sisukaid suhteid, mis toetavad koosarengut tehniseeritud elamisruumiga.

Publikatsioon I. Kozicki, Alec 2021. A semiotic model for smart home affordances: Trajecting semiotic components in a technological living environment. In: Suárez-Puerta, Bianca; Merkoulova, Inna (eds.), *Reflections on Paths, Scenarios and Semiotic Methodology Routes*. IASS-AIS, 204–226.

Artiklis käsitletakse nelja semiootilist komponenti nutikodus ning nende rolli tähendusloomeprotsessi tugevdamisel disaineri, kasutaja ja nutikodu süsteemi vahel. Neli semiootilist komponenti – ressursid, võimaldused (*affordances*), kompetentsus ja tugistruktuur (Campbell jt 2019) – pakuvad lähenemisviisi, kuidas kasutaja ja tema keskkond koosarenevad.

Iga keskkond sisaldab unikaalseid semiootilisi komponente, mida elanik tõlgendab. Nutikodude kontekstis aitab disain luua kasutajal tähendusi nutikodu süsteemi kujundamisel. Selles arengus on semiootilised komponendid semioosi ehituskivid ja neid käsitletakse käesolevas töös biosemiootilise teooria ja disainiprotsessi ühendamiseks. Nutikodu loomise protsess sõltub disaineri ja kasutaja semiootilistest komponentidest – näiteks peab kasutaja valdama teatavat programmeerimisoskust, samas kui tehniku paigaldatud süsteem põhineb rikkamate võimalustega komponentidel. Semiootilised komponendid nõuavad disaineri tähelepanu, et arvestada, kuidas kasutaja võib loodud artefaktiga suhelda, ning võimaldavad kasutajal avastada uusi viise nutikodu kasutamiseks.

Artiklis tehakse vahet potentsiaalsel ja tegelikul kasutajal. See vahetegemine aitab modelleerida kasutaja kaasatust võimalikkuse ja tegelikkuse tasandil, aidates disaineril paremini mõista kasutaja reaktsioone ning kujundada disainiprotsessi paindlikumaks.

Publikatsioon II. Kozicki, Alec 2023a. Umwelt in an umwelt: Co-developing within immersive virtual environments and the paradoxical nature of reality and hyperreality. *Sign Systems Studies* 51(1): 73–100.
https://doi.org/10.12697/SSS.2023.51.1.03

Virtuaalreaalsuse (VR) kasvav tööstus ja tarbijateadlikkus on osa Web 3.0 tehnoloogiate arengust. Füsioloogilisest vaatepunktist võib immersiivne tehnoloogia muuta inimese baasvajadusi – näiteks virtuaalse maa omamine, töötamine virtuaalkeskkonnas ja meelelahutuslikud võimalused. Selles artiklis analüüsitakse füüsilise ruumi ja hüperreaalse ruumi vahelist paradoksaalset suhet, mis mõlemad võistlevad kasutaja semiootilise reaalsuse ning komponentide tähelepanu eest (Campbell jt 2019).

VR-tehnoloogiat käsitletakse nutikodu tehnoloogia ühe artefaktina, kuna kasutajad kasutavad seda sageli oma koduses keskkonnas. Virtuaalkeskkonda sukeldudes eemaldub kasutaja füüsilisest ruumist, kehastudes avatarina digitaalses ruumis. Artiklis tuuakse paradoksaalselt esile, et virtuaalkeskkonnal on neli „looduse astet“ (Kull 1998) ning et harjumuspärane kasutus võib saavutada „realistliku looduse“ taseme korduvate kogemuste kaudu.

Publikatsioon III. Kozicki, Alec 2023b. Affordance and Ton: The meaning-carriers of semiosis. In: Kõvamees, Erik; Miyamoto, Oscar; Randviir, Anti (eds.), *Concepts for Semiotics II*. Tartu Semiotics Library 24. Tartu: University of Tartu Press, 149–165.

Artiklis uuritakse James Gibsoni võimalduste (*affordances*) ja Jakob von Uexkülli tooni (*Ton*) mõistete teoreetilisi piire ning nende kahe mõiste erinevust seoses paradoksiga tõese ja reaalse vahel (Seif 2014). Teoreetiliselt on võimaldus seotud objektiivsete füüsikaliste omadustega ning kuulub „tõese“ alla. Võimalduste

modelleerimine nõuab kontekstitundlikku piiri, mida organism tajub ökoloogilises ruumis – siin nähakse Gibsoni (1986) võimalduse mõistet mitte ainult objektiivse loomusena, vaid ka subjektiivse protsessina ökoloogilises keskkonnas, mis aktiveerib taju funktsiooni. Organism ja keskkond arenevad koos, ning subjektiivse tähenduse kehastumine on seotud ökoloogilises sfääris omailmaga (Campbell jt 2019). Oluline aspekt, mida artiklis käsitletakse, on võimalduse ja tooni erinevus. Uexkülli kirjelduste põhjal tekib ja eksisteerib toon ainult omailmas ning ei ole keskkonna lahutamatu omadus – organism peab tundma konventsioone, et tuvastada objekti tähenduslikke omadusi. Sellisena on toon „reaalne", samas kui võimaldused jäävad „tõese" raamidesse. See eristus võimaldab sügavamalt uurida kvalitatiivseid aspekte, kuidas subjekt suhestub millegagi, mis käivitab käitumusliku funktsiooni keskkonnas. See omakorda pakub teoreetilist sügavust, mis aitab siduda disainipraktikaid ja semiootikat võimalduste modelleerimisel.

Publikatsioon IV. Kozicki, Alec 2025. Earthships as a de-sign process to harmonize with the environment. *Semiotica* 267: 135–161.
https://doi.org/10.1515/sem-2024-0191

Artiklis uuritakse maalaeva (*Earthship*) kontseptsiooni ning kasutatakse Berque'i (2019) trajektsionalismi, et analüüsida, kuidas isemajandavad elamud võivad harmoneeruda ümbritseva keskkonnaga. Teoreetiline osa ühendab Seifi (2019) tähendusdisaini (*de-sign*) mõiste, Kulli (1998) semiootilise ökoloogia ja mitmed täiendavad arusaamad disainipraktikate ja ökoloogiliste süsteemide kohta (Bookchin 1982; Norman 2023). Kokkuvõttes kirjeldab artikkel elanike kohanemisprotsessi, kes püüdlevad, et saavutada oma eluruumi ja ümbritseva keskkonna harmoonia. Fookuses on maalaeva tehnoloogiad, mis toetavad isemajandamist mitte ainult elaniku, vaid ka ökosüsteemi tasandil. Maalaeva ehituses kasutatavad taaskasutatud materjalid, mida muidu peetakse toote elutsükli lõppfaasiks – nagu rehvid, purgid ja pudelid – pakuvad uudse võimaluse muuta objekti otstarvet. Seda modelleerides tuleb arvestada, mida nähakse kohaliku keskkonna olemasoleva ressursina (Kozicki 2025). Seifi (2010) poolt kirjeldatud öko-humanistlik metamorfoos ja mõiste „miljöö" seotakse tähendusdisaini protsessi ning tähendusdisaini agentsusega. Artikli eesmärk on näidata, kuidas potentsiaalsed elanikud suunavad oma kaasarenemist tehniseeritud elamisruumiga.

PUBLICATIONS

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2021–2025	PhD in Semiotics and Culture Studies, University of Tartu
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Research topics:

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Conference presentations:

1. "A semiotic model for smart home affordance: Trajecting semiotic components in a technological living environment". II International Meeting of IASS-AIS career start-up young people, X International Congress of Semiotics of Colombia ASC Colloquium (online, October 2021).
2. "The paradox of virtual and realistic nature: How self-reclusion into an immersive environment transforms the semiotic reality and living space". Semiotics in the Lifeworld: 15th World Congress of the IASS-AIS (Thessaloniki, September 2022).
3. "The degrees of nature for immersive virtual environments and the intentionality of semiotic components". 46th annual conference of the Semiotic Society of America: Intentionality and Semiotic Labyrinths (online, October 2022).
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5. "Semiotic consulting and the development of future societies". Ülemiste City Future Forum (Tallinn, May 2023).

6. “Break the Algorithm: How a card game can de-sign meaning in a living space”. 13th conference of the Nordic Association for Semiotic Studies: Feeling, Skill, Knowledge (Helsinki, June 2023)
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8. “Umwelt in an umwelt and the co-development within an immersive virtual environment”. International Conference Semiosis in Communication New Challenges of Multimodality in the Digital Age (Bucharest, June 2023).
9. “Why the world needs semiotic consulting”. Coming soon: Tartu Semiotics Summer School 2023 (Tartu, August 2023).
10. “Interoperability as a key affordance to live with nature”. Semiotic Resonance Summer Retreat: International Semiotics Institute (Olomouc, July 2024).
11. “Trajective design and mesosemiotics: Transforming rubbish into realty”. Signs and Realities: 16th World Congress of the IASS-AIS (Warsaw, September 2024).

Publications:

Kozicki, Alec 2021. A semiotic model for smart home affordances: Trajecting semiotic components in a technological living environment. In: Suárez-Puerta, Bianca; Merkoulova, Inna (eds.), *Reflections on Paths, Scenarios and Semiotic Methodology Routes*. IASS-AIS, 204–226.

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Konverentsiettekanded:

1. „Nutikodu võimalduste semiootiline mudel: Semiootiliste komponentide trajektoorimine tehniseeritud elamisruumis“. IASS-AIS karjääri alustavate noorte II rahvusvaheline kohtumine, X rahvusvaheline semiootikakongress, Colombia ASC Colloquium (oktoober 2021).
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3. „Immersiivsete virtuaalkeskkondade loodusastmed ja semiootiliste komponentide kavatsuslikkus“. Ameerika Semiootika Seltsi 46. aastakonverents: Intentsionaalsus ja semiootilised labürindid (oktoober 2022).
4. „Omailm omailmas: Semiootiliste komponentide kasutamine elaniku ja tema tehniseeritud elamisruumi koosarendamiseks“. Kaasaegsed omailmaanalüüsi rakendused kultuuris ja ökoloogilistes suhetes (Tartu, aprill 2023).
5. „Semiootiline nõustamine ja tulevikuühiskondade areng“. Ülemiste City tulevikufoorum (Tallinn, mai 2023).

6. „Murra algoritm: Kuidas kaardimänguga saab tähendusdisainida eluruumi “. Põhjamaade semiootiliste uuringute ühingu 13. konverents: Tunne, oskus, teadmine (Helsingi, juuni 2023).
7. „Sisekõne jälgimine kunstiliste tekstide kaudu tähenduse loomisel“, kaasettekanne koos Aleksander Fadejeviga. Põhjamaade semiootikauuringute ühingu 13. konverents: Tunne, oskus, teadmine (Helsingi, juuni 2023)
8. „Omailm omailmas ja kaasarääkimine immersiivses virtuaalses keskkonnas“. Rahvusvaheline konverents Semioos kommunikatsioonis: Multimodaalsuse uued väljakutsed digiajastul (Bukarest, juuni 2023).
9. „Miks maailm vajab semiootilist nõustamist“.Tartu semiootika suvekool (Tartu, august 2023).
10. „Koostalitletavus kui loodusega kooselamise võtmetähtsusega võimaldus“. Semiootilise resonantsi suveretriit: Rahvusvaheline Semiootikainstituut (Olomouc, juuli 2024).
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