

POLITECNICO DI MILANO
DESIGN DEPARTMENT
DOCTORAL PROGRAMME IN DESIGN

DESIGN FICTION 4 CRITICAL THINKING: DESIGNING CONSCIOUSLY TECHNOLOGICAL ARTEFACTS TO TACKLE AWARE BEHAVIOURS

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Cycle | 34°



*To my Uncle,
who conducted me to this professional path...*

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ABSTRACT

Critical design theories and practices, such as Speculative Design and Design Fiction, offer principles able to trigger critical thinking and use the future as a space for critical inquiry (Dunne and Raby, 2013) regarding the opportunities, limitations, constraints, and application of technologies, with a purpose to design more consciously technological artefacts. In this research, the author focuses on technological artefacts to tackle aware behaviours, for instance, influence the users to adopt and maintain more sustainable habits, make more sustainable choices (i.e., air pollution, energy consumption, health and wellbeing, others). To design more consciously imply the adoption of critical thinking in design research and practice. Critical thinking is intended here as a capability to reason about the technology and the society (considering both human and non-human actors) as an interconnected system, exploiting its ethical and societal implications and crosscutting factors involved in change processes.

Nowadays, design researchers and practitioners are required to deal with the complexities of the changing world and its uncertainty where dealing with human behaviour have become difficult task. Designing for enabling aware human behaviour needs more critical approaches that can help design researchers and practitioners to deal with these complexities and design more consciously both for the users and for the planet. (Rapp et al. 2019) This research aims at exploring and defining new and more critical approaches for the design of technological artefacts for aware behaviours, founded on Design Fiction principles and speculative design proposals, considered able to trigger critical thinking. Design Fiction enables us to use the future as a space for critical inquiry through the speculation about what could be, and accordingly approach critically to reality as a field of possible actions. (Dunne and Raby 2013, Bleeker 2009)

Through design fiction principles, such as anticipatory scenarios and diegetic prototypes, we can investigate the potential future applications and implications of technological artefacts, explore new physical forms, experiences, and interaction rituals. Anticipatory scenarios are alternative constructions of the worlds (in a social, cultural, political, historical sense) within which the designer anticipates, creates, and contextualises the diegetic prototype and builds mediations between humans - technology - environment.

Established upon the Research Through Design (RTD) methodology, this research commits to answer how design fiction can help design practitioners and researchers design

more consciously the technological artefacts to tackle aware behaviours, through the pluriversal perspective considering the societal and ethical implications and exploration and anticipation of mediations generated through the interaction rituals, experiences, new forms and applications of technologies. In regard, this research proposes a new and more critical approach, and it operationalises this approach into the protocol ready to use by design researchers and practitioners. Protocol is intended here as a set of rules and procedures to follow to design more consciously technological artefacts. The protocol within this PhD sets and combines several theoretical concepts, methods and tools proposed by the theoretical approach, described in depth through the dissertation.

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PREFACE

This PhD research was conducted in the three years (2018-2021) at the Design department of Politecnico di Milano (Dottorato di Ricerca in Design) and under Professor Venere Ferraro's supervision.

Here and after, I would like to introduce the motivations behind this research, how my background is related to it, who is addressing this research, and a few instructions about how to read it.

My interest in designing technological artefacts to support human behaviour was raised during the development of the master of science (MSc) thesis, titled "P.O.D. Protective and Interactive Wearable System for Occupational Disease." My MSc thesis was investigating how the technologies can help the workers in coating plants understand better their environment and individual health state in regard to adopt more aware behaviour when it comes to wearing the personal protective equipment (PPEs). This thesis was developed upon the EU-funded SAFERA Joint Call 2014 supervised by Professor Venere Ferraro.

From this experience, several other collaborations and projects were born in years that inspired this PhD research.

Studying the design of technological artefacts to tackle aware behaviours in users in different projects raised some important questions and concerns for design research and practice. For instance, how to deal with ethical and societal issues when designing for human behaviour and technologies, and how to manage all the complexities of contemporary societies like environmental, health and wellbeing, and others.

I noticed that there were lacking the design and research approaches able to grasp these complexities concerning the design of technologies to tackle aware behaviours in users. Together with my supervisor, we started to question what approaches the design research and practice need to propose to embrace this issue.

This is how the research "Design Fiction for Critical Thinking: Designing Consciously Tech-

nological Artefacts to tackle Aware Behaviours” was born.

This research explores and exploits the new approach for designing technological artefacts founded on Design Fiction and Speculative Design proposals. These critical design approaches have been emerging in the last year with the scope to raise the questions about the possible ethical and societal implications of technologies human behaviour and analyse critically how design researchers and practitioners approach the design of technological artefacts. In my PhD research, I propose such an approach to support design researchers and practitioners deliver the more conscious design of technological artefacts, adopt the pluriversal perspectives, and deal with the complexities.

This research addresses the design researchers and practitioners operating within the sphere of product, interaction, and service design, interested in designing for human behaviour, with and for technologies, and sustainable development. Beyond the design research and practice, the knowledge produced from this three-year research is also beneficial for the design education activities concerned with the design of technological artefacts.

The findings from this research are beneficial for understanding how to deal with complex systems analyse the technologies and human behaviour as a part of a more extensive and interconnected system to design the technological artefacts more consciously. To design consciously refers to adopting the pluriversal perspectives by design researchers and practitioners, anticipating the possible ethical and societal implications of technologies and barriers and cross-cutting factors that can support or prevent the people from adopting aware behaviours toward sustainable questions.

This dissertation offers a new approach to the design of technological artefacts to tackle aware behaviours, exploiting the future as a space for critical inquiry, adopting the principles derived from Design Fiction and Speculative design where scenarios and diegetic prototypes. The dissertation is framed in four sections and ten chapters to describe the research development.

In the first section, the reader is introduced to the research’s grounds, motives, hypothesis, research questions and methodology, and theoretical background.

The second section introduces the reader to the construction of a new (critical) approach for designing technological artefacts to tackle aware behaviours in users, that includes the development of the different elements of approach - Protocol for designing and Envisioning Tool - through several stages, including systematisation of the theories, engaging the design researchers and students in building the knowledge. This section demonstrates how the PhD knowledge within this research is built to answer the research questions.

The third section is about Research through Design, applying the new approach with the Protocol and Envisioning tool in design and research activities. These activities had a scope to test whether the approach I proposed can trigger critical thinking in design research and

practice enabling the researchers and practitioners to deliver more conscious designs. The fourth section is dedicated to the discussion and findings. This part introduces the reader to the contributions of the research, limitations, and further developments.

In conclusion to the Preface, I would like to mention that many people contributed to the development of this research. Firstly the researchers, professors, and students of Politecnico di Milano Design Department and Design School. Then the researchers and professors from ITU Copenhagen who hosted me for the collaboration to the project and were available to contribute to the findings of this research through active engagement. I would also like to mention the experts from different fields concerned with this research, which took an essential part in building the PhD knowledge within this research. I acknowledge all the participants in the section Acknowledgments of this dissertation.

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LIST OF PUBLICATIONS [2018/2021]

PhD research related publications

Ferraro, V., Stepanovic, M. (2020) "IA, Design Fiction e pensiero critico (AI, Design Fiction, and Critical Thinking)" in DIID Disegno Industriale (Industrial Design)

Stepanovic, M., Ferraro, V.: "Reflecting on new approaches for the design for behavioural change research and practice: Shaping the technologies through immersive design fiction prototyping" DUXU 9TH INTERNATIONAL CONFERENCE ON DESIGN, USER EXPERIENCE AND USABILITY 21 – 24 July 2020, Virtual sessions (presenter: Mila Stepanovic)

Stepanovic, M., Ferraro, V.: "Disruptive technologies and behavioural change: Design fiction as trigger for critical thinking", Design Culture(s), Rome June 2021, Virtual Session (presenter: Mila Stepanovic)

Stepanovic, M., Ferraro, V.: "Envisioning Technological artefacts through anticipatory scenarios and di-gegetic prototypes", in Design!Open, Parma May 5-6 (abstract accepted for presentation, pending the print version)

Other publications

Venere Ferraro, Lucia Rampino, and Mila Stepanovic, "A Plurisensorial Device to Support Human Smell in Hazardous Environment and Prevent Respiratory Disease," *Advances in Human-Computer Interaction*, vol. 2019, Article ID 3094560, 10 pages, 2019. <https://doi.org/10.1155/2019/3094560>. WOS (Web of Science™) Indexed Journal.

Mariani, I., Parisi, S., Bolzan, P., Stepanovic, M., Invernizzi, M., & Varisco, L. (2019). INDATA, ENVISIONING & PROTOTYPING INFORMED BY KNOWLEDGE. OPEN-ACCESS DATA PLATFORM TO SUPPORT DESIGN SCENARIOS. 5696–5705. <https://doi.org/10.21125/edulearn.2019.1384>

Varisco, L., Mariani, I., Parisi, S., Stepanovic, M., Invernizzi, M., & Bolzan, P. (2020). InData Envisioning and Prototyping Informed by Data. A Data Scraping and Visualization Tool to Support Design Scenarios. In T. Ahram, R. Taiar, S. Colson, & A. Choplin (Eds.), *Human Interaction and Emerging Technologies* (pp. 441–447). Springer International Publishing.

Mariani, I., Parisi, S., Bolzan, P., Stepanovic, M., Invernizzi, M., & Varisco, L. (2021). Envisioning and prototyping smart material system and artefacts from data-informed scenarios. A case study of design hackathon between digital and physical. *Design Culture(s)*, Rome June 2021, Virtual Session

Ingaramo, M.O., Stepanovic, M. (2021). Quando le luci si spengono. Prospettive future per la progettazione della casa intelligente (When the lights turn off. Future perspectives for the design of Smart Home), in *Aghaton* vol. 10

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ABBREVIATIONS

BC	Behavioural Change
CTA	Constructive Technology Assessment
DfBC	Design for Behavioural Change
DfSB	Design for Sustainable Behaviour
Dwl	Design with Intent
ET	Emerging Technologies
NGD	New Green Deal
HCI	Human Computer Interaction
SCs	Societal Challenges
TICs	Tech Inspiration Cards
SDGs	Sustainable Development Goals
SICs	Societal Inspiration Cards

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IMPORTANT DEFINITIONS

AWARE BEHAVIOURS

concern raising the awareness in users (consumers) about sustainable issues like air pollution, water pollution, water consumption, energy consumption, waste management, health and general wellbeing that can go from specific health issue monitoring to sport and dietary applications, but also safety intended as urban and cyber safety, and others.

This concept is tightly related to the calls of European Commission: “Enabling citizens to act on climate change, for sustainable development and environmental protection through education, citizen science, observation initiatives, and civic engagement” and builds on the challenges set by the European Commission that calls for “examples on how to engage the wider community in the effective behavioural changes and changes in social practices needed for a successful and just transition.

The key component of this subtopic is to raise awareness, engage and empower citizens and consumers with concrete tools to monitor their impacts on the environment, collect information enabling them to change their behaviour, and reduce their carbon and environmental footprint as users and consumers through individual and social innovation. Actions should include the development and improvement of devices (low-cost sensors, consumer apps, such as wearable sensors, a trusted, us-

er-friendly app with robust carbon footprint calculations, extreme weather community app, for early warning, marine and freshwater litter watch) taking into account the interoperability and exchange of future and existing data collected. Attention should be paid to promoting gender-equal participation and deconstructing gender stereotypes.”

CONSCIOUS DESIGN

“ is an enactive, equitable, empathic process of creating environments that are aware of and responsive to the needs and aspirations of its participants. It entails places, spaces, and objects that have an awareness of, and responsibility towards people.” (The Centre for Conscious Design)

in relation to human behaviour

“The primary questions that arise as a result of considering the potential ethical dimensions of designing for behavioural change are:

- 1. Why do people persist with “undesirable” behaviour? (Questions of moral psychology),*
- 2. What is “desirable” behaviour? (Questions of philosophical ethics),*
- 3. How can the gap between “undesirable” and “desirable” behaviour be narrowed in an ethically acceptable way? (Questions of design ethics).” (Jun, Carvalho, & Sinclair, 2018)*

CRITICAL THINKING

“is a human capability [...] the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and, or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.” (Michael Scriven & Richard Paul, 2008)

CRITICAL DESIGN PRACTICES

strive for generating the social action through the speculative and fictional projects to inspire the real-world social actions and “engage designers in a different kind of thinking that delivers more conscious design products” and offer opportunities to “Include certain concepts into the range of quality criteria to be taken into consideration when designing.” (Jakobsone, 2017)

DESIGN FICTION

as a critical and speculative design practice is commonly related to prototyping the futures (design fiction prototyping concerning the diegetic prototypes), the not-yet-existing technologies. It can be described as “strategy for more explicitly attending to the feedback loop between fictional imagined futures and actual technology design.” (Tanenbaum, 2014)

Design Fictions “are assemblages of various sorts, part story, part material, part idea-articulating prop, part functional software. The assembled design fictions are component parts for different kinds of near future worlds. They are like artifacts brought back from those worlds in order to be examined, studied over.” these prototypes “help one imagine and tell stories about new near future objects and their social practices [...]. This kind of prototype has nothing to prove

— it does not represent technical possibility. The technical prototype serves the purpose of proving whether or not instrumental functionality is possible. Design fiction prototyping — or design fiction prop making — communicates possibility through the stories it evokes and the conversations it starts.” (Bleeker, 2010) There; so the diegetic prototypes, with their strong rhetoric and narrative dimension (Kirby, 2010), can engage, and “emphasizes the role and the responsibility of the designer in educating the users and raising awareness of their passiveness as citizens” (Jakobsone, 2012).

_diegetic prototypes

Diegetic prototypes have a role to let the people get a feel of the things one might do with not yet existing technological artefacts and experience the consequences and implications of a world in which these artefacts exist. (Bleeker, 2010)

What differentiates them from the traditional prototypes is that these prototypes have a strong narrative and performative character, and they are always concerned with the future, commonly not-yet-existing technological artefacts. These prototypes have the purpose of generating new discourses, make visible there plausible the existence of these fictions by contextualizing them in the real world with real people.

_anticipatory scenarios

These scenarios start from past and present trends and leading to a likely future. Godet and Roubelat (1996) explain: “These anticipatory or exploratory scenarios may, moreover, be trend-driven or contrasted, depending on whether they incorporate the most likely or the most unlikely changes.”

CRITICAL THEORY OF TECHNOLOGY

“Analysing technologies and technological systems at several levels, a primary level at which natural objects and people are decontextualised to identify affordances, complemented by a secondary level of recontextualisation in natural, technical and social environments.” (Feenberg, 1999)

TECHNOLOGICAL MEDIATION

“concerns the role of technology in human action (conceived as how human beings are present in their world) and human experience (conceived as the ways in which their world is present to them). [...] Technological artifacts [...] actively co-shape people’s being in the world: their perceptions and actions, experience, and existence.” (Verbeek, 2006)

“Here is yet another clue to the complexity of embodiment: every change in our newly magnified world is also a change in our embodied experience. I shall call this first technological mediation, which extends already extant visual capacities, a magnificational mediation. This same ‘analog’ capacity pretty much belongs to the whole continuum of early modern optical instruments: telescope (for distant phenomena), the microscope (for micro-phenomena), camera obscura variants (for 3d to 2d transformations) and the like. In this step I now have extended direct bodily-perceptual experience in its classical phenomenological sense, to include instrumentally mediated bodily-perceptual phenomena made present through technologies, thus extending the classical phenomenological sense to include material mediational capacities, into an extended sense of embodiment.” (Ihde, 2011)

AGENCY

In general terms, the agency represents one’s ability to act in a specific situation and under certain conditions. Alternatively, “Agency in this context refers to a system’s ability to carry out known actions per predefined parameters.” (Shedroff and Noessel, 2012). There are different kinds of agency from human to the artificial, mental, collective, shared, relational, intentional, agency as initiation by agent, moral, and others. Based on Latour’s (2005) Actor-Network-Theory (ANT), the author focuses on the concept that humans are capable of acting and artificial entities – like artefacts and in a general material environment. According to Latour, artefacts can co-shape actively human action. In such a theory, “non-humans” become equally actants who “affect the world through expressions of agency.” (Broome, 2007)

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1

INTRODUCTION

Due to the complexities and uncertainties of the contemporary world, such as societal issues (sustainability challenges), rapid technological and scientific development (pervasiveness of technology), economic and political crisis, emerges the need to revise the current approaches for the design of technologies and technological artefacts to tackle human behaviour. Design discipline should offer new approaches and methods able to grasp a broader context of events and actors involved in the processes of change, consider the changes in an individual's life circumstances, and help design researchers and practitioners deal with these complexities. (Grand and Wiedmer, 2010; Rapp, Tirasa, and Tirabeni, 2019)

Such approaches, founded on pluriversal perspectives, could lead design researchers and practitioners to design more consciously technological artefacts, considering possible ethical and societal implications of the technological influence on the individual, society, and environment, and become aware of the mediations generated through human-technology interactions. To design consciously technological artefacts requires adopting critical thinking as an intellectual activity to engage in a different kind of thinking that includes complex concepts and specific criteria. (Jacobson, 2012) By engaging in different kinds of thinking design, researchers and practitioners could prevent the implications and anticipate the mediations generated through technological artefacts to influence the users to adopt more aware behaviours to support sustainable practices and development. The aware behaviours consider all those behaviours addressing the sustainability issues such as environment, health, and wellbeing.

Often the technologies are designed as if they could work equally well for everyone, addressing the particular issue for a specific target of behaviours and people, leaving all other social and individual life aspects out from it. Some of the established models and strategies on how to influence one's behaviour through interaction with technologies are framing the user as "merely an executor of behavioural programs" (Rapp, Tirasa, and Tirabeni, 2019) rather than an active participant (actor) in social and technological transformations, where "[...] most behavioural change approaches assign too much responsibility to agency and self-efficacy without much consideration to variables of a social or contextual nature." (Jun,

Carvalho, & Sinclair, 2018)

The author of this PhD research proposes introducing new and more critical approaches to trigger the critical thinking for designing technological artefacts concerned with tackling the aware behaviours in users, founded on pluriversal perspectives to enable design researchers and practitioners to deal with the complexities. In this regard, this research aims to explore and define new and more critical approaches, derived from several other fields and research areas, with the idea to trigger critical thinking concerning societal and ethical issues and implications when designing with and for technologies (technological artefacts) and human behaviour (tackling aware behaviours through interaction with technological artefacts).

Building on this, the author employs in researching and answering how critical thinking can be triggered in design research and practice to design more consciously the technological artefacts to tackle aware behaviours?

The author of this PhD research proposes introducing critical design theories and practices (such as design fiction principles and speculative proposals) into research and practice concerned with designing this kind of technological artefacts. Recently, both the Human-Computer Interaction (HCI) and Behavioural Design are calling for new and more critical approaches exploiting the principles of Design Fiction and Speculative Design such as scenario building and design fiction prototyping (diegetic prototypes).

Throughout the scenario building, it is possible to tell the stories about the future and about “different kinds of continuity and discontinuity” (Riel, 2015) in terms of occurrence and evolution of different phenomena in the world; project ourselves from the existing reality into the fictional world and feel how it could be in the alternative, without occurring any real consequences. The role of diegetic prototypes is to materialise and contextualise the not-yet-existing technological artefacts and test the future ideas with the broader public to understand how these can be appropriated to anticipate the mediations and suspend disbelief about the future.

Throughout the research, the author investigates the principles and theories of Design Fiction that can be implemented and used to trigger critical thinking in research and practice concerned with the design of technological artefacts to tackle aware behaviours.

Finally, this research shows how the design fiction principles can be systematised and operationalised to design technological artifacts, support design researchers and practitioners to adopt critical thinking, and design more consciously.

This research does not aim at refusing the established theories and practices interested in behavioural change and the design of technological artefacts to tackle and support behavioural modification. It applies and combines the established theories and practices with several other concepts, approaches, and tools, originating from the social sciences, philosophy of technology, philosophy of design to deliver a new and more critical approach. These theories and tools are systematised into the four-stages Protocol with tools for de-

signing consciously technological artefacts developed by the author as the output of this PhD. The Protocol is the author’s answer on how to trigger critical thinking concerning the design of technological artefacts to tackle aware behaviours. Such an approach suggests using the future as a space for critical inquiry, designing fiction principles such as anticipatory scenarios and diegetic prototypes to question the current research and practice.

In parallel with the Protocol, the author develops an Envisioning tool exploiting the diegetic prototypes from Sci-Fi films titled Tech Inspiration Cards (TICs) and Social Inspiration Cards (SICs). The Envisioning tool is a collection of cards, each representing one Sci-Fi film, through which the design researchers and practitioners can open critical discussions. These cards are framed to guide the discussion starting from the future visions and disbeliefs about the technological and scientific development and societal issues, analysing the collective imaginaries and understanding why the future is perceived in such a way and how the people and society can act to prevent or change some scenarios. The role of design researchers and practitioners is to guide the people and society on this journey by anticipating and prescribing the mediations embodied in technological artefacts. The cards were thought of as a support tool to use with the Protocol, but they can also be used separately in any design research activity.

The development of the Protocol and envisioning tool is the core of this dissertation. The dissertation is structured in four sections and ten chapters. Here and after, the author introduces the sections with chapters.

The first section of the dissertation’s corpus (Section 1: PhD Overview) consists of theoretical foundations and research settings and includes three chapters (1. Introduction, 2. Narrowing Down, 3. Theoretical Background) describing the background of the research, aims, and objectives, research questions, and established research methodology. In the first part of this section (1. Introduction), the author explains more in-depth the grounds, motives, and hypothesis of this research and touch the domain areas, where Design for Behavioural Change (DfBC), Critical Design Practices, then the field of Emerging Technologies and Human-Computer Interaction (HCI) research, and finally explain the potential meeting for these three macro fields.

Starting from the Design for Behavioural Change research and practice, the author takes an overview of the field and related areas of interest within this research, such as design for sustainable behaviour, design with intent, persuasive technologies, and the development of Design for Behavioural Change in parallel with the HCI field since this research is concerned with technological artefacts.

The author narrows down the introductory part in the second chapter (2. Narrowing Down) by defining two macro topics of this research elaborated throughout this dissertation: (1) designing consciously through critical thinking and (2) critical thinking through design fiction. The author introduces the research questions, research paradigm of reference, and established design research methodology to answer the questions.

In the third chapter (3. Background knowledge), the author deepens the theoretical background, describes some weaknesses within the existing practice concerned with the design of technologies to tackle behavioural modification, emerged from the in-depth literature review (desk research), observes the alternatives already proposed by the current research, identifies the knowledge gap, and introduces the field of opportunities for new approaches. The author goes through the Critical Design Practices and its role to help designers deal with the world's complexities and take an active role in change processes. The author reflects on using the future as a space for critical inquiry and how such an approach could help us design more consciously in the present. The principles used in speculative design and design fiction research and practice are explored, including anticipatory scenarios and diegetic prototypes.

Following up on the previous text, the author investigates how technological artefacts can tackle aware behaviours and how design researchers and practitioners can consciously design the technological artefacts by applying critical thinking and design fiction principles to meet the complexities of the contemporary world.

She observes how the development of the HCI field has influenced the development of ubiquitous technologies and technologies that influence Human behaviour (in an intended but unintended manner). Besides, the text of this chapter describes how the Critical Design Practices tackled the interest of HCI research when it comes to questioning the ethical and societal concerns of technologies and exploring the possible new technological applications, forms, mediations, and others. Further on, the author analyses the technological artefacts through several levels to understand how these mediate between humans and the environment. Firstly, the morphology of the artefacts, different forms, and nature of the artefacts. Then the author investigates the philosophy and critique of technology and the post-phenomenological approaches for designing with and for technologies, found it essential to understand the experiential dimension of using the technological artefacts to mediate with the outer world. Finally, the author explains the importance of the agency in building the mediations between the human and technology and the technology and the environment, through different layers (from the individual to collective perspective), involving different actors (natural and artificial).

In the second section of this dissertation (Section 2: Building the PhD knowledge), the author shows how the previously introduced theories are systematised (introduced in Section 1, chapter 2) to deliver the Protocol for designing consciously technological artefacts and the envisioning tool exploiting the diegetic prototypes from Sci-Fi cinematography. The Protocol is an assemblage of tools, theoretical concepts, and models to guide the design researchers and practitioners designing technological artefacts concerned with tackling more aware behaviours toward societal issues in users. The envisioning tool (Envisioning cards and platform) exploiting the Sci-Fi genre aims to provoke the discussion about the societal and ethical questions within the context of the future and help the designers and design researchers suspend the disbelief about the future of technologies and their impact on society and the environment by exploring the currently established technology social

imaginaries. This tool explores two dimensions of Sci-Fi films - technological and societal (Tech Inspiration Cards and Societal Inspiration Cards).

The Protocol and Tool development is described in 3 chapters, starting from the initial experimentations with design researchers, workshop with design students, self-reflection activity, and reflective activities with experts (4. The construction of the Protocol, 5. An overview of the semi-final protocol, 6. The final version of the Protocol). Chapter 4 (4. The construction of the Protocol) includes the description of the early stages and the experimentation with researchers that had the purpose of identifying the theories and tools to apply to Protocol. Chapter 5 (5. An overview of the semi-final protocol) describes the development of the Protocol, or better the operationalisation of the theoretical approach, from the theoretical foundations and the second experimentation to test and refine the first provisional Protocol. Chapter 6 (6. The final version of the Protocol) describes how the final version of the Protocol was generated starting from the findings of the first two experimentations, through two more activities (self-reflection activity and sessions with experts) to test the Protocol's validity in triggering the critical thinking when designing technological artefacts to tackle aware behaviours.

In conclusion, the author shows the final version of the Protocol and tool that are the main outputs of this PhD research.

The third section of this dissertation (Section 3: Research Through Design) focuses on the design research activities aiming at applying the final version of the Protocol and show how it can be used to conduct the design research and which are the advantages of such an approach comparing to the existing ones. This section contains two chapters (7. Toward materialization: Development of design concepts and diegetic prototypes from scenarios, 8. Collaboration at the project "Future of Mobile Technologies" with ITU Copenhagen).

Chapter 7 (7. Toward materialization: Development of design concepts and diegetic prototypes from scenarios) shows how the analysis and scenarios developed in the activities with experts using the Protocol proposed by the author (described in Section 2, chapter 6) can be used to generate the diegetic prototypes and how the design researchers and practitioners can use these prototypes to anticipate and test the not-yet-existing technologies and innovation, study the interactions between the artefacts and environment, understand how to appropriate these artefacts and interactions to the build more thriving futures. The diegetic prototypes developed at this stage were tested in focus groups to understand, first, whether the people perceive the values embedded throughout the Protocol (technology application, new interactions, and interaction rituals, forms) and whether such proposals could be appropriate for addressing the specific societal issues – efficient in enabling the users to adopt and maintain more aware behaviours. Second, to understand whether the diegetic prototypes generated from the scenarios built through the Protocol could engage the people in the design process actively through critical reflection and anticipation of interaction modalities and interaction rituals.

Chapter 8 (8. Collaboration at the project "Future of Mobile Technologies" with ITU Copen-

hagen) shows how the Protocol and Envisioning tool were applied in a project with the ITU of Copenhagen (IxD lab) collaborating on the project “Future of Mobile Technology.” This collaboration is the output of the author’s research internship that lasted six months. This research aimed to use the Protocol long the design research process at different stages, starting from the desk research analysis and identifying the design spaces to the generation of artefacts and the materialisation of diegetic prototypes. The objective of this project was to understand how the new interaction rituals and forms could enable smartphone users to adopt more aware and intentional relationships with this technology to prevent problematic usage patterns such as Social networks and Internet addiction. Throughout the Protocol used transversally in the project, the authors identified different scenarios that might lead the smartphone users to more aware and intentional usage patterns. The author tested these scenarios and diegetic prototypes in focus groups to understand how meaningful these proposals are and map the potential fields of action for designing these technologies.

The last section of this dissertation (Section 4: Conclusions and findings) consists of two chapters (9. and 10.), dedicated to the conclusions and critical reflection about the overall research, introducing further developments. This part is dedicated to the conclusions, including the results and main findings in the sense of the knowledge generated throughout this PhD research, the main contribution to the fields of interest, and other potential fields of interest. The author makes a critical overview of the research and discusses how these could be improved, including some hypotheses about further development.

1.1. *Grounds, Motives, and Hypothesis*

“Our world is increasingly involved and engaged in complex, collective political and economic debates and experiments (the current financial crisis is just one of the most recent examples), in which different actors including governments, companies, NGOs, social movements, virtual communities, ... are engaged, and in which the differentiation between scientific research, institutions and laboratories on the one hand, and societal and political processes, on the other hand, are blurring (Novotny, 2008) [...] In this regard, design and design research are pre-disposed to play a very active and important role in those controversies and collective experiments, and that design and design research should do its particular practices, tools and methods relevant to those debates, while at the same time developing new tools and methods, which are important for collectively dealing with possible futures in a complex world.”
(Grand and Wiedmer, 2010)

The uncertainty has signed the present times. Building thriving and resilient societies is becoming a more difficult task for designers and design researchers. Complex systems and transformations in which researchers and practitioners are involved require critical approaches to help them design more consciously, deal with the complexities, and adopt pluriversal perspectives.

The author of this dissertation focuses on the design of technological artefacts able to tackle and support aware behaviours in users, such as adopting more sustainable habits and practices. In such a rapidly changing society designing for human behaviour has become a very complex issue, and the author wants to suggest one possible approach to help design

researchers and practitioners deal with these complexities, adopt critical thinking, and, as a result, design consciously technological artefacts to tackle aware behaviours.

In those terms, this research consists of revising the current research approaches and practice interested in designing technological artefacts to influence human behaviour. This research studies the critical design theories and principles (focus on Speculative Design with Design Fiction) and how to appropriate and apply it in a design and research concerned with technological artefacts to tackle human behaviour.

This part of the dissertation aims at providing a brief overview of the PhD research in question introducing the areas and fields of research interest and showing why they are relevant and related.

The author starts by introducing Human-Computer Interaction (HCI). HCI discipline is increasingly designing technologies aimed at supporting behaviour change. This phenomenon has been present in HCI since '90 when it first coined the term "Captology" at Stanford University.

Captology is the study of computers as persuasive tools, often given a negative connotation because the risk behind it is manipulative, but also because through computer interactions, users tend to lose all the richness and wonder of experiences. (Oinas-Kukkonen, Harjuma, and Segerstahl, 2007) However, the researchers from Stanford University (Behavior Design Lab) worked a lot from '00 on improving the issues concerning the ethical sphere of Persuasive Technologies, highlighting the importance of addressing the ethical issues when designing for this kind of technology.

Together with the HCI also, the design discipline tried to propose many tools and methods to design models and strategies for human behaviour and behavioural change, focusing on specific behaviours like health and wellbeing, sustainability, and others. Some of the methods and tools proposed by design research are Loughborough's model for sustainable behaviour, Design with Intent by Dan Lockton, Product Impact Tool by Dorrestijn, Design for Socially Responsible Behaviour by Tromp, Hekkert and Verbeek, and others. Some of the strategies are drawing on behavioural theories, neurosciences, psychology, social sciences, behavioural economics (Loughborough model); others are focused more on how the materiality of the artefacts impact human behaviour (Product Impact Tool, Design for Socially Responsible Behaviour), or they mix both the knowledge from the sciences and design-materiality and interaction (Design with Intent tool). This argument is deepened in Chapter 3 of this dissertation.

The issue lies in that many of the models currently used in design discipline focus "on the idea that change occurs on the behavioural level and that it is externalistic, monistic, mechanistic, fragmented, and episodic. [...] the majority of these attempts are addressed to modify behaviour. This happens as most behaviour change designs are informed by a "behavioural model" encompassing the idea that the central focus of technological interventions should

be on the "external" manifestations of change. [...] Within HCI, it has been noted that the behavioural model usually does not account for changes in an individual's life circumstances (Clawson et al.2015); that it brackets the environment in which individuals live (Brynjarsdóttir et al.2012); and that it frames the user as merely an executor of behavioural programs (Purpura et al.2011)." (Rapp, Tirassa, and Tirabeni 2019)

This PhD research identifies the need to propose the approaches that can grasp the broader context of change anticipate the possible implications and barriers that may sabotage the user toward achieving target behaviours. In the case of this PhD research, the author defines the target behaviours as adopting more aware behaviours toward the sustainability issues – motivating and supporting the users in adopting more sustainable habits and practices to participate in building more thriving futures.

This research starts from the hypothesis that design research and practice should adopt new and more critical approaches when designing technologies for human behaviour. Technological artefacts are mediators between humans and the environment; they can establish a dialogue. The technological artefacts need to be trustworthy and build upon meaningful interactions to establish the dialogue. The author finds that anticipating mediations between technology and human and the human environment is crucial, and for that, she finds that exploiting the future as a space for critical inquiry is opportune.). In regard, this dissertation explores the field of HCI and Emerging Technologies (ET), and it stresses the role of technological artefacts as mediators and the role of designers in building these mediations through interactions and material forms. (Verbeek, 2006)

Technologies are in continuous development and always provide more space for design researchers and practitioners to design new interactions. The author retains importance to focus on Emerging technologies and exploiting their potential when building the mediations and meaningful dialogue. Emerging technologies are those that "have been enabled building a range of computationally enhanced and Internet-connected devices commonly called "smart artifacts," "semantic devices," "connected artifacts," etc. They can sense, log, and interpret what's occurring in their context and can interact, intercommunicate and exchange information with other artifacts and also with users." (Ghajargar and Wiberg, 2018.)

However, there is a need to recognise that technologies are not always friends. If designed without critical reflection upon the ethical and societal implications, they can instead become a foe and even an obstacle for the user.

As a critical and future-oriented practice, Design Fiction offers principles and theories that can be used to analyse critically technological artifacts. Such an approach, based on critical thinking, would enable the design researchers and practitioners to adopt pluriversal perspectives and consider different factors, events, and actors involved in adopting aware behaviours. Design Fiction can anticipate the possible implications of technologies and barriers that prevent the user from achieving desired behaviour. Design fiction is a fictional space where the exploration and investigation cannot produce any negative consequences

but identify the preferable states and reflect upon how to design more consciously (adopting critical thinking) in the present to achieve those preferable states in the future.

Recently, the interest in critical approaches has been rising within HCI research. The reason for this is mainly because the pervasive development and use of technologies raised some questions about the ethical implications concerning the design with, and for technologies, especially with the expansion of Artificial Intelligence and always more independent smart and ubiquitous devices, able to collect and an elaborate significant amount of data (i.e., personal assistants, wearable sensors, others). This relationship between the artefacts and human behaviour Latour (1992) explains in the following way:

“[...] The behaviour is imposed back onto the human by non-human delegates. Prescription is the moral and ethical dimension of mechanisms. Despite the constant weeping of moralists, no human is as relentlessly moral as a machine... We have been able to delegate to non-humans not only force as we have known it for centuries but also values, duties, and ethics.”

Nevertheless, humankind always has more independent and sophisticated technologies; it will never be possible to prescribe moral values and duties to the “machines” - the cultural and cognitive processes typical for human beings. The more technologies become independent and sophisticated; there is a need to abandon the instrumental visions and adopt critical visions that focus on the technologies as frameworks for the way of life rather than the instruments to achieve specific goals. (Feenberg, 2003) Thus, technological artefacts are not just “things,” but rather: “nodes in a network that contains both people and devices in interlocking roles,” and the Actor-network theory argues that the social alliance in which the technology is constructed are bound together by the very artefacts they create. Thus, social groups do not precede and constitute technology, but emerge with it.” (Feenberg, 1999)

Beyond the human-technology relationship, when designing with and for technologies, there is a need to consider possible societal and environmental implications of technological artefacts. All these factors recall a more conscious approach to the design of artefacts, which considers a more extensive system of relationships between the actors involved directly and indirectly into interactions with technological devices.

Artefacts (including also technologies) shape people’s actions intentionally and unintentionally. How one interacts with the artefact depends much on how the interaction is designed, but not only. Designers can anticipate some people’s actions, but it would be too optimistic to think that they can predict human behaviour completely.

“Designers anticipate how users will interact with the product [...] they build prescriptions for use into the materiality of the product [...] When technologies fulfil their functions, they also help to shape the actions of their users.” (Verbeek, 2006)

Nevertheless, by designing more meaningful interactions and mediations, we can suspend blasé attitudes provoked by the technological pervasiveness in which the Human being always has a minor role and always becomes less interested in his/her surroundings. Technological artefacts are potent tools that can help us meditate and relate to our environment, but these leave nothing less than a disenchanting world ^[1] if not appropriately designed.

Beyond the HCI research and practice, behavioural scientists and design research concerned with human behaviour are calling for new approaches and methods that go beyond the mere practice of Design for Behavioural Change (DfBC) and persuasive technology by fostering critical reflection when it comes to the complex issues, ethical questions, and societal implications.

Most of the current DfBC theory and practice approaches are based on psychological and socio-psychological behaviour models (Rapp, 2019). Applied in DfBC research and practice, these behavioural models often lack the design-centric approaches and the more holistic and critical view on human behaviour. The critical and holistic approach refers to analysing a social context and network of relations that determinants individuals’ behaviour. Some tools and methods in DfBC research and practice suggest more design-centric approaches, expanding and interlacing the psychological models with social practice theory. Later on, in the text, the author analyses some of these.

The alternative approaches stressing critical reflection and inquiry concerning human behaviour have not yet been explored by DfBC research and practice. This research stresses the importance of introducing critical thinking and critical reflection as an intellectual activity to design technological artefacts to tackle and support the user in adopting aware behaviours. The existing tools and methods are not considering the employment of critical thinking, such as understanding a system of relations involved in the processes of change from the individual to the broader network of actors, benefits, and consequences. Understanding the broader image of actors and events could prevent treating the user as an executor of the behavioural program and focus more on the conditions in which the change is happening, experiences, and how this can benefit the broader community beyond the individual.

Throughout fictional (Design Fiction) and speculative proposals (Speculative Design), the critical design tries to propose an alternative, often even only provocation, to the current technology solution and the worlds’ complexities and implications. These design genres often do not offer “practical solutions to everyday problems” but seek to satisfy people’s emotional and intellectual needs. (Malpass, 2017) Yet, in some cases, there are more applied approaches in critical design practice that use the future as a space for critical inquiry, raise questions, innovation, and “explore new kinds of social interaction rituals.” (Bleeker) The author of this dissertation focuses on the second approach, exploiting the design fiction with scope to propose the alternatives that may bring the individuals and society to more thriving conditions. The author is interested in exploring how the speculation through design fiction can inform the present, what Auger (2013) defines as Alternative presents:

“Alternative presents step out of the lineage at some poignant time in the past to re-imagine our technological present. These designs can challenge and question existing cultural, political and manufacturing systems.”

This dissertation aims to operationalize design fiction principles and move a step ahead of the theories into DfBC research and practice. Here and after, the author will introduce the domain areas of research and potential meetings of these.

1.2. Domain areas and Research Objectives

Here and after, the author will briefly introduce the domain areas of the research, which will be explored more in-depth further on in the dissertation. This part employs in giving just an overview of the theoretical background.

Starting from the Design for Behavioural Change (DfBC) research and practice, the author will hint at the field and related areas of interest within this research, such as design for sustainable behaviour, design with intent, persuasive technologies, and the development of DfBC in parallel with the Human-Computer Interaction (HCI) field. Some weaknesses within the existing practice will be described, emerge from the in-depth literature review, and observe which alternatives are already proposed by the current research. Identify the knowledge gap and subsequently introduce opportunities for new approaches.

After the Design for Behavioural Change, the author investigates the field of critical design theories and practices, focusing on speculative design as the paramount field of exploration and design fiction with its principles, considered able to trigger critical thinking. This introductory stage will foretaste what the author explains more in-depth later in the text, starting from the etymology of Critical Thinking to arrive to the Critical Design, how the branches of Critical Design are currently applied into design research and practice, and which of the principles are currently used by design research and practice to foster critical inquiry.

An introduction to Emerging Technologies and HCI fields follows the previous text. The question about the technologies is in a certain way wrapping out the last discourse because here the author investigates how technological artefacts can tackle more aware behaviours, and how can we, design researchers and practitioners, design in a more conscious way the technological artefacts by applying the critical thinking through critical design principles (anticipatory scenarios and diegetic prototypes). The development of the HCI field has influenced the development of technologies able to influence our behaviour.

[1] Disenchanted world > “**disenchantment**, in philosophy and sociology, the supposed condition of the world once science and the Enlightenment have eroded the sway of religion and superstition. The concept of disenchantment, so defined, emphasizes the opposed roles of science and religion in modern society. The German sociologist Max Weber is credited with popularizing the term in a lecture given in 1918. Weber used the German word Entzauberung, translated into English as “disenchantment” but which literally means “de-magic-ation.” More generally, the word connotes the breaking of a magic spell. For Weber, the advent of scientific methods and the use of enlightened reason meant that the world was rendered transparent and demystified. Theological and supernatural accounts of the world involving gods and spirits, for example, ceased to be plausible. Instead, one put one’s faith in the ability of science to eventually explain everything in rational terms. But, for Weber, the effect of that demystification was that the world was leached of mystery and richness. It became disenchanted and disenchanting, predictable and intellectualized. In that sense, the disenchantment of the world is the alienating and undesirable flip side of scientific progress.” (Britannica)

However, it has also tackled the interest of critical design research and practice in questioning ethical and societal concerns and exploring possible new technological applications, forms, mediations, and others.

Finally, the author will narrow the introductory part to reflect the potential meeting for these three research areas and their fields.

1.2.1. Design for Behavioural Change

Design for Behavioural Change gained increasing interest from the HCI and Interaction Designers due to the pervasive development of technologies. Still, “current theoretical approaches to behaviour change have yet to be operationalized this in design process support.” (Cash, Hartlev, and Durazo, 2017).

Recently Design for Behavioural Change (DfBC) research is trying to propose new approaches and techniques to trigger critical thinking regarding the technological impact on individuals, society, and the natural environment. This research starts from exploring the theories and practices widely around the DfBC field, from the psychology and social-psychology perspective, neurosciences, through the Human-Computer Interaction (HCI) field and design. Initially, the author observes how the design field was changing with the evolvments in psychology and neurosciences, and then she decides to narrow down the research by selecting several strategies and theories to study in-depth. The selection is on those found as the most suitable to apply in this research, considering that the author deals with technological artefacts (products and services) and aware behaviours concerning sustainable development. The following strategies and theories were used as the main reference in this research: Design with Intent (Dwl), Design for Sustainable Behaviour (DfSB), and Persuasive Design.

The focus here is on technological artefacts that modify human behaviour toward societal issues, such as more sustainable and safe behaviours. The author takes as a reference the Loughborough classification of interventions for behavioural modification addressed through design discipline: “Design for behaviour change is concerned with how design can shape or influence human behaviour and sustainable innovation. Key areas of its application include sustainability, health and wellbeing, safety and crime prevention as well as social contexts.” (Loughborough University) In Chapter 2, the author shows the complete analysis of the theories, strategies, tools, and models used to influence users’ behaviour in different cases and how these are applied through technologies.

1.2.2. Critical Design Practices

The critical design grew out of from the concerns with the “uncritical drive behind technological progress when technology is always assumed to be good and capable of solving any problem.” (Dune and Raby, 2013) The definition provided by Dune and Raby (2013) about Critical Design is that it “uses speculative design proposals to challenge narrow assumptions, preconceptions, and givens about the role products play in everyday life.”

This PhD research studies the capability of Critical Design practices to “engage designers in a different kind of thinking that delivers more conscious design products.” (Jacobsone, 2012)

The author researches how could Critical Thinking be triggered in design research and practice concerned with the design of technological artefacts to tackle aware behaviours in users through Critical Design practices such as Design Fiction and Speculative Design and its principles.

To define Critical Thinking, the author relies on the following definition:

“Critical Thinking is a human capability [...] the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and, or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.” (Michael Scriven & Richard Paul, 2008)

This is a general definition that can describe Critical Thinking in different contexts, addressing the human capacity to generate and apply knowledge (in learning processes). However, it applies well to all the cases in which humans need to deal with complex issues. Going back to the Critical Design, Jacobsone explains:

“Critical design offers opportunities, especially as part of the design studies, to include certain concepts into the range of quality criteria to be taken into consideration when designing.” The practices within this area, like speculative design and design fiction, are characterized by that all are putting the focus on the future because they are “aware of design’s potential in influencing it.” (Jacobsone, 2012)

Critical Design practices are highly concerned with societal issues and technological development. They question scientific development and often try to answer in a provocative way. Critical Designs are “testimonials to what could be, but at the same time, they offer alternatives that highlight weaknesses within existing normality.” (Dunne & Raby, 2013)

In this research, the author focuses on Speculative Design and Design Fiction – two overlapping branches of Critical Design. The author is interested in using Design Fiction and speculative proposals, where design fiction prototyping and storytelling, to trigger the critical reflection about the technologies, societal issues, and human behaviour, through anticipation and envisioning. This approach, exploiting the future (anticipate possible implications), can help the design researchers and practitioners reflect on the alternative presented and consequently design more consciously.

To employ the critical thinking and reflection when designing with and for technologies means to analyse “technologies and technological systems at several levels, a primary level at which natural objects and people are decontextualized to identify affordances, complemented by a secondary level of recontextualization in natural, technical and social environments.” (Feenberg, 1999)

The Critical Design practices serve to expand the exploration and adopt more pluriversal perspectives, open debates, and discussions, engage the broader public in the critical reflection to stimulate the action. The nature of Critical Design practices permits this because its primary purpose is not to propose the solutions or commercial products but to reflect upon how the Things could be in the alternative. This does not mean that it cannot inspire the present innovation and design; on the contrary, it can inform and inspire the design discipline to start the action in the present.

Design Fiction is commonly related to prototyping the futures (design fiction prototyping concerning the diegetic prototypes), the not-yet-existing technologies. It was often a subject of criticism, too, because it is believed to celebrate technological progress differently from some other Critical Design practices. The author refuses to use Design Fiction as a mere medium through which one can only represent the future visions, but it suggests using the design fiction as “creative provocation, raising questions, innovation, and exploration,” as Julian Bleeker (2010) suggests. Bleeker (2010) explains design fiction in the following way:

“They are assemblages of various sorts, part story, part material, part idea-articulating prop, part functional software. The assembled design fictions are component component parts for different kinds of near future worlds. They are like artifacts brought back from those worlds in order to be examined, studied over.”

Indeed, these prototypes “help one imagine and tell stories about new near future objects and their social practices [...]. This kind of prototype has nothing to prove — it does not represent technical possibility. The technical prototype serves the purpose of proving whether or not instrumental functionality is possible. Design fiction prototyping — or design fiction prop making — communicates possibility through the stories it evokes and the conversations it starts.” (Bleeker, 2010) There; so the diegetic prototypes, with their strong rhetoric and narrative dimension (Kirby, 2010), can engage, and “emphasizes the role and the responsibility of the designer in educating the users and raising awareness of their passiveness as citizens” (Jacobsone, 2012).

The argument about the Critical Design practices is continued and deepened in Chapter 3 of this dissertation.

1.2.3. Emerging Technologies and Human Computer Interaction research

“Technology is the medium of daily life in modern societies,” Feenberg (1999) explains. Technological Artefacts can influence human behaviour in different ways: “Designers anticipate how users will interact with the product they are designing and, implicitly or explicitly, build prescriptions for use into the materiality of the product [...] When technologies fulfill their functions, they also help to shape the actions of their users.” (Verbeek, 2006)

Indeed, technologies are neither neutral nor purely technological, instead: “they are heterogeneous, artifacts embody trade-offs and compromises [...] they embody social, political, psychological, economic, and professional commitments, skills, prejudices, possibilities, and constraints [...] the technologies with which we are actually endowed could in another world have been different. And this means that the technologies that are currently in the process of being developed might [...] take a variety of different forms, shapes, and sizes.” (Bijker and Law, 1992)

Here the author would like to introduce the segment of this research that is explored further in Chapter 3, which concerns the technologies and technological artefacts and their ability to change human lives and influence human behaviours.

The author is interested in anticipating the technological artefacts and interactions through critical approaches, with the scope to imagine all possible implications of emerging technologies and human behaviour.

The technologies are in continuous evolution. The Emerging Technologies evolve to permit designers to imagine new interactions and formal aspects that can be applied to propose new and more engaging ways to interact with objects and support aware behaviours in users. The Emerging Technologies can be conceived as:

“a radically novel and relatively fast growing technology characterised by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and patterns of interactions among those, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous.”
(Rotolo et. al. 2015)

Rotolo and Martin (2015) propose an exhaustive analysis of Emerging Technologies, defining them in the following way:

“The first defining attribute of emerging technology [...] is radical novelty:” novelty (or newness)” (Small et al., 2014) may take the form of discontinuous innovations derived from radical innovations” (Day and Schoemaker, 2000) and may appear either in the method or the function of the technology. To achieve a new or a changed purpose/function, emerging technologies build on different basic principles (Arthur, 2007) (i.e., cars with an internal combustion engine vs. an electric engine, cytology-based techniques vs. molecular biology technologies). Novelty is not only a characteristic of technologies deriving from technical revolutions, i.e., technologies with relatively limited prior developments (i.e., DNA sequencing technologies, molecular biology, nanomaterials), but it may also be generated by putting an existing technology to a new use. The evolutionary theory of technological change views this as the speciation process of technology, that is the process of applying an existing technology from one domain to another domain or’ niche’ (Adner and Levinthal, 2002).”

This PhD research is interested in exploiting and anticipating new interactions and strategies for influencing human behaviour through technologies such as Artificial Intelligence (AI) and Machine Learning (ML), novel sensors and materials, simulated reality, bioengineering, and other emergent fields of science and technological development.

The author acknowledges that the ethical and societal aspects are essential to address when it comes to designing and for entirely new and radical technologies.

Further on in Chapter 3, the author opens up a discourse on the importance of technological embodiment, mediations, and questions of agency when it comes to anticipations and human-technology interactions. The author builds the discourse upon Ihde, Verbek, and Latour’s works as essential theories to tackle in critical approaches.

1.2.4. Potential meeting

In conclusion, the theoretical background of this research is within the intersection of three macro fields of research, where Design for Behavioural Change (DfBC), Critical Design Practices, and Human-Computer Interaction (HCI), concerned with Emerging technologies (ET) and Sustainable development. In Figure 1, the author maps the principal research domains and their relationship to specific areas of interest.

Building on the theoretical background, the author finds the nodes to connect and propose the new approach for designing conscious technological artefacts that tackle aware behaviours in users. The author wants to suggest using the future as a space for critical inquiry, exploiting different theoretical concepts and tools that can help researchers and designers craft the worlds and systems of relations through a reflective approach and, as a result, build better and more thriving tomorrows.

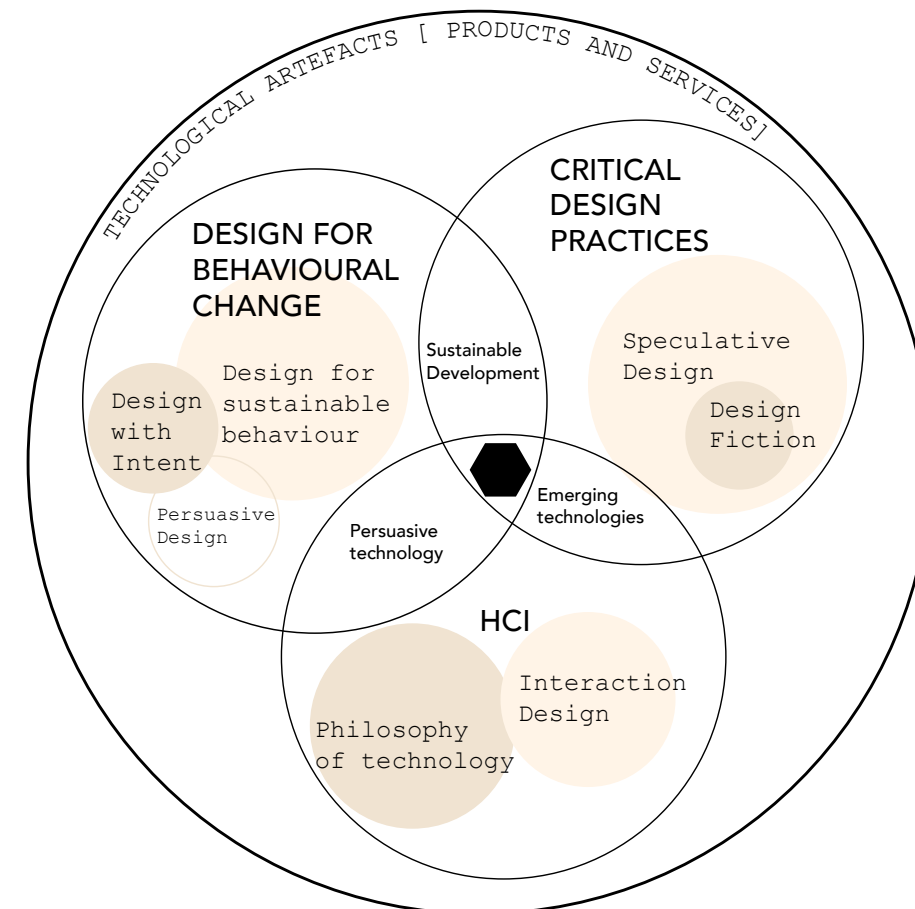


Figure 1: Potential meeting for the fields and areas of interest of this PhD research

Besides, the author explores and exploits the potentialities of diegetic prototypes at triggering discussion about how we perceive the future, ethical and societal implications, to suspend disbelief, stereotypes, and myths about the future, technological and scientific development. This part is concerned with the domain area of Critical Design Practices.

The foundations of such an approach lie in speculative design with design fiction. It exploits the mediums such as anticipatory scenarios and diegetic prototypes to investigate the topics concerned with sustainable development of societies (i.e., Sustainable Development Goals, European Green Deal) and human behaviour. According to the findings of this research, through the mediums such as anticipatory scenarios and diegetic prototypes, design researchers and practitioners can materialise and explore the possible implications of technological artefacts, contextualise them within the existing world to understand how these may be appropriated to deliver conscious design and research in present. With designing consciously concerning the technologies to tackle human behaviour author intends analysing the products on several levels: their physical properties (i.e., sustainability), how the product as an artificial entity influences our relationship to the world, and the product itself.

Here the author borrows from the foundations of design ethics and the philosophy of technology and deepens the knowledge within the field of HCI. This part concerns the second domain area of this research.

Feenberg (2003) explains the philosophy of technology in the contemporary world in the following way:

“Philosophy of technology belongs to the self-awareness of a society like ours. It teaches us to reflect on what we take for granted, specifically, rational modernity. The importance of this perspective cannot be over-estimated.”

Feenberg stresses the importance of turning toward the critical theory when it comes to the contemporary philosophy of technology and argues for the democratization of technology:

“Critical theory of technology holds that human beings need not await a God to change their technological society into a better place to live. Critical theory recognizes the catastrophic consequences of technological development highlighted by substantivism but still sees a promise of greater freedom in technology. The problem is not with technology as such but with our failure so far to devise appropriate institutions for exercising human control over it. We could tame technology by submitting it to a more democratic process of design and development.” (Feenberg, 2003)

This is the point where Critical Design Practices and HCI overlap. The author identifies Emerging Technologies as the area of interest in between. Critical Design Practices are very much interested in critically observing emerging technologies and what implications their development might bring.

The technological artefacts embed prescriptions and values in their form and through interaction rituals. These prescriptions are the result of the designer’s intention, who delegates responsibilities to the “nonhuman,” as Latour (1992) explains:

“We have been able to delegate to nonhumans not only force as we have known it for centuries but also values, duties, and ethics.”

Feenberg (1999), in his analysis of the theory of critique of technology, stresses the importance of design in attributing the values to the technological artefacts, and he stresses the importance of design discipline in this process: “valuative dimensions of technologies are “embodied” in devices through design.”

Through the artefacts designers influence their users – the human behaviours are prescribed through and anticipated with interactions, forms, and material designers assign to the artefacts. Here the author arrives in the third field of research is, the Design for Behavioural change, focusing on aware behaviours. The author defines two directions within this field: the Design with Intent and Design for Sustainable Behaviour, as the two are tightly concerned with the objectives of this PhD (this is deepened in Chapter 3). Also, it is well known that the technologies can be a powerful tool for influencing one’s behaviour and enabling the user to engage in different processes and, as a consequence, adopt specific behavioural patterns. In the overlapping space between the HCI and Design for Behavioural Change, the author places Persuasive Technologies. The Persuasive technologies are taken with caution in this research because its objective is to offer an approach that can help design researchers and practitioners use the technology more ethically, adopting critical thinking. The critical thinking regarding the design of technologies concerns:

“Analysing technologies and technological systems at several levels, a primary level at which natural objects and people are decontextualised to identify affordances, complemented by a secondary level of recontextualisation in natural, technical and social environments.” (Feenberg, 1999)

The author defines that designing consciously requires critical (design) thinking. Through design fiction principles, such as anticipatory scenarios and diegetic prototypes, design researchers and practitioners can investigate the potential future applications and ethical and societal implications of technological artefacts, explore the systems of relations that go beyond human-machine interactions, and at the same explore new physical forms, experiences, and interaction rituals. Applying the Design Fiction principles is with a scope to trigger the critical thinking toward the design of technological artefacts to tackle aware behaviours.

This PhD research offers one possible way to help design researchers and practitioners trigger critical thinking. It aims at researching and defining new and more critical approaches for the design of technological artefacts able to tackle aware behaviours, founded on Design Fiction principles considered able to trigger the critical thinking toward the role of technology and related societal and ethical issues. Critical design theories and practices, such as Design Fiction principles and Speculative Design proposals (anticipatory scenarios and diegetic prototypes), can help explore the societal challenges, agency structures, ethical issues, and the role of (emerging) technologies, with a purpose to guide the researchers and designers design more consciously technological artefacts able or tackle the behavioural change.

Building on this, the main objective of this research is to propose and operationalise a new approach for researchers and practitioners working in the field of product, interaction, and service design, involved in designing such technological artefacts.

Additionally, the author focuses on all those practices that support sustainable development and thriving societies, such as environmental sustainability, health and well-being, and others. This part of the research builds upon the New Green Deal (NGD), Horizon 2020, and UN's Sustainable Development Goals (SDGs) values and objectives. The author tackles only those challenges that can be tackled through the design discipline and the interaction with artefacts. Later on, in Chapter 6 and Chapter 8, we will see how some of these topics were tackled starting from the EU calls and transformed into design challenges.

Bleecker, J. (2009). Design Fiction: A short essay on design, science, fact and fiction. Near Future Lab, March, 103–114. <https://doi.org/10.1145/1516016.1516021>

Bleecker, J. (2010). Design Fiction: From Props to Prototypes. Proceedings of the 6th Swiss Design Network Conference, 58–67. <https://doi.org/10.1002/glia.20282>

Cash, P. J., Hartlev, C. G., and Durazo, C. B. (2017). Behavioural design: A process for integrating behaviour change and design. *Design Studies*, 48, 96–128. <https://doi.org/10.1016/j.destud.2016.10.001>

Dunne, A. and Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press

Escobar, A. (2018). *Designs for the Pluriverse*. Duke University Press.

Feenberg, A. (1999). *Questioning the Technology*. Routledge

Ghajargar, M. and Wiberg, M. (2018). Thinking with Interactive Artifacts: Reflection as a Concept in Design Outcomes. *Design Issues*. 34. 10.1162/DESI_a_00485.

Grand, S., and Wiedmer, M. (2010). Design fiction: a method toolbox for design research in a complex world. *Designresearchsociety.Org*, 1–25. <https://doi.org/10.1145/1141911.1141937>

Jakobsone, L. (2017). Critical design as approach to next thinking. *The Design Journal*, vol. 20(sup1), S4253–S4262. <https://doi.org/10.1080/14606925.2017.1352923>

Kirby, D. (2010). The future is now: Diegetic prototypes and the role of popular films in generating real-world technological development. *Social Studies of Science*, 40(1), 41–70. <https://doi.org/10.1177/0306312709338325>

Latour, B. (1992). Where are the Missing Masses: The Sociology of a Few Mundane Artifacts. In Bijker, W. E. and Law, J. (eds.), *Shaping technology/building society: studies in sociotechnical change*: Vol. Inside tec. pp. 225–258. Cambridge: MIT Press.

Loughborough University Institutional Repository. (2017). *Creating sustainable innovation through design for behaviour change: summary report* (Vol. 91).

Malpass, M. (2017). *Critical Design in Context: History, Theory, and Practices*. Bloomsbury Academic. <https://books.google.it/books?id=QpGWDQAAQBAJ>

Rapp, A., Tirassa, M., and Tirabeni, L. (2019). Rethinking Technologies for Behavior Change. *ACM Transactions on Computer-Human Interaction*, 26(4), 1–30. <https://doi.org/10.1145/3318142>

Verbeek, P. (2006). Materializing Morality Design Ethics and. *Science, Technology and Human Values*, 31(3), 361–380.

Verbeek, P. (2005). *What things do: Philosophical reflections on Technology, Agency, and Design*. Pennsylvania State University Press

Weber M. (1946) Science as a Vocation. In: Tauber A.I. (eds.) *Science and the Quest for Reality. Main Trends of the Modern World*. Palgrave Macmillan, London. https://doi.org/10.1007/978-1-349-25249-7_17

2

NARROWING DOWN

In this chapter, the author is narrowing down the objectives of this PhD by making the research assumption - clarifying the meaning behind designing consciously and why the author stresses that the design fiction principles can help design researchers and practitioners adopt the critical thinking to design more consciously technological artefacts to tackle aware behaviours. The author provides several important definitions upon which this research is structured.

Building on the research assumptions, the author introduces the research questions and explains what each question is examining.

Following the research questions, the author introduces the applied research methodology, starting from the scientific paradigm of reference and the design research approaches on which this PhD is constructed. The author illustrates each research stage to show how she conducted the research and answered the research questions throughout the established methodology.

In conclusion to this chapter, the author declares the design research methods used to evaluate the research output at different levels of development.

2.1. Research assumption: *Designing consciously through critical thinking, Critical Thinking through Design Fiction*

Here and after, the author narrows down the research assumptions and defines the main concepts on which this research is founded. This research is interested in investigating how designers and practitioners can design more consciously technological artifacts to tackle aware behaviours in users.

The concepts author is introducing and explaining here are the following:

- ***What does it mean to design consciously, and how is this related to critical thinking?;***
- ***Why is designing consciously relevant for designing the technological artefacts to tackle aware behaviours in users?;***
- ***Which is the relationship between critical thinking and design fiction?.***

The Centre for Conscious Design defines the Conscious Design as “an enactive, equitable, empathic process of creating environments that are aware of and responsive to the needs and aspirations of its participants. It entails places, spaces, and objects that have an awareness of, and responsibility towards people.” To design consciously implies the use of critical thinking intended as “the intellectually disciplined process of actively and skillfully conceptualising, applying, analysing, synthesising, and, or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.”(Michael Scriven & Richard Paul, 2008) Critical thinking “comprises the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts.” (Sternberg, 1986) In the case of this research, the concept of critical thinking is multi-layered.

To design more consciously is concerning two dimensions. The first is about the technologies and their impact on individuals and society. The second is about influencing human behaviour through interaction with technological artefacts. At the first level, the author stresses the importance of understanding “both the practice of designing and creating artifacts (in a wide sense, including artificial processes and systems) and the nature of the

things so created.” (Stanford Encyclopaedia of Philosophy) Designing consciously technological artefacts must consider the ethics of technology and the extension of one’s knowledge of how technology is conceptualized in the world. The conceptualisation of technology needs to be understood as a political phenomenon, social activity, and cultural phenomenon while being a professional and cognitive activity. Thus, the design researchers and practitioners need to design the technologies considering the broader context of actors and social events, preventing the possible societal and ethical implications of technological artefacts long in time.

At the second level, the author is considering some essential questions when it comes to the ethics of designing for modification of human behaviour and how to prevent the unintended behavioural outcomes from the technological artefacts they design-build intentional and meaningful interactions between the user and technological artefact to support the user in adopting and maintaining the aware behaviours persistent in time. The author finds useful Jun, Carvalho, & Sinclair’s Sinclair’s (2018) definition about the ethical dimension of designing for behavioural change to explain better what is intended by designing consciously for human behaviour:

“The primary questions that arise as a result of considering the potential ethical dimensions of designing for behavioural change are 1. Why do people persist with “undesirable” behaviour? (Questions of moral psychology), 2. What is “desirable” behaviour? (Questions of philosophical ethics), 3. How can the gap between “undesirable” and “desirable” behaviour be narrowed in an ethically acceptable way? (Questions of design ethics).” (Jun, Carvalho, & Sinclair, 2018)

To design technological artefacts for human behaviour can be both unethical and counter-productive if we do not consider several aspects. Behavioural design researchers and practitioners study ways to improve the lives of individuals and produce a social benefit. (Stiebe and Cugelman, 2016) However, not all behavioural interventions achieve desired outcomes or bring social benefits. Designing nowadays for human behaviour has become an even more complex issue due to the uncertainties and controversies of the contemporary world.

The design of technological artefacts for human behaviour needs to embrace these complexities and variables. There is a “need of tackling the human’s lived, felt, and meaning-laden experience when designing technology, the behavioural model usually does not account for changes in an individual’s life circumstances (Clawson et al.2015); that it brackets the environment in which individuals live (Brynjarsdóttir et al.2012); and that it frames the user as merely an executor of behavioural programs (Purpura et al.2011).” (Rapp and Tirabeni, 2019) In this PhD research, the author is focusing on aware behaviours. To tackle aware behaviours in users is about addressing the changes in one’s attitudes and habits toward sustainable development, including the environmental sustainability goals, health, and general wellbeing. However, it may even consider citizens’ safety, such as urban safety or cyber safety. The author finds that the design research and practice need to address the topics proclaimed by the European Commission and United Nations. The author focuses on the

topics like “Enabling citizens to act on climate change, for sustainable development and environmental protection through education, citizen science, observation initiatives, and civic engagement,” where the design discipline (research and practice) can give its contribution. The key component of this topic is to raise awareness, engage and empower citizens and consumers with concrete tools to monitor their impacts on the environment, collect information enabling them to change their behaviour, and reduce their carbon and environmental footprint as users and consumers through individual and social innovation. Moreover, some of the actions proposed by the EU Commission should include the development and improvement of devices (low-cost sensors, consumer apps, such as wearable sensors, a trusted, user-friendly app with robust carbon footprint calculations, extreme weather community app, for early warning, marine, and freshwater litter watch) considering the interoperability and exchange of future and existing data collected. The PhD research in question is trying to marry these elements and build the relationships between human behaviour, sustainable development, technological artefacts.

The author suggests investigating and operationalising design fiction principles, considered as enablers of critical thinking..Critical design practices, such as design fiction and speculative design, offer principles that can be applied in design research and practice to trigger critical thinking regarding the possible ethical and societal implications of the use of technologies. Critical design practices can “engage designers in a different kind of thinking that delivers more conscious design products” and offer opportunities to “Include certain concepts into the range of quality criteria to be taken into consideration when designing.” (Jakobsone, 2017)

The author retains that the design fiction (as a critical, speculative, and future-oriented design practice) offers the principles (anticipatory scenarios and diegetic prototypes) that can engage the design researchers and practitioners to deliver more conscious and intentional designs.

However, the research-oriented toward critical design practices goes beyond the scenario making and fictional prototyping “instead relies on imagination and fiction to develop critical dialogues and discourse about new, alternative and future paradigms of technology use.” (Elsden et al., 2017)

Through the fictional and speculative exploration, “designers can look into possible consequences of technological applications before they happen” and “we can use speculative designs to debate potential ethical, cultural, social, and political implications.” (Dunne and Raby, 2012)

In regard, in the last few years, there has been an increased interest to introduce critical design practices into the behavioural design with a purpose to add a more phenomenological perspective and investigate the lived experiences, consider the changes in one’s life and comprehend a more comprehensive network of actors involved in complex processes in which the individual is involved. The same interest is constantly increasing in HCI re-

search and practice to design critically for and with technologies and anticipate possible ethical and societal implications and consequences. The conceptualisation of technologies in the world requires considering the technologies “as a political phenomenon, as a social activity, as a cultural phenomenon, as a professional activity, and as a cognitive activity.” (Stanford Encyclopedia of Philosophy)

The technological artefacts are not just artificial entities surrounding us. They embed prescriptions and values in their form and through interaction rituals. These prescriptions are the result of the designer’s intention, who delegates responsibilities to the “nonhuman” as Latour (1992) explains: “We have been able to delegate to nonhumans not only force as we have known it for centuries but also values, duties, and ethics.” (Verbeek, 2006) To adopt critical thinking when designing with and for technologies means to analyse technologies and technological systems at several levels, “a primary level at which natural objects and people are decontextualised to identify affordances, complemented by a secondary level of recontextualisation in natural, technical and social environments.” (Feenberg, 1999)

2.2. Research Questions

This research aims to operationalize a new and more critical approach relying on a pluriversal perspective exploiting speculative design with design fiction to trigger critical thinking when designing technological artefacts able to tackle aware behaviours. This research is founded on one central question, supported by another two sub-questions.

This research starts from the hypothesis that the principles found in critical design theories and practices, such as Design Fiction and Speculative Design, can help trigger critical thinking in designing for technological artefacts to tackle aware behaviours. To research this statement, the author sets the main research question:

How can we trigger the critical thinking in design research and practice to design more consciously the technological artefacts able to tackle aware behaviours?

This question implies the investigation and research within the area of the design fiction principles and speculative proposals, and its application in design research and practice, but also the methods, practices and theories coming from other fields beyond design (social sciences, psychology, philosophy of technology, HCI).

To help this investigation, the author sets another two sub-questions:

(a) Which principles and theories of Design Fiction (as a critical and speculative design practice) can be implemented and used to trigger critical thinking in research and practice concerned with the design of technological artefacts able to tackle aware behaviours?

This sub-question explores and exploits design fiction principles and theories, case studies in which these principles are used, and related literature and experimentations.

And the second sub-question is:

(b) How can we systematize and operationalize the design fiction principles to design more consciously technological artefacts to tackle aware behaviours?

The second sub-question (b) is more concerned with transforming the knowledge gained from answering the first sub-question and giving design researchers and practitioners a systematized approach ready to use in their research or projects.

In the following text, the author introduces the design methodology she established to answer research questions.

2.3 Research Methodology

In this part of the text, the author introduces the methodology behind this PhD research starting from the overview of the scientific paradigm of reference, through the established design research methodology, and different evaluation methods, and explain the reasons behind this decision. The author illustrates how the research was planned and executed in three years period.

2.3.1. Scientific Paradigm of reference

This research aims at producing the knowledge that offers a possible way to design more consciously technological artefacts to tackle aware behaviours through critical thinking, exploiting speculative design with design fiction. Before going into design research methodology, the scientific paradigm is introduced to show how the research methodology of this PhD is established.

This research observes the phenomena of design researchers and practitioners adopting critical thinking and the efficiency of different approaches, tools, and methods to trigger critical thinking.

The study of critical thinking “combines the educational, philosophical, and psychological traditions of thought.” (Sternberg, 1986) Measuring critical thinking is a difficult task. Most of the studies concerning the measurement of critical thinking are within education and pedagogy research. This PhD focuses mainly on the design research and practice; however, some definitions coming from education and pedagogy are appropriate to explain how the acquisition of critical thinking is evaluated by the author in this research.

Critical thinking “improves an individual’s ability to analyze and synthesize knowledge to

form cohesive arguments, promote intrinsic motivation [...]” (Shively, Stith, and Rubenstein, 2018) The question that opens here is how can one measure the acquisition of critical thinking? Shively, Stith, and Rubenstein (2018) explain that critical thinking can be described through eight universal standards: all reasoning has a purpose, all reasoning is an attempt to conclude a problem, all reasoning is based on assumptions, all reasoning is done through a point of view, all reasoning is based on evidence, all reasoning is shaped by constructs, all reasoning contains interpretations by which we conclude, and all reasoning has implications. Research and design activities can be analysed and interpreted using these standards to understand the completeness and the level of the critical thinking engaged in the process. The author of this PhD research is building the evaluation parameters by taking in account these standards of critical thinking acquisition, which is explained further on in the chapter.

Evaluating critical thinking is a matter of experience and interpretation, observation of the research and design process, and outputs. Building on these assumptions, this research relies on the foundations of interpretivism as a scientific paradigm of reference. This PhD research is mainly concerned with exploring the reality throughout the interaction with design researchers and practitioners. The author investigates how different approaches may trigger critical thinking when designing technological artefacts to tackle aware behaviours through these interactions. The author engages design researchers and practitioners in producing the knowledge through participation and sharing of the experience, which is recorded by the author and interpreted through several parameters to evaluate the acquisition of critical thinking in the design research process.

The findings the author collects are brought from the participants’ experiences engaged in the experimentation and considered sources to produce knowledge and from the theoretical perspective of reference, in this case, phenomenological research and hermeneutics.

In the following text, the author shows established design research methodology, describing the stages of research development to show how the methodology was applied.

2.3.2. Design Methodology and Approaches

Building on the scientific paradigm of reference, the author establishes the Research through Design (RtD) methodology to answer the research questions. This approach is suitable for the problems that need to integrate the knowledge and theories from different disciplines, which is the aim of this PhD research.

Research through the Design approach enables the investigation of “preferred states as an intentional outcome of the research” opens up the questions upon the possible ethical and societal implications of what is designed. (Zimmerman, Stolterman, and Forlizzi, 2010)

The research through Design term was coined around 20 years ago to describe practice-based inquiry that generates transferrable knowledge. (Durrant et al., 2017) Gaver (2012) defines Research through Design as design practice that “is brought to bear on situations chosen for their topical and theoretical potential [...] embodying designers’ judgments about valid ways to address the possibilities and problems implicit in such situations” allowing “a range of topical, procedural, pragmatic, and conceptual insights to be articulated.”

In this research, the RtD based methodology is conducted on two levels.

The first level is the sessions with researchers and practitioners (experimentation) to test different tools and concepts, which will be subsequently systematized in a protocol and applied in the research. The second levels are the reflection and design of research activities.

The author applies and studies the Protocol for designing more consciously technological artefacts for aware behaviours developed within this research. In this research, materialization has an important role. The artefact becomes the “key means in constructing the knowledge.” (Zimmerman, Forlizzi, and Evenson, 2007). It simulates the existence of the fictional artefacts (diegetic prototypes) generated through the Protocol by contextualizing them in the present.

Stappers (2007) acknowledges the importance of creating the prototypes as a part of reflective design and research activity:

“The designing act of creating prototypes is in itself a potential generator of knowledge (if only its insights do not disappear into the prototype, but are fed back into the disciplinary and cross-disciplinary platforms that can fit these insights into the growth of theory).”

This PhD research aims to construct knowledge through making and reflecting critically and interacting. Such an approach has its foundations in Applied (design) research¹ and Action research², enabling practitioners to reflect on and evaluate their work (Muratovski, 2016). It is characterized by a systematic inquiry directed towards acquiring, converting, or extending knowledge in particular applications.

In this PhD research, the author proposes a new approach for designing consciously technological artefacts. The first level of the research is about building the approach with Protocol and envisioning tools. The second level is applying the Protocol approach in design and research activities and prototyping and user tests.

Here and after, the author describes the established design research methodology through all stages.

At the first level, the author conducts the research to set a new approach for designing consciously technological artefacts to tackle aware behaviours. These initial stages of the research were conducted in an academic context at Politecnico di Milano. The first stage is desk research (in-depth literature review), during which the author sets the theoretical background, identifies and analyses different theories, tools, methods within behavioural change field to understand the weaknesses in the current research and practice. In parallel, the author examines critical design practices to investigate different principles and identify which could be applied in design research and practice concerned with technological artefacts, sustainable development, and human behaviour. Additionally, the author goes through HCI and emerging technologies to observe how the technological artefacts act as mediators and their role in societies (technologies as social actors). Also, here, the author observes different approaches in the design of technologies and how these were changing in time to provide meaningful interactions between the users and artefacts (postphenomenological approaches). In the desk research author generates the knowledge upon which she establishes the first approach with Protocol and the first version of the envisioning tool, exploiting the design fiction principles for designing technological artefacts.

This research stage answers the first sub-question: *Which principles and theories of Design Fiction (as a critical and speculative design practice) can be implemented and used to trigger critical thinking in research and practice concerned with the design of technological artefacts able to tackle aware behaviours?*

The Protocol and Envisioning tool approach is the first output of this PhD research. The author tests the output with design researchers to evaluate how efficient is the Protocol with tools and the Envisioning tool to trigger critical thinking when designing technological artefacts to tackle aware behaviours. The author observes the activity, whether the participants got engaged in the process, whether the discussions were stimulated, how the participants were building upon one's other point of view and knowledge. Another instrument to measure the critical thinking and evaluate the tool's efficacy was the questionnaire – the participants evaluated the activity through their experience, how they perceived that the critical thinking was

triggered and how much the tools in the Protocol helped the process. Afterward, the author analyses the output of the activity – anticipatory scenarios delivered by the participants. Through the analysis of scenarios, the author observes how the tools and methods offered in the Protocol guided the participants in building anticipatory scenarios (how they applied the knowledge); how consistent were the scenarios in terms of how they interpreted and analysed the initial topic (topics within the sphere of sustainable development based on evidence such as environmental issues); how they transformed the topic in a design challenge, how they took in consideration the implications of technology.

At this stage, the author brings the first results and assumptions concerning the Protocol and Envisioning tool architecture used to understand how to refine the approach and tools. Building on the results, the author sets the second desk research to deepen the initial analysis on the theories, tools, methods, and models for designing technological artefacts concerning human behaviour and sustainable development. Once again, she generates the knowledge to propose the provisional version of the Protocol. The new Protocol and improved Envisioning tool are tested in an educational activity on the topics of applying Artificial Intelligence in Public Administration and Health. The students used the Protocol and Envisioning tool to build the anticipatory scenarios that could help them revise the design briefs through a critical lens and to nourish the design ideas. The results were collected from the questionnaires where the students described and evaluated their experience with the Protocol and Envisioning tool. Besides, the author analyses the outputs of the activity – the anticipatory scenarios. The parameters set for the analysis are the same as the first testing.

The findings collected from the activity with the students were elaborated and used to generate the semifinal Protocol and improve the Envisioning tool again. In conclusion to the first level of the research, the author provides the answer on: *How can we systematize and operationalize the design fiction principles to design more consciously technological artefacts to tackle aware behaviours?*

The author sets the semifinal protocol and starts with the final tests. The following activities concern the second level of methodology – applying the approach with the Protocol and Envisioning tool in design and research activities. The activities conducted at this level are not concerning only the academic context of Politecnico di Milano. However, it expands its horizons to the experts from different fields of study (concerned with the knowledge treated by this PhD) and external institutions like ITU Copenhagen.

Before testing the semifinal Protocol and Envisioning tool with the experts, the author conducts a one-day self-reflection activity, immersing herself in the process. This activity aimed to check whether there were some issues and problems with clarity in the Protocol and to understand how to set the activities in terms of organisation, topics, and participants. After fixing several issues, she organised two activities (half-day each) to test the Protocol and Envisioning tool, engaging the experts from different fields of study from behavioural design, behavioural sciences, social-psychology, design for sustainability, digital design,

HCI, critical design. The experts engaged in the activities were both from academic and professional spheres. The author had a loud discussion during the process, and some significant insights about the Protocol emerged. The experts evaluated the Protocol with tools and Envisioning tool in the questionnaire to evaluate all stages of the Protocol, tools, methods, and models applied and comment on the efficacy of each in triggering the critical thinking long the process. They were very knowledgeable about the topics treated in this PhD and the theoretical background behind the Protocol, so their contribution was essential to improve the Protocol and Envisioning tool. The outputs generated from the activities – the anticipatory scenarios – were used to create diegetic prototypes. To remember, the author suggests the approach founded on the creation of anticipatory scenarios and diegetic prototypes (materialising scenarios) to reflect and discuss the technological artefacts, anticipate the mediations between the artefacts and humans, and anticipate the possible implications, to design more consciously. Translating scenarios in diegetic prototypes at this stage was necessary because the author could demonstrate and test the overall approach. This passage could not be seen at the first level of research because the Protocol was still in development. At the second stage, developing diegetic prototypes had more sense because of the completeness of the research and the quality of the scenarios that improved as the Protocol was evolving.

The diegetic prototypes were tested in focus groups with people (users) to understand how the values prescribed throughout the Protocol were evident and to identify the possible implications of proposed scenarios. These implications could be used as a guideline to deliver more conscious technological artefacts to support the user in adopting and maintaining more aware behaviours, in this case concerning air pollution, energy consumption, and waste management.

After the sessions with experts, the Protocol was slightly refined and applied in the design and research activity with the IxD lab of ITU Copenhagen on the project “Future of Mobile Technology .” In this case, the author wanted to test the Protocol in a long-term activity throughout the entire research and design process. The research was conducted following the Protocol stages used iteratively to inform various stages of the research from desk research, identifying the design spaces, surveys, creation of scenarios, and diegetic prototypes as the research outcome. Also, the diegetic prototypes were tested with the people to understand how the new interactions, interaction rituals, and forms could prevent the unintentional and compulsive use of the smartphone. The findings of the focus group were used to generate the design knowledge about how the future of mobile technology could be to take more into consideration one’s life circumstances needs and establish a more healthy relationship to this technology.

The knowledge generated from the sessions with experts, in the design and research collaboration with ITU Copenhagen, as well as the results of the focus groups with users, the author generates the PhD knowledge and answers on the main research question: *How can we trigger the critical thinking in design research and practice to design more consciously the technological artefacts able to tackle aware behaviours?*

The author proposes the approach with the Protocol, an assemblage of theories, tools, methods, and models to guide design researchers and practitioners adopt critical thinking and consequently design more consciously for human behaviour, technologies, and environment, and suggests using

the future as a space for critical inquiry to deliver anticipatory scenarios and diegetic prototypes – instruments for the critical reflection and discussion. To support the Protocol, the author ideates the Envisioning tool exploiting the Sci-Fi genre as a possible way to reflect upon the collective imaginaries about the future, scientific and technological development.

Figure 11 illustrates how the methodology is structured on two levels and how each stage informed the following to generate the PhD knowledge.

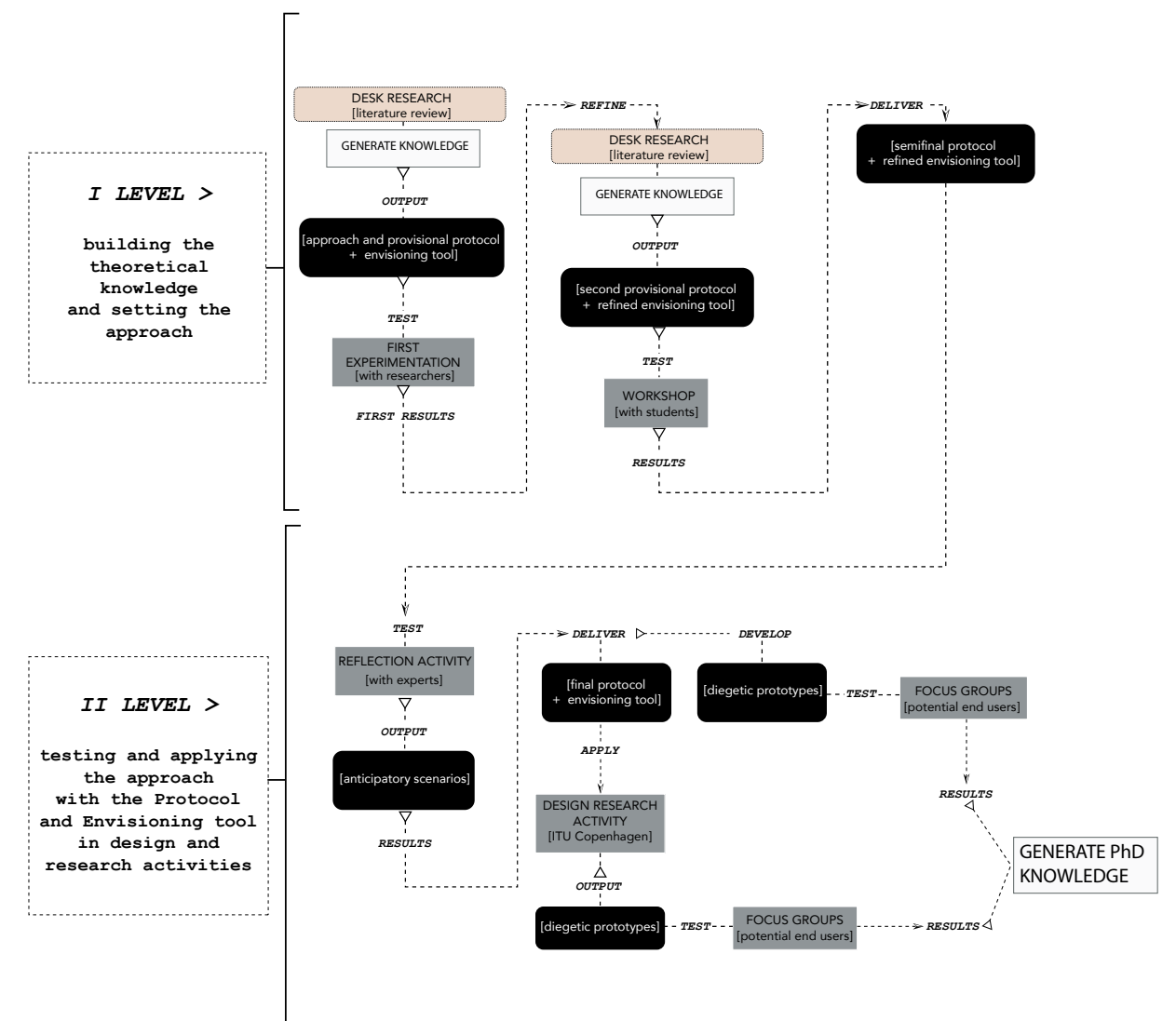


Figure 2: Design research methodology illustrated

2.3.3. Methods of evaluation

This research is mainly concerned with qualitative methods for analysing reality. Still, it does not exclude some quantitative methods such as questionnaires and surveys for evaluating the fictional artefacts produced as the output of the activities. The author observes how the evaluation methods were applied through two levels of research development.

The first level of the research concerns examining the theoretical foundations and setting the approach for designing consciously technological artefacts.

The first stage concerns the desk research and, as a result, setting the approach with Protocol and Envisioning tool. In the desk research, the author researched and defined different theories, tools, and methods for triggering critical thinking in design research and practice on the one side and on the other for influencing human behaviour through interaction with technological artefacts. Assumptions and research hypotheses brought at this stage were systematised into the first Protocol and Envisioning tool.

The author sets the first experimentation with design researchers to evaluate the most suitable tools and approaches for triggering critical thinking proposed in the Protocol. The participants were given several topics from the EU Commission agenda (concerning sustainable development) and explored the topics using the Protocol to deliver anticipatory scenarios.

The evaluation methods applied at this stage were:

- **The observations (of the researchers using tools and suggested approach), participants inquiry (researchers commenting critically on the tools and suggested approach),**
- **Semi-structured questionnaires (evaluating different parts of the Protocol like tools, methods, application of the theories),**
- **Output analysis (in this case, analysis of the scenarios generated by the researchers and how different tools influenced the scenarios).**

The participants needed to evaluate the entire process that led them to build the anticipatory scenarios and single tools inside the Protocol. The findings collected from the first experimentation were used to understand the weaknesses of the first Protocol and Envisioning tool. These findings were the input for deepening, expanding the research on theories, tools, and methods to apply in the Protocol, and improving the Envisioning tool.

The author generated the new (semifinal) Protocol and refined the Envisioning tool. The

semifinal Protocol and Envisioning tool are tested in a workshop with students. This activity was a bit different because the students were working on their topics to deliver the anticipatory scenarios and use them for the critical discussion in the group to improve the design briefs putting a critical eye on it.

The evaluation methods applied in this second session were:

- **Semi-structured questionnaires (evaluating different parts of the Protocol, tools, approach itself, others),**
- **Output analysis (in this case, analysis of the scenarios generated by the researchers and how they used the tools influenced the scenarios),**
- **Analysis of how the students used the anticipatory scenarios to inform design briefs (present).**

This activity was conducted online due to the COVID-19 emergency, so the 'traditional' observation of the activity was not possible. To make the evaluation method more heterogeneous with the first experimentation, the author structures the questionnaire to compensate for this factor, like leaving more space for the students to tell their experience, instead of just evaluating the tools, theories, and methods.

The findings of the second session helped the author set the final Protocol and structure the Envisioning tool in a definite way.

At the second level of the research, the author dedicated entirely to applying and testing the final versions of the approach with the Protocol for designing consciously technological artefacts and the Envisioning tool in two activities. The first is concerning the reflection activities (n.2) with experts – a short term brainstorming activities in which the author, together with the experts, used the Protocol with Envisioning tool to build anticipatory scenarios and evaluate the stages of the Protocol and the selected tools, methods, models and theoretical concepts.

The first phase of the activities at this level is with experts. These activities are aimed at testing (evaluating) the Protocol and Envisioning tool and generating the design research outcome that the author subsequently uses to generate diegetic prototypes. The evaluation methods used during the activities with experts aimed to investigate the efficacy of the final approach with Protocol in triggering critical thinking.

The methods author apply at this stage are:

- **Observations (observing how the experts are approaching the Protocol and tools);**
- **Participant's inquiry (engaging the experts in building knowledge and activities**

stimulating critical discussion and reflection, loud discussion);

- **Semi-structured questionnaires (evaluating all the parts of the Protocol, tools, and others).**

The author used the outputs of the activities – anticipatory scenarios to generate the diegetic prototypes. Diegetic prototypes have a purpose of demonstrating the entire approach with the Protocol proposed by this PhD. Nevertheless, the diegetic prototypes are also tested with the people to understand how these can be used as a tool to open the critical discussion among the wider community (beyond the design research and practice); how these discussions between the people and researchers or practitioners can influence the design research and practice providing some valuable guidelines for designing consciously technological artefacts to tackle aware behaviours.

To prove the efficacy of the diegetic prototypes in doing so, the author sets the following evaluation methods:

- **Focus groups,**
- **Semi-structured questionnaires,**
- **Open discussion.**

Focus groups (the author held three sessions testing three different diegetic prototypes) were also helpful to verify whether the diegetic prototypes resemble the values prescribed using the Protocol and understanding whether the translation from the scenarios to diegetic prototypes (materialisation of scenarios) is managed well or there is a need to take some notions in regard. The author structured the semi-structured questionnaires in a way to evaluate the diegetic prototypes, putting in question all the values contained in the Protocol, such as the ethical aspect of proposed technology (trustworthiness), recognised (individual and social) benefits or implications of proposed artefacts, interaction modalities, and rituals and its potential to engage the user to adopt more aware behaviours, and other.

Besides, the open discussion with people helped understand how they perceive the future and how they would like the future to look like, their fears and disbelief about the technologies and scientific development, and what kind of implications there is awe of. All this information helps guide the design researchers and practitioners more consciously in the present and building more thriving futures. The future is inseparably related to the present. The approach proposed by the author wants to emphasize the feedback loop between the present and the future. Testing the not-yet-existing technological artefacts with people can help design researchers and practitioners anticipate possible ethical and societal implications between humans, technology, and the environment.

After the sessions with experts, the author applies the approach with the Protocol in a design

and research collaboration with ITU Copenhagen. On this occasion, the author demonstrates how the approach with the Protocol can be applied in a long-term activity. In this case, the evaluation is not concerning the Protocol and Envisioning tool anymore – declared as the final versions at this point. Together with collaborators from ITU, the author is producing the anticipatory scenarios and diegetic prototypes as the output of the research and tests the output with the people. The testing with users in this project aimed at verifying whether the interactions and interaction rituals and new forms of the (future) mobile technology (smartphones) could prevent the unintentional and compulsive use of this technology and, in conclusion, map the fields of possible action in regard.

To evaluate the diegetic prototypes authors of this project applied the following methods:

- **Focus group,**
- **Open discussion,**
- **Semi-structured questionnaires.**

The authors organised one focus group to test three different diegetic prototypes. Each of these was discussed loudly and evaluated in the semi-structured questionnaires. The questionnaires are structured in a way to understand how the users' perceived different aspects of the proposed scenario and technological artefact, such as the form, interaction modalities, interaction rituals, context of use, how this kind of interaction would help them change the relationship to the smartphone (establish more intentional and aware usage patterns, prevent antisocial behaviours, etc.), and others.

The author gave an overview of the methodology established to answer the research questions and methods applied to evaluate the Protocol through various stages of development and application in design and research activities. These activities and tests are explained more in-depth in the upcoming chapters. The complete questionnaires conducted during the PhD research are the section Appendix of this dissertation.

- Feenberg, A. (1999). *Questioning the Technology*. Routledge
- Johnson, D.G., et al. (2009). *Technology and Society. Building our Sociotechnical Future*. Inside Technology
- Latour, B. (1992). *Where are the Missing Masses: The Sociology of a Few Mundane Artifacts*. In Bijker, W. E. and Law, J. (eds.), *Shaping technology/building society: studies in sociotechnical change: Vol. Inside tec.* pp. 225-258. Cambridge: MIT Press.
- Latour, B. (2005). *Reassembling the Social - An Introduction to ANT*. In *Journal of Chemical Information and Modeling*, Vol. 53 (9). <https://doi.org/10.1017/CBO9781107415324.004>
- Corbetta, P. (2014). *Metodologia e tecniche della ricerca sociale*. Il Mulino
- Friedman, K. (2003). *Theory construction in design research Criteria: Approaches, and methods*. *Design Studies*, 24(6), 507–522. [https://doi.org/10.1016/S0142-694X\(03\)00039-5](https://doi.org/10.1016/S0142-694X(03)00039-5)
- Hall, A. (2011). *Experimental design: Design experimentation*. *Design Issues*, 27(2), 17–26. https://doi.org/10.1162/DESI_a_00074-Hall
- Hummels, C., and Frens, J. (2012). *Designing Disruptive Innovative Systems, Products and Services: RTD Process*. *Industrial Design - New Frontiers*, May 2014. <https://doi.org/10.5772/22580>
- Hummels, C., and Frens, J. (2009). *The reflective transformative design process*. January, 2655. <https://doi.org/10.1145/1520340.1520376>
- Kivisto, P., Kuklick, H., & Long, E. (1988). *Knowledge and Society: Studies in the Sociology of Culture Past and Present*, Vol. 6. *Contemporary Sociology*, 17(6), 813. <https://doi.org/10.2307/2073617>
- Lipo, K. (2011). *Design research through practice*. In Morgan Kaufmann (Issue 3).
- Michel, R. (2015). *Design Reserch Now*. Birkhauser
- Muratovski, G. (2016). *Research for Designers*. Sage
- Zimmerman, J., and Forlizzi, J. (2008). *The Role of Design Artifacts in Design Theory Construction*. *Artifact*, 2(1), 41–45. <https://doi.org/10.1080/17493460802276893>
- Zimmerman, J., Forlizzi, J., and Evenson, S. (2007). *Research through design as a method for interaction design research in HCI*. *Conference on Human Factors in Computing Systems - Proceedings*, January, 493–502. <https://doi.org/10.1145/1240624.1240704>
- Zimmerman, J., Stolterman, E., and Forlizzi, J. (2010). *An analysis and critique of research through design: Towards a formalization of a research approach*. *DIS 2010 - Proceedings of the 8th ACM Conference on Designing Interactive Systems*, January, 310–319. <https://doi.org/10.1145/1858171.1858228>

3

BACKGROUND KNOWLEDGE

In this chapter, the author deepens the background knowledge of this PhD research, describing in-depth the three main areas of this research. Firstly she introduces Design for Behavioural Change (DfBC) research and practices with an overview of the evolution of this field from the birth of Captology in the '90s up to today. This is to observe how some other research fields such as neurosciences, psychology, and social psychology influenced the development of design theories and tools. Then the author analyses and explores the current tools, theories, and methods used in DfBC, including the field of HCI. This research focuses on the theories and tools interested in sustainable behaviours and the potential of artefacts to influence human behaviour - how the artefacts influence our behaviour and become social actors. Technological artefacts to tackle behavioural change open several ethical and societal implications. Gyuchan, Carvalho, and Neil suggest some questions that everyone dealing with design for human behaviour need to take into account:

Who is affected by the type of behaviour?

What are the interests of those affected?

What are the conflicts between those interests?

What is collectively desirable?

Human behaviour is not a standalone issue, but it engages a broader context of actors and events that are complex to manage. When using the technologies to tackle human behaviour these issues are even emphasized. To manage all these complexities, more pluriversal perspectives and critical approaches are needed.

For this reason, the author moves from the DfBC toward the Critical design theory and practice. This part of the text explores in depth the role of this discipline in enabling design researchers and practitioners to deal with and understand the complex issues of the rapidly changing world, dominated by uncertainty and pervasive technological development and use - even abuse. The author explains why it is beneficial to use the future as the space for critical inquiry. Then the author introduces the Design Fiction and Speculative design as two principal branches of this discipline, with their principles and tools, with the

specific attention on the fictional artefact (scenarios and diegetic prototype).

The final part of this chapter is dedicated to exploring technologies as mediators between the human and environment/real world. It starts from the analysis of the morphology of the technological artefacts through its metaphysical and even social dimension and wrapping up with the analysis on the ethical and social implications of the use of technologies and technological artifacts for tackling human behaviour.

This chapter concludes the desk research analysis. The theoretical findings from this stage were subsequently applied to build the PhD knowledge.

3.1. Design for behavioural change foundations, theories and practices

In the following text, the author goes through the evolution of Design for Behavioural Change (DfBC) research and practice starting from introducing the origins of behaviourist science through the development of this discipline and different models and theories in psychology, social psychology and economics. Finally, the author will go through the DfBC approaches, models, and tools and observe how these emerged, starting from the Captology in the '90 up to nowadays. The author gives an overview of how these two tendencies, one within the science field and the other within the design field, were evolving in parallel and how behaviourist science influenced the design field and raised some challenges for the design discipline.

Then the author will explain the focus of this research when it comes to human behaviours where the ability of the artefacts to tackle and support more aware behaviours. Beyond the introduction on what the author means for aware behaviours, some essential concepts for this research will be introduced, like design scripts and mediations – how the artefacts influence human behaviour through its material and attributes and embodiment of technologies.

3.1.1. Evolution of the Behavioural Change and Design for Behavioural Change theories and practices: An overview

Behaviourist science had its beginnings back in the early 1900. (Araiba, 2019). From that period on, many theories and models were born to help the scholars define human behaviour and identify the most suitable strategies to influence one's behaviour toward different tasks, such as health behaviour, education, political, social, sustainable, and many other attitudes. In the middle of the 20th century, Functional Theories emerged. Some of the functional theories are: ABC model (1950 emerges for the first time), Cognitive Dissonance Theory ('50s), Balance Theory ('60s), Social Learning Theory ('60s), Theory of Reasoned Action ('60s), Reasoned Action Approach ('70s), Dual Process Theory ('70s), Theory of Planned Behaviour ('80s), Social Cognitive Theory ('90).

From the middle of '90, we can notice the emergence of Environmental Psychology Theories, and here we can find Information-motivation behavioural skill model (2001), Behavioural Perspective model (around 2008), nudge theory, and others. The interest in behavioural economics emerges, and different tools are present, like the Mindspace tool (2014). In Fig. 3., we can observe the development of Behavioural Change (BC) theories and models within psychology, social psychology, and behavioural economics.

Some of these theories were revised several times through the history of behavioural science, reintroduced. The author classifies the most important theories and models, the foundations behind the specific theory or model, and the applications. This analysis was helpful to the author to identify cases in which the specific theories and strategies can be applied and observe how some of these are currently applied for the behaviours addressing the sustainability issues (environmental topics, health, and wellbeing).

What can be observed is that the theories and models are often built one upon the other, even combining more than one theory. Besides, it can also be observed how the application of behavioural science was expanding long in time, from the health and consumer behaviour to other applications such as discriminatory behaviours, traffic behaviours, business, media, and also the interest in social and environmental issues was raising quite a lot in years.

Pervasive development and use of technologies and their miniaturization motivated the HCI and Interaction Designers design increasingly for behavioural change. From the birth of Captology (study of computers as persuasive tools) in the '90s, HCI scholars and designers started to propose new strategies and tools for behavioral change, and the attention toward the potential of (technological) artefacts to influence human behaviour was rising. Technologies to influence human behaviour are commonly known as Persuasive Technologies. Persuasive technologies are “computer-based tools designed to change people’s attitudes and behaviours” (Fogg, 2003), can persuade users toward a healthier lifestyle, safe behaviour, making sustainable choices, and many others.

However, the HCI and design research interested in behaviour change “commonly draws on psychological theories to make decisions about design.” (Rapp, 2019)

Rapp (2019) adds:

“In the last decade, a variety of systems have been developed informed by, e.g., the Health Belief Model (HBM) (Rosal and Bodenos, 2009) or the Theory of Planned Behavior (TPB) (Ajzen1991), both of which emphasize the role of intentions and beliefs in driving human actions; the goal-setting theory, which claims that a positive linear relation exists between degrees of goal difficulty and levels of performance (Strecher et al.1995); the Social Cognitive Theory (SCT) (Bandura1986), which posits that change is affected by outcome expectations and efficacy expectations (ourself efficacy); or the Trans Theoretical Model of behavior change (TTM) (Prochaska and Velicer1997) [...] behavior change designs

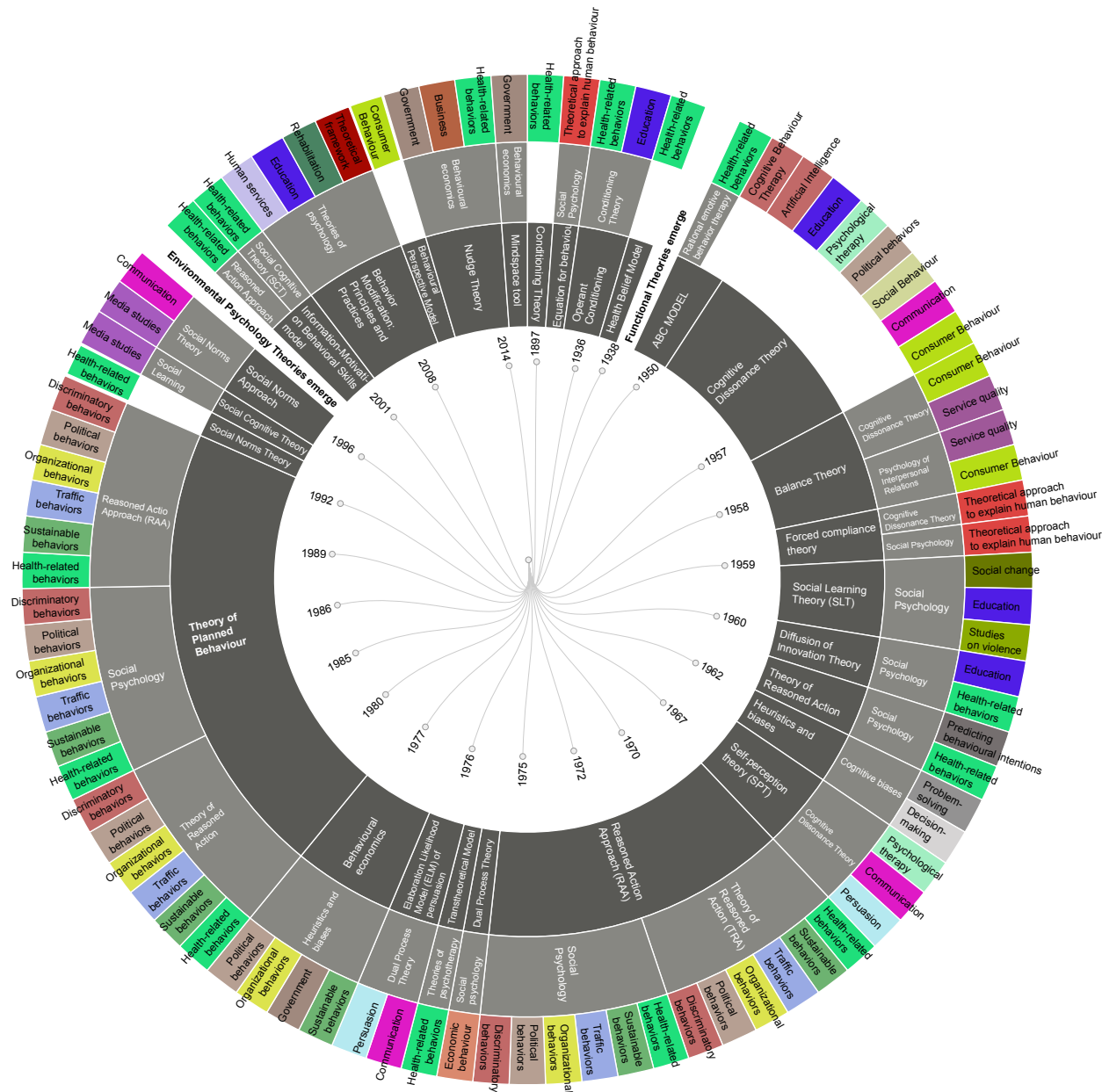


Figure 3: Classification of the evolution of BC theory within behaviourist science (including psychology and social sciences)

are informed by a “behavioral model” encompassing the idea that the central focus of technological interventions should be on the “external” manifestations of change. Designers may find this model pragmatically useful because it appears to focus on visible and identifiable variables that can be directly tackled by technology, representing actionable challenges and presenting opportunities for measurable results.”

There are some criticalities of exploiting established models as they are by the HCI. One of these is that the current behavioural models “usually does not account for changes in an individual’s life circumstances (Clawson et al. 2015); that it brackets the environment in which individuals live (Brynjarsdóttir et al.2012); and that it frames the user as merely an executor of behavioural programs (Purpura et al.2011).” (Rapp, 2019)

The same is for the design discipline. Some of the theories and models have been revised, yet “current theoretical approaches to behaviour change have yet to be operationalized this in design process support.” (Cash, 2017)

As part of the analysis, the author observed how the HCI research concerned with human behaviour and design theory evolved in parallel with social-psychological and behavioural economics. (Figure 4)

This map focuses on the period from '90 until today, taking the birth of Captology as a reference. From this mapping of theories and models, we can notice several tendencies.

- **First, the environmental and social issues start to rise from the beginning of the '90 in behavioural sciences, and it slowly translates into design discipline.**

- **The second is the technologies, and here we can observe the tendency toward persuasion, information, media, and communication.**

- **The third tendency is that from some point, there is an increasing interest in human experience there in adopting phenomenological perspectives – this particularly in the last several years and typically in the design field.**

Mapping these strategies had the purpose of observing and describing the role of design discipline in designing for human behaviour. The author subsequently could select and analyse some of these strategies and concepts more in-depth to identify how they can be revised and readapted to propose a new approach for designing more consciously technological artefacts to tackle aware behaviours. The author’s interest is within the intersection between the strategies addressing the sustainability questions, the experiential dimension of artefacts on human behaviour (materiality and interaction), and the role of technologies as mediators.

Recently, the design for behavioural change research is trying to propose new reflective ap-

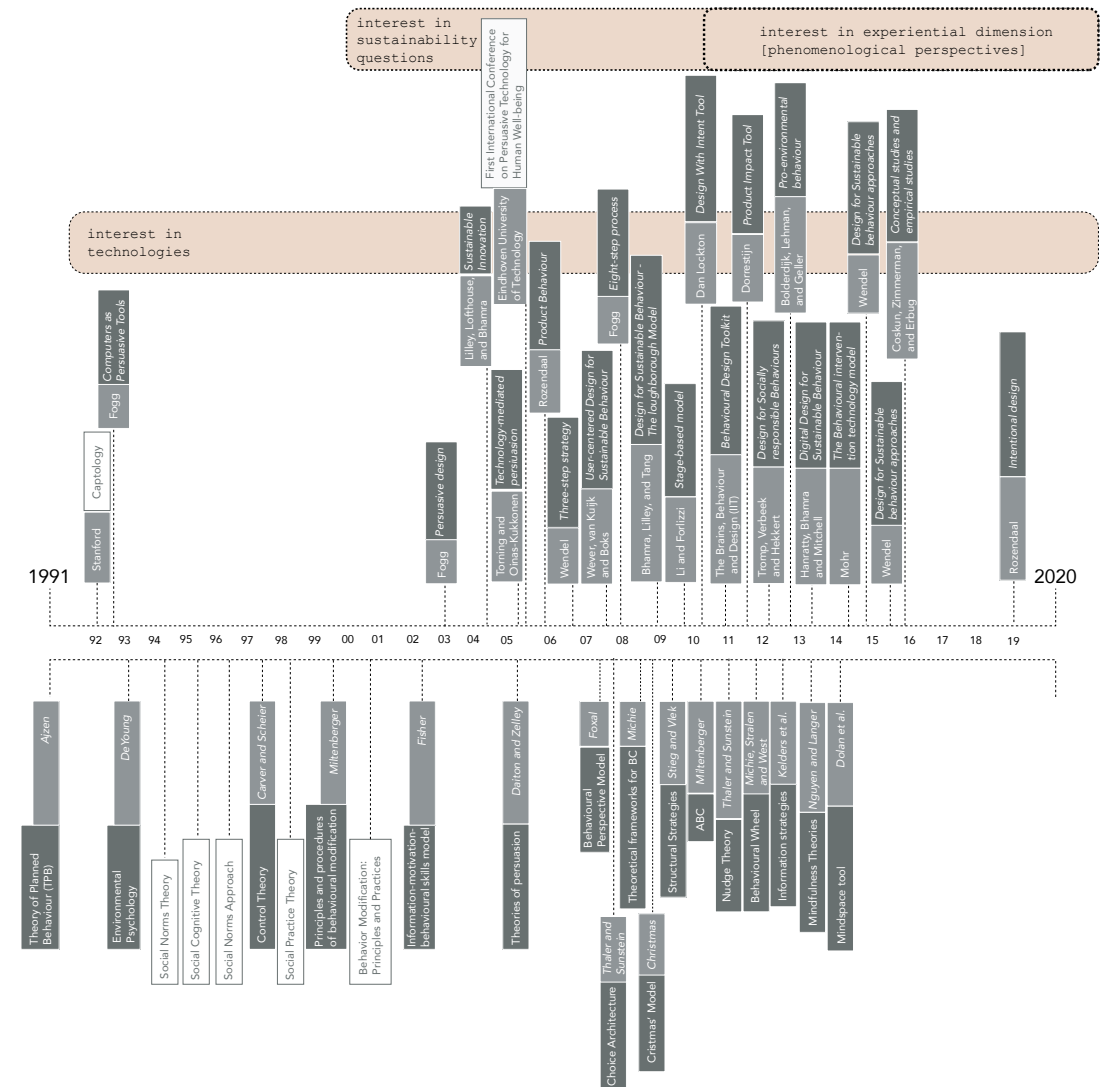


Figure 4: Comparison of the BC and DfBC theories, approaches, and tools evolution from '90s up to nowadays

proaches and different kinds of techniques able to trigger more critical thinking regarding the technological impact on individuals, society, and the natural environment. The need for new approaches emerged due to several factors, such as the complexities of the contemporary world and the uncertainties and the rapid and pervasive technological development and implementation. There is a need to consider human behaviour and technologies in the broader context of use, through the impact on the individuals, society, and environment nowadays. All these events raised the demand on ethical and societal issues when designing these

artefacts, and among all, it is important to guide the users' behaviour in an ethical and sustainable way and understand the impact of behavioural change in the future: "[...] it is fundamental to start reflecting on whether and how these technologies could affect individuals and the society in which they live." (Rapp, 2019)

The design for behavioural change can be unethical and even counterproductive or cause unintended adverse effects. (Jun, Carvalho, and Sinclair, 2018; Stibe and Cugelman, 2016) It was noticed from the scholars that many current strategies and designs for behavioural change "assign too much responsibility to agency and self-efficacy without much consideration to variables of a social or contextual nature." (Jun, Carvalho, and Sinclair, 2018)

The design discipline will need to adopt approaches and methods that permit the design researchers and practitioners to deal with all these complexities in times of uncertainty. (Grand and Wiedmer, 2010)

The author lists several tools designed in the last years to support designers when designing for behavioural change, taking into account the sustainability issues the role of technology in influencing human behaviour, that stress the importance of ethical dimension when designing for human behaviour or technologies for human behaviour:

- ***Design for Sustainable Behaviour (Loughborough University)*** – addressing the sustainability issues and role of technologies as persuasive tools

- ***Design with Intent Tool (Dan Lockton, Brunel University)*** – addressing the sustainability issues, the influence of the materiality of the artefacts, and interaction (digital and physical) on human behaviour, exploiting the ethics behind influencing human behaviour.

- ***Product Impact Tool (Dorrestijn)*** – addressing the sustainability issues, the influence of the materiality of the artefacts, and interaction (digital and physical) on human behaviour, exploiting the ethics behind influencing human behaviour.

The tools listed above are mainly concerned with designing products and services interested in sustainable development, health, and wellbeing. These tools meet most of the objectives behind this PhD research. The author places these models and tools side-by-side, some other theories presented in the *Design for Socially responsible Behaviours* by Tromp, Verbeek, and Hekkert, and *Intentional Design* by Rozendaal found as relevant when treating the topics of technological artefacts as mediators and conscious design.

3.1.2. Human behaviour from different perspectives: what do we mean by Aware Behaviours?

Human behaviour can be influenced in different ways and for other purposes. The most typical applications for the technological artefacts able to change behaviours are health and wellbeing, sport, work, safety, sustainable practices such as energy-saving, water-saving, pollution, and others. (Rapp, 2019)

In the last years, Design concerned with human behaviour has become relevant as a strategy for enabling social change and supporting sustainable behaviours. (Coskun, 2015) Design can shape human behaviour and, through human behaviour, contribute sustainable innovation (Nieddedar et al., 2016) Nieddedar et al. (2016) define several key areas for design discipline in terms of behavioural change: "Design for behaviour change is concerned with how Design can shape or influence human behaviour and sustainable innovation (Lockton et al., 2010; Niedderer et al., 2014b). Key areas of its application include sustainability, health and wellbeing, safety and crime prevention as well as social contexts."

In terms of terminology, the author of this research defines the ***aware behaviours*** as those behaviours to tackle through technological artefact in users and consumers. The interest of this research is also in thematic areas within the New Green Deal (NGD) and Sustainable Development Goals (SDGs). There, the author is interested in ***raising the awareness in users about sustainable issues like air pollution, water pollution, water consumption, energy consumption, waste management, health and general wellbeing*** that can go from specific health issue monitoring to sport and dietary applications, but also safety intended as urban and cyber safety, and others.

The author refers to the topics such as:

"Enabling citizens to act on climate change, for sustainable development and environmental protection through education, citizen science, observation initiatives, and civic engagement" and builds on the challenges set by the European Commission that calls for "examples on how to engage the wider community in the effective behavioural changes and changes in social practices needed for a successful and just transition. The key component of this subtopic is to raise awareness, engage and empower citizens and consumers with concrete tools to monitor their impacts on the environment, collect information enabling them to change their behaviour, and reduce their carbon and environmental footprint as users and consumers through individual and social innovation. Actions should include the development and improvement of devices (low-cost sensors, consumer apps, such as wearable sensors, a trusted,

user-friendly app with robust carbon footprint calculations, extreme weather community app, for early warning, marine and freshwater litter watch) taking into account the interoperability and exchange of future and existing data collected. Attention should be paid to promoting gender-equal participation and deconstructing gender stereotypes.” (EU Commission)

The actions concerning design discipline considered within this research focus on influencing the citizen’s and consumer’s habits and attitudes toward more sustainable practices in everyday life through awareness-raising, observation and monitoring of their environmental impacts, providing information and education.

Technologies can have a significant impact on these processes, as there was mentioned by the EU Commission. The role of the designer can be crucial in these processes. The technological artefacts to support these actions need to be designed consciously, efficient in influencing the users and consumers ethically and without coercion, take into account the safety of data and privacy measures, be designed to satisfy environmental requirements, take in account complex social and political debates and dynamics, and many other. The artefacts become active players in these processes and essential tools for mediating between humans and the environment.

3.1.3. Direct and indirect influence of artefacts on human behaviour: Design Scripts and Mediations

The author introduced different theories, strategies, models, and tools for behavioural change from different scientific perspectives in the previous text. Here and after, the author wants to focus on the role of artefacts as physical and technological entities in influencing human behaviour.

Whether or not we are speaking about behavioural change, design influences human behaviours. (Boudewijn, Rozendaal, Stappers, 2018) Every product is designed with a specific function, yet this does not mean that the products are merely functional. They generate the mediations between the user and the outer world. There, the artefacts embody prescribed behaviours. Rozendaal, Keyson, Ridder (2007) explain:

“Product behavior and product appearance are thought to influence richness and control. Product behavior captures the responsiveness of a product in relation to the actions of a user and combines both the possibilities of the product and the means in which they are manipulated. Product appearance captures the means in which a digital product is presented including its digital and physical aspects.”

How we will approach the product and use it to compile different actions depends on the product’s shape, but not only. However, people can use the same product in many different ways. How people use products depends on how they de-codify the product’s characteristics.

There are many ways in which one artefact can act as a persuasive tool or influence human behaviour; through different kinds of materializations, from physical to digital.

Recently there was observed “an increasing awareness in design research and practice that products are not merely functional to end-users (i.e. products as tools or a means to an end), but that they also mediate people’s everyday life in sometimes unexpected ways (i.e. products as mediators; i.e. see Nardi & O’Day, 1999; Verbeek, 2005).” (Boudewijn, Rozendaal, Stappers, 2018) Accordingly, Boudewijn, Rozendaal, Stappers (2018) add: “Several design approaches have emerged that make use of this mediating capacity of products, aiming to achieve desirable changes in people’s behaviour.”

It is not breaking news that the products can influence social behaviours and, as a result, have a significant impact on society. (Tromp, Hekkert, Verbeek, 2001) Additionally, the studies show that “technologies profoundly influence the behavior and experiences of us-

ers.” (Verbeek, 2006)

The author wants to introduce several concepts on which this research is founded: the scripts and mediations.

The concept of scripts about the artefacts was for the first time introduced by Akrich and Latour (1992), where they put in question the functionalist approaches when it comes to the vision of technologies. (Verbeek, 2006) They suggest that the technological artefacts possess scripts that prescribe the actions to the involved actors. (Verbeek, 2006) (Fig. 5)

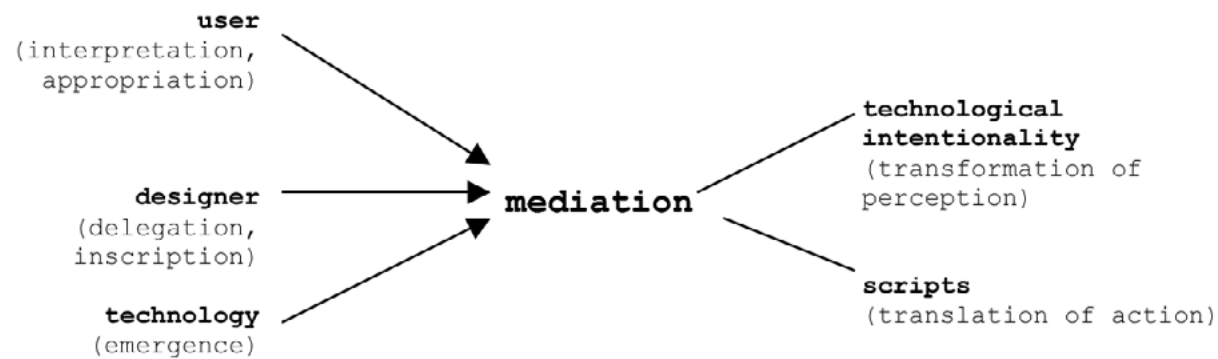


Figure 5: Verbeek's illustration of the sources of mediation (2006)

In their Vocabulary for the Semiotics of human and non-human assemblies (Akrich and Latour, 1992), they set a systematic description of the influence of technology on human behaviour considering the role of technology in human-world relations. Building on this concept, Latour explains the relations between the designer, product, and user by distinguishing “inscriptions,” which refer to the effects on user’s actions intended by the designer, from “prescriptions,” which concern the actions a product allows the user (resembling Gibson’s concept of affordance), and “subscriptions,” which explain how users interpret these prescriptions.” (Tromp, Hekkert, Verbeek, 2011)

The technological artefacts are not neutral; they embody values. These are the mediators between humans and the environment; they can establish or perhaps interrupt the dialogue between humans and the environment. The technological mediation “concerns the role of technology in human action (conceived as how human beings are present in their world) and human experience (conceived as the ways in which their world is present to them). [...] Technological artifacts [...] actively co-shape people’s being in the world: their perceptions and actions, experience, and existence.” (Verbeek, 2006)

There, it is a designer’s role in anticipating how the user will interact with the artefact and how this interaction can generate the dialogue with the outer world. These anticipations and prescriptions are embodied in the materiality of the artefact. However, it would be too

optimistic to believe that designers could anticipate all possible interactions between the artefacts and the user.

Boon, Rozendaal, Stappers, and Jan (2018) explain the relationship between the designer’s intention embodied through the materiality of the artefact, interpretation of the artefact by the user, and human behaviour:

“Ideally, users have a specific interpretation of a product’s purpose or message (i.e. products provide clarity) or they engage in a specific course of interaction (i.e. products provide guidance) as intended by the designer (e.g. see Jelsma, 2000; Lockton et al., 2010; Wever et al., 2008) [...] clarity and guidance increase the likelihood for intended behaviours to occur. The designs are successful in their directionality insofar as they correspond with some concern of the end user. Road signs, for example, might trigger concerns about the safety of others, whereas a speed bump is more likely to raise worries concerning the bottom of the one’s car (see Tromp et al., 2011; Waelbers, 2011). [...] This is very reasonable for a designer to pursue, in particular when designing for situations of risk or urgency. In many situations, however, it might be the case that there is no such need for directionality; it might even work counterproductive due to its restrictiveness or inability to engage users. Here designers might benefit from a more facilitative approach that leaves room for end users’ meaning making and self-direction.”

The multiple ways to interpret an artefact are defined as ambiguity, defined as “the possibility of something giving rise to multiple possible meanings. Similar to Gaver et al. (2003), we see ambiguity as a property of the relationship between an artefact (e.g., its accuracy of feedback or clarity of purpose) and end users (e.g., prior experience, norms, values, or worldview).” (Boon, Rozendaal, Stappers, and Jan, 2018)

How the artefacts are interpreted is tightly related to the context, the users who need to be addressed, different individual and social factors. Again, the need to stress the importance of analysing the broader context of the use of the artefacts to analyse and possibly anticipate the unintended behavioural outcomes and the barriers that may obstacle the user in adopting ‘desirable behaviour’ (Stibe and Cugelman, 2016).

When it comes to the technological artefacts as persuasive tools, there is a need to recognise that the technologies can have multiple roles in influencing the user’s behaviour. Fogg (2003) sets the three levels on which the technologies can assume the role of persuasive tools: technology as a medium, technology as a tool, and technology as a social actor. He calls this triple function of persuasive technologies the Functional Triad (FT).

Technology as a medium persuades throughout the experience, allowing people to explore cause-and-effect relationships of their actions, provide the experiences that can motivate, and help the people rehearse a behaviour. Technology as a tool can increase the capability of people by making the behaviour easier to accomplish, leading people through the process, and performing the calculations or measurements that can motivate them. Technology as a social actor creates relationships, and some of the strategies are rewards such as positive feedback, modeling a target behaviour, and providing social support. The Functional Triad helps describe the technology and understand its potential in influencing one's behaviour.

Throughout this text, the author provided the main concepts within this research regarding the potential of the technological artefacts to influence human behaviour – tackle and support more aware behaviour through its materiality and the embodiment of technologies. Further on in this dissertation, the author shows how these ideas were articulated within the approach and protocol for designing consciously technological artefacts to tackle aware behaviours.

3.2. *Critical Design theory and practice*

Critical theories have their origins far in the classical period of Greek philosophy with Aristotle's metaphysics and literary criticism. The author would not go through all the history of the critical theory, but it would be important to mention several references in this field that are important for critical design practices. The age of Enlightenment (17th – 18th century) is the first to mention the "First Critique" or "Critique of pure reason" by Kant (1781). The Kantian solution "denies the need for direct cooperation with the sciences on issues related to normativity since these were determined independently through transcendental analysis of the universal and necessary conditions for a reason in its theoretical and practical employment."^[2]

The second reference in chronological order is Marx's critique on capitalist economic relations in "Capital: A critique of political economy." Subsequently, in the era of Modernism in the 20th century, the social theorists and here the author refers to Frankfurt School of Social Theory and Critical Philosophy (Horkheimer, Adorno, Marcuse, and Habermas) develop and refine the Marxian critical theory of capitalist economic and social relations. The members of Frankfurt School "argue that the forms of oppression distinctive of "late" capitalism are importantly different from the forms Marx found in the early capitalism of the Industrial Revolution, and so a critical theory about them must also be different." (Koltonski, 2014) Remarkable literary works from this period are Horkheimer's and Adorno's "Dialectic of Enlightenment" (1947), Habermas' "Knowledge and Human Interest" (1968), and Marcuse's "Some Social Implications of Modern Technology."

The postmodern critique is signed by the work of Michel Foucault, who questions modern human sciences (biological, psychological, social): "These purport to offer universal scientific truths about human nature that are, in fact, often mere expressions of ethical and political commitments of a particular society. Foucault's 'critical philosophy' undermines such claims by exhibiting how they are the outcome of contingent historical forces, not scientifically grounded truths." (Stanford Encyclopedia of Philosophy) In "Power of Discourse," Foucault provides an analysis of how the meaning of the knowledge changed

[2] <https://plato.stanford.edu/entries/critical-theory/>

in Western thought from the Renaissance to the present, where “at the heart of his account is the notion of representation” (Staford Encyclopedia of Philosophy). Foucault moves from ideology as power and says that power is based on knowledge and makes use of knowledge.

From this brief introduction into the critical theories, there can be observed how the critical theory was evolving and expanding over different fields from the philosophy, economy, politics, social sciences, natural sciences, technology.

Historically, when it comes to design discipline, it was assigned the role of the problem-solving discipline, eventually concerned with aesthetic expressiveness. However, this started to change over the last decade. Dunne and Raby (2013) explain:

“Faced with huge challenges such as overpopulation, water shortages, and climate change, designers feel an overpowering urge to work together to fix them, as though they can be broken down, quantified, and solved. Design’s inherent optimism leaves no alternative but it is becoming clear that many of the challenges we face today are unfixable and that the only way to overcome them is by changing our values, beliefs, attitudes, and behavior.”

Indeed, in the last years, many new branches of design can be observed emerging to move beyond the conventional design concerned with industrial production toward the more critical approaches and methods, exploiting the future and the fictional boundaries, borrowing from the heritage left by the previously mentioned theorists and philosophers. Moving beyond the conventional design methods and approaches do not mean to separate two different ways to intend the design discipline; on the contrary, the design branches interested in the critical approaches, which are inevitably interested in the future, have as a purpose to enhance the current design methods and approaches. These branches are commonly categorised under the Critical Design Practices. These practices question the current practices and beliefs about scientific and technological development and propose the alternatives that could improve our lives, which has become a crucial task for design discipline.

Critical Design Practices speculate mainly on new technologies but also on social, economic, and political constellations of the future. Critical Design Practices strive for generating the social action through the speculative and fictional projects to inspire the real-world social actions. (Fig.6)

Dunne and Raby (2013) listed these branches: speculative design, critical design, design fiction, design futures, antidesign, radical design, interrogative design, design for debate, adversarial design, discursive design futurescaping, and even some design art.



Figure 6: Projects evolution, *NEW REFLECTIONS ON SPECULATIVITY– Speculative Design and Education*, Ivica Mitrović and Oleg Šuran, HDD Gallery, 2019

These alternative and experimental approaches let design researchers and practitioners explore the unknowns of their projects and many aspects such as new aesthetic possibilities for technology; social, cultural, and ethical implications for science and technology research; or large-scale social and political issues such as democracy, sustainability, and alternatives to our current model of capitalism. (Dunne and Raby, 2013)

The artefacts crafted within these practices are cultural probes committed to satisfying the emotional and intellectual needs of the people rather than proposing practical solutions. (Malpass, 2012)

The following text provides an overview of the critical design practices and describes the principles, methods, and different approaches within this field of study.

3.2.1. Dealing with complex issues in changing world: An overview of Critical Design theories and practices

Contemporary societies are signed by the uncertainty and rapid transformations, social, political, economic, health, economic, and others, for which very often governments, citizens, scientists, industries, and other actors playing an active role in societies, do not have proper tools and methods to deal with.

“Our world is increasingly involved and engaged in complex, collective political and economic debates and experiments [...] design and design research should make its particular practices [...] which are important for collectively dealing with possible futures in a complex world.” (Grand and Wiedmer, 2010)

Manzini (2015) explains that “today, we must expect to be living this turbulence for a long time, in a double world where two realities live together in conflict: the old “limitless” world that does not acknowledge the planet’s limits, and another that recognises these limits and experiments with ways of transforming them into opportunities.”

Fundamentally, our societies are lacking “modern solutions for modern problems”. (Escobar, 2017)

Beck tackled the questions of the rapidly changing societies and technological and scientific development in his work “Risk Societies” (1986). He explains that societies often do not consider the possible implications of technological and scientific development, and once the damage occurs, societies search for other technologies that could solve these problems or simply replace the existing technologies. He explains (1986): “Science is one of the causes, the medium of definition and the source of solutions to risks, and it opens up new markets for scientificisation. In the reciprocal interplay between the risks, it has helped to cause and define, and the public criticism of these risks, scientific and technological development becomes contradictory.”^[3]

To face these global challenges and manage the technological and scientific development, it will be needed to “reinvent the human”, and this process will need to imply critical reflection at all levels of transformation, at the species level, “by means of story and shared dream experience”. (Berry, 1999)

.....
[3] This text was translated from Italian edition of this book (La Società del rischio. Verso una seconda modernità.”) published in 1999 by Carocci editore.

Design researchers and practitioners faced with the challenges like an environmental crisis (climate change, water shortages, pandemics and others) designers felt an urge to act and propose alternatives to the present solutions. Even though some of these challenges are not reversible there neither fixable; designers and researchers try to influence change in human values, attitudes, practices and behaviours. (Dunne and Raby, 2013)

As the need for a new and critical discourse emerged, this has resulted in critical design approaches and practices, such as design fiction and speculative design. These approaches have in common “the use of design as a tool to explore, highlight, problematise and change norms (Auger, 2013). In parallel to this, several approaches see the potential of using design as a tool for change, suggesting its use for social or societal challenges such as transformation design, social innovation and sustainable design (Brown, 2009; Manzini, 2003; Thackara, 2005). Common to these approaches is the use of prototyping as a central method for co-creation, innovation and rehearsal of the future (Hillgren, Seravalli & Emilsson, 2011).” (Ilstedt and Wangel, 2014)

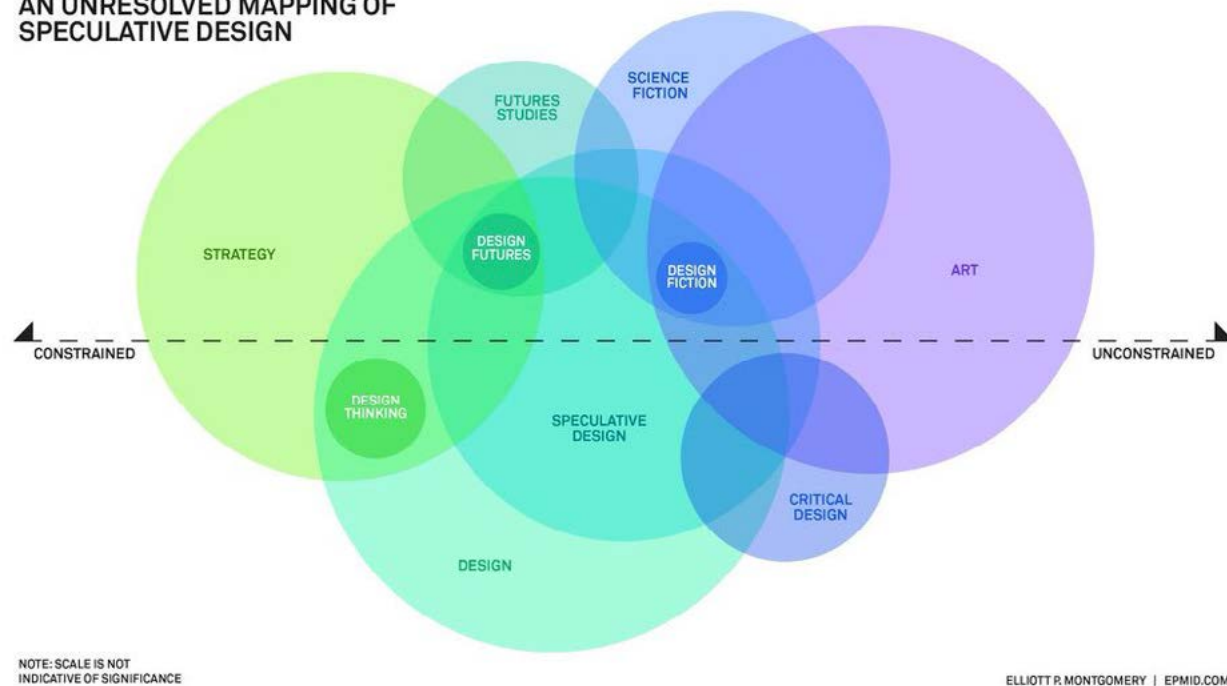
These new branches put the designer in a role of facilitator and mediator rather than expert and “conceive of design as eminently user-centred, participatory, collaborative, and radically contextual; seek to make the process and structures that surround us intelligible and knowable to induce ecological and systems literacy among users; and so forth”. (Escobar, 2017) There can be observed an attempt to build alternative “cultural visions as drivers of social transformation through design”. (Escobar, 2017)

These branches of design discipline are in between activism and design; they offer cultural probes rather than solutions. Some speculative proposals within critical design practices seek to “highlight weaknesses within existing normality” (Dunne and Raby, 2013) (enchanted world), while others try to anticipate and communicate the futures (thriving societies).

Most commonly, Critical Design Practices are interested in exploring and researching the possible implications of electronic objects and emerging scientific frontiers (i.e. bioengineering, gene engineering, artificial intelligence, and others).

Fig. 7 is a plot developed by Montgomery, and it illustrates the speculative design concerning the other approaches and practices. Montgomery shows the speculative design as a paramount or foundation of all other critical design practices where interlaced with other fields brings to life some other approaches such as design futures, critical design and design fiction. He is plotting all the approaches and practices on the axis, laying between the zone of unconstrained (artistic) and constrained (more strategy-oriented or, if preferred, pragmatic). He places the speculative design in the middle between these two poles.

AN UNRESOLVED MAPPING OF SPECULATIVE DESIGN



NOTE: SCALE IS NOT INDICATIVE OF SIGNIFICANCE

ELLIOTT R. MONTGOMERY | EPMID.COM

Figure 7: Mapping the speculative design and other critical design practices by Montgomery

In this PhD research author positions within the Speculative Design with Design Fiction, exploiting the principles such as anticipatory scenarios and diegetic prototypes. The author's approach is oriented toward the anticipation rather than provocation, raising the questions on how design researchers and practitioners can build more thriving tomorrows rather than offer the proposals that highlight the weaknesses within the existing normality is interested in operating within these areas to raise the questions about how design researchers and practitioners can design for thriving conditions rather than survival.

Speculative design, as a paramount critical design practice, can be defined as “a critical medium for exploring the implications of new developments in science and technology, to the aesthetics of crafting speculative designs.” (Dune and Raby, 2013)

For the first time, design fiction was coined by Bruce Sterling, the Sci-Fi writer, in his book “Shaping of Things” in 2005. He realised that design thinking was tightly related to his literary work. In the last years, it gained an increased interest within the HCI practice, and it was adopted as a “strategy for more explicitly attending to the feedback loop between fictional imagined futures ad actual technology design.” (Tanenbaum, 2014)

The author would like to stop for a moment on the importance of the feedback loop when it comes to anticipating the things of the future. Figure 8 illustrates an elaboration of the concept of the feedback loop made by the author to explain iteration between the fictional (future) and actual (present) space. The author finds essential to expand this concept and compares the theoretical concept of Aristotle's metaphysics to describe the way the things and beings can be designated “according to its potentiality (dynamis) or instead to its actuality (entelecheia)”. The actuality designates thing as an actuality, effective reality and completed reality.^[4]

While the potentiality designates “the being of that which is not yet accomplished or realised.” The potentiality can be interpreted as a capacity to be. It is assimilated with the possibilities, which may be or not. The possibility is less than real because it precedes the existence of things. In conclusion, possible is “open to ‘realisation’, it is understood as an image of the real, while the real is supposed to resemble the possible.” (Deleuze, 1994) The author illustrates this concept in Figure 8.

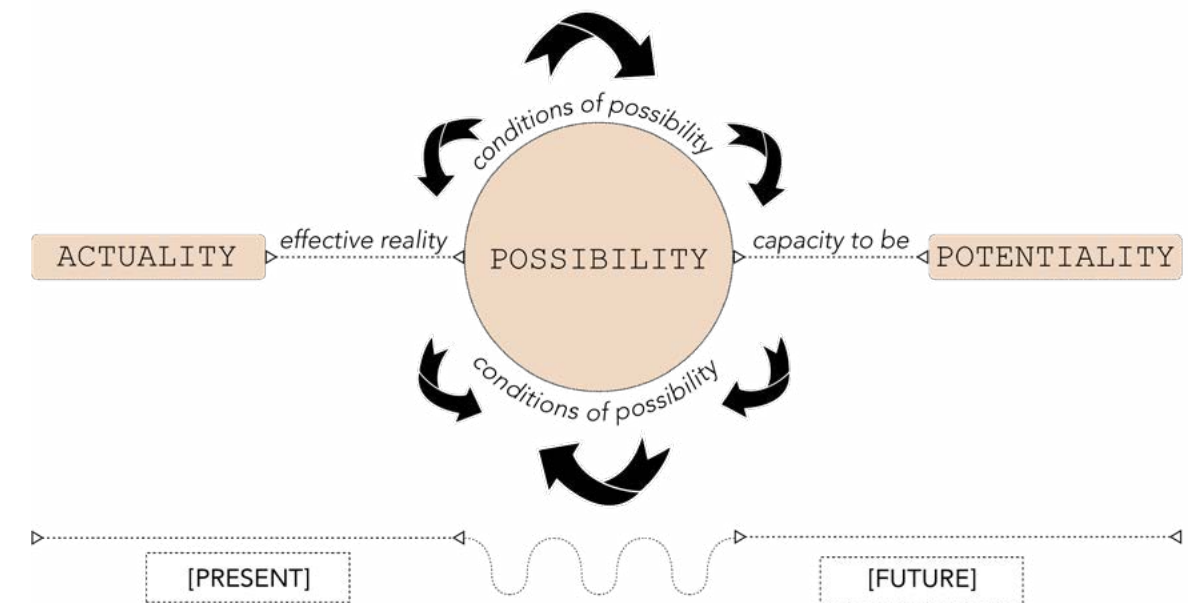


Figure 8: Elaborating and illustrating the concept of feedback loop to explain the interactions and iteration between the present and future

[4] The author takes this concept entirely from “The Potentiality of Art, the Force of Images and Aesthetic Intensities” by Prévost (2017).

To see how this is related to the design fiction and speculation, the author cites Bleeker (2010) who explains how good design fiction can make the not yet existing (potential) things become relevant and let the audience consider their possibility:

“Things become imminent in a really good design fiction and we cannot help but to consider their possibility. They are familiar enough to our everyday that they are legible, yet different enough that they suggest that things have changed slightly. [...] How does this happen? These design fictions exploit genre conventions suggesting that these objects exist. They are presented simply and without embellishment. [...] we become an observer in this world, identifying with the characters and their world in which the things we might otherwise find extraordinary are quite ordinary. [...] we relegate them to our mental catalog of the normal and the routine. The extraordinary becomes ordinary and, therefore, possible.”

There, design fiction with its speculative proposals has as a purpose to help design researchers and practitioners:

- **Propose alternatives** to social, technological and ethical values,
- **Provoke discussion and inquiry**, active involvement in social and technological transformations,
- **Suspend disbelief, stereotypes, and myths** about scientific and technological development, and exploit its potential through critical reflection.

In very simple words, design fiction is speculating about the future “through a combination of prototyping and storytelling”, and it is the capacity to imagine and make concrete not yet existing products and services.” (Ilstedt & Wangel, 2014). This approach “allows us to adopt a range of different intellectual commitments and values about the future and explore the consequences of those commitments [...]. It allows us to insulate ourselves from the emotional consequences of perceived proximal dystopias.” (Tanenbaum, Marcel, and Tanenbaum, 2014)

On an abstract level, the speculative and fictional proposals let us imagine and narrate future scenarios. These fictions can be contextualised and materialised into fictional prototypes. Anticipatory scenarios and diegetic prototypes are two principles of speculative design and design fiction that the author introduces. These scenarios and prototypes can be intended as artefacts – intangible and tangible design fictions. They have a plural function. First, they can have the role of a research or design process output. Second, they can be used as ex-

plorative artefacts to inform the research and practice of design. Common in both of these cases is that these artefacts (anticipatory scenarios and diegetic prototypes) are generated through critical reflection and to open a new discourse and narration of the worlds.

Here and after, the author introduces these two natures of fictional prototypes.

3.2.2. Speculative Proposals and Fictional Prototypes: use of Fictional Artefacts in design research and practice

The most common principles used within the speculative design and design fiction are scenarios and diegetic prototypes. Speculative design is a discursive practice. It aims in establishing a critical dialogue and question the current states. (Fig.9)

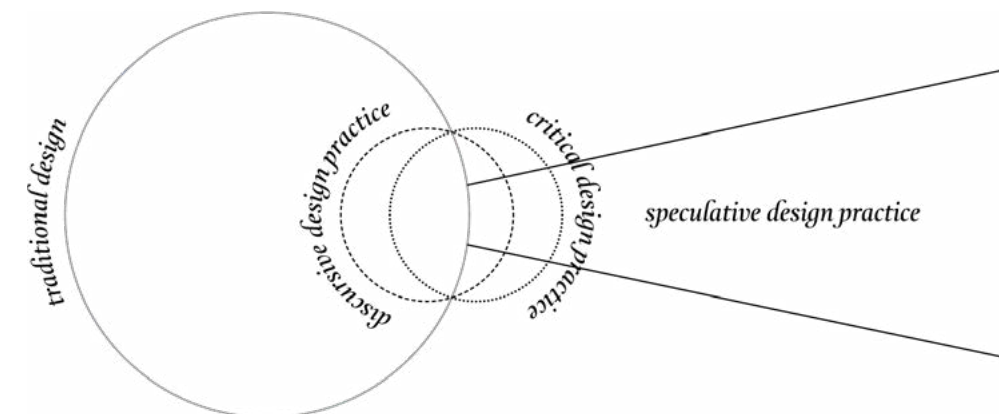


Figure 9: Speculative Design vs Traditional Design by Ivica Mitrović

In this PhD, the author explores the power of scenarios (intangible/narrative artefacts) and diegetic prototypes (tangible artefacts) to trigger critical thinking. The purpose of these narrations and prototypes is not to represent the future as realistic as possible; these are the speculative proposals that resemble how it could be. These two characteristics of speculative design and design fiction borrow from the literature, art and philosophy and the concepts of mimesis and diegesis. In literary criticism, art and philosophy, mimesis is commonly married with the meaning of imitation, representation, mimicry, resembling, theatrical illusion and others. This term is tightly related to the classical period and art. Mimesis is originally a Greek word used in “aesthetic or artistic theory to refer to the attempt to imitate or reproduce reality”. (Merriam Webster Dictionary)

Therefore “the painter, the tragedian, and the musician are imitators of an imitation, twice removed from the truth. Aristotle, speaking of tragedy, stressed the point that it was an ‘imitation of action—that of a man falling from a higher to a lower estate. Shakespeare, in Hamlet’s speech to the actors, referred to the purpose of playing as being ‘...to hold, as ‘there, the mirror up to nature.’ Thus, an artist, by skillfully selecting and presenting his material, may purposefully seek to ‘imitate’ the action of life.” (Britannica)

Diegesis represents the narrative world. In the film, theory diegesis is: “The spatiotemporal world depicted in the film. Anything within that world (such as dialogue or a shot of a road sign used to establish a location) is termed diegetic, whereas anything outside it (such as a voiceover or a superimposed caption) is extradiegetic. This distinction is especially associated with diegetic sound: for example, when a record player is shown to be the source of onscreen music. A diegetic audience is an audience within the depicted world.” (Oxford Dictionary)

Tanenbaum (2014) explains the diegesis in a straightforward sentence:

“In the contemporary narratology, diegesis has come to refer to anything that exists within the reality of a fictional world.”

Therefore, the design fiction and speculative proposals are about building and crafting the alternative worlds that resemble all the characteristics and elements of that specific world, such as historical, social, economic, cultural and others.

Within these two primary forms of speculative proposals and design fiction principles, different artefacts can be found, and the worlds can be crafted in many ways. In Fig. 10 author maps what can be found in the literature regarding the fictional prototypes, from those using traditional prototyping techniques to those enhanced with simulated reality, from the narratives to diegetic prototypes.

The author overviews the artefacts used in design fiction and speculative design – scenarios and diegetic prototypes in the following text.

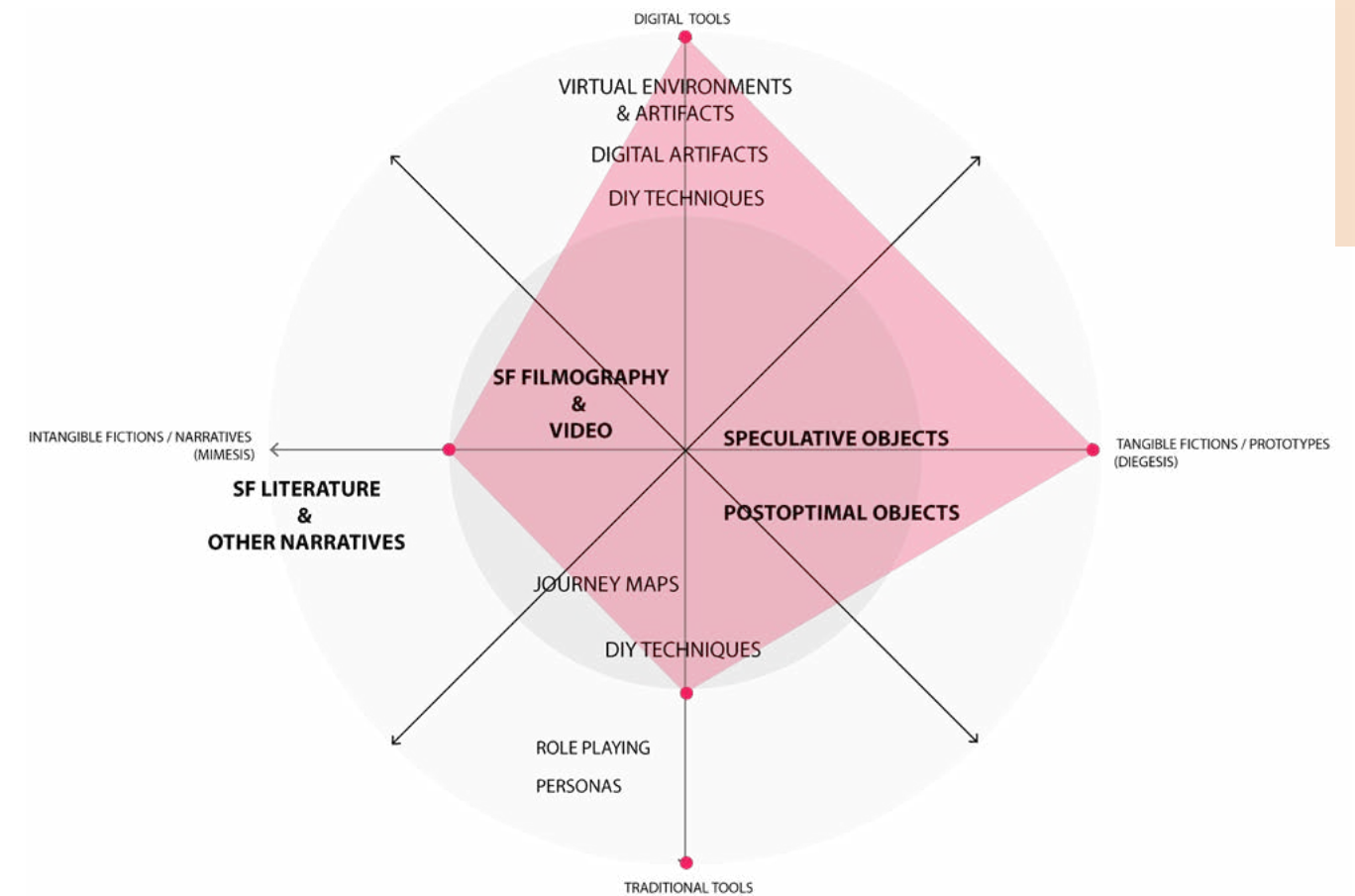


Figure 10: Mapping the typology of the design fiction artefacts and the author's positioning within this sphere

3.2.2.1. Typology and use of Scenarios in design research and practice

Scenario building is a well-known practice used in many disciplines, originally derived from the military sector (Koskinen, 2012). The purpose of the scenarios is mainly to tell the stories about the future and about “different kinds of continuity and discontinuity.”⁶ (Riel, 2015) Scenarios as a technique of the future studies and other disciplines concerned with analysing futures (like design) contribute to improving the Futures Literacy of organisations, companies, designers, governments, even citizens.

Depended on the field of study they are applied and on the purpose of scenario creation and use, different scenarios can be found.

Bergman, Karlsson, and Axelsson (2010) analyse the classification of the typology of scenarios respect their use and users in the following way:

- **Predictive scenarios (what will happen?);**
- **Explorative scenarios (what can happen?);**
- **Normative scenarios (how can a specific target be reached?).**

The predictive scenarios are commonly founded on scientific ambitions, planning precise outcomes with explicit truth claims, tending to define involved mechanisms of the events. (Bergman, Karlsson, and Axelsson, 2010)

The glossary of the *European Environment Agency*^[5] defines the explorative scenarios (also known as descriptive scenarios) as “those that begin in the present and explore trends into the future.” This typology of scenarios is used to “explore a wider range of uncertain futures” (Avin and Goodspeed, 2020).

Normative scenarios are concerned with preferable futures “without transgressing the realm of the possible [...] they make the values, attitudes and the mindset of their authors explicit, and they can be used as a starting point for discussions about visions and values.” (Gaßner and Steinmüller, 2018)

Beyond the Bergman, Karlsson, and Axelsson’s (2010) taxonomy, in literature, there can be found many different definitions of scenarios, depended on the discipline in which these are used and with which purpose. Here, the author references the exhaustive taxonomy of scenario definitions made by Balula and Bina (2014). They identify scenario planning and

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[5] <https://www.eea.europa.eu/help/glossary/eea-glossary/exploratory-scenario>

foresight, backcasting and forecasting as the most commonly used in the literature. The author list below related definitions and adds several others often mentioned in the design discipline that she found.

Scenario planning:

“Scenario planning is a ‘strategic management tool with an emphasis on the improvement of the decision-making process ... useful in dealing with uncertainty’ (Varum & Melo, 2009: 362).” (Balula and Bina, 2014)

Foresight (and strategic planning):

“In strategic planning the scenarios are used as devices to be employed for stimulating strategic thought and communication within companies, improving internal flexibility of response to environmental uncertainty and provide better preparation for possible system breakdowns, and reorienting policy options according to the future context on which their consequences would impinge (Godet and Roubelat, 1996).” (Kymaleinen, 2019) Foresight scenarios are suitable for the “activities that lead to ‘knowledge’ about possible, preferable and plausible futures”. (Steen & Twist, 2012: 476)

Backcasting and forecasting:

“a technique and a step on the process of scenario building (Bishop et al. 2007). [...] when used in the context of scenario building forecasting is “an approach that is designed to accommodate the complex and uncertain interactions of indeterminate forces that can result in discontinuous change” (MacKay & Tambeau, 2013: 674).” (Balula and Bina, 2014) In technology forecasting, scenarios have been used to explore the development paths of technologies and how they roll out into the world. (The National Academies Washington)

Another typology of scenarios that authors would like to add here is Anticipatory scenarios and Value scenarios.

Anticipatory scenarios:

This typology of scenarios could be collocated within the exploratory category. These scenarios start from past and present trends and leading to a likely future. Godet and Roubelat (1996) explain: “These anticipatory or exploratory scenarios may, moreover, be trend-driven or contrasted, depending on whether they incorporate the most likely or the most unlikely changes.”

Value scenarios:

These scenarios extend Carroll and Rosson’s scenario-based design (SBD) approach and can “support envisioning the systemic effects of new technologies. [...] five key elements of value scenarios: stakeholders, pervasiveness, time, systemic effects, and value implications.” (Nathan, Klasnja and Friedman, 2007).

The author provided a brief overview of the scenarios’ typology and their uses. Scenario-based design techniques seek to exploit the complexities of the issues and challenges

in question “by trying to learn more about the structure and dynamics of the problem domain, trying to see the situation in many different ways, and interacting intimately with the concrete elements of the situation.” (Carroll, 2000)

However, scenarios are human discourses, and this makes of them “a complex phenomenon which always has complex points of reference, domains of meaning and interpretation as well as consequences as regards both its subject matter and participants.” (Hideg, 2007)

Nonetheless, which approach to scenario building one chooses to go for, there are some basic rules to apply to transform anticipation (fictional) into action through appropriation. (Godet and Roubelat, 1996) For achieving this, Godet and Roubelat (1996) suggest that the scenarios should follow four conditions: relevance, consistence, likelihood and transparency.

In this PhD research, the author mainly focuses on the Anticipatory and exploratory scenarios. The approach proposed by the author suggests building the future design challenges starting from today’s issues. For instance, analysing the current societal issues such as environmental and building upon the future by studying the possible outcomes and understanding how to design to prevent it. However, it would be difficult to fit perfectly in one category, so it is necessary to note that the scenarios in this research may also be contaminated by other typologies of scenarios, such as value scenarios investigating the systemic effects of new technologies.

3.2.2.2. *Design Props and Diegetic Prototypes: nature of Fictional Artefacts*

Bringing the fictional scenarios into the real world requires considering many facets of their existence. (Bleeker, 2010) Diegetic prototypes are material forms of discourse; they are the protagonist of the fictional world.

David Kirby (2010) builds on the props⁸ from cinematography to explain the potential of diegetic prototypes:

“Entertainment producers create diegetic prototypes by influencing dialogue [...] These technologies only exist in the fictional world – what film scholars call the diegesis – but they exist as fully functioning objects in that world. [...] prototypes as ‘performative artefacts’ [...] as well as the role of prototypes in contextualizing technologies within the social sphere.”

There are some remarkable examples of props from the film industry that have influenced or inspired technological innovation. For instance, “Minority Report” by Steven Spielberg in 2002, based on Philip Dick’s novel (1956), anticipates several technologies developed meanwhile, such as personalized apps, biometric recognition, gestural interaction modalities, and others. Beyond these extravagant, at that time technologies, “Minority Report” taught the audience that the justice system is a human activity that intelligent predictive systems cannot entirely exchange.

Another remarkable and recent example of how the technologies get contextualized within the fictional sphere successfully is the series of “Blackmirror” (produced by Annabel Jones; Charlie Brooker; various directors). This series questions the impact of the near-future technologies on human lives and emotional and mental states. They treat the topics such as technologies and technological artefacts for pervasive monitoring (“Arkangel”, directed by Jodie Foster), social networks (SN) (“Nosedive”, directed by Joe Wright), dating apps (“Hang the DJ”, directed by Tim Van Patten), digital clones (“White Christmas”, directed by Carl Tibbetts), memory implants (“The Entire History of You”, directed by Brian Welsh), hyper-realistic immersive gaming (“Playtest”, directed by Dan Trachtenberg). In this case, technologies are anticipated and contextualized to critique and stress possible weaknesses within that kind of reality – the fictional one.



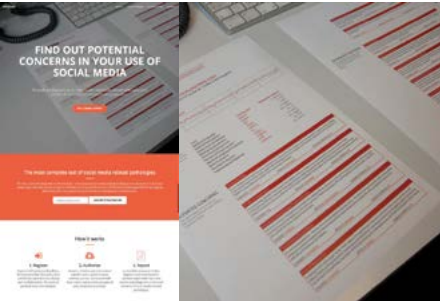

Indeed, as a critical design practice, design fiction is also defined as the “deliberate use of diegetic prototypes to suspend disbelief about change” (Sterling, 2012). Diegetic prototypes have a role to let the people get a feel of the things one might do with not yet existing technological artefacts and experience the consequences and implications of a world in which these artefacts exist. (Bleeker, 2010)

What differentiates them from the traditional prototypes is that these prototypes have a strong narrative and performative character, and they are always concerned with the future, commonly not-yet-existing technological artefacts. These prototypes have the purpose of generating new discourses, make visible there plausible the existence of these fictions by contextualizing them in the real world with real people.

There are different ways to intent diegetic prototypes, from material tangible artefacts to the digital models and renderings. Recently, there is a interest in exploring the virtual reality as a space for prototyping diegetic prototypes.

There are different diegetic prototypes, from the material, tangible artefacts to digital models and renderings. Recently, there has been an interest in exploring virtual reality as a space for prototyping diegetic prototypes. The author shows several different diegetic prototypes in the *Table 1* classified the project typology (product, service) and morphology (tangible – intangible – mixed /physical-digital – both) and prototyping technique.

Table 1: Diegetic prototypes from design research and practice

Designer / Studio	Project and typology of Design Fiction	Diegetic prototype	Morphology
Near Future Lab	Helios Pilot: “To spark a conversation around the larger questions regarding a world of autonomous vehicles, we set about to create a tangible artifact from the near future of the self-driving car.”		Physical prototypes
Near Future Lab	IKEA catalogue: “Ask yourself — in the IoT future, what role might Ikea play? They make 'things', don't they? And not just hokey, silly, confusing things, things that normal humans can understand, like chairs, beds, lamps, pet combs and kitchen counters. Well, we have some answers based on a design brief to consider the IoT future through the nearly ubiquitous Ikea catalog.”		Physical [photomontage]
Near Future Lab	6ANDME: Diagnosis service for social media related pathologies [fictional spin off] “fictional online service that produces a diagnosis for 25+ widespread social media related pathologies from the online content you consume and share”		Physical and digital [Fictional agency and website]
Superflux	Mitigation of Shock: “Mitigation of shock (London 2050) is our attempt to make the size and complexity of a hyperobject like climate change tangible, relatable and specific. Following extensive research and prototyping, as well as interviews with experts from NASA, the UK Met Office and Forum for the Future, we build an entire future apartment situated in the context of climate change and its consequences on food security.”		Spatial installation

Superflux

Uninvited guests:
"connected home within the context of elderly healthcare and remote tracking, as it is touted as one of the most compelling IoT applications. Situated behind this, is the bigger, more political issue around the future of healthcare and the growing argument to replace human care givers with robots and connected, networked smart devices."



Physical prototypes, post-production in video.

Benqué David

Acoustic Botany:
"fantastical acoustic gardens, a controlled ecosystem of entertainment, I aim to explore our cultural and aesthetic relationship to nature, and to question its future in the age of Synthetic Biology."



Renderings, ambientation of 3D model, use cases.

Benqué David

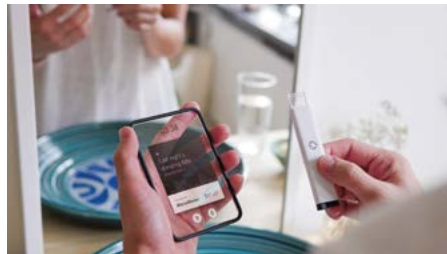
SEMICOPIA:
"The production and consumption of meat raise great environmental concerns. While some advocate that we should simply stop this industry, others propose to solve the problems with technology by growing meat in lab without animals. This project explores the cultural implications of this idea and the history of food-futures."



Physical-scenography, animated in postproduction in video

Trievy Luu and Martijn Van Den Broeck

Data Economy: A Design Fiction of Data obsessed Future.
Data Economy explores how far people are willing to go to satisfy their individualistic hunger to consume by creating a tension between consumerism and data collection.



Physical artefacts, post-production in video.

From these examples, one can see that the diegetic prototypes may vary much in the typology, from physical artefacts like products, scenography, spatial installations to web-sites, renderings and photomontages, and others. They all question the possible opportunities and implications of the technologies, societal issues and challenges, the human factor in these processes. These projects, as it can be observed from examples, have different dimensions in terms of complexity; they vary from industrial production systems or urban transportation like in the case of the projects Semicopia and Helios Pilot, to IoT devices like in Uninvited Guests or Data Economy, and living projects like in the case of Mitigation of Shock.

In this text, the author introduced props – the cinematographic depictions of not-yet-existing technological artefacts. Then, diegetic prototypes were introduced – not-yet-existing technological artefacts belonging to the fictional world, constructed starting from reality. Props with their narrative nature inspire diegetic prototypes, which is the opposite of what is intended with traditional prototypes in the design discipline. Diegetic prototypes are somewhere in between these two; they circulate "back and forth between prototype and story prop, influencing, challenging, questioning, blurring fact and fiction." (Bleeker, 2010)

3.3. Technological artefacts as mediators

This closing part of the chapter stresses a several concepts of the essential importance for this PhD research: technological mediations, agency, experiential dimensions of the technological artefacts and a turn in a paradigm of approaches for design of technologies and technological artefacts, and finally a reflection on how technological artefacts influence human behaviour through mediations. These concepts are found by the author as essential when designing with and for emerging technologies, especially those with intent to influence one's behaviour. In the first part the author defines the technological artefacts to provide and clear image of what kind of artefacts are researched throughout this research. Then the author investigates the postphenomenological approaches for designing with and for technologies, building on the works of Ihde, Feenberg and Guttari. Then the author moves toward the definition of agency and mediations starting from the works of Verbeek and Latour. The last part is dedicated to the ethical concerns when it comes to design of the technological artefacts to influence human behaviour – intended and unintended outcomes of the product's impact.

3.3.1. Nature of technological artefacts

The world we live in is pervasively artificial or man-made rather than a natural world. (Simon, 1996) Even most of the stimuli humans receive from the outer world are artificial, for instance, symbols and written language.

Simon (1996) sets boundaries within which one can define artificial things and separate them from the natural ones (what he calls the science of artificial):

- **Artificial things are synthesised by human beings;**
- **Artificial things may imitate appearances in natural things while lacking, in one or many respects, the reality of the latter;**
- **Artificial things can be characterised in terms of functions, goals, adaptation;**
- **Artificial things are often discussed, particularly when they are being designed, in**

terms of imperatives as well as descriptives.

The artefact is “the product of human skill and ingenuity. The term derives from the Latin *ars* (art or skill) and *factum* (made or done)”; this would mean that almost any design object can be defined as an artefact: “a common definition of design is the organisation of the interface between humans and the “made world,” that is, the interaction between people and our artifacts.”^[6]

Technological artifacts can be defined as “material objects made by (human) agents as means to achieve practical ends. Moreover, following Aristotle, technological artifacts are as kinds not seen as natural objects: artifacts do not exist by nature but are the products of art.”^[7]

With the pervasive development of technological artefacts considering the new and advanced technologies and new interaction modalities, the understandings of a material (artefact) have changed.

Digital technologies changed human conceptions about materiality. Technological artefacts are not anymore necessarily material. Why it is important to make these observations? Well, the ambiguity of the artefact's nature opened different possibilities, design spaces, but also concerns with which designers need to learn how to deal and how to think transversally. Designing with and for technologies has become a complex task, that engage different actors and structures of the society (included the institutions), and at the same time it cannot be separate from the nature.

From the Leonardi's introduction into the materiality of digital, one can observe that the meaning of the artefact is vast; there, it may assume many different forms of materiality but also complexity.

“If someone asked you to point your finger at an organisation, at what would you point? Would you point at a person? A group of people? What about the sign reading “XYZ Corporation” carefully placed on the lawn in front of an office building? How about the office building? Would you point your finger at desks? Computers? Conveyor belts? You might answer that no one thing alone is an organisation and you would argue instead, as theorists have been doing recently (Fayard and Weeks, 2007; Orlikowski and Scott, 2008; Pentland and Feldman, 2007), that organisations are made

[6] The author takes this concept entirely from “The Potentiality of Art, the Force of Images and Aesthetic Intensities” by Prévost (2017).

[7] <https://www.oreilly.com/library/view/a-companion-to/9781118394236/OEBPS/c28-s2.htm>

up of people doing work with material artifacts. Following such a definition, you'd likely point to both people and the technologies (both of which might be broadly called "artifacts") they use to do their jobs" [...] If material is defined as having physical matter, the software is not material. But under the second definition of material, the software clearly helps to instantiate the abstract idea of management. As alluded to above, the software was not the only medium through which the abstract process could become material; organisational policies or specific routines of refusing work could have served this function too. What these policies, routines, and software all have in common is that they exploit some type of social practice that compels people to follow the abstract plan. Thus, to say something is "material" in this definition would be to emphasise its ability to instantiate ideas in practice." (Leonardi, 2010)

Beyond its material and intellectual aspect of the artefacts, it is essential to take the notion that the artefacts are the witnesses of the changing world; they are created for the human needs, and they are shaped respectively to the environment in which they are contextualised in that specific, social and historical, moment. Technological artefacts are in an interdependent relation to the humans and society.

The nature of an artefact (this refers to technical and technological artefacts) can be explained through the goals that "link the inner system to the outer system. The inner system is an organisation of natural phenomena capable of attaining the goals in some range of environments, but ordinarily there will be many functionally equivalent natural systems of doing this. The outer environment determines the conditions for goal attainment."

There so, any designed artefact needs to be adapted to its natural environment, which makes it in a certain sense an interconnected part of the natural system beyond the artificial.^[8]

Building on this premise, the author dedicates the following text to the critical approaches for design with and for technologies.

.....
[8] With artificial author defines all the parts of the man-made world, there also the organisational and social (or societal) system; this may include different layers of the society such as institutions, industry, governments., and other components.

3.3.2. Postphenomenological approaches: Insights from the philosophy and critique of technology

Technology is not neutral neither it has a singular facet. Technology is plural as a phenomenon; it has different facets. In this part of the text author introduces the postphenomenological approaches and its emergence in design of technologies. The author gives an introduction into the philosophy and critique of technology to observe the complexity behind the design of technologies and its integration into the social sphere, and analyses how this knowledge could be applied in design research and practice concerned with design of technological artefacts, to deliver more conscious designs and meaningful interactions.

Feenberg (2005) explains that technology is a two-sided phenomenon where on the one hand, the operator and on the other the object. Both object and operator are human while the technical action (technology) is an exercise of power:

"Society is organised around technology, technological power is the principle form of power in the society." Here, he recognises one issue, and that is that the exercise of technical power "evokes resistance of a new type immanent to the one-dimensional technical system. Those excluded from the design process eventually suffer the undesirable consequences of technologies and protest. Opening up technology to a wider range of interest and concerns could lead to its redesign for greater compatibility with the human and natural limits on technical action."

Building on this call for greater compatibility between nature, humans and technology author introduces postphenomenological approaches as a turn in the way to intend the technologies in the world related to the experience and embodiment.

Phenomenology is "the study of structures of consciousness as experienced from the first-person point of view. The central structure of an experience is its intentionality, its being directed toward something, as it is an experience of or about some object. An experience is directed toward an object by virtue of its content or meaning (which represents the object) together with appropriate enabling conditions." (Stanford Encyclopaedia of Philosophy)

While, the postphenomenological approaches are "emphasising embodiment—and with and through technologies— also a sensitivity to materiality", they have interdisciplinary character and always remain experiential but not subjective; it's instead "intersubjective

checking and critique are also part of the descriptive process.” (Ihde, 2008)

According to Guattari (1995), the semiotic production of technology (he mentions mass media, informatics, telematics, and robotics) should not be kept as separate from the psychological subjectivity. He explains:

“Just as social machines can be grouped under the general title of Collective Equipment, technological machines of information and communication operate at the heart of human subjectivity, not only within its memory and intelligence, but within its sensibility, affects and unconscious fantasms. Recognition of these machinic dimensions of subjectivation leads us to insist, in our attempt at redefinition, on the heterogeneity of the components leading to the production of subjectivity.”

The embodiment and sensitivity to the materiality open another window into the dimension of (technological) mediations:

“Here is yet another clue to the complexity of embodiment: every change in our newly magnified world is also a change in our embodied experience. I shall call this first technological mediation, which extends already extant visual capacities, a magnificational mediation. This same ‘analog’ capacity pretty much belongs to the whole continuum of early modern optical instruments: telescope (for distant phenomena), the microscope (for micro-phenomena), camera obscura variants (for 3d to 2d transformations) and the like. In this step I now have extended direct bodily-perceptual experience in its classical phenomenological sense, to include instrumentally mediated bodily-perceptual phenomena made present through technologies, thus extending the classical phenomenological sense to include material mediational capacities, into an extended sense of embodiment.” (Ihde, 2011)

The author opened this text by saying that the technologies are not neutral, and she meant that the technologies do not mediate in the neutral ways human experiences (individual and collective) nor our lifeworld. (Ihde, 2008)

“Technologies are multistable, as Ihde calls it. They have no fixed identity but get defined only in their context of us.” (Verbeek, 2006)

Verbeek (2006) introduces the concept of technological mediation, tightly related to the postphenomenological philosophy of technology, to explain and analyse the role of technologies in people’s daily lives, the structure of relations between these different actors populating the world.

Verbeek believes that starting from this kind of perspective, one could analyse the influence of technologies on human behaviour systematically, focusing on the role technology play in human-world relations – the role of technology in human action and human experience.

Further on, in the text, the author shows how to apply Verbeek’s concept to the design of technological artefacts.

From this brief overview of postphenomenology, the importance of such approaches when designing technological artefacts can be recognised. The questions of experience and consciousness on different levels have become crucial nowadays with the pervasive development and implementation of technologies in everyday lives. Adapting the postphenomenological approaches, like Verbeek’s concept of mediation, into the design research and practice dealing with the design of and with technology is essential to consider the possible implications of technologies, unintended outcomes and build more meaningful mediations.

3.3.3. Importance of Agency in building the mediations

In general terms, the agency represents one's ability to act in a specific situation and under certain conditions. Alternatively, "Agency in this context refers to a system's ability to carry out known actions per predefined parameters." (Shedroff and Noessel, 2012).

There are different kinds of agency from human to the artificial, mental, collective, shared, relational, intentional, agency as initiation by agent, moral, and others.

Bryant (2011) says (referring to Guattari's work from 1995) that the collectives (also read societies) are made of a "variety of different actors or objects ranging from subjects to signs to technologies and groups and institutions interact with one another in a highly complex fashion."

The position taken in this research is that there is no something like an intentional agency, but rather the agency is also conditioned by the other factors that populate the environment. The author analyses both individual (human) and collective aspects of agency and introduces artificial agency.

Based on Latour's (2005) Actor-Network-Theory (ANT), the author focuses on the concept that humans are capable of acting and artificial entities – like artefacts and in a general material environment. According to Latour, artefacts can co-shape actively human action. In such a theory, "non-humans" become equally actants who "affect the world through expressions of agency." (Broome, 2007)

The artefacts non-necessarily communicate to the user in a lingual way. Verbeek (2006) explains that:

"Things are able to exert influence as material things, not only as signs or carriers of meaning. As is the case with perception, in the mediation of action, transformations occur."

Moreover, here, building on Latour's ANT, Verbeek introduces the concept of translations and programs of action. Programs of action are both human and non-human characteristics, and they are the actions that one is intentioned to accomplish. When two entities (i.e. human and artefact) enter in interaction one with another, the initial programs of action translate into one.

When it comes to technological artefacts, there is an important notion to make. Artificial

entities (like technological artefacts) cannot be free agents, or at least not wholly free. The freedom or autonomy requires the possession of the mind. (Kroes et al., 2008).

Still, this does not mean that they cannot have some autonomy and degree of freedom. The reason to mention this is because autonomy becomes an important concept when it comes to moral agency. In this specific case, the question is, *how do the artefacts influence people's moral decisions? Do they embody moral values?*

The answer is Yes, they do, and in the case of technological artefacts, the degree of freedom and autonomy is continuously increasing (the example on this is Artificial Intelligence and Machine Learning). This part is an introduction to the following text in which the author underlines the importance of social and ethical aspects in the human-technology interaction and relation.

3.3.4. Technological artefacts to tackle aware behaviours, social and ethical concerns and implications

There was already said that the technological artefacts are never entirely free or autonomous agents because they do not have a mind; there, the values they embed are the result of human activity. Latour (1992) explains: "We have been able to delegate to non-humans not only force as we have known it for centuries but also values, duties, and ethics."

Designers prescribe these values, duties, end ethics through the materiality of the artefact. For Ihde (1997), there is a "very mundane sense in which every technology at least every interesting technology non-neutrally transforms both the project or object towards which the technology is directed and reflexively, the human user of that technology. The very worth of any technology thus entails this double transformation."

Artefacts shape human activity, behaviours and influence how the human will relate to the outer environment. They "embody trade-offs and compromises [...] they embody social, political, psychological, economic, and professional commitments, skills, prejudices, possibilities, and constraints." (Bijker & Law, 1992).

Technological artefacts resemble, mimic, human-like thinking; they can even build upon human thought autonomously (think of Machine Learning). Nevertheless, thinking like a human is "a complex developmental interaction between the whole organism and its environment, including other people" (Winograd, 2006), which the technologies will never be able to do.

While the technologies are continuously becoming more independent, several questions for the design discipline emerge. Some ethical concerns include privacy issues, responsibility delegation, influencing one's decisions and tastes, and many others. There are also some societal questions to consider concerning the social and natural environment and relations. The relationship between the human and artificial systems relies on many values, such as trustworthy, engagement, even aesthetics, and it is shaped by ethical, political, economic, and societal values.

Designers and engineers assign these values to the artefacts and technologies. However, it does not finish here. These prescriptions, made by the designers and engineers, are interpreted by the users in a second moment. How the user will interact with the artefact depends on the user's interpretation of the artefact. Furthermore, as a result, this will impact how one uses the artefact to mediate with the outer world.

The design of the artefacts somehow always implies a dose of intentionality. Yet, this does not mean that the artefacts are always interpreted coherently by the user. In this chapter, the author has already introduced the concept of scripts. The scripts are the sources of mediation, and they represent the translation of action. If the user does not interpret these scripts as it was the designer's intention, this can generate undesired or unintended behaviours in the user, which in the first-place impact the user negatively but may also impact the environment. It can be said that through the artefact's mediations, the individual or society and environment can be impacted intentionally and unintentionally, directly, or indirectly.

Even though intelligent technologies and automation make everyday life easier, this does not necessarily mean making our lives better. (Dorrestijn, 2009) Once the technologies fulfil their functions, they need to help their user shape their actions and establish meaningful interactions with the outer world and other species populating the same environment. (Verbeek, 2006; Dorrestijn, 2010) When it comes to the technologies able to tackle human behaviour toward different tasks, such as influencing and supporting the user in adopting more aware and sustainable behaviours, there is needed to pay even more attention to possible ethical implications.

Jun, Crvalho and Sinclair (2018) explain that "the process of designing for behavioural change can be unethical or counterproductive if a set of important issues – pertaining both to the practical and the philosophical realms – are not carefully considered." What they suggest is to consider two aspects when designing for human behaviour:

"First, they must be based on trustworthy evidence that feeds into well-informed opinions, meaning that the determination of the ultimate ends to which the intervention is aiming would have to be based on the best available evidence to describe the relevant facts in question. Second, they must enable the views and voices of the multiple stakeholders involved in, and impacted by, the intervention to be properly represented and embedded in the processes of change."

Verbeek (2006) suggestion is to anticipate the mediations through imagination and constructive technology assessment (CTA)^[9].

The model illustrating these interconnections between the artefact, designer, user and the context is in Fig.11 Anticipating the possible undesirable effects of technological artefacts on individuals and society and the possible occurrence of unintended adverse behaviour outcomes (Stiebe and Cugelman 2016) may bring the design researchers and practitioners to design more consciously and intentionally technological artefacts to tackle more aware behaviours.

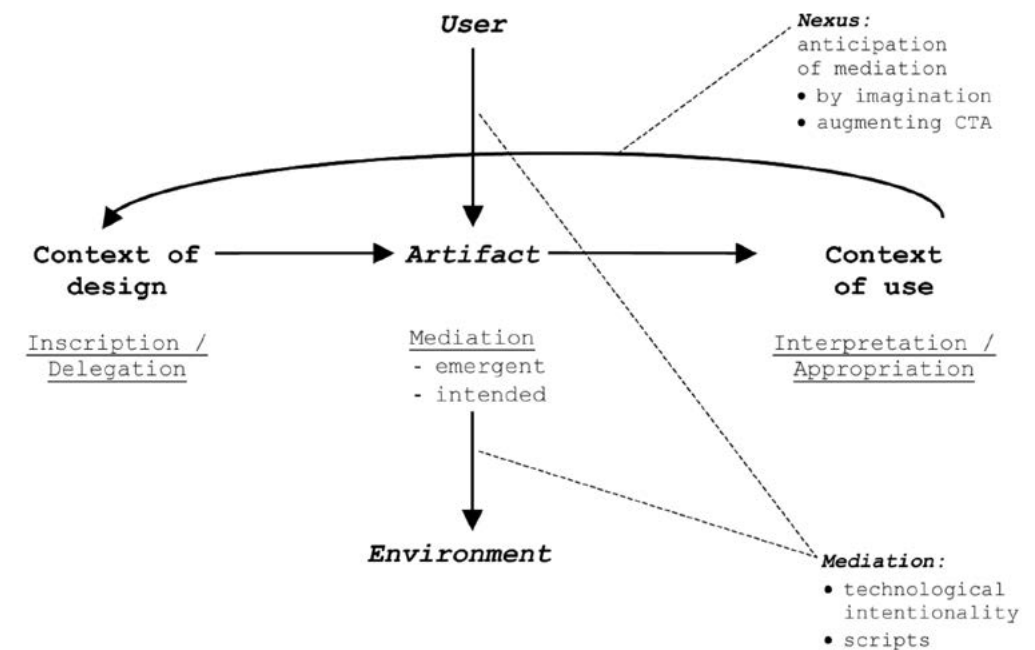


Figure 11: Verbeek illustrates approaching the artifact-in-design in terms of mediation to create a nexus between the contexts of design and use (2006)

[9] "Constructive technology assessment (CTA; cf. Schot 1992; Rip, Misa, and Schot 1995). CTA creates a link between the contexts of design and use in a practical way: it aims to involve all relevant stakeholders in the design of technologies." (Verbeek, 2006)

Abraham, C., and Michie, S. (2008). A Taxonomy of Behavior Change Techniques Used in Interventions. *Health Psychology*, 27(3), 379–387. <https://doi.org/10.1037/0278-6133.27.3.379>

Akrich, M. and Latour, B. (1992). A Summary of a Convenient Vocabulary for the Semiotics of Human and Nonhuman Assemblies. In *Shaping Technology/ Building Society, Studies in Sociotechnical Change*, Bijker, W.E., and Law, J. (eds.), pp. 259-264, The MIT Press

Araiba S. (2019). Current Diversification of Behaviorism. *Perspectives on behavior science*, vol.43(1), pp. 157–175. <https://doi.org/10.1007/s40614-019-00207-0>

Arendt, H. (1958). *Vita activa. La condizione umana*. Bompiani. 2014

Avin, U., and Goodspeed, R. (2020) Using Exploratory Scenarios in Planning Practice, *Journal of the American Planning Association*, 86:4, pp. 403-416, DOI: 10.1080/01944363.2020.1746688

Axon, S., , et al, (2018). The human factor: Classification of European community-based behaviour change initiatives. *Journal of Cleaner Production*, 182, 567–586. <https://doi.org/10.1016/j.jclepro.2018.01.232>

Bardzell, J., Bardzell, S., and Stolterman, E. (2014). Reading critical designs. 1951–1960. <https://doi.org/10.1145/2556288.2557137>

Bardzell, J., Bardzell, S., & Stolterman, E. (2014). Reading critical designs. 1951–1960. <https://doi.org/10.1145/2556288.2557137>

Beck, U. (1986). *La società del rischio. Verso una seconda modernità*. Carocci editore, 2000

Berry, T. (1999). *Thw Great Work: Our Way into the Future*. New York, Bell Tower

Bina, O., Mateus, S., Pereira, L., and Caffa, A. (2017). The future imagined: Exploring fiction as a means of reflecting on today's Grand Societal Challenges and tomorrow's options. *Futures*, 86, 166–184. <https://doi.org/10.1016/j.futures.2016.05.009>

Bleecker, J. (2009). Design Fiction: A short essay on design, science, fact and fiction. Near Future Lab, March, 103–114. <https://doi.org/10.1145/1516016.1516021>

Bleecker, J. (2010). Design Fiction: From Props to Prototypes. Proceedings of the 6th Swiss Design Network Conference, 58–67. <https://doi.org/10.1002/glia.20282>

Boon, B., Rozendaal, M. C., and Stappers, P. J. (2018). Ambiguity and Open-endedness in Behavioural Design. Proceedings of the DRS 2018 International Conference: Catalyst, 2075–2085. <https://doi.org/10.21606/dma.2018.452>

Bryant, L.R. (2011). *The Democracy of Objects*. Open Humanities Press

Burnam-Fink, M. (2015). Creating narrative scenarios: Science fiction prototyping at Emerge. *Futures*, 70, 48–55. <https://doi.org/10.1016/j.futures.2014.12.005>

Burnam-Fink, M. (2015). Creating narrative scenarios: Science fiction prototyping at Emerge. *Futures*, 70, 48–55. <https://doi.org/10.1016/j.futures.2014.12.005>

Cash, P. J., Hartlev, C. G., and Durazo, C. B. (2017). Behavioural design: A process for integrating behaviour change and design. *Design Studies*, 48, 96–128. <https://doi.org/10.1016/j.destud.2016.10.001>

Consolvo, S., McDonald, D. W., and Landay, J. A. (2009). Theory-driven design strategies for technologies that support behavior change in everyday life. Proceedings of the 27th International Conference on Human Factors in Computing Systems - CHI 09, 405. <https://doi.org/10.1145/1518701.1518766>

Cooper, S. (2003). Technoculture and Critical Theory. In *Technoculture and Critical Theory*. <https://doi.org/10.4324/9780203167021>

Coskun, A., Zimmerman, J., & Erbug, C. (2015). Promoting sustainability through behavior change: A review. *Design Studies*, 41, 183–204. <https://doi.org/10.1016/j.destud.2015.08.008>

Dainton, M., and Zolley, E. D. (2005). Explaining Theories of Persuasion. Applying Communication Theory for Professional Life, 103–131. <https://doi.org/10.1177/0191453708090332>

Darnton, A. (2008). An overview of behaviour change models and their uses. *Health (San Francisco)*, July, pgs. 10-15. https://doi.org/https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/498065/Behaviour_change_reference_report_tcm6-9697.pdf

De Medeiros, J. F., Da Rocha, C. G., & Ribeiro, J. L. D. (2018). Design for sustainable behavior (DfSB): Analysis of existing frameworks of behavior change strategies, experts' assessment and proposal for a decision support diagram. *Journal of Cleaner Production*, 188, 402–415. <https://doi.org/10.1016/j.jclepro.2018.03.272>

Dunne, A. and Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press

Dunne, A. and Raby, F. (2006). *Hertzian Tales. Electronic Products, Aesthetics, and Critical Design*. The MIT Press

Elsden, C., et al (2017). On speculative enactments. Conference on Human Factors in Computing Systems - Proceedings, 2017-Janua, 5386–5399. <https://doi.org/10.1145/3025453.3025503>

Erlhoff, M., Bruce, L., and Lindberg, S. (2008). Design Dictionary. In *Design Dictionary*. <https://doi.org/10.1007/978-3-7643-8140-0>

Feenberg, A. (2005). Critical Theory of Technology: An overview. In *Tailoring Biotechnologies*, vol. 1(1), pp.47-64.

Feenberg, A. (1999). *Questioning the Technology*. Routledge

Fogg, B., et al., (2008). Persuasive Technology. 5033(June), 35–46. <https://doi.org/10.1007/978-3-540-68504-3>

Fogg, B. J., Cuellar, G., & Danielson, D. (2008). Motivating, Influencing, and Persuading Users. *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, 133–146. <https://doi.org/10.1201/9781410615862>

Fogg, B. J. (2009). Creating persuasive technologies: an eight-step design process. Proceedings of the 4th International Conference on Persuasive Technology - Persuasive '09, 1. <https://doi.org/10.1145/1541948.1542005>

Fogg, B.J. (2003). *Persuasive Technology: Using Computers to change what we think and do*. Morgan Kaufmann Publishers

Follet, J. (2014). *Designing for Emerging Technologies*. O'Reilly

Freedman, C. (2000). *Critical Theory and Science Fiction*. Wesleyan University Press

Gaßner R., and Steinmüller K. (2018) Scenarios that tell a Story. Normative Narrative Scenarios – An Efficient Tool for Participative Innovation-Oriented Foresight. In: Peperhove R., Steinmüller K., Diemel HL. (eds) *Envisioning Uncertain Futures. Zukunft und Forschung*. Springer VS, Wiesbaden. https://doi.org/10.1007/978-3-658-25074-4_3

Ghajargar, M., and Wiberg, M. (2018). Thinking with Interactive Artifacts: Reflection as a Concept in Design. April. <https://doi.org/10.1162/DESI>

Gieryn, T. F., Bijker, W. E., and Law, J. (1994). *Shaping Technology/Building Society: Studies in Sociotechnical Change*. In *Technology and Culture*, Vol. 35, (2). <https://doi.org/10.2307/3106331>

Godet, M., and Roubelat, F. (1996). Creating the Future: The Use and Misuse of Scenarios. *Long Range Planning*, 29(2), 164–171. [https://doi.org/10.1016/0024-6301\(96\)00004-0](https://doi.org/10.1016/0024-6301(96)00004-0)

Gonzatto, R. F., van Amstel, F. M. C., Merkle, L. E., & Hartmann, T. (2013). The ideology of the future in design fictions. *Digital Creativity*, 24(1), 36–45. <https://doi.org/10.1080/14626268.2013.772524>

Grand, S., and Wiedmer, M. (2010). Design fiction: a method toolbox for design research in a complex world. *Designresearchsociety.Org*, 1–25. <https://doi.org/10.1145/1141911.1141937>

Guattari, F. (1995) *Chaosmosis: An Ethico-Aesthetic Paradigm*, trans. Paul Bains and Julian Pefanis, p.4, Bloomington: Indiana University Press,

Hailes, K. (1999). *How we became Posthumans*. The University of Chicago Press

Hardeman, W., et al. (2002). Application of the theory of planned behaviour in behaviour change interventions: A systematic review. *Psychology and Health*, 17(2), 123–158. <https://doi.org/10.1080/08870440290013644a>

Hideg, É. (2007). Theory and practice in the field of foresight. In *Foresight*, vol. 9 (6), pp.36–46. <https://doi.org/10.1108/14636680710837299>

Hongladarom, S. (2013). Don Ihde: Heidegger's Technologies: Postphenomenological Perspectives. *Minds and Machines*, 23(2), 269–272. <https://doi.org/10.1007/s11023-012-9296-9>

Ihde, D. (2000). Putting technology in its place. *Nature*, 404(6781), 935. <https://doi.org/10.1038/35010184>

Ihde, D. (2008). Introduction: Postphenomenological research. *Human Studies*, 31(1), 1–9. <https://doi.org/10.1007/s10746-007-9077-2>

Ihde, D. (2000). Technoscience and the “other” continental philosophy. *Continental Philosophy Review*, 33(1), 59–74. <https://doi.org/10.1023/A:1010092421546>

Ihde, D. (2012). Postphenomenological Re-embodiment. *Foundations of Science*, 17(4), 373–377. <https://doi.org/10.1007/s10699-011-9244-9>

Ihde, D. (2011). Stretching the In-between: Embodiment and beyond. *Foundations of Science*, 16(2–3), 109–118. <https://doi.org/10.1007/s10699-010-9187-6>

Ihde, D. (1997). Structure of technology knowledge. *International Journal of Technology and Design Education*, 7(1–2), 73–79. <https://doi.org/10.1023/A:1008809019482>

Ilstedt, S., and Wangel, J. (2014). Altering expectations: How design fictions and backcasting can leverage sustainable lifestyles. *Proceedings of the Design Research Society International Consortium (DRS)*, pp.1–12. <http://www.drs2014.org/media/654245/0265-file1.pdf>

Jakobsone, L. (2017). Critical design as approach to next thinking. *The Design Journal*, vol. 20(sup1), S4253–S4262. <https://doi.org/10.1080/14606925.2017.1352923>

Janlert, L.E., and Stolterman, E. (2008). Complex Interaction. *ACM Trans. Comput.-Hum. Interact.*, 17(2). <https://doi.org/10.1145/1746259.1746262>

Jun, G. T., Carvalho, F., and Sinclair, N. (2018). Ethical Issues in Designing Interventions for Behavioural Change. *DRS2018: Catalyst*, 1. <https://doi.org/10.21606/drs.2018.498>

Kroes, P., Vermaas, P. E., Light, A., and Moore, S. A. (2008). Philosophy and Design. In *Philosophy and Design*. <https://doi.org/10.1007/978-1-4020-6591-0>

Kirby, D. (2010). The future is now: Diegetic prototypes and the role of popular films in generating real-world technological development. *Social Studies of Science*, 40(1), 41–70. <https://doi.org/10.1177/0306312709338325>

Klenk, M. (2020). How Do Technological Artefacts Embody Moral Values? *Philosophy & Technology*. <https://doi.org/10.1007/s13347-020-00401-y>

Kymäläinen, T. (2019). Science Fiction Prototypes as a Method for Discussing Socio-Technical Issues within Emerging Technology Research and Foresight. *Athens Journal of Technology & Engineering*, 3(4), 333–348. <https://doi.org/10.30958/ajte.3-4-4>

Kymäläinen, T. (2015). Science fiction prototypes as design outcome of research: Reflecting ecological research approach and experience of things (Issue February).

Kymäläinen, T. (2019). An approach to future-oriented technology design - with a reflection on the role of the artefact. *DRS2016: Future-Focused Thinking*, 4 (September). <https://doi.org/10.21606/drs.2016.87>

Langrial, S. (2012). From Digital Interventions to Behavior Change Support Systems: Understanding Persuasive Systems’ Development and Evaluation Process. *Proceedings of IRIS*, 2012, 1–16. http://iris.im.uu.se/wp-uploads/2012/08/iris2012_submission_14.pdf

Latour, B. (1992). Where are the Missing Masses: The Sociology of a Few Mundane Artifacts. In Bijker, W. E. and Law, J. (eds.), *Shaping technology/building society: studies in sociotechnical change: Vol. Inside tec*. pp. 225-258. Cambridge: MIT Press.

Latour, B. (2005). Reassembling the Social - An Introduction to ANT. In *Journal of Chemical Information and Modeling*, Vol. 53 (9). <https://doi.org/10.1017/CBO9781107415324.004>

Leonardi, P. M. (2010). Digital materiality? How artifacts without matter, matter. *First Monday*, 15(6). <https://doi.org/10.5210/fm.v15i6.3036>

Lockton, D., Harrison, D., and Stanton, N. A. (2010). The Design with Intent Method: A design tool for influencing user behaviour. *Applied Ergonomics*, 41(3), pp.382–392. <https://doi.org/https://doi.org/10.1016/j.apergo.2009.09.001>

Loughborough University Institutional Repository. (2017). *Creating sustainable innovation through design for behaviour change: summary report (Vol. 91)*. (To check the reference go:)

Michie, S., Ashford, S., Sniehotta, F. F., Dombrowski, S. U., Bishop, A., & French, D. P. (2011). A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALO-RE taxonomy. *Psychology and Health*, vol. 26 (11), pp.1479–1498. <https://doi.org/10.1080/08870446.2010.540664>

540664

Michie, S. Stralen, M.M., and WEST, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, vol. 6 (42). <https://doi.org/10.1001/archderm.1985.01660070119033>

McVeigh-Schultz, et al, (2018). Immersive design fiction: Using VR to prototype speculative interfaces and interaction rituals within a virtual storyworld. *DIS 2018 - Proceedings of the 2018 Designing Interactive Systems Conference*, 817–830. <https://doi.org/10.1145/3196709.3196793>

Miltenberger, R. G. (2001). Behavior modification: Principles and procedures (2nd ed.). In *Behavior modification: Principles and procedures (2nd ed.)*. <https://doi.org/10.1080/01431161.2016.1204478>

Nathan, L. P., Klasnja, P. V., and Friedman, B. (2007). Value scenarios: A technique for envisioning systemic effects of new technologies. *Conference on Human Factors in Computing Systems - Proceedings*, 2585–2590. <https://doi.org/10.1145/1240866.1241046>

Niedderer, K., Clune, S., and Ludden, G. (2017). Design for Behaviour Change: Theories and practices of designing for change. Taylor & Francis. <https://books.google.it/books?id=WFsyDwAAQBAJ>

Niedderer, K., et al (2014). Joining Forces: Investigating the influence of design for behaviour change on sustainable innovation. *NordDesign*, April, 620–630.

Niedderer, K., et al (2016). Design for Behavioural Change as a Driver for Sustainable Innovation: Challenges and Opportunities for implementation in the private and public sectors, in *International Journal of Design*, vo.10 (2), pp. 67-85

Pierce, J., Sengers, P., Hirsch, T., Jenkins, T., Gaver, W., & Disalvo, C. (2015). Expanding and refining design and criticality in HCI. *Conference on Human Factors in Computing Systems - Proceedings*, 2015-April(May 2016), 2083–2092. <https://doi.org/10.1145/2702123.2702438>

Preece, J. J. (2010). I Persuade, They Persuade, It Persuades! [technology-mediated social participation applications]. In *Persuasive Technology Proceedings 5th International Conference PERSUASIVE 2010*. https://doi.org/tp://dx.doi.org/10.1007/978-3-642-13226-1_2

Prost, S., Mattheiss, E., and Tscheligi, M. (2015). From Awareness to Empowerment: Using Design Fiction to Explore Paths towards a Sustainable Energy Future. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15*, 1649–1658. <https://doi.org/10.1145/2675133.2675281>

Rapp, A., Tirassa, M., and Tirabeni, L. (2019). Rethinking Technologies for Behavior Change. *ACM Transactions on Computer-Human Interaction*, 26(4), 1–30. <https://doi.org/10.1145/3318142>

Reddiar, W. E. (2010). The Object Speaks : Connecting the Post- Optimal Object Design with New Media Arts Discourse. February.

Rhodes, D. H., & Ross, A. M. (2010). Shaping Socio-technical System Innovation Strategies using a Five Aspects Taxonomy. *Incoze*, 1999, pp.1–15.

Miller, R. (2015). Learning, the Future, and Complexity. *An Essay on the Emergence of Futures Literacy*. *European Journal of Education*, 50(4), 513–523. <https://doi.org/10.1111/ejed.12157>

Rotolo, D., Hicks, D., & Martin, B. R. (2015). What is an emerging technology? *Research Policy*, vol. 44(10), pp. 1827–1843. <https://doi.org/10.1016/j.respol.2015.06.006>

Rozendaal, M. M. C., Keyson, D. V., and de Ridder, H. (2007). Product behavior and appearance effects on experienced engagement during experiential and goal-directed tasks. *August*, 181. <https://doi.org/10.1145/1314161.1314178>

Tanenbaum, J., Pufal, M., and Tanenbaum, K. (2016). The limits of our imagination. *September*, 1–9. <https://doi.org/10.1145/2926676.2926687>

Tanenbaum, J. (2014). Design fictional interactions. *Interactions*, 21(5), 22–23. <https://doi.org/10.1145/2648414>

Tanenbaum, J., Pufal, M., and Tanenbaum, K. (2017). Furious futures and apocalyptic design fictions: Popular narratives of sustainability. *Interactions*, 24(1), 64–67. <https://doi.org/10.1145/3022123>

Tang, T.; Bhamra, T. (2009). Understanding consumer behaviour to reduce environmental impacts through sustainable product design. Loughborough University. Conference contribution. <https://hdl.handle.net/2134/8375>

Tanyoung, K., and DiSalvo, C. (2010). Speculative visualization: a new rhetoric for communicating public concerns. *Design Research Society*. <http://www.designresearchsociety.org/docs-procs/DRS2010/PDF/066.pdf>

Torning, K., and Oinas-Kukkonen, H. (2009). Persuasive System Design: State of the Art and Future Directions. 1–8. papers2://publication/uuid/1941731C-F23D-46B6-8BCB-A1D676F7F485

Tromp, N., Hekkert, P., and Verbeek, P.-P. (2011). Design for Socially Responsible Behavior: A Classification of Influence Based on Intended User Experience. *Design Issues*, 27(3), 3–19. https://doi.org/10.1162/DESI_a_00087

Tuinen, van Sjoerd, (ed). (2017). *Speculative Art Histories. Analysis at Limits*. Edinburgh University Press

Schon, D.A. (1991). *The Reflective Practitioner*. Ashgate Publishing.

Shedroff, N., Noessel, C. (2012). *Make it so*. Rosenfeld media.

Simon, H.A. (1996). *The Science of the Artificial*. The MIT Press

Sterling, B. (2006). *La forma del futuro*. Apogeo editore.

Sterling, B. (2002). *Tomorrow Now*. Mondadori

Stienstra, J., Alonso, M. B., Wensveen, S., & Kuenen, S. (2012). How to design for transformation of behavior through interactive materiality. *Proceedings of the 7th Nordic Conference on Human-Computer Interaction Making Sense Through Design - NordiCHI '12*, 21. <https://doi.org/10.1145/2399016.2399020>

Somerville, I. (1999). Agency versus identity: Actor-network theory meets public relations. In *Corporate Communications: An International Journal*, vol.4(1), pp. 6–13. <https://doi.org/10.1108/13563289910254525>

Suchman, L., Trigg, R., and Blomberg, J. (2002). Working artefacts: Ethnomethods of the prototype. *British Journal of Sociology*, 53(2), 163–179. <https://doi.org/10.1080/00071310220133287>

Verbeek, P. (2006). Materializing Morality Design Ethics and. *Science, Technology and Human Values*, 31(3), 361–380.

Verbeek, P. (2005). *What things do: Philosophical reflections on Technology, Agency, and Design*. Pennsylvania State University Press

S_02 > BUILDING THE PhD KNOWLEDGE



4

THE CONSTRUCTION OF THE PROTOCOL

In the previous chapters, the author introduced the foundations of this research. Building on theoretical foundations, she systematises the theory into the first approach for designing consciously technological artefacts to tackle aware behaviours. The result is the Protocol as the main output of this PhD research.

A *Protocol*^[10] is intended as a set of rules that lead to the conduction of a specific task.

The Protocol was developed through several stages. Before delivering the final version, the author creates two provisional protocols (Protocol v.1 and Protocol v.2), the semifinal and, in the end, the final output of this PhD research – the final Protocol for designing. Figure n shows the evolution of the Protocol throughout the stages.

In this chapter, the author shows the early stages of approach building and its initial operationalisation into the provisional Protocol v.1. The provisional Protocol v.1 operationalises the approach linearly, and it applies several already existing tools to support the Protocol.

The Protocol in question uses the future as a space for critical inquiry, founded on design fiction principles. Throughout this protocol design, researchers and practitioners dealing with the design of technological artefacts to tackle human behaviour (concerning the products and services) can craft the anticipatory scenarios and subsequently diegetic prototypes. These scenarios and prototypes become the tools for critical reflection and inquiry to let the design researchers and practitioners adopt more pluriversal perspectives and

[10] In these terms, it gets close to the definition of the scientific protocol: "A protocol is also the rules to be followed when doing a scientific study or an exact method for giving medical treatment." (Cambridge dictionary) In computer science the protocol is "a set of technical rules that control the exchange of information between different computers or computer networks." While, in terms of social rules and norms protocol is "the system of rules and acceptable behaviour that people or organizations should follow in official situations, for example when they have formal discussions." (Cambridge dictionary)

learn how to deal with the complexities. Through such an approach, more conscious designs and research can be delivered in the present.

The author proposes an assemblage of the theories, tools, methods, and models and tests its efficacy in triggering critical thinking. Critical thinking is measured through several parameters and evaluation methods. The author measures the critical thinking by analysing: how the Protocol guided the design researchers in transforming the Societal Challenge to the design challenge (the interpretation of the issue); how in-depth they analysed the issues in question; whether they employed the pluriversal perspective (considering the analysis of the ecosystem of the issue in question); whether the discussion was stimulated among the participant; whether they took in consideration the possible implications of their reasoning, and how consistent was the output they produced (whether the anticipatory scenarios take in consideration all the elements contained in the analysis conducted through the Protocol). The methods of evaluation are described further in the chapter.

In parallel with the Protocol, the author develops one envisioning tool called Tech Inspiration Cards (TICs), exploiting the diegetic prototypes present in Sci-Fi films that aim to stimulate the critical reflection and discussion upon the possible ethical and societal implications due to the use of technologies. Also, the envisioning tool was developed through various stages of research. In this chapter, the author introduces the initial ideation of the tool and the method behind its development.

The approach behind the Protocol and envisioning tool is a possible way to answer the research question “How can we trigger the critical thinking in design research and practice to design more consciously the technological artefacts able to tackle aware behaviours?”

Here and after, the author describes the entire process behind developing the Protocol and envisioning tool. First, she introduces how the theoretical foundations are put together to set the approach, and then how the approach is operationalised into the Protocol ready to use by design researchers and practitioners.

4.1. *Developing the Protocol v.1: setting the Approach*

The author started to put the knowledge together to understand how different concepts can trigger critical thinking when designing technological artefacts to tackle aware behaviours. First, this research proposes to adopt several design fiction principles such as the use of the future for critical inquiry, production of anticipatory scenarios, and creation and exploitation of diegetic prototypes. In critical design theory and practice, these are believed to be enablers of critical thinking when it comes to investigating technologies and society. (Jakobson, 2017)

People are pretty used to the future stories, imagining possible futures. These stories have several purposes: “They reveal underlying trends, and they caution, inspire, give meaning, and teach us about social change. Some visions are full of hope and promise; they explain how technologies will set us free, ease everyday drudgery, help us to live longer, and bring global justice”, yet “many science fiction films present visions of the future that serve as ominous warnings about the ultimate effects of certain trends. The authors of such futures challenge readers with pictures of a dystopian world that could result from the implementation of certain technologies, often in conjunction with particular types of government or corporate practices.” (Johnson and Wetmore 2009)

Within the design field, using fiction is not only dreaming about the distant future but rather “intentional political actions in the present time.” Nevertheless, these can sometimes “cause social frictions.” (Gonzatto et al., 2013) Using the future as a space for critical inquiry must have a meaningful application. Otherwise, it is useless. The most common design fiction serves with the scenarios. Burnam-Fink (2015) explains the scenarios in the following way: “Scenarios are about creating representations of the future and evaluating the quality and consequences of those representations. The scenario process is both analytic and synthetic, as it seeks to reduce the overabundance of available knowledge to the most critical elements, and then blend combinations of those elements to create possible futures.”

Another common technique is design fiction prototyping that materializes and contextualises the scenarios: “These prototypes use literary techniques to test the development of

a new technology, evoking some of the complexity and messiness of the real world through the affective and emotional lenses of fictional characters impacted by a changed future.” (Burnam-Fink, 2015)

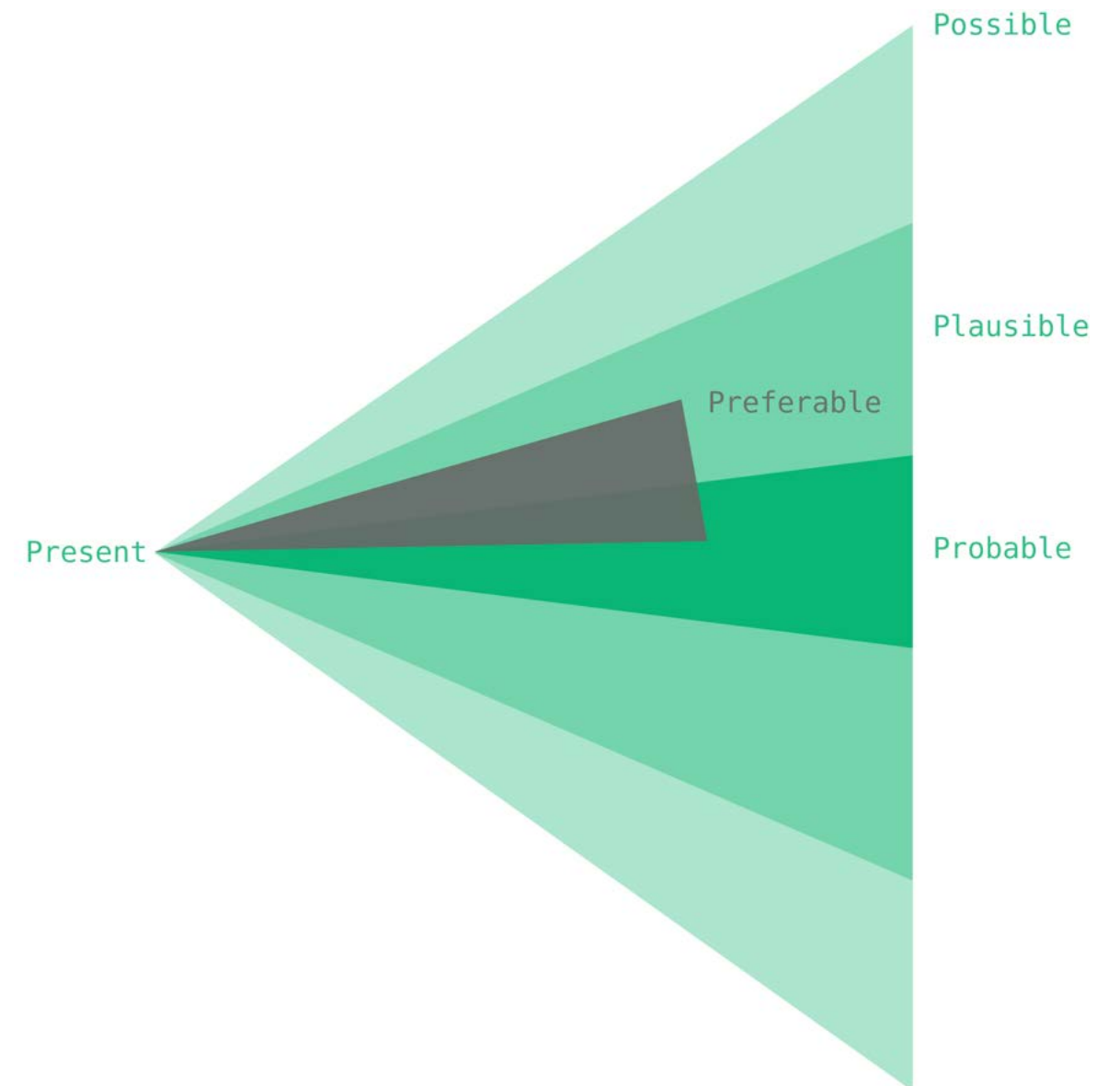
Through this research, the author is trying to understand how these principles can be applied in a meaningful and useful way to design technological artifacts to tackle aware behaviours. This research combines several concepts, found as essential, where societal challenges, human behaviour, and technologies. The technologies (technological artefacts) can influence human behaviour toward adopting more aware habits and practices, which is the objective of the societal challenges such as Sustainable Development Goals (SDGs) and Green New Deal (GND). Now we will see how the author puts these concepts in a system using the future as a space for the critical inquiry and design fiction principles to trigger the critical thinking concerning these issues.

Building on the in-depth literature review in the first three chapters, the author identified several models, methods, and tools that could be useful to combine to set the provisional Protocol v.1.

First, the author wanted to understand how design researchers and practitioners can build the anticipatory scenarios in a meaningful way for this research. Then how can design researchers and practitioners use these scenarios to materialize the future as a part of the reflective design activity, get better in touch with the future, and use these materializations (design fictions) to rethink the present? (Figure n – double diamond or approach)

At this stage of the research, the author found the PPPP model, proposed for the first time by the futurologist Stuart Candy and revised for the design discipline by Dunne and Raby (2013), as a valuable way to map the future at different levels, and help in this way design researchers and practitioners build the future scenarios through different stages, starting from the present states through the plausible and possible, to the preferable futures. This model is known in the form of several overlapping cones. (See Fig.13) Dunne and Raby explain this kind of approach as the one that enables to “open up all sorts of possibilities that can be discussed, debated, and used to collectively define a preferable future for a given group of people: from companies to cities, to societies.”

The author elaborates this model to fit the purposes of this research and defines a linear protocol (provisional Protocol v.1) founded on four stages and scenario building as output; each of these corresponded to one of “P.” (Fig. 14). The author believed this kind of approach could help navigate the future more easily and enable critical thinking transversally in the process.



PPPP. Illustration by Dunne & Raby, Robin Bergman reproduction

Figure 12: PPPP model (illustrated by Dunne and Raby, reproduction of Robin Bergman)

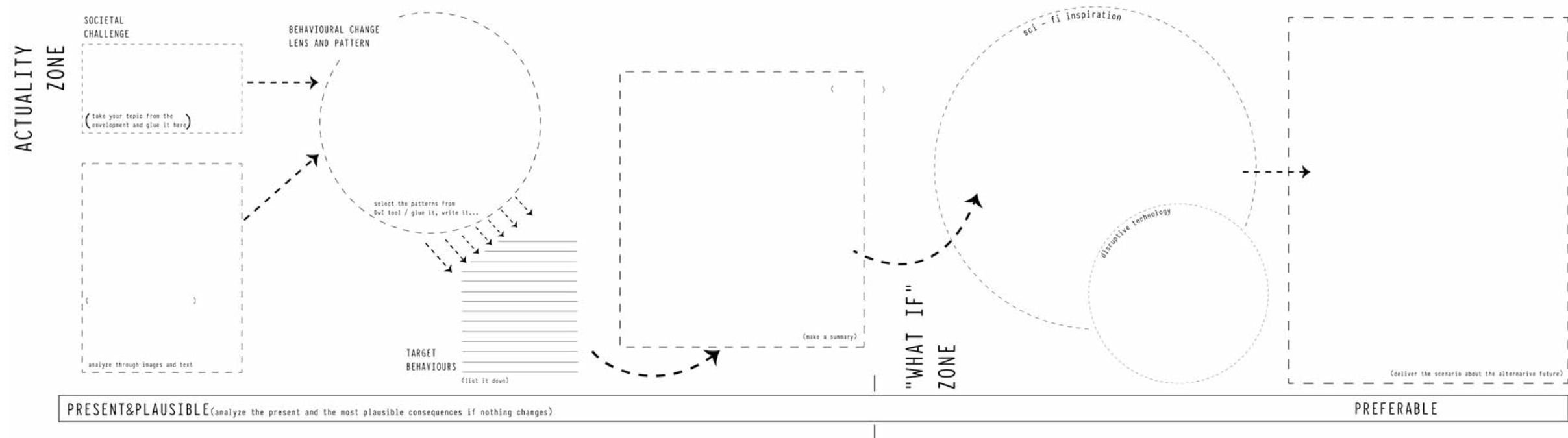


Figure 13: Provisional protocol n.1 founded on PPPP model

Now how the main concepts of this research were integrated? Starting from the Societal Challenges. The Societal Challenges cited within this research are those in which, first, the design discipline is interested in contributing. Moreover, this research is interested in those challenges tightly related to human (more aware) behaviours. Besides, this research relies on values proclaimed by the EU and integrated in Horizon 2020, Green New Deal (GND), Sustainable Development Goals (SDGs), and Grand Societal Challenges (GSCs) that have as an explicit aim to shape the future and “increase research into human, social, political and cultural processes involved in techno-science endeavors.” (Bina et al., 2017) Another relevant reference here is the Loughborough University classification of the Societal Challenges (SCs) related tightly to the human behaviour and relevant for the behavioural design where Environmental sustainability (improving the state of the planet), Health and wellbeing (addressing health crisis), Safety of population (risk prevention), Social Design, and Reduction in crime. (Niedderer et al., 2014)

Chapter 3 (3.1.1.) lists several theories, models, and tools found as relevant to exploit for this PhD research concerning the design for behavioural change. The parameters for selecting these tools were set to satisfy this research’s needs in addressing the aware user behaviours, defined through the Societal Challenges, and that are suitable to apply in case of technologies to tackle behavioural change. The selection of models and tools to apply in Protocol v.1 are the following:

• *Design for Sustainable Behaviour/Innovation (Loughborough University)*

“Design for Sustainable Behaviour is a new field of inquiry exploring how design can influence user behaviour to reduce negative social or environmental use impacts. [...] This work examined literature which provided an understanding of the psychological and behavioural factors of behavioural change, and identified ways in which they could be applied within a design context.” (Tang, 2010; Tang and Bhamra, 2008).”

• *Design with Intent Tool (Dan Lockton, Brunel University)*

“The Dwl Method has been developed primarily in response to the need of influencing user behaviour to reduce the environmental impact of products which consume resources during use: helping people use products and systems more efficiently. [...] Dwl Method is intended to be generally applicable to influencing user behaviour, including but going beyond the ecodesign field [...] its potential by application to an everyday human-technology interaction problem.” (Lockton, Harrison, Stanton, 2010)

• *Functional Triad (B.J. Fogg)*

“Computers play many roles, some of which go unseen and unnoticed. From a user’s perspective, computers function in three basic ways: as (a) tools, as (b) media, and as (c) social actors. In the last two decades, researchers and designers have discussed variants of these functions, usually as metaphors for computer use (i.e., Kay, 1984; Verplank, Fulton, Black, & Moggridge, 1993). However, these three categories are more than metaphors; they are basic ways that people view or respond to computing technologies. These categories also represent three basic types of experiences that motivate and influence people.” (BJ Fogg, 2007)

Now the author explains how these theories and tools are applied into Protocol v.1 and with what scope.

The reason to inspire on *Design for sustainable Behaviour/Innovation* is that this PhD research is interested in human behaviours addressing sustainable development (what the author defines as aware behaviours). It is concerned with the user’s awareness regarding sustainability issues. Design for Sustainable Behaviour stresses that the lack of consumer awareness of the link between their behaviour and the direct impact on the environment or society is one of the key issues in adopting sustainable practices and habits. In the Loughborough University study on the Design for Behaviour Change as a Driver for Sustainable Innovation, the author finds the concept of agency divide, or rather how the behavioural design models could be classified from those impacting only or mainly the individual, the contextual more oriented toward the society, or the middle ground, impacting equally individual and the society. This division of the impact was proper to support the Protocol and describe the impact/contribution of design intervention and expand the analysis of human behaviour to grasp the broader context of events that may impact one’s behaviour. They classify three levels of intervention: individual - cognitive, middle ground, and context related. Understanding the level on which the design and research intervention is conducted is essential for understanding what kind of strategies to apply to influence the user’s behaviour. For the Loughborough University analysis, the sustainability-related interventions can be treated on each of these three levels. In Figure n. author elaborates and simplifies Loughborough’s mapping of the theories and models by agency divide to explain this concept. To remind, the study in question defines the Design for behaviour change as being “concerned with how design can shape or influence human behaviour and sustainable innovation (Lockton et al., 2010; Niedderer et al., 2014b). Key areas of its application include sustainability, health and wellbeing, safety and crime prevention as well as social contexts.” In this PhD, the author focuses mainly on sustainability, health, and wellbeing as part of this concept and less on safety. However, the Design for Sustainable Behaviour/Innovation is not applied in this re-

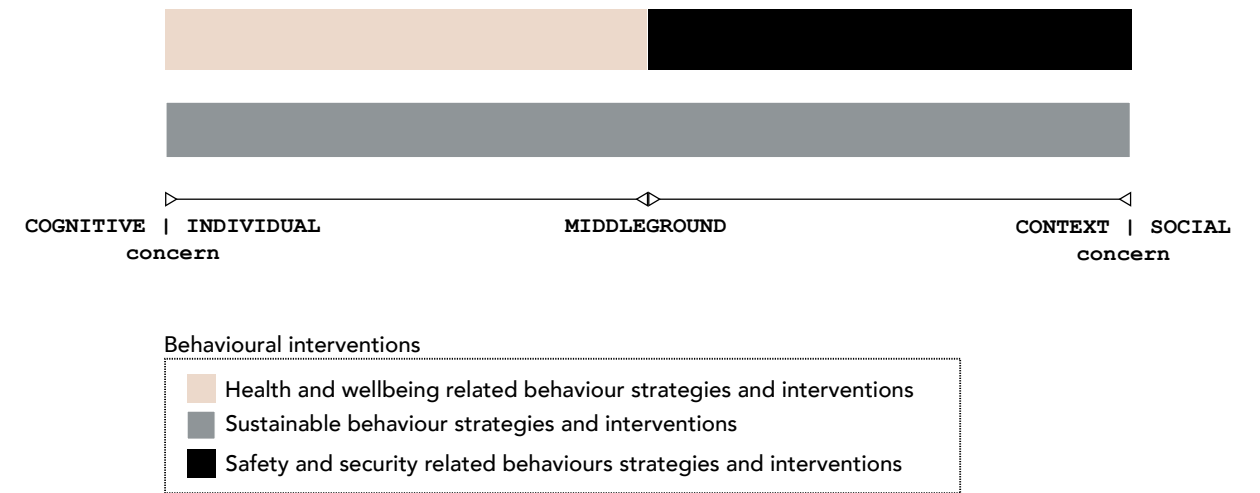


Figure 14: Mapping Agency Divide - scaling behavioural interventions and strategies

search as a tool, but the knowledge author gained from it is transversally applied into the Protocol. Later in the text, the author shows how.

From the *Design with Intent tool*, the author borrows the patterns and lenses framing the strategies for behavioural change, which is also suitable for writing design briefs. These patterns provide very explicit examples, sometimes even unconventional or critical, to help designers influence the users through the products and services, letting them adopt aware behaviours. The tool has 8 lenses divided in two categories - environment and mind (Fig. 15). For this research, the author focuses on those strategies identified as the most suitable for the products and services embedding technologies (considering that this PhD is not interested in architecture and security interventions that are part of this tool).

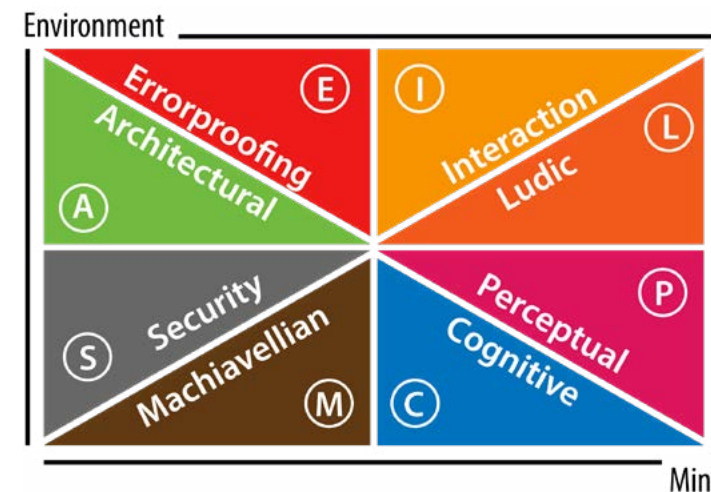


Figure 15: Design with Intent classification of patterns and the field of intervention

The author focuses on 5 lenses, those concerned with interaction aspects, technologies, experience, and morphology of the artefacts. These are introduced later in the text.

The author introduces the *Functional Triad (FT)* (Fogg) to support the analyses of the role of technologies in shaping the future and human behaviour. The purpose of this tool in the Protocol proposed by the author is to define and describe the technology to motivate users to adopt aware behaviours. The goal here is to assign to the technology a specific role and understand how to materialise these roles through interactions and materiality.

Beyond the listed tools that serve to inform the design for human behaviour and design of technologies for human behaviour, the author introduces the Tech Inspiration Cards (TICs) - the envisioning tool developed by the author to stimulate the critical discussion upon the technologies and societal issues with a scope to identify the possible ethical and societal implications of what one is designing. Through the use of cards, the researchers and designers can inspire diegetic prototypes from films and reflect critically upon the role of technology. The author finds it essential to define critically the role of technology in a society, its influences on individuals and the environment, as Johnson and Wetmore (2009) explain:

“Only when the role of technology in society is understood can strategies be developed to get from here to there. [...] Just as technology influences the kind of society we have, society influences the kind of technologies that are developed. This means that one cannot understand either as separate. Indeed, technology and society are complex interconnected systems.”

Only in this way can we avoid the negative consequences of the technologies while increasing their benefits. The TICs and their development are further deepened in the chapter (4.3.).

The author assumes that building on these elements (theories and tools), design researchers and practitioners can create meaningful and critical scenarios about the technological artefacts to tackle aware behaviours. The approach proposed by the author suggests building anticipatory scenarios using these theories and tools. The scenarios are an intangible fictional artefact that can be used to study the issues' possible implications and material and experiential aspects of the technologies with scope to inform the design research and practice and guide the design researchers and practitioners in delivering more conscious designs in the present. The scenarios can be subsequently materialised (diegetic prototypes) to communicate and test the alternative futures (scenarios) with the broader public.

The author illustrates in Figure n. how the approach behind Protocol v.1 is framed.

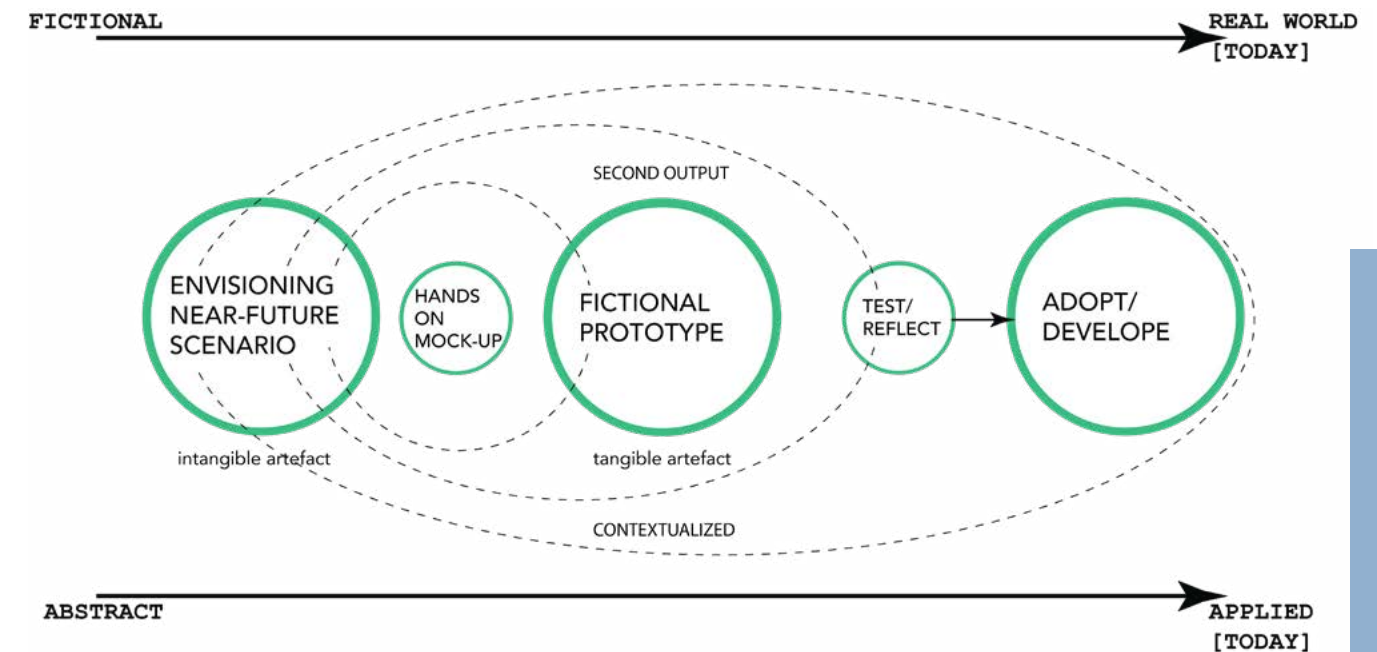


Figure 16: Approach exploiting the Future as a space for critical inquiry suggested by the author

4.2. Putting the knowledge together: the first systematization of the approach into provisional Protocol v.1

Here and after, the author goes more in detail in explaining the protocol that exploits several tools and methods.

Building on the PPPP model author suggests the protocol that can help design researchers and practitioners trigger critical thinking when designing technological artefacts to tackle aware behaviours in users through the linear process conducted to deliver the anticipatory scenarios at the first stage of exploration. (see Fig. 13)

This four-stage protocol aims at helping the design researchers and practitioners investigate the Societal Challenges, then question human behaviour in regard and analyse the target behaviours and possible design strategies; define and envision the technologies in regard through the critical reflection, and finally deliver the scenario.

The idea behind elaborating the PPPP model is to help the researcher and practitioner analyse the future starting from the present and most plausible states through the possible and finally the construction of the preferable future, with a scope to rethink the present once again.

The author goes through each stage of the protocol to show how the tools and theoretical concepts are arranged.

The first “P” (Present) - the first stage of the protocol, is dedicated to analysing societal challenges. This stage of the protocol analyses the present states through the Societal Challenges such as those proclaimed by the EU Commission and United Nations to understand how design researchers and practitioners change the most plausible (expected) futures and prepare better for tomorrow by building more thriving societies. Here the researchers and practitioners can explore the current challenges, identify those concerned with the design discipline, and understand how human behaviour is related to these chal-

allenges. There is no specific tool suggested at this stage. It is an open analysis that finds its roots in New Green Deal (NGD), Sustainable Development Goals (SDGs), Horizon 2020. However, the author tries to suggest the possible fields of operation for design research and practice, where environmental sustainability is concerned with air pollution, water pollution, energy and water consumption, waste management; health and wellbeing like health prevention, occupational health, aging; but also safety intended as citizen's safety (urban safety) and cyber safety (safe behaviours on the internet and concerning other digital content). The challenges do not have to limit to these. Besides, we must consider that some of the mentioned challenges are often related to one another, so exploration possibilities are broad.

The second stage of the analysis is concerned with the behavioural analysis regarding the previously selected challenge. The analysis suggests discussing how human behaviour is related to Societal Challenges and identifying possible design strategies to answer this issue. For this analysis, the author suggests using the agency divide to define the scale of the issue in question and behavioural intervention. Then it is introduced the Design with Intent tool defines the target behaviours and identifies the strategies to apply to motivate the user's behaviour. The author identifies 5 from 8 lenses with patterns as the most suitable to apply in this case - to explore the strategies about the Societal Challenges and technological artefacts (products and services). The selected lenses (Fig. 17) are the following: Perceptual lens, Cognitive lens, Interaction lens, Ludic lens, and Machiavellian lens.



Figure 17: Selected Design with Intent patterns to apply in the Protocol v.1

These lenses with patterns can help in inspiring the possible design strategies that can help and support the users in adopting aware behaviours.

The protocol suggests, to sum up, the findings of the first two stages before going through stages three and four. This passage between two dimensions puts together the knowledge and findings of the SCs and human behaviour – it is a sort of design brief from which we can start envisioning. This is the zone of Possible (the third “P”).

The next stage is about envisioning and setting the What if? Questions. From here on, the

protocol enters the zone of Preferable Future. The author suggests exploring the technologies in stage three by exploring diegetic prototypes from Sci-Fi films. The output of this stage is to define and describe the technologies and interactions that we could apply in our near-future artefact. This stage uses Tech Inspiration Cards (TICs) to enable the exploration and critical discussion through the Sci-Fi genre and Functional Triad (FT) to help define and describe the role of technology in acting as a persuasive tool.

The last stage of the linear protocol is the anticipatory scenario. In this version of the protocol, no specific guidelines or tools were suggested for building the scenario. However, the objective was to build the scenario upon the findings from the protocol stages. Through the scenario, one should envision the near-future technological artefact (products and services) and describe the facts behind the artefact's existence, such as the context in which the artefact is collocated. This stage concerns the initial analysis of SCs and human behaviour (background story). These scenarios, delivered throughout the protocol, have as a purpose to open discussions on how our future might look like and make us reflect on how we design in the present to avoid negative consequences and possible technological and societal implications. Additionally, the author suggests that these scenarios can be materialised subsequently (create diegetic prototypes). The advantage of diegetic prototypes in this sphere is that we can communicate these artefacts more realistically, engaging the broader public in discussion and others.

This version of the protocol with tools was tested in the first experimentation within this PhD research to understand how efficient such an approach is when it comes to triggering critical thinking concerning the design of technological artefacts to tackle behavioural change.

4.3. *The background and development of the Tech Inspiration Cards (TIC)*

In Chapter 3 (Background knowledge), the author made an overview of critical design theories and practices, focusing on speculative design with design fiction and using the Future as a space for critical inquiry and fictional artefacts as objects of inquiry in design research and practice. The nature of these Artefacts was observed in-depth, from its intangible forms to design props and diegetic prototypes. The analysed artefacts are the outcomes of design research. They propose alternatives to the existing normality of technological and scientific innovation in the future.

Besides, the author introduced how Design Fiction was coined and how the approach behind creating the props for films inspired the design discipline – using the fiction and fictional artefacts (diegetic prototypes) to speculate about the future.

This study led the author toward the ideation of an envisioning tool, exploiting the Sci-Fi films and the philosophical thinking behind them. The envisioning tool - Tech Inspiration Cards (TICs), uses diegetic prototypes from Sci-Fi films to tackle critical discussion and reflection about the collective imaginaries of the future, scientific and technological development.

The author's idea was to propose this tool together with the Protocol. This tool becomes one of the tools in the Protocol that has as a purpose to help the design researchers and practitioners analyse the technologies with a critical lens anticipate the possible implications. However, the tool can be used separately from the Protocol in any design and research activity to open a critical discussion and suspend disbelief about the future. The author does not propose the Sci-Fi films as an answer to the future; instead, she proposes to analyse the fears society perceive about the future, observe the possible scenarios critically like environmental disasters, pandemics, and other, and identify the stereotypes and myths the society cultivates regarding the scientific and technological development. What the author wants from this tool is to show the scenarios and artefacts that can raise one's concern about the possible implications of technologies and suspend disbelief caused by the stereotypes.

The author describes the foundations of this tool through a brief observation of how critical thinking is related to the Sci-Fi genre historically. Then, this text describes how the tool was

generated, which was the development method. Finally, the author comments critically on the limitations of such a method.

Before going into an in-depth description of the envisioning tool development, the author dedicates a few words to the background of critical thinking and Science Fiction (Sci-Fi) to arrive at Design Fiction as a branch of Critical Design practices.

There is a close relation between critical theory and Sci-Fi, philosophy and Sci-Fi. Freedman (2000) finds the co-junction between critical theory and science fiction as fundamental. Both critical theory and Sci-Fi are characterised by speculating about the future.

Further on, Freedman explains that the similarity between the critical theory and Sci-Fi lies in that both insist upon “historical mutability, material reducibility, and utopian possibility.” He defines Sci-Fi as a genre most devoted to the “historical concreteness and rigorous self-reflectiveness of critical theory” and explains these fictional worlds as not the one that is only different from the present time and place, we know, but somewhat as interested in “difference that such difference makes.”

Sci-Fi elaborates different topics concerning society and science and “provides materials for philosophical thinking about the logical possibility and paradoxes of time travel, the concept of personal identity and what it means to be human, the nature of consciousness and artificial intelligence, the moral implications of encounters with extraterrestrials, and the transformations of the future that will be brought about by science and technology.” (Sanders 2008)

It is a genre about possibilities, alternatives, and critical assumptions. However, there is a need to put particular attention when it comes to the analysis of the Sci-Fi genre, by taking into consideration the historical and cultural context in which these worlds were ideated and what kind of collective imaginaries were present at the time, which moral values and beliefs were dominant in that specific discourse.

Freedman explains that the dialectic between estrangement and cognition determines Sci-Fi. He explains this phenomenon in the following way:

“The first term refers to the creation of an alternative fictional world that, by refusing to take our mundane environment for granted, implicitly or explicitly performs an estranging critical interrogation of the latter. But the critical character of the interrogation is guaranteed by the operation of cognition, which enables the science-fictional text to account rationally for its imagined world and for the connections as well as the disconnections of the latter to our own empirical world. If the dialectic is flattened out to mere cognition, then the result is “realistic: or mundane fiction, which can cognitively account for its imaginings but performs no estrangement; if

the dialectic is flattened out to mere estrangement (or, it might be argued, pseudo-estrangement), then the result is fantasy, which estranges, or appears to estrange, but in an irrationalist, theoretically illegitimate way.”

The sensations of estrangement and temporal disjunction are significant in the constructions of the future worlds, both in the case of Sci-Fi as a cinematographic and literature genre and design fiction as a critical design field. The temporal disjunction in this sense is when we perceive the “ghosts from the past” emerge from the future ideas. Concept tackled by Derrida (1994) through the term of Hauntology^[11].

Nowadays, we can find some examples of retro-futurism in popular culture and contemporary mass media (i.e., Netflix serials: “The Stranger’s Things” or “The Maniac”). In this research, the author puts a critical eye on it instead of commenting on this new mass media tendency. This is of great importance when it comes to Design Fiction. Hales (2013) explains: “Design fictions can create folds of the ‘archaic ideas of futurity.”

So, what does it mean to create actual futures based on what we know from our past and present? Hales tries to propose several ways in which we can think about the actual futures:

“One way to think of the actually futuristic might be through something like the diegetic prototyping of David Kirby (2009). This is the idea that you can create a prototype as if a ‘prop’ in a narrative environment where a futuristic object can appear as material within the diegesis. Within the fictional world, the prop or prototype can exist and be rendered material, functioning in all respects, can be rendered ‘actually’ futuristic. Another way of thinking the futuristic takes the idea of emerging technologies as an actualised futuristic, as a sort of reaching into the virtual to evert an actual future for the present. At some pace of emergence, however, such things ‘cannot belong to the future because the future, in the shape of technology, is already here, exactly synchronous with the present’ (Eagleton quoted in Frascina and Harris 1992, 92). In both these ways, ‘actual

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[11] “Hauntology is an idea within the philosophy of history introduced by Jacques Derrida in his 1993 work Spectres of Marx. The name of Derrida’s book comes from Marx’s assertion that the spectre of communism is haunting Europe. Derrida argued that Marx would become even more relevant after the fall of the Berlin Wall and that the West’s separation from the ignorance of the suffering still present in the world will “haunt” it and provide impetus for a fresh interest in communism. The present exists only with respect to the past and society after the end of history will orient itself towards ideas and aesthetics that are rustic and bizarre; that is, towards the “ghost” of the past. Derrida concludes that because of this form of intellectual realignment, the end of history will be unsatisfactory.” (Gericke, 2012)

**futures’ form as material assemblages and technologies. Such actual futures we could consider to be processual, where the past is contiguous with the present and the future, and the future contiguous with its anterior.”**

Sterling (2004) explains that the future is instead a process than the destination, saying that “people need a motivating vision of what comes next and the awareness that more will happen after.”

For this research and development of the envisioning tool that is introduced in a short, the author focuses on diegetic prototypes – the protagonist of the fictional world.

Kirby (2010) introduces Diegetic Prototype to describe how cinematic depictions of futuristic technologies demonstrate a technology’s need, viability, and benevolence to large public audiences. These prototypes have a solid performative aspect; they exist only in the narrative or fictional world, they become socially relevant in the fictional sphere. Typically, here we are speaking about the technological artefacts in Sci-Fi films. Kirby explains that the film (narration) “serve as ‘virtual witnessing technologies’ that depict natural phenomena in such a way as to convince the audience that the representations accurately reflect the ‘natural world.’”

By creating these prototypes, engineers, futurists, and designers can encounter the mere feasibility of the technological proposals and the users’ social needs.

Bleecker (2010) explains that diegetic prototypes in the Design Fiction sphere have a purpose not only to test the technologies in a technical sense but also to “probe the larger set of questions that inevitably surround new, provocative and transformative ideas.” When brought in design sphere” these fictional prototypes have the potential to “help one imagine and tell stories about new near future objects and their social practices.”

Starting from these foundations, the author proposes a tool that can help design researchers and practitioners study the diegetic prototypes from Sci-Fi cinematography and understand how this way of thinking can be applied in the design discipline. Such a tool has as a purpose to stimulate the critical discussions upon the technological and scientific development, suspend disbelief about the future, recognise some typical imaginaries founded on the people’s fears and doubts about the future, but also inspire when possible, the design of technological artefacts in terms of aesthetics and interactions. In the following text, the author introduces the development of the envisioning tool Tech Inspiration Cards (TICs).

Building on the previously introduced background, the author ideated an envisioning tool called Tech Inspiration Cards (TICs) - a collection of cards and a library of Sci-Fi films and diegetic prototypes. We can observe how these diegetic prototypes are contextualised regarding the historical, political, and social sphere and reflect critically upon the possible ethical and societal implications of technologies and technological development through the Sci-Fi genre.

The author's intention with these cards is to inspire the imagination and let the researchers and practitioners open many possibilities when exploring the new forms, interaction rituals, materials, applications, and others, always keeping a critical eye on it.

Here and after, the author describes the method she employed to develop TICs.

There were set and combined several parameters to create cards. First, the author researched actual disruptive technologies and future trends, focusing on 15 years from now. Mainly the research led to the following technologies (as macro-categories): Artificial Intelligence, Simulated Reality, Wearables, and Smart Materials. These categories emerged from the research conducted on disruptive technologies described in Chapters 1 and 3.

This initial process helped generate a list of technologies that were subsequently applied in Seealsology<sup>[12]</sup>. This tool collects data from the web (Wikipedia) and classifies data on different levels, building the relationships between semantic areas within Wikipedia pages. Thanks to this tool, it was possible to enlarge the investigation zone, find new relationships between different technologies and concepts, and identify the subcategories and applications. Subsequently, the author generated the final keywords due to the literature review and data gathered from Seealsology. The keywords represented the most emergent technologies and technological processes within the macro-categories.

The next step was to identify all the Sci-Fi titles tightly related to these technologies, or rather, contain diegetic prototypes concerned with these technologies. For this passage, the author used InData<sup>[13]</sup>, a scraping tool developed at the Design Department of Politecnico di Milano “designed to support the envisioning of scenarios for students from various design disciplines. The tool takes advantage of the online repository *IMDb.com* that provides content related to storytelling artefacts and user-generated metadata. It uses suggestions and inspirations coming from the collective intelligence so to nourish the designers' creativity and lessen in individual biases and limits of knowledge – that come their subjective perspective that relies on socio-cultural backgrounds as a source of knowledge.”

In parallel, there was investigated the field of design fiction and collected the most remarkable examples from cinematography when it comes to the representation and contextualisation of diegetic prototypes.

Initially, there were selected and analysed around n. 28 titles.

As we can see, both tools used as support in this process are data scraping web tools. The reason for that was to confirm, deny or enlarge the field of exploration and keyword's relevance, and try to make the process more valuable in a scientific sense. While the TICs were

generated manually. Fig.18 illustrates the entire process of TICs development.

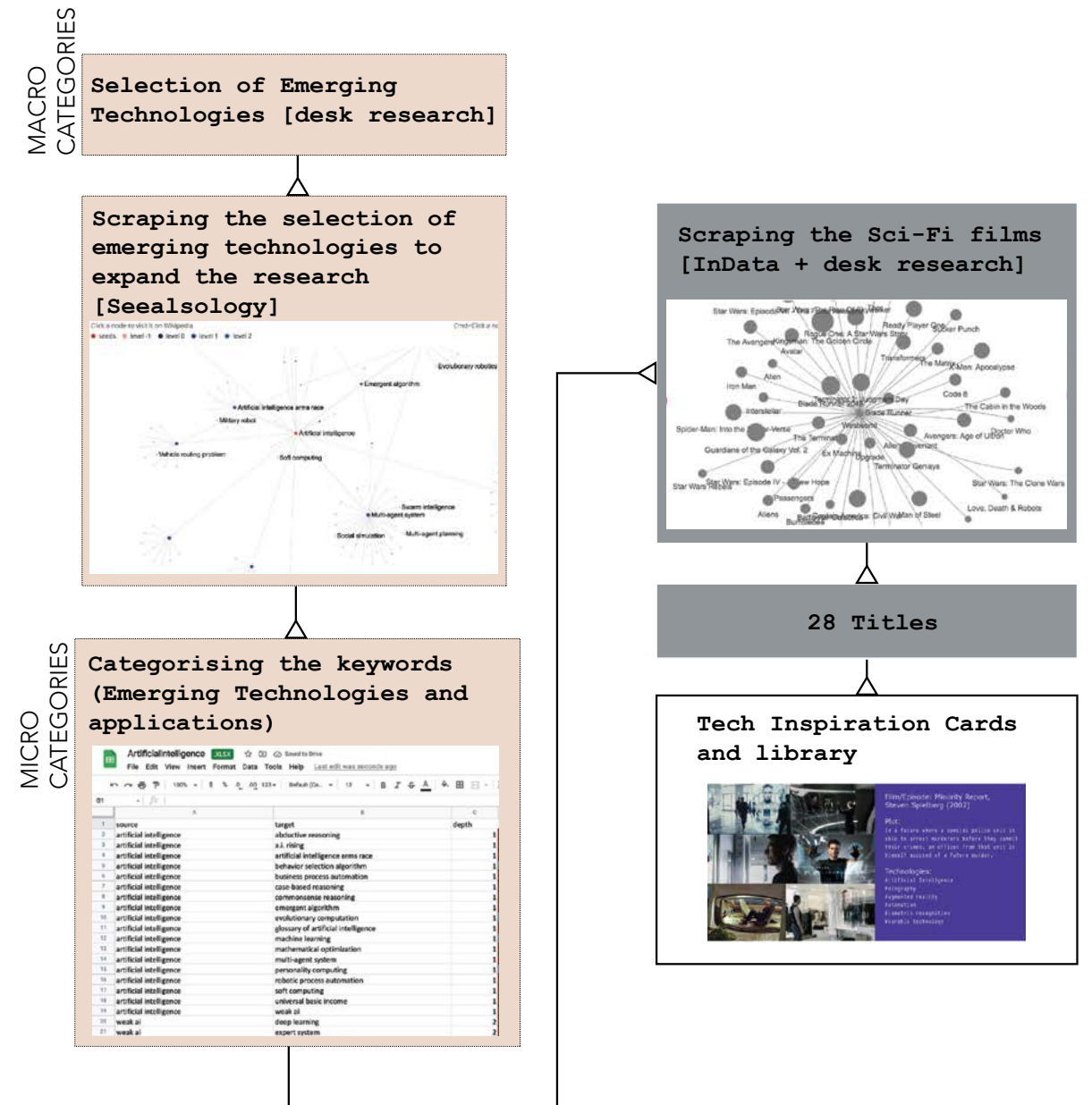


Figure 18: Development of Tech Inspiration Cards (TICs)

[12] <https://densitydesign.github.io/strumentalia-seealsology/>

[13] <https://www.indata.polimi.it>

Now the author describes what the TICs looked like at this stage. Each card had a part dedicated to selected images representing diegetic prototypes found in that film. The second half of the card is dedicated to the general information about the film, such as the plot taken from the IMDb22 or Wikipedia23, the most relevant technology in the origin of represented diegetic prototypes, and other relevant technologies that can be found in a film. Fig.19 illustrates the single card.



Figure 19: Tech Inspiration Card (“Minority Report” directed by Steven Spielberg)

The collection of TICs was uploaded on the web platform created by the author in a gallery. Figure 20 illustrates the gallery at this stage.

The author would like to stress some limits and comment critically on the method applied in the tool’s development.

There were recognized some limitations concerning mainly scraping tools and the overall method. Starting from the Seealogy, this tool, without any doubt, permits exploring many relationships between different concepts and enlarging the analysis. It is focused exclusively on the data found within the Wikipedia platform.

When it comes to InData, also in this case as in the previous one, the search is limited only to the one platform that is IMDb. Besides, applying the keywords in InData was not always successful; often, there was a need to combine more keywords. The results generated by the tool needed, in this case, some further revision and analysis. The author wanted to narrow down the search to some and not all possible Sci-Fi genres. The selection of titles narrowed on the technologies and technological and scientific innovation, and have a rich imagination in that sense and understanding societal issues and implications.

The fact that the cards are generated by the author manually is quite time-consuming and perhaps limits the card’s performance and subjectivity. The author believes that the cards could become more affluent and even more explorative with the help of specific software. This would certainly give some more scientificity at the same time.

Besides, engaging other people (not only design researchers and practitioners but also common people, passionate about Sci-Fi) in the creation process would solve the problem of subjectivity.

These were the limitations observed at this initial stage of TICs development. This version was tested in the first experimentation with design researchers. The following text shows how this tool was applied and how the limitations described here are related to the results obtained from the test.



Figure 20: Tech Inspiration Cards online library (part dedicated to Simulated Reality)



## 4.4. *Setting the first experimentation*

Here, the author introduces the first experimentation that had as objective to investigate how design fiction can trigger critical thinking when designing technological artefacts to tackle aware human behaviours. The author focused mainly on the narrative dimension of design fiction principles in this experimentation, specifically on anticipatory scenarios and their potential to engage the designers and researchers in a different kind of thinking – adopting pluriversal perspectives.

The objective of this experimentation was to test the efficacy of the approach and Protocol with tools in triggering critical thinking when it comes to the design of technological artefacts to tackle aware behaviours.

Through this linear Protocol, the participants were supposed to build the anticipatory scenario (focusing on 2045), envisioning the not-yet-existing technologies embodied into artefacts (product and services) able to help the people adopt more aware behaviours and habits regarding different societal challenges such as air pollution, safety (cyber and urban), health and wellbeing.

The author wanted to understand whether the construction of the scenarios through such activity can open up the critical discussion among the participants, support and inform the more conscious design of technological artefacts. The experimentation was carried out with nine participants actively involved in design research, six PhD students, and two Research fellows from different design fields. This experimentation was organized as a one-day workshop at the Design Department of Politecnico di Milano.

The text below describes the activity, experimentation methodology, the evaluation method through which the approach was evaluated, and finally, the results.

## 4.4.1. Activity and participants

The first experimentation took place on 10th January 2020 at Politecnico di Milano, Design Department, with n.9 participants (PhD students and Researchers) coming from different fields of design research where: smart materials, digital manufacturing technology, interaction and experience design, industrial design, fashion for sustainability, crosscultural teamwork in design-based learning. The reason for selecting these participants was because they were all involved actively in design research and deal with the fields of design in which this research is interested, there they could evaluate objectively and critically the Protocol v.1 with tools.

The participants organised into three groups answered on the three different macro-topics, where within each, they needed to select some more specific micro-topics. The experimentation topics inspire some fundamental societal challenges the *EU commission* and *UN Sustainable Development Goals*.

The objective of this experimentation was to engage the participants in creating the anticipatory scenarios about the not yet existing technological artefacts and systems (near-future) able to tackle more aware behaviours concerning mentioned societal challenges.

The participants were given the linear protocol inspired by the PPPP model and support tools. (see Fig. n)

The experimentation lasted one day and was divided into two sessions. The Morning session was framed around three activities:

**1| Selection and analysis of the Societal Challenges' topic;**

**2| Defining the behavioural concern and identifying the target behaviours on which to focus for designing the technological artefact;**

**3| Definition of the general brief that describes the design requirements and objectives.**

The Afternoon session was framed around two main activities:

**4| Take inspiration for technology from the SCI-FI films to find the most suitable technological solutions for the brief and observe the possible ethical implications and imagine how these will evolve 15 years from now, in the sense of applications, interaction modalities, aesthetics;**

**5| The participants developed scenarios, considered in the practice of design fiction as intangible explorative artefacts to envision and anticipate "preferable Future".**

The following text describes the applied methodology and how different tools were applied in the linear approach.

## 4.4.2. Toward conscious design (experimentation methodology and evaluation methods)

The activity was divided into several stages, and each corresponded to the different parts of the linear Protocol. The approach behind this Protocol relies on the PPPP model, and the main idea here was to trigger critical thinking through the use of the future as a space for critical inquiry. For each "P," one can explore the different levels of the future from present and plausible states to the preferable future. There are different tools to use as support in analysis at each of these stages.

The "present and plausible future" space in the Protocol is dedicated to the analyses of the Societal Challenges (SCs) topic and the behaviour analysis as a current state. Societal Challenges (SCs) (Loughborough University) selected for this occasion, based on the parameters that were introduced previously in the text, are (1) Environmental Sustainability, (2) Health and wellbeing, (3) Safety of citizens.

For analysing human behaviour (concerning the societal challenge), this approach suggests using Design with Intent (DwI), suitable for empowering the design for behavioural change briefs through the several lenses offering different strategies for designing the products and services able to tackle the behavioural change. The introduction of the DwI tool had as a purpose to help researchers set the design brief, describe the target behaviours, and identify the most suitable design strategies to apply to tackle aware behaviours. The lenses selected by the author are the Cognitive, Perceptual, Machiavellian, Ludic, and Interactive lens was facultative. The Cognitive lens takes inputs from the behaviourist economy and cognitive psychology. The Perceptual is combining the concepts of gestalt psychology and products semantics. The Machiavellian proposes solutions based on the thought that "end justifies the means," and it tackles the ethical questions regarding how the artefacts influence human behaviour. The Ludic proposes the strategies that can engage the user long in time, while the Interactive lens uses interaction modalities and interfaces to stimulate the user's behaviour. The interaction lens offers the principles from HCI and Persuasive Technologies (referring to BJ Fogg)like kinds of feedback, progress bars, and previews, and some currently less-used such as feedforward, changing attitudes, and so changing behaviour through contextual information, advice, and guidance where kairos, tailoring,

and tunneling.

The author suggests the following way to analyse *behavioural concern*, using the Dwl tool:

- **Identifying the behavioural concern related to the topic of analysis;**
- **Identifying the lenses and patterns suitable to apply in our design to influence aware behaviours in regard (change those identified as unfavorable from the analysis);**
- **List down the target behaviours on which we want to focus.**

The brief is the output of the topic analysis and behavioural analysis and represents the zone of “possible” - it tries to link the present to the future. Using the previously developed brief, we are entering the “What if?” zone, which leads us to the “preferable future” and the final output – the near-future scenario. Here the “possible” is revised through the lens of the future, using the Sci-Fi genre to inspire the technologies and technological artefact, analyse how these are shaped by the social, historical, and political context in which they exist. In this envisioning phase, the suggested tool to use is Tech Inspiration Cards (TICs) developed by the author. In this experimentation, the participants were asked to select several films and diegetic prototypes that they found relevant for their analysis, critically discuss the possible ethical implications, and try to inform their artefact. The approach suggests using Fogg’s Functional Triad (FT) at this stage to help define the role of technology as a persuasive tool. This scheme helps to describe the role of persuasive technology on three levels:

- **Technology as a medium provides the experience;**
- **Technology as a tool that can increase capability;**
- **Technology as a social actor creates relationships.**

This stage had the purpose of helping the participants define and describe the technology to tackle aware behaviours, understand how to appropriate the previously selected strategies, and embody them into the materiality of the artefact.

The next and the last stage is writing the scenario based on the entire analysis from the present and plausible states, through the possible, and finally to the plausible futures. The scenario should narrate the story about the world in 2045 (accordingly to the EU commission goals about the carbon-free future), starting from the Societal Challenges topic. The scenario should contain the background story about how human behaviour is related to the specific societal issue, and describe the not-yet-existing technology and the near-future technological artefact embedding this technology, showing/describing how it helps the user to adopt and maintain the more aware behaviours (such as the waste management, air pollution, etc.). At this stage, the Protocol did not suggest any guidelines; the only requirement was

that there should be one part dedicated to the written narration, but also using sketches, illustrations, analogies, images, and other material and techniques that describe the narrated world and artefact are welcome. Fig.21 illustrates the methodology behind the first experimentation. This experimentation had the purpose of letting the author understand whether the theoretical approach and the way the approach is operationalised into a linear Protocol with tools can trigger critical thinking when designing technological artefacts that tackle aware behaviours and, as a consequence, let the design researchers and practitioners design more consciously.

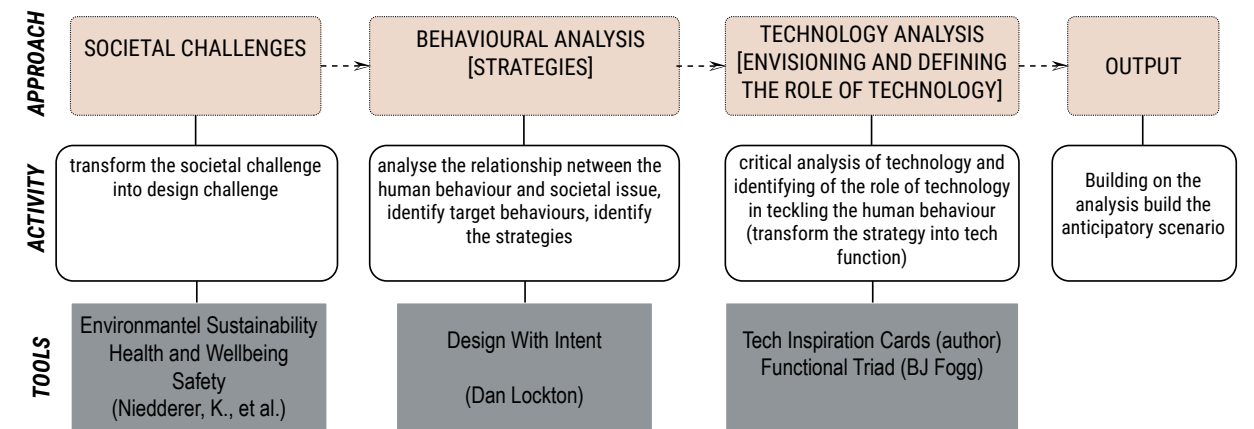


Figure 21: First experimentation methodology

The author uses several evaluation methods to evaluate the Protocol, tools, and activity. First, participants’ inquiry considers observation of the participants while using the Protocol with tools and the loud discussion about it.

The second evaluation method was the questionnaire to evaluate the approach, linear Protocol and all its stages and tools, with the focus on evaluating how efficient they were in triggering the critical thinking and whether the creation of the scenario as an intangible form of design fiction can be a valuable way to design more consciously technological artefacts to tackle aware behaviours. The participants needed to evaluate each tool in how these tools helped them open a critical discussion and adopt pluriversal perspectives. Besides, it was essential to understand whether all the parts and tools were comprehensive and logical to enable the transition from the present state toward the preferable futures and whether we could use this preferable future to inform the present designs. The participants also needed to explain whether the scenarios generated through such an approach are consistent enough to inform the design of technological artefacts in the present – how the generated output can lead to more conscious designs.

The third evaluation method was analysing the output - how the participants used the tools at different stages and how this influenced the final scenario. This part of the analysis was compared to the questionnaires to confirm and observe the criticalities behind Protocol v.1.

Here and after, the author introduces the results gained from the first experimentation and observes the limitations of the approach with Protocol and tools and the activity itself critically.

### 4.4.3. Results and limitations of the experimentation

The first experimentations where the author tested the approach and linear Protocol with tools provided useful insights for the research to find out if and how the tools we selected for the design of near-future scenario were effective or not in trigger critical thinking and if it offers a way to design consciously technological artefacts. The observation results, activity outputs, and questionnaires showed that the overall approach and the Protocol with tools needed some improvement. The approach, Protocol and tools, and the activity were evaluated through three stages:

Participants' inquiry (open discussion);  
 Analysis of the delivered scenarios and the influence of the tools' use;  
 Questionnaire.

Before describing the results and the output participants produced during the experimentation, the author will list several parameters to explain how critical thinking was evaluated. The critical thinking in the case of this research is multi-layered.

Firstly, it concerns the capacity to analyse detailed information given from the topic concerning the Societal Challenges and translate it into a design challenge. Second, the participant relates and analyses human behaviour in relation to the Societal Challenge, considering the implications of human behaviour, identifying how this may change, and understanding why it is not changing (barriers that prevent the human from aware behaviours). Another level is the analysis of technologies, where the author observes the capacity to anticipate and analyse the possible implications of technologies and how the technologies can ethically embody the behavioural strategies. The last level is the scenario – how consistent the scenario builds upon the elements from the Protocol – articulation of the Societal Challenge, human behaviour, and technology considering the possible ethical and societal issues.

It was evident that the participants got very engaged while using the linear Protocol. All groups were capable of using most of the tools. At the initial stages of the activity, the participants were entirely independent in doing the analysis and using the tools. There were observed some difficulties in the second part of the session concerning envisioning technologies and scenario building.

When it comes to the use of Tech Inspiration Cards (TICs), the participants who are more engaged with design fiction or more passionate about Sci-Fi showed fewer doubts in regard. In contrast, the participants who were less familiar with this genre had some difficulties because they needed more time to explore the plots. This influenced quite a lot how they approached the process because they tended to select only those titles that they were familiar with, and in this way, it was difficult for the author to understand how much this tool contributed to critically analyzing the technologies.

Regarding this difficulty, one of the groups tried to invert the order of the Protocol's stages where they firstly defined the technology and the role of technology (Functional Triad) and then used the TICs for envisioning. However, they claimed it was even more blundering and not efficient in letting them analyse the ethical implications of technologies.

About the scenarios delivered by the participants, we can observe that the participants produced very different scenarios by using mainly the textual form, while some of them also used sketches and user journeys. Below, the author briefly describes the activities of each group.

Group 1 started from cyber safety, focusing on digital assistants, control, and management of personal data. They identified a lack of awareness when dealing with these devices due to the poor comprehension of data. The results of the use of the Design with Intent tool and selection of the strategies are shown in Table 2:

**Table 2: Group 1 selection and application of Dwl strategies**

| Dwl Lens      | Dwl Pattern                                    | Target behaviour                                                                                                                                                                                                                                                                       |
|---------------|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Interactive   | Tailoring, and Summary Feedback                | (1) Inform the user about the relationships, activities and functions of the digital assistant, (2) Monitoring of the collected data, (3) Acting pro-actively toward the data collection, (4) Communicating with the assistant in a uncomfortable, intentional and unconventional way. |
| Perceptual    | Metaphors, Possibility trees, and Transparency |                                                                                                                                                                                                                                                                                        |
| Ludic lens    | Unpredictable reinforcement                    |                                                                                                                                                                                                                                                                                        |
| Machiavellian | Degrading performance                          |                                                                                                                                                                                                                                                                                        |

Their brief suggests the solutions to increase the awareness related to the use and expectations we have from digital assistants, where the concept of “tailoring metaphors” for data storage, and transparency concerning user - assistant. They found the technology inspiration in the films and episodes such as “Her,” “The Entire History of You,” and “Nodesive.” These titles have in common the topic of Artificial Intelligence (AI), so the participants started to build the scenario from here. The scenario narrates the assistant as a digital organism that expands on users' needs. In the year 2045, data will become recognized as the property of the user, and he will be able to decide when and how much data to provide through different “metaphoric profiles” (i.e., relatives profile, secretary profile, partner profile), where each of these can be manipulated through different interaction modalities. According to the functional triad, technology becomes a tool able to

increase the user's capability by improving the comprehension toward the use of the device and management of personal data, and the social actor because it improves the communication between the user and the device. As a result of the activity, Group 1 delivers the scenario where they describe a world in which are established new laws regarding the use and management of data. In this scenario, they do not indicate how the user adopts aware behaviours; they suggest new interaction modalities without actually describing them – the ideation of the technological artefact was too abstract. The impression is that SCI-FI content did not help them much in envisioning the not-yet-existing technologies. Fig. 22 shows how they used the Protocol at different stages in the experimentations.

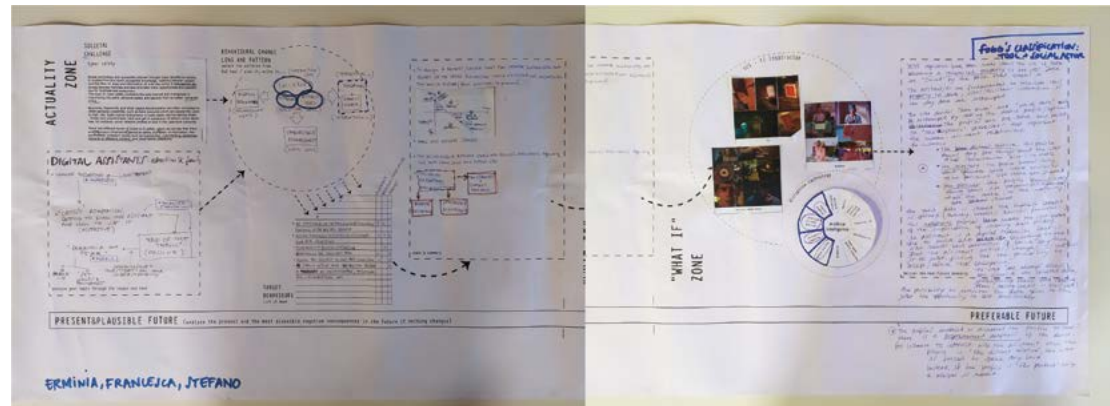


Figure 22: Use of the protocol Group 1

Group 2 selected the topic of health prevention related to eating habits and food quality. They relate lousy eating habits to bad lifestyle quality. The strategies and target behaviours defined through the Design with Intent tool are represented in Table 3.

Table 3: Group 2 selection and application of Dwl strategies

| Dwl Lens      | Dwl Pattern                                         | Target behaviour                                                                                                                                    |
|---------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Cognitive     | Habits, Emotional engagement, Personality, Scarcity | Eat earlier, Balance diet, Change the way of cooking, Foresting sociality, dimension of eating, cooking and sharing; Create good eating conditions. |
| Perceptual    | Fake affordance, Mood, Nakedness                    |                                                                                                                                                     |
| Machiavellian | Worry resolution, Serving suggestion                |                                                                                                                                                     |

Their brief proposes a product able to prevent the users from eating late in the evening and change their attitude toward healthy food through enriching the social dimension and suggesting new cooking techniques. The technology inspiration they find in films "Little Joe" that shows the not-yet-existing olfactory stimulation technology, "Strange days," "Arkangel,"

and "Black Museum" that treat the topic of behaviour control and surveillance, "Her," "Hang the DJ" that show AI through Operative System (OS) -human relationship and personalization, and "Gattaca" where we can find the ideas on bioengineering technologies. They selected three technologies to apply as persuasive tools: AI, Smart Materials, and Wearables.

The character of their scenario is a man, too tired to cook in the evenings. In the fridge, he finds two alternatives: an already prepared sandwich and a healthy fresh salmon to cook. The moment he tries to reach it, the sandwich gets spoiled. At the same time, the salmon package starts to glow to remind John to cook and eat healthily. The scenario described some innovative cooking tools that activate chemically and change the food properties; an automatic cooking machine and wearable able to track the health and user's needs. Accordingly, to the functional triad, here the technology is a medium because it provides the experience able to influence the positive attitude toward healthy food; they want to suggest a new technique for cooking, so the technology has a role of a tool, and the technology as a social actor when it wants to enrich the social dimension. They lack an explanation of how human behaviour changes.

Additionally, they missed the detailed description of context and why the user should change his attitude toward the food in the near- future. They make a wide selection of film inspirations, but it is challenging to identify what they inspired and whether the Sci-Fi tech cards helped them. Fig. 23 shows how they used the Protocol at different stages in the experimentations.

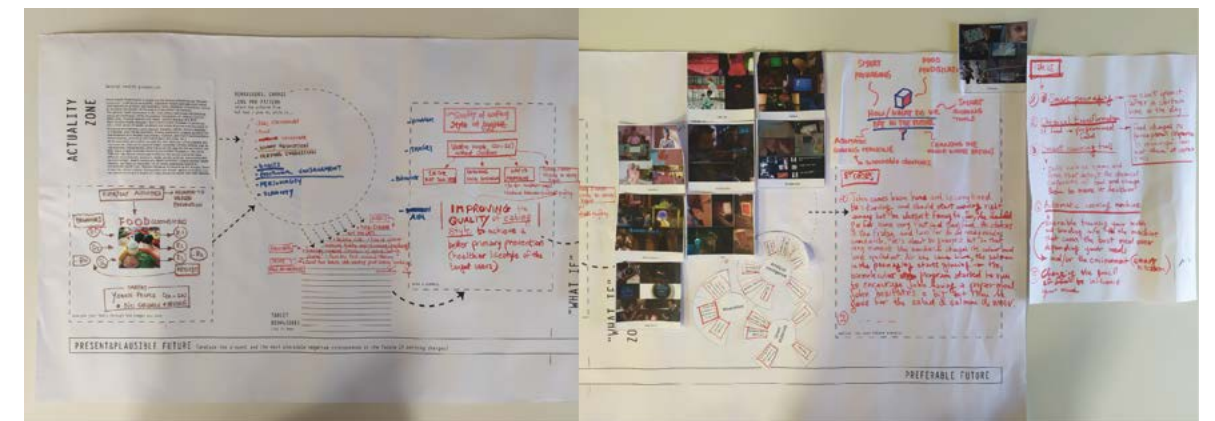


Figure 23: Use of the protocol Group 2

Group 3 started with the topic of Air pollution. They identified negative behaviour emerging on two levels. The first level concerns the industries, waste management, and transportation. The second level considers an individual's behaviour when using chemicals at home. In the table below, we can see how they used the Design with Intent tool:

**Table 4: Group 3 selection and application of Dwl strategies**

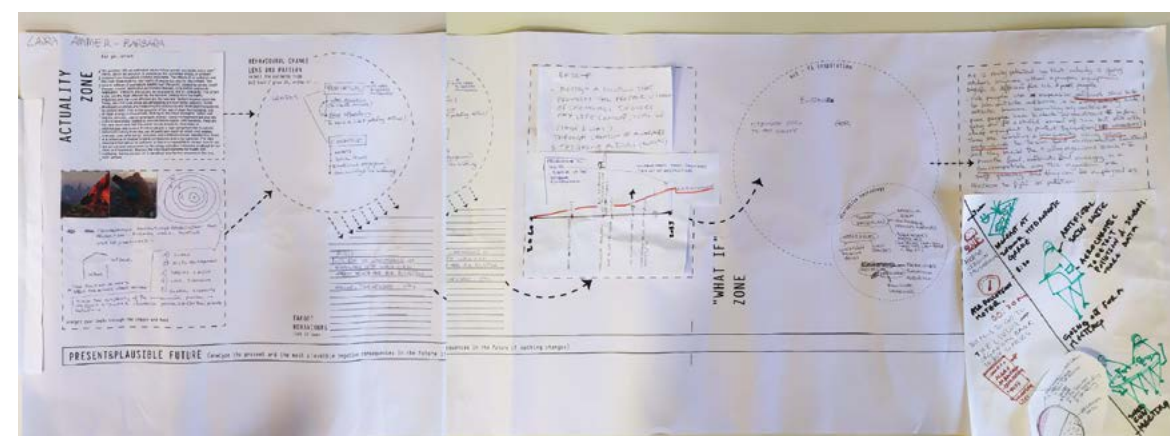
| Dwl Lens   | Dwl Pattern                                                             | Target behaviour                                                             |
|------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Cognitive  | Habits, Social proofs, Emotional engagements, Community and Consistency | Avoid misuse of chemicals in everyday life that harm health and pollute air. |
| Perceptual | Colour association, Fake affordance                                     |                                                                              |

Their brief suggests a solution to persuade people to use chemicals properly in everyday life. This group was more skilled in the use of design fiction principles, so they proposed the films not mentioned in our library, where: “Existenz” speaking about the simulated reality but also organic technologies and materials, and “Hitchhiker guide to the galaxy” offers a wide scale of materials and flexible technologies. Also, they take as a reference for the AI “Her.” They selected the smart materials, AI, and wearables to use in their scenario.

Their scenario is about a polluted world where people need to wear protective equipment continuously. The rich wear artificial skin suits while the poor wear the DIY (Do It Yourself) equipment, made of living organisms stored in living organisms’ banks. Before going out, it is necessary to measure pollution. They wear the organic head accessorize that indicates the level of pollutants through the change of color, a helmet for data collection, and a protective mask. Besides protecting, this equipment purifies the air. Here, the technology is a medium because it has to provide the experience able to increase awareness toward the use of chemicals, and the technology becomes a tool because it is supposed to enhance the human capability of surviving in a polluted world.

The scenario of Group 3 was the one that moved more toward the near future compared to others, and that succeeded in creating the story through analysing the context and socio-political implications. It is essential to mention that this group was more familiar with Design Fiction, Speculative Design, and Sci-fi. The consistency of the scenario in terms of how they elaborated and translated the initial topic (issues), how they defined the human impact and engagement of the people in change processes toward more sustainable futures, and finally, the ideation of the artefact was more advanced concerning the other two groups – better consistency, the building of relationships between the issue-behaviour-technology, taking in consideration the possible implications. They explain well the adaption of humans to new climatic conditions and new habits and behaviours through the artefact. The solutions they propose are envisioning, and the inspiration taken from the films is evident. Fig. 24 shows how they used the Protocol at different stages in the experimentations.

The last evaluation method used in this experimentation is the questionnaire, based on open questions and the qualitative evaluation of the experience, transformed into qualitative data. The questionnaire was divided into two main sections: (1) General information and (2) Activity.



**Figure 24: Use of the protocol Group 3**

From the General section information, it was possible to collect some data regarding the participants’ previous experience with the topics and comprehension of the relation between Societal challenges, Design for behavioural change, and Design fiction. The first thing to stress is that all the participants acknowledged the importance of providing an approach that can help design more consciously (adopting critical thinking) when designing for human behaviour and technologies.

When it comes to using specific tools, less than half of participants have already used the design for behavioural change tools and strategies (50% have heard about it, 30% used some of the tools, 20% have never heard either used either the tools). The Design with Intent tool was the one that most of the participants were familiar with.

Additionally, the author was interested in understanding whether the participants understood the relationship between different topics/stages tackled in this workshop (societal challenges – behavioural change – technologies). The results of the questionnaire show that the participants found quite well the relationship between the different elements (55,6% evaluated this parameter with 4 on the scale of 0-not at all, 5 – very much). However, during the conversation, some of the participants suggested thinking about inverting some tools or introducing them in the beginning, such as Tech Inspiration Cards.

The participants generally think this activity triggered critical thinking regarding human behavior and the role of technologies (89% agreed that the stage dedicated to the behavioural concern was the one where critical thinking was triggered the most).

When it comes to evaluating the last stage, they believe that writing the near future scenarios might help design researchers and practitioners design more consciously. Although they experienced some frustration while producing it, some more guidelines were needed on how to do it and what was expected from the scenario.

Participants state that the critical thinking regarding the selection of behavioural concerns and

possible design interventions was triggered and supported by the Design with Intent tool. In contrast, the critical thinking related to the use of technologies was less triggered during the use of Tech Inspiration Cards. Societal Challenges as a starting topic resulted in not so motivating for participants.

The perception about navigating through different levels of the future was not highly perceived, which is evident also from the scenarios they delivered. From the questionnaire emerged that in this experimentation, the critical thinking was more triggered for the behavioural issues than for the technologies in the Protocol v.1. This stage stimulated the reflective discussions among the participants, pushing them to investigate human behaviour through possible implications barriers, define the desired behaviours, and others.

Summarizing all the findings, we can observe that the linear-like Protocol was found as too flat in a sense that did not help the participants focus on the future and use the future space for critical inquiry. Besides, at some stages, such as initial topic analysis and subsequently behavioural concern analysis, the participants needed more guidelines on how to conduct the tasks and apply the tools. Another notion was that Tech Inspiration Cards was introduced too late in the process and that it would have been better if they were given at the beginning to open up the discussion and reflection.

- Burnam-Fink, M. (2015). Creating narrative scenarios: Science fiction prototyping at Emerge. *Futures*, 70, 48–55. <https://doi.org/10.1016/j.futures.2014.12.005>
- Dunne, A., and Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press.
- Fogg, B.J. (2003). *Persuasive Technology: Using Computers to change what we think and do*. Morgan Kaufmann Publishers
- Hall, A. (2011). Experimental design: Design experimentation. *Design Issues*, 27(2), 17–26. [https://doi.org/10.1162/DESI\\_a\\_00074-Hall](https://doi.org/10.1162/DESI_a_00074-Hall)
- Kirby, D. (2010). The future is now: Diegetic prototypes and the role of popular films in generating real-world technological development. *Social Studies of Science*, 40(1), 41–70. <https://doi.org/10.1177/0306312709338325>
- Lockton, D., Harrison, D., Neville, A.S. (2010). The Design with Intent Method: A design tool for influencing user behaviour. *Applied Ergonomics*, vol.41(3), pp. 382–392. [http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx\\_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&atitle=The+Desi](http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&atitle=The+Desi)
- Loughborough University Institutional Repository. (2017). *Creating sustainable innovation through design for behaviour change: summary report (Vol. 91)*. (To check the reference go: )
- Niedderer, K., et al. (2016). Design for Behaviour Change as a Driver for Sustainable Innovation : Challenges and Opportunities for Implementation in the Private and Public Sectors. In *International Journal of Design*, vol.10(September), pp. 67–85. <http://www.ijdesign.org/ojs/index.php/IJDesign/article/viewFile/2260/733>
- Shedroff, N., Noessel, C. (2012). *Make it so*. Rosenfeld media.
- Tanenbaum, J. (2014). Design fictional interactions. *Interactions*, 21(5), 22–23. <https://doi.org/10.1145/2648414>

# 5

## AN OVERVIEW OF THE SEMI-FINAL PROTOCOL

The results of the first experimentation showed that there was a need to revise the way the theoretical approach was systematized into a linear protocol. Besides, there was a need to improve Tech Inspiration Cards (TICs) since the participants of the first experimentation claimed some issues. The main issues were regarding the card's content that was evaluated as poor because it gives too little information to the person, especially if the person using the cards did not see the film in question. The relation between the technology and images representing the diegetic prototypes in films was not clear, too (only those participants who were familiar with the films could make the relationship).

The protocol was almost wholly revised in its structure, while the tools evaluated as valid for triggering critical thinking on different levels were maintained. The main change in the protocol is that it is not inspiring anymore on the PPPP model since it was not found particularly useful, the added value of making the transition from present to the future was not recognized. The linearity of the first protocol was quite limiting, the participants were moving forward without connecting different parts of the analysis, and in the end, it was difficult for them to realize the value of the future scenario in designing for the present issue/challenge.

Here and after, the author shows how the protocol changed in its form and structure due to the revision of the theoretical background. The Tech Inspiration Cards were improved mainly in the content of technologies. Now it gives a complete image of the application of the technology in a film.

The following text describes the development of the second provisional protocol, the first refinement of TICs, and the semifinal version of the protocol.



## 5.1. Revising the theoretical foundations: Protocol v.2

According to the results of the first experimentation, there was a need to revise the linear Protocol for designing technological artefacts for aware behaviours, mainly in its structure that was initially inspiring on the PPPP model. Then, the order in which the tasks and tools were organised inside the Protocol needed to be revised. Beyond these insights from the first experimentation, the author noticed some more issues and expanded the theoretical foundations. Hence, the author introduced several other concepts that play a crucial role in designing technological artifacts and societal questions.

Another weakness of the linear Protocol is that a system of relations was missing between different elements and actors involved in change processes. There was missing a holistic image of how each part within the Protocol is related to another, which made the Protocol a bit disconnected and weak. The author decides to introduce the concept of Social Agency into the Protocol. The social agency is about analysing the human, collective and individual actions, impacts and influences, moral judgments, and conflicts that prevent us act in one way or another. This concept enables the understanding of an entire system of relations between the human (behaviour), society, and technology and to observe the issues from all angles.

Artefacts are the mediators between humans and the environment and directly and indirectly influence society. Technological artefacts, as material objects designed by humans, impact the environment (directly) and shape human actions, and in this way, the impact results from human behaviour (indirectly). The author relates the societal challenges (i.e., environmental sustainability, health and wellbeing, the safety of citizens), agency (defining the social dimension through context and actors), and the role of technology in being persuasive tools (Functional Triad) in building the provisional protocol n.2. The provisional protocol 2 is in Fig.24.

The provisional Protocol v.2 is a circular approach and suggests using the future as a space for critical inquiry. The reason behind providing the circular approach is to emphasize the relationship between different stages stress the feedback loop between the present and future (the Protocol starts from the present issues and explores the future until the circle is

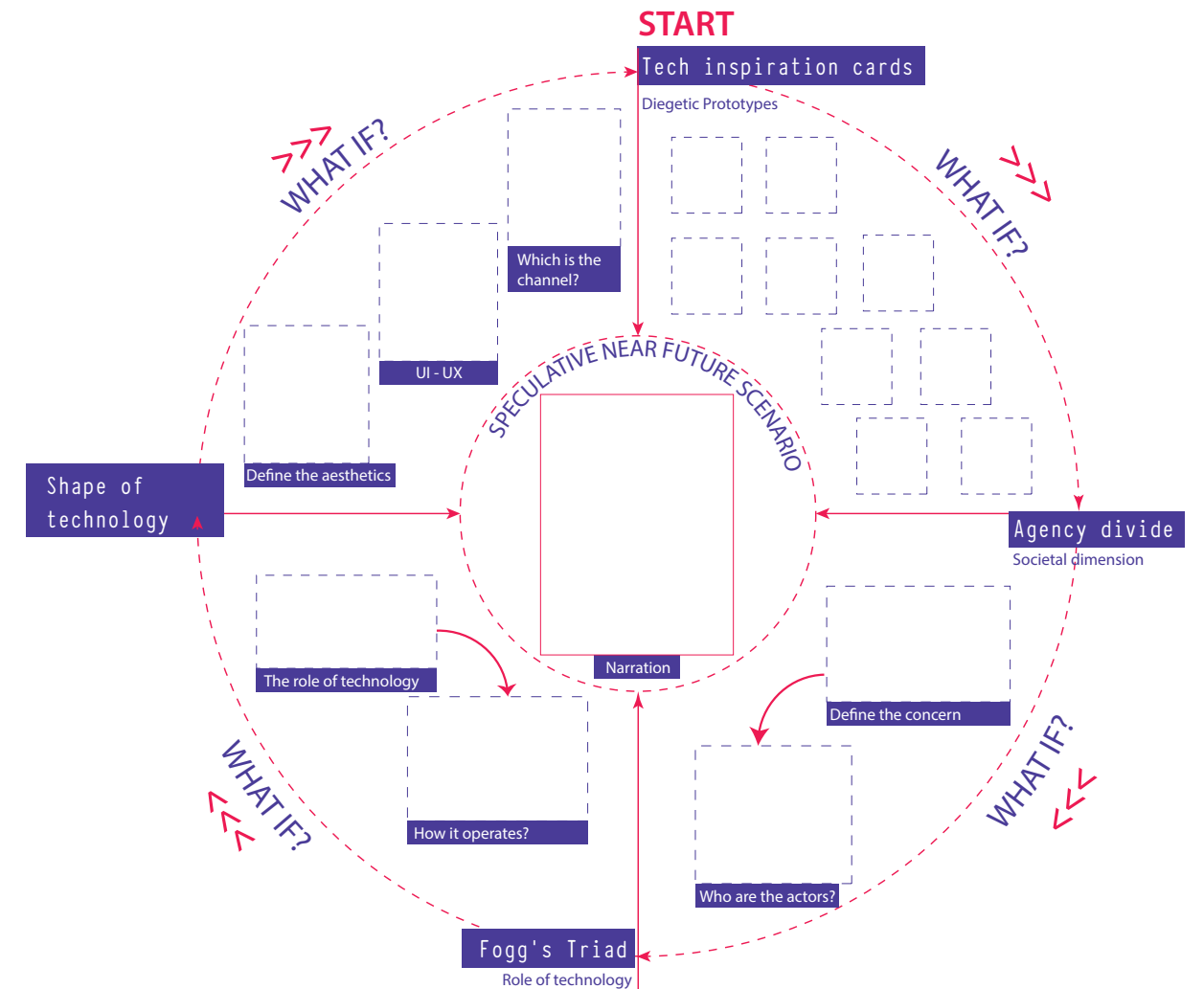


Figure 25: Provisional protocol v.2

closed). The Protocol's output is in the middle Speculative Near-Future Scenario, and it is built from all the elements contained in the analysis done through the Protocol. The scenario closes the cycle. The scenario can be a starting point for designing acting in the present. The overall approach - analysis through the Protocol and the output in the form of scenario – gives the instruments to design researchers and practitioners to design more consciously technological artefacts, adopting critical thinking.

The author describes the provisional Protocol v.2 and tasks related to each stage. The first stage of Protocol v.2 is about analysing the Societal Challenges through Sci-Fi. The decision about this was taken after the first experimentation was revised. The participants claimed that the Tech Inspiration Cards came too late in the process, while it would be better to introduce them in the

beginning, to open the critical discussion among the participants. The second stage of Protocol v.2 is the Agency divide that is the societal dimension of the issue/task in question, and it suggests defining the concern (individual, social, middle ground) of the problem that one needs to solve (for instance: dealing with the waste management as an individual concern). The second task within stage 2 of Protocol v.2 is defining the actants (actors) involved in change processes. The second stage is about scaling the issue, defining the level on which design researchers and practitioners want to operate. To support this stage, the author suggests using the Design with Intent to start to identify the possible strategies to apply to influence the user adopting aware behaviours.

The third stage is about defining technology's role as a persuasive tool – translating the strategies into technologies. At this stage, one is supposed to identify the specific role of technology starting from the Functional Triad (technology as a social actor, medium, or tool). This considers finding the most appropriate and ethical way to delegate to the technology the role of the persuasive tool. The second task within this stage is describing how this technology could operate. For instance, let us imagine that the objective is to support the user in adopting more aware behaviours toward waste management, and we say that the best way in our specific case is to assign to the technology the role of Tool (technology increases the capability of the user and in this way, it acts as a persuasive tool). The technology as a Tool supports the user by measuring and providing objective data that can motivate, lead the user through the process, and make the task easier. Defining how this technology could operate is about imagining what our system needs to measure (e.g., sensors), how it could lead the user through the process (i.e., feedback through an app), how it could make the activity easier to do (i.e., providing to the user a device to support the user in sorting the waste).

Stage four is about the shaping of technology. The author means by this to embody the technology and imagine how the interaction occurs – experiences and interaction channels. This part is about defining how the technology mediates between the person and the environment.

## 5.2. Evolution of envisioning tool (TICs)

In parallel with the evolution of the provisional Protocol v.2, the author revises and improves the Tech Inspiration Cards (TICs). During the first experimentation, the participants claimed that the TICs were not evocative enough and limiting for the bond between the diegetic prototypes present in films and the technologies card suggests concerning the film. They suggested that showing the trailer where the diegetic prototypes are contextualized and used by the actors would have been more helpful and comprehensive. Besides, the relationship between the technologies and props was needed to make more evident.

Building on this, the TICs were revised and refined. This second version offers a broader analysis of technologies and access to the video content beyond the images. The card suggests the leading technologies present in the film, or those that are remarkably recognizable, and the second level of exploration is all the other technologies present in the film or combined with the main one.

Beyond, it specifies how the technology is applied and what purpose (i.e., Wearable technology – gloves – leap motion). The cards do not contain all the information regarding technology in a single film, but it suggests how the technologies can be explored. The following figure (Fig.26 - next page) shows the second version of the card delivered in April 2020.

The method behind the card creation did not change itself. The author used the same data collected during the creation of the first version. It deepened a bit more and researched video content that explicitly shows the diegetic prototypes and integrates more content on the card itself.

**TECHNOLOGY**  
\_tech of reference  
\_other technologies  
present in this plot

Film : "Prometheus"  
Ridley Scott (2012)

AI  
+  
Simulated Reality  
Wearables

**PLOT**

Plot:  
In 2089, archaeologists Elizabeth and Charlie discover a star map in Scotland that watches others from several disconnected ancient cultures. They interpret this as an invitation from humanity's forefathers, the "Engineers." Peter Weyland, the elderly CEO of Weyland Corporation, funds an expedition, aboard the scientific vessel Prometheus, to follow the map to the distant moon LV-223. The ship's crew travels in stasis while the android David monitors their voyage. The Prometheus lands on the barren, mountainous surface near a large, artificial structure, which a team explores. Inside, they find stone cylinders, a monolithic statue of a humanoid head, and the decapitated corpse of a large alien, thought to be an Engineer....  
The film deals with humanity's relationship with the gods-their creators-and the consequence of defying them. A human expedition find superior beings who appear god-like in comparison to humanity, and the Prometheus crew suffer consequences for their pursuit.

**VIDEO TO WATCH**

Selection of video online >>>

Figure 26: Refinement of the TICs

## 5.3. Second experimentation

Once the author generated the second version of the Protocol and refined Tech Inspiration Cards (TICs), it was time to test it. The second experimentation took place on 15th April 2020 at the School of Design of Politecnico di Milano within the Interaction Design MSc course called Envisioning AI through Design.

The provisional protocol v.2 and TICs were tested within the one-day educational activity engaging n.40 students. The students were developing the projects within Public Administration and Health topics, using Artificial Intelligence (AI) embedded in products and services for the citizens. It was a good opportunity to test the Protocol because the topics of this lab were highly concerned with Societal Challenges, human behaviour, and emerging technologies. The students needed to use the Protocol to generate the scenarios that can make them reflect critically on their briefs and deliver more conscious designs considering the possible implications of Artificial Intelligence.

This experimentation aimed to test the provisional Protocol v.2 and understand whether such an approach can trigger critical thinking regarding the design of technological artefacts able to tackle aware behaviours. Secondly, this was an occasion to test whether the second version of TICs is better than the first one in stimulating the critical discussion upon the technologies and Societal Challenges.

Considering the weaknesses identified during the first experimentation, the author revises the activity itself a bit. During the first experimentation, the participants claimed the time, especially when analysing Sci-Fi (TICs). The author gives the time to the participants to prepare, watch some titles at home, and analyse them in the group before the activity.

Another strength of the second experimentation is that the students were supposed to apply the Protocol and Envisioning tool in actual activity so that the author could observe the activity itself and how the scenarios were subsequently used to revise briefs and inform concept generation.

This experimentation was also useful to identify whether the Protocol and Envisioning tool can be applied in educational activities beyond applying its design and research projects.

Here and after, the author describes the experimentation's activity and output.

### 5.3.1. Activity

This activity (second experimentation) had the purpose of helping students envision the near-future technological artefacts, products, and services embedding Artificial Intelligence (AI) technology through the protocol with tools and delivering anticipatory scenarios. The activity's objective was to deliver the anticipatory scenario that they would use to critically discuss their course's topic and try to understand how to pass from the speculative (future) to the feasible (present) dimension. Before going deeper into the activity description, the author introduces the students' starting point.

The students of this course had a task to design products and services embedding AI on the topics related to Public Administration and Health. When the experimentation was organized, the students had already selected topics for their projects within these two macro-topics. Besides, they have already had design briefs. The topics within these two macro-topics were various: waste management, public transport solutions, anorexia nervosa, Alzheimer's patients and caregivers, chronic kidney disease management, and several others.

The use of the design fiction principles, in this case, scenarios, had the purpose of helping the envisioning phase before developing design concepts for products and services.

Unlike the first experimentation, the students had one week to prepare for a session. The author lists the activities that preceded the second experimentation.

- 1| **Firstly, the students were given a lecture about design fiction and speculative design to get to know this practice (one week before the experimentation);**
- 2| **The author provided a list of films (already present in Tech Inspiration Cards) with a plot and access to the trailers;**
- 3| **The students had to extract three keywords from their design briefs and select one film per person to watch before the session. The students watched 4-5 films per group, selecting the film from the keywords.**
- 4| **The students were asked to discuss the future imaginaries derived from Sci-Fi films they watched within a group before the session.**

Besides, they had all the material on disposition to consult and inform about the protocol and tools. Beyond the titles they focused on for the group discussion, they could also consult the TICs before the session.

The students were divided into groups, and the session lasted half day. The activity was conducted in an online modality (due to the COVID-19 emergency), and for this reason, the students used a collaborative online board Miro which contained the protocol with tools.

The activity was divided into stages, around 30 minutes each (totally 120 minutes), and at the end of the activities, students presented their scenarios. They had some more time to discuss how they could transform future speculative scenarios into feasible products and services for Public Administration and Health and how this critical reflection could be integrated into their design briefs.

### 5.3.2. Methodology and evaluation method

Here the author focuses on the description of the methodology of the provisional Protocol v.2. This Protocol version is founded on n. 4 stages of exploration and is a circular, iterative-like process. The author reintroduces the feedback loop concept between the present and the future. The participants found the provisional Protocol v.1 a flat process where the connection between the future and the present was confusing. Protocol v.1 led the participants linearly from the present issue to the preferable future. The iteration between the present and future blurred the process and made these two entities far from each other, which is not the objective of the approach proposed by the author. The author suggests helping the design researchers and practitioners design more consciously, exploiting the future-oriented scenarios to reflect critically in the present and deliver the conscious design of technological artefacts. There is no future without the present, so the circular Protocol v.2 wants to emphasize this feedback loop, believed by the author as the enabler of conscious design.

The stages and tasks within the provisional Protocol v. 2 are organised in the following way:

- **Analyse the challenge with the support of Tech Inspiration Cards;**
- **Define the agency and behavioural concern (define the agency divide and actors, support of Design with Intent tool to identify the strategies);**
- **Identify the role of technology (define the role of technology using Functional Triad, identify how the technology operates);**
- **Identify the shape of technology (translate the role of technology into the aesthetics/formal aspects, interaction modalities, and interaction channels).**

The first stage of the Protocol suggests the analysis of the Societal Challenges (SCs) using Tech Inspiration Cards (TICs). During the first experimentation, the TICs were introduced too late in the

process, and the participants claimed that it would have been better to introduce them at the beginning of the process. Here the author suggests using TICs at the first stage to open up a critical discussion starting from the diegetic prototypes. The analysis suggests selecting the films (cards) that are the most pertinent to the topic of interest (i.e., air pollution) and discussing the collective imaginaries represented in the Sci-Fi genre about this issue.

What is meant by this is to critically analyse the perceptions, fears, and disbeliefs about the future, how the technologies and technological and scientific innovation integrate into these processes, and the most common ethical and societal implications that can be recognised. The agency divide is the next step once the topic of interest is analysed and revised through this lens. This stage is dedicated to the analysis of the societal dimension by defining all the parties interested in the issue, including collective (society) and individual (personal) concern, and the middle ground dimension dedicated to the other non-human factors like product and services (i.e., energy crisis due to the lack of natural sources, others). It requires the definition of all the actors involved in the processes (i.e., big corporations, citizens, others) and how they could influence the change. At this stage, the author suggests using the Design with Intent (Dwl) tool, which can support the analysis in the sense of defining the opportunities for the design of products and services. The third stage is for analysing the role of technology as a persuasive tool to help the people participate actively in the change processes. The author suggests the Functional Triad (FT) use as a guideline. Once the role of technology is defined, this stage requires describing how the system will operate to fulfill its role and help the actors involved make the change. This is the first step toward the description of the technological artefact.

Starting from describing how the technological artefact should operate, the last part of the Protocol is dedicated to shaping the technology or better embodying the technology. The author suggests the analysis to define the aesthetics, interaction rituals, and interaction channels to define the technological artefact.

The Protocol's output is an anticipatory scenario that includes or, better, narrates all the elements analysed through the Protocol and describes the technological artefact's existence within this context. The author takes a moment here to observe the role of the scenario and how this scenario can be "used" in such a Protocol. Just as in the first version, also here, the scenario has the same role. The scenario is an intangible fictional artefact, and it is the output of the critical activity. It can be "used" as a starting point for designing or deepening the design inquiry. It can be materialised (diegetic prototypes) to study and investigate the future to design better in the present. The idea of the circular Protocol is that it can become an iterative process that we can use repetitively, as many times as we need. It can be used just for brainstorming and revising the existing design briefs, for creating design briefs, deepening the research, or others (some cases will be introduced later in the text).

The behavioural concern was not explicitly present in this version of the Protocol. The author noticed that there is no need to make the behavioural concern explicit but rather transversally present in the process. The human factor is necessarily present in any SCs. The

agency necessarily considers the human factor, and at the third stage, observes the behavioural strategies through the lens of technologies. In this chapter (5.3.3.), the author shows whether Protocol v.2 is appropriate and efficient in triggering critical thinking based on the results from the workshop with students. Before describing the findings, the author wants to clarify what is intended with being 'efficient in triggering the critical thinking' and 'appropriate.' The author applies the parameters used in the first experimentation to understand how different stages and tools within the Protocol v.2 helped the participants adopt the critical thinking toward the topic in question.

Firstly, it concerns the capacity to analyse detailed information from the topic in question and concerning different facets of the issue. To remind, this concerns the analysis of Societal Challenges (in the case of the second experimentation, the focus is on Public Administration and Health topics) and how it is translated into a design challenge.

Second, the participant relates and analyses human behaviour concerning the Societal Challenge, considering the implications of human behaviour, identifying how this may change, and understanding why it is not changing (barriers that prevent the human from aware behaviours). Another level is the analysis of technologies, where the author observes the capacity to anticipate and analyse the possible implications of technologies and how the technologies can ethically embody the behavioural strategies.

The last level is the scenario – how consistent the scenario builds upon the elements from the Protocol – articulation of the Societal Challenge, human behaviour, and technology considering the possible ethical and societal issues. The participants are supposed to evaluate each stage and task, including tools based on their experience regarding how the specific task or tool stimulated the discussion and debate, exploration, and analysis. They needed to give an evaluation on scale from 0 (not at all) to 5 (very much), but also they needed to comment the stages and describe what was going on long the process.

The evaluation method author applied here was the semi-structured questionnaire and the analysis of the scenarios delivered by the students. In the end of the activity the students were asked to present their scenarios and give a reflection about how their brief could be revised using the scenario they created throughout the protocol. This was an important aspect, to understand whether the scenarios produced throughout the Protocol are consistent and critical enough to help in designing more consciously.

The questionnaire was structured in several sections.

The first section of the questionnaire is about the general information where the author investigates how the students prepared for the session, which films they selected for the analysis, which was their starting topic, and what it means for them to think critically when designing with/for technologies.

The second section was activity-related questions where the author wanted to understand the performance of each part of the Protocol, how efficient was the Protocol and tools to trigger criti-

cal thinking, whether the relationship between different stages was evident, and whether this kind of approach was recognized as useful for their projects (course).

### 5.3.3. Results and limitations of the experimentation

The results reported in the following texts are the outcome of the questionnaires and analysis of the scenarios produced by the participants.

The author starts by introducing the results from the questionnaires. The questions within the questionnaire followed the structure of Protocol v.2.

Most of the students stated that they were able to inspire on Tech Inspiration Cards (TICs) (97%), where 61% found it relatively easy while 31% had some difficulties initially, but they managed it—some of the students associated their difficulties with the film selection that it was perhaps too abstract. Someone felt a bit lost because the context of the film was too far future, and it was found difficult to transform elements of these scenarios in the real world. When it comes to critical thinking, most of them think that TICs helped them trigger the critical thinking quite well (on the scale from 0-not at all to 5-very much 60% rated from 3-5), yet it can be better. Not all topics were equally related to human behaviour or raising awareness behaviours in this session. Nevertheless, those that were tightly dealing with it stated that the TICs played an essential role in triggering the critical thinking in regard (50% rated with four on the scale 0-not at all to 5-very much), while for some of them, it was not clear how these collaborate, they could not find a relationship.

Most of the students confirmed that they understood how different stages within the Protocol are related and why they are relevant for the design of technological artefacts (around 73% agreed). When it comes to evaluating at which stage of the process, the participants noticed that the critical thinking was triggered the most, considering the technologies and human behaviour, the answer at the first place when defining the role of technology (stage 3), then while watching the film and defining the agency (stage 1 and 2) and the last shaping the technology and scenario.

When it comes to the overall evaluation of this Protocol in triggering critical thinking, most students believe it is efficient (on the scale 0-not at all to 5-very much 90% rated between 3 and 5). Almost 70% believe this activity was helpful for the objectives of their project (course). The rest, 30%, answered “so and so,” claiming in some cases the time as a limit, the fact that they found it too abstract, they could not relate the present issues to the future, and few others.

On the question “Do you think that the near future scenarios, as the one you produced in the workshop, may help you in being more critical in idea generation phase (on return from future to present state of idea generation),” - most participants believe that building future-oriented scenarios can help them think more critically about the present problems. Some of them claimed the difficulty in transition between the fictional and the real world. The small number of students who showed some doubts said that the main issue was that they did not know how to explore the user’s actual needs through the future, or that the approach was a bit abstract, so they would not know how to appropriate the technologies to address their brief. The author reports the quotes from the questionnaire in Fig. 27.



**Figure 27: Selected quotes answering on the question “Do you think that the near future scenarios, as the one you produced in the workshop, may help you in being more critical in idea generation phase (on return from future to present state of idea generation).”**

The students also left several suggestions. They would have preferred to be in presence because of the interaction, which they said would be more stimulating. They would like to have a TICs library even broader, with more titles. Moreover, one of the quite persistent remarks is the question of time. Many of them needed some more time for the analysis and scenarios. Still, the students' scenarios generally reflected all the elements of the analysis, and it was evident that the inspiration taken from the films and TICs influenced their critical thinking and the final output.

The overall impression is that with this Protocol, the final output is much more coherent with the analysis than in the scenarios delivered after the first experimentation. An example of one of the scenarios is in Fig. 28.

As we can see from the results, more refinement of the Protocol and TICs is needed. Indeed, different stages of the Protocol need to be better correlated, and here, the author also noticed that some parts need to be more investigated and detailed, provided more guidelines, and perhaps even explained or introduced the theoretical concept behind it. The first stage of the Protocol was too abstract. Using the TICs at this stage was helpful, but the problem was related to the present issue. To marry these concepts better is needed, add more references regarding future trends, objectives, and others.

Significantly, the question of the agency should be explored more, offer more guidelines, and stress the importance of this stage. Still, rethinking the Protocol as an iterative process is much better than linear. It is more dynamic and easier to generate the output (scenario).

Here the author will stress some more limits of the Protocol. For instance, the behavioural concern needs to be reintroduced more explicitly. For the students, it was unclear how to introduce it or identify the strategies. The last part was too focused on the functional aspects of the technological artefact and less on the interaction rituals, ethical dimension, even metaphysical, more poetic dimension. The author found that this part needed some more improvement since this Protocol wants to help researchers and practitioners design more consciously, implying intentionality through the designer's ability to anticipate the actions and define the responsibilities to assign to the artefact and the end-user. Moreover, this dimension completely missed the second version of the provisional Protocol.

In part 5.4. of this chapter, the author describes how she improved the Protocol regarding the results achieved from the second experimentation.

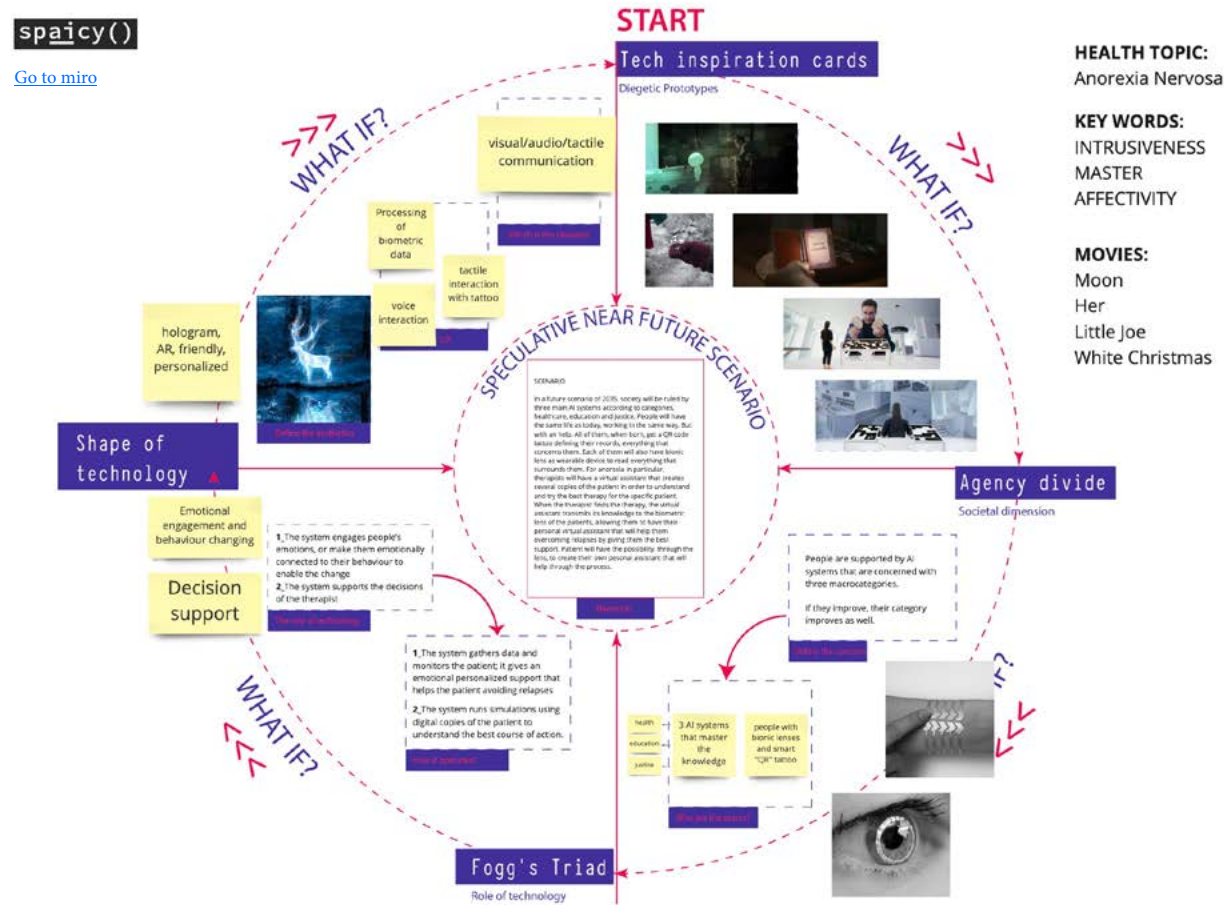


Figure 28: Scenario of the group Spacy on the topic of Anorexia Nervosa (Health agenda)

## 5.4. First refinement of the protocol: Semi-final Protocol

Building upon the results of the second experimentation, the author again revises the theoretical foundations behind the approach for designing consciously technological artefacts to tackle aware behaviours in users and refines the Protocol. Here and after, the author describes the development of the Semi-final Protocol, illustrated in Fig. 29.

The semi-final protocol puts in a system several theories and tools derived from the Design for Behavioural Change theory, design philosophy, social sciences and psychology, and philosophy of technology. Some of these concepts were already present in the previous version (provisional Protocol v.2), some are revised, and others are newly introduced. Besides, the author provides some more guidelines and theoretical references to help the process. The author introduces the theories applied in the Semi-final Protocol and how this new version is formalised in terms of stages and tasks.

The Semi-final Protocol keeps the four stages but changes the tasks within each stage. The author lists the stages with tasks:

- 1| **Scraping and topic analysis (discover and define the issue);**
- 2| **Agency analysis and human action (social and individual dimension and relationships);**
- 3| **Behavioural concern (behavioural planning and design strategies);**
- 4| **Tech mediation (Technology and design concerns).**

At the first stage of the Protocol (topic analysis), the author proposes to analyse the topic of interest, putting the focus on the societal challenges (Green New Deal and Sustainable Development Goals topics), through the critical discussion using the Sci-Fi genre (Tech Inspiration Cards) to analyse the collective imaginary about the future, technological and scientific development, and sustainability issues. The tasks and tools within stage 1 are the following:

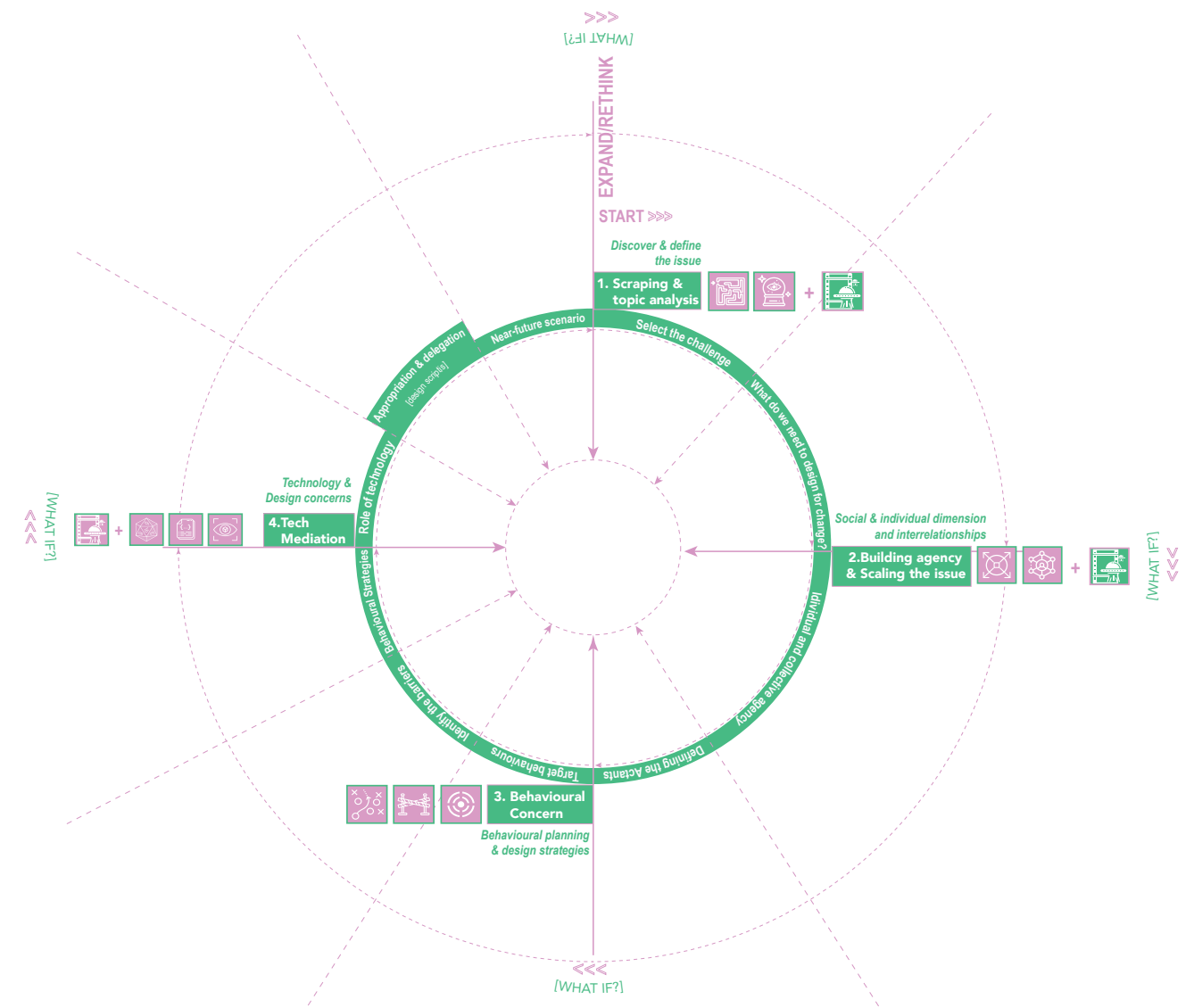


Figure 29: Semi-final Protocol

- **Select the topic (related to Societal Challenge);**
- **Analyse perceived disbeliefs (using Tech Inspiration Cards);**
- **Identify the design challenge (how design research and practice could answer this challenge).**

The purpose of such an approach is to stimulate design researchers and practitioners' reasons on how they could act to prevent dystopic scenarios, suspend disbelief and fears about the future, and create thriving conditions rather than solutions for survival. There are two tasks to answer at the first stage. The first is to set a particular challenge or topic that needs to be investigated



through the Protocol and discuss it with the help of Tech Inspiration Cards. While the second task is to answer the question: How do we need to design for a change? This question suggests setting several design requirements and possible issues for which the design research or practice can provide its contribution. It is about defining the research and design objective. For each stage within the Protocol, the author provides detailed guidelines on conducting the tasks and using the tools and references.

Carrying on with the second stage, the author suggests doing the agency analysis to scale the issue in question (i.e., air pollution). The previous version of the Protocol contained this concept, but it was very general and abstract to analyse. In Semi-final Protocol, the agency analysis questions human action through the individual and collective agency, including perceptions about the present and future (fears, disbeliefs, myths, others), moral judgments, and conflicts that prevent the individual from acting. The conflicts may be inner (personal benefits and beliefs) and outer (social and contextual benefits and beliefs). Identifying possible conflicts is understanding what in specific prevents the individual and society from acting toward thriving conditions and why the benefits of making more environmentally sustainable choices are not evident. The second task at this stage is to identify the actors (actants) involved in the processes of change, including both human and non-human actants, natural and artificial. Here the author suggests using Actants mapping, the model (developed by Monika Sznal and Marta Lewan). The author lists the tasks and tools suggested at this stage:

- **Individual agency about the issue in question (what individuals perceive in regard, which is their fears and disbeliefs, what prevents them from acting);**
- **Collective agency (what the society perceive in regard, which are their fears and disbeliefs, what prevents them from acting);**
- **Actants (or actors) mapping (map all the actants possibly involved in the processes of change using the actants mapping by Monika Sznal and Marta Lewan).**

The next stage is the analysis of behavioural concern, where the author suggests defining the target (aware) behaviours that the individuals should adopt. These target behaviours must concern the previous analysis on agency and actors involved in change processes. Once the target behaviours are defined, the possible barriers that prevent the individual from achieving target behaviours or cause rather adverse outcomes should be identified. This task has the purpose of helping anticipate possible behavioural issues and subsequently identify the strategies that can help avoid these adverse outcomes. The next task is selecting the design strategies to achieve target behaviours. For this, the author suggests using the Design with Intent tool. The author lists the tasks and tools in this stage:

- **Identify the target behaviours building on the previous analysis;**
- **Identify possible barriers (that may prevent from achieving target behaviours);**
- **Identify the behavioural strategies (using Design with Intent).**

The last stage is about the technological mediations. The first task within this stage sug-

gests defining the role of technology starting from the strategies selected in the last stage. The strategies can be revised through the Functional Triad levels to assign a specific role to the technologies and understand how to translate the behavioural strategies into interactions and forms. In the last version of the Protocol, this stage focused on the shape of technology, or rather the embodiment of the technology, stressing the functional aspects and less experiential and critical aspects of technological devices. There, the author introduces some new theoretical concepts here. The author finds the aspect of technological mediations in Verbeek's work, referring to "Materializing Morality Design Ethics and Technological Mediation," where she introduces his concept of design scripts – technological appropriation and delegation. The technological artefacts have a role in mediating between the user and the outer world. To design the artefacts intentionally, we need to anticipate the human Action (appropriation) and delegate a specific responsibility to the artefact (delegation).

Furthermore, how the Functional Triad is married to this concept? When one defines the role of technology, the Protocol suggests appropriating these technologies to the user. The appropriation is to analyse, applying critical thinking, which aspects of the technologies (analysed with Functional Triad) may be misunderstood or not appropriately perceived by the user. It identifies barriers that may interrupt the communication between the user and the artefact, negatively affecting the mediations (with the outer world and actors). There, the last task is dedicated to delegation or script. Here the Protocol suggests assigning specific scripts to the technological artefact. To assign scripts means assigning the specific "codes" to the artefact, intended as material and functional properties that have the purpose of establishing the dialogue (mediation) between the user and the outer world. At the fourth stage, the author suggests using Tech Inspiration Cards beyond the Functional Triad, which was already mentioned. The Tech Inspiration Cards (TICs) are particularly useful in the first task when we are supposed to identify the role of technology. They can stimulate the critical discussion upon the possible ethical and societal implications of technologies and help assign technology's role. The tasks and tools of this stage are listed below:

- **Role of technology (use Functional Triad to define the role of technology in being a persuasive tool);**
- **Interpretation and appropriation (anticipating how the user may interpret the technology and understand how to appropriate the technology to the user, using the TICs );**
- **Delegation (define the materiality of the artefact, functional properties, and interactions).**

The Protocol's output is the anticipatory scenario, built upon the elements analysed throughout the Protocol.

This version of the semi-final protocol was then tested in a self-reflection activity to understand its efficacy in triggering critical thinking. The upcoming chapter (Chapter 6) describes the self-reflection activity and subsequently the reflection activity with experts where the Semi-final Protocol was tested. The findings collected from these activities informed the generation of the final Protocol for designing consciously technological artefacts.

- Arendt, H. (1958). *Vita activa. La condizione umana*. Bompiani. 2014
- Berger, L.P., and Luckman, T. (1968). *The Social Construction of the Reality*. Golden City, New York, Doubleday and Co.
- Bleecker, J. (2009). *Design Fiction: A short essay on design, science, fact and fiction*. Near Future Lab, March, 103–114. <https://doi.org/10.1145/1516016.1516021>
- Carroll, J. M. (2000). Making use: scenario-based design of human-computer interactions. In *Zeitschrift Fur Bibliothekswesen Und Bibliographie* (Vol. 48). <https://doi.org/10.1145/347642.347652>
- Dunne, A., and Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press.
- Escobar, A. (2018). *Designs for the Pluriverse*. Duke University Press.
- Feenberg, A. (1999). *Questioning the Technology*. Routledge
- Fogg, B.J. (2003). *Persuasive Technology: Using Computers to change what we think and do*. Morgan Kaufmann Publishers
- Kirby, D. (2010). The future is now: Diegetic prototypes and the role of popular films in generating real-world technological development. *Social Studies of Science*, 40(1), 41–70. <https://doi.org/10.1177/0306312709338325>
- Klenk, M. (2020). How Do Technological Artefacts Embody Moral Values? *Philosophy & Technology*. <https://doi.org/10.1007/s13347-020-00401-y>
- Lockton, D., Harrison, D., Neville, A.S. (2010). The Design with Intent Method: A design tool for influencing user behaviour. *Applied Ergonomics*, vol.41(3), pp. 382–392. [http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx\\_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&atitle=The+Desi](http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&atitle=The+Desi)
- Latour, B. (1992). Where are the Missing Masses: The Sociology of a Few Mundane Artifacts. In Bijker, W. E. and Law, J. (eds.), *Shaping technology/building society: studies in sociotechnical change: Vol. Inside tec.* pp. 225-258. Cambridge: MIT Press.
- Latour, B. (2005). Reassembling the Social - An Introduction to ANT. In *Journal of Chemical Information and Modeling*, Vol. 53 (9). <https://doi.org/10.1017/CBO9781107415324.004>
- Lockton, D., Harrison, D., Neville, A.S. (2010). The Design with Intent Method: A design tool for influencing user behaviour. *Applied Ergonomics*, vol.41(3), pp. 382–392. [http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx\\_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&atitle=The+Desi](http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&atitle=The+Desi)
- Maldonado, T. (1972). *Design, Nature & Revolution*. University of Minnesota Press Minneapolis, 2019.
- Niederer, K., et al. (2016). Design for Behaviour Change as a Driver for Sustainable Innovation : Challenges and Opportunities for Implementation in the Private and Public Sectors. In *International Journal of Design*, vol.10(Sep-tember), pp. 67–85. <http://www.ijdesign.org/ojs/index.php/IJDesign/article/viewFile/2260/733>
- Sanders, M.S. (2009). *The philosophy of Science Fiction Film*. The University Press of Kentucky.
- Janlert, L.E., and Stolterman, E. (2008). Complex Interaction. in *ACM Trans. Comput.-Hum. Interact.*, vol. 17(2). <https://doi.org/10.1145/1746259.1746262>

# 6

## THE FINAL VERSION OF THE PROTOCOL

This chapter introduces the last year of the dissertation development, dedicated entirely to the protocol refinement and testing through several activities. In chapter 6, the author describes the self-reflection activity aimed at testing the Semi-final Protocol and two reflection activities to apply and test once again the Protocol, conducted with experts coming from different fields concerned with this PhD research. These activities had the purpose of testing the Semi-final Protocol and Envisioning tool and applying the results from the activities to deliver the final versions.

First, the author describes the self-reflection activity, introduces the findings that emerged from it, and how these helped set the sessions with experts bringing a minor refinement to the Semi-final Protocol.

Then the author introduces the sessions with experts from design research and professional fields, where psychology and neurosciences, digital design, critical design, HCI, behavioural design, and others. The author organised two half-day sessions, engaging different experts on different topics concerning Societal Challenges. The experts actively developed the anticipatory scenario using the Protocol with tools. They evaluated the Protocol and envisioning tool through several parameters. Firstly they shared their experience through the process by reflecting critically and discussing loudly. Then they evaluated the Protocol and tools through the questionnaire. The outputs produced from the self-reflection activity and the reflection activity with experts were scenarios.

After these sessions, the author used these scenarios to develop and test diegetic prototypes, but this is described subsequently in Chapter 7.

## 6.1. Design and Research activity I: Self-reflection activity

After the experimentation with the students, the Protocol was further refined to deliver the Semi-Final Protocol and refine the Envisioning tool. At this stage, the author wanted to ensure that the way the Protocol was structured now was proper, in the sense that all its parts are logically and comprehensively put in an order, to offer to the design researchers and practitioners a practical way and enough tools and guidelines to use the future as a space for critical inquiry and reflection and design fiction principles to support this process. For this reason, she sets the self-reflection activity to test the Semi-final Protocol first by herself to identify the eventual weaknesses and criticalities when it comes to approaching and the set of tools, methods, and concepts used within the Protocol.

The self-reflection activity was a one-day activity, and the final output was the anticipatory scenario on air pollution.

Here and after, the author introduces the aim and structure of the self-reflection activity, describes the use of tools, shows the output of the activity, and the results that helped in refining once again the Protocol.

### 6.1.1. Aim of the activity and structure

To start exploring the protocol, the author first needed to select one topic to analyse. The topic selected for this session was Air pollution, referring to the Green New Deal calls. The author chooses to set 2050 as a reference year. The reason for this is that the objective of the EU commission is to go carbon-free by 2050. Later on, the author will discuss this decision.

The activity was a one-day session where the author used the protocol to deliver anticipatory scenarios and at the same time reflect critically upon each stage of the protocol and the

tools. As the output of the session, the author developed a near-future scenario.

The author structured the activity in the morning and afternoon, where in the morning she went through the first two stages and in the afternoon through the last two and scenario writing.

The evaluation method, in this case, was a critical inquiry done by immersing the author in the active use of the protocol- the author used the protocol as a design practitioner and researcher imaging to use the protocol in her everyday research and practice.

There were two stages of reflection in this activity. The first one was during the process of protocol use, and the second one was after the process, where the author summarised all the critical points again.

Here and after, the author describes the activity in detail how she used different tools.

Before starting the activity, the author set the topic and framed it in a format containing the objectives declared in Green New Deal and Sustainable Development Goals. It was a document to use as a starting point and build the design requirements for the future (in this specific case, 2050).

The first stage of the protocol is about the topic analysis and setting of the design challenge. The protocol offers several stages and guidelines for analysing the topic, yet the author realised that exploring the topic needs some more support and reference on where to search the information and references to investigate the topic. Besides, translating the societal challenge into a design challenge was difficult since there were no guidelines or references on how to do it.

This first stage suggests using Tech Inspiration Cards to explore the societal dimension of the fictional worlds to identify fears and disbeliefs related to air pollution through Sci-Fi. The author realised that the envisioning tool needed to be further improved and advanced to provide the cards focusing on technologies and, more specifically and explicitly, on social dimension and building of the relationship between two levels of analysis. The cards developed at this level were framed around the technologies present in the film, taking for granted the societal dimension behind the plot. The author realised that the societal dimension needs to be more evident to ease cards and provide more detailed guidelines.

The second stage of the protocol is concerned with building agency and scaling the issue. The main issue was that this analysis was still too general, even though some guidelines were provided to support it. Defining the actants (human and non-human, natural and artificial) was more specific and guided. However, due to the difficulty to build the agency and system of relations between the issue in question and the society, the result of this part of the analysis the author retained was not satisfying enough. It was not satisfying to provide enough elements for the next stage of the analysis (behavioural concern), and it was not easy to analyse the agency without any support tool.

Through the third stage, the behavioural concern was identified by defining target behaviours, barriers, and strategies using the Design with Intent tool. This part of the analysis was quite well

structured, yet one issue was found. This stage did not have any conclusion. In other words, this stage helps set the strategies to apply in the design of technological artefact and some hypotheses on how to implement it, but it was noticed that such a result was subsequently a bit difficult to apply in stage 4.

The last stage, concerned with tech mediation, suggests using Tech Inspiration Cards (TICs) to analyse technologies critically and think of the possible technologies to combine with the previously identified strategies. Another tool to use here is the Functional Triad to define the role of selected technologies. This part of the protocol should help reflect critically upon possible ethical implications of technologies on society, individuals, and human behaviour. The author realised that it was difficult to correlate the strategies identified in the previous stage and TICs. The impression was that an element was missing to link these two concepts. Stage n.4 consists of another task, inspired by the concept of tech mediation by Verbeek (2006). The task is about trying to appropriate the selected technologies to the human perception, or instead anticipating how the dialogue between the technological artefact and the person could be established and what could go wrong. The role of the technological artefact is to mediate between the person and the environment. The communication between the artefact and the person becomes essential then. Verbeek explains that a designer's role is to assign the scripts to the artefact. The scripts are values assigned to the artefact to establish the dialogue with the person and influence how the person will mediate with the world. The person's understanding (perception) about the scripts (artefacts values) will influence how one uses the artefact and how we mediate with the outer world. If the scripts are decoded incorrectly, the mediation will also be interrupted or not proper. Here, the author calls for reflecting on how to embody the values we defined through the protocol into the artefact's materiality. The protocol was not guiding enough through this stage, so the concept of the mediation remained quite abstract and difficult to apply. The first part dedicated to technology and ethical implications was structured more logically, which made the analysis fluid; still, it appears a bit disconnected from stage n.3. At the same time, the part dedicated to the perceptions and scripts needed some more refinement.

The last task was to build the scenario from the analysis. Here the author gives some guidelines on how to build the scenario. The conclusion is that the elements collected through the protocol were consistent enough to permit a solid and quite structured anticipatory scenario in describing the issue, objectives, the future context, system of relations between different elements that constitute the context, human behaviour, and others. Figure 30 shows the anticipatory scenario built by the author through the self-reflection activity.

Nevertheless the output achieved from the Semi-final Protocol is much more satisfying than in the previous experimentations (provisional Protocol v.1, Protocol v.2), both the Protocol and TICs needed some improvement. The following text describes the issues identified throughout the activity and how the author decided to solve them before applying them with experts.

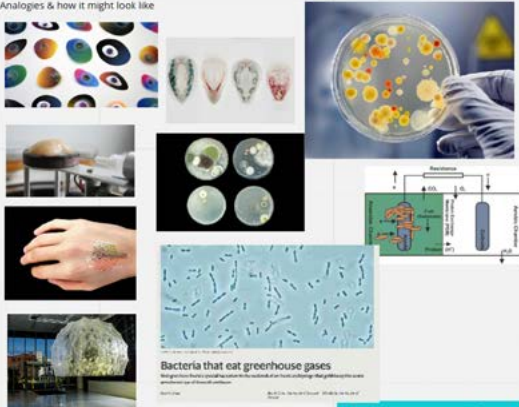
| Narration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Analogies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>In 2050, we will become more connected to our household environment and aware of our natural habitat, other natural and artificial cohabitants, and our impact on the outer world. By that time, our households will start to change still, our world won't be completely decarbonized yet, and we will still depend on some of the "old technologies" present in our homes. What will change is that we will be able to prevent those pollutants exit to the outer environment, be more aware of their presence, and transform it into something good/useful.</b></p>                                                                            | <p><b>What is this artefact?</b><br/>These are living artefacts that "colonize" our household with the purpose to capture the CO<sub>2</sub>, methane, and other pollutants, keep the user informed about the levels of pollution, and help the person reuse these pollutants as energy or food.</p>                                                                                                                                                                                                                                |
| <p><b>Microbial engineering and microbial materials will become more common by that time. The knowledge about the bacteria's metabolism and its capability to absorb CO<sub>2</sub>, methane, and other pollutants and transform those pollutants into energy, or even food for other species or soil will be more widely applied. Microorganisms will become alternative sensors and barrier between us and the household environment, and the household environment and outer world.</b></p>                                                                                                                                                          | <p><b>What does it do?</b><br/>It captures the pollutants (prevent the pollutants exit to the outer world).<br/>It informs the user about the presence of pollutants.<br/>It transformed bacteria into energy or food for other species/soil.</p>                                                                                                                                                                                                                                                                                   |
| <p><b>This scenario suggests the integration of living artefacts, grown from the microbial materials/surfaces able to host and grow the bacteria, in our households – artefacts able to change behaviour and in this way, influence our behaviour. The feedback will become visible through the interaction between the artefact and the household environment, where the artefact will continuously change and unobtrusively communicate to its cohabitants. When the artefact is saturated, the microbes are transformed into energy for the household or food for other species. In this way, the user keeps being engaged in the processes.</b></p> | <p><b>How and where do we use it (the context of use)?</b><br/>These artefacts are engineered and grown in the labs and perform in the households; they are part of the environment/furniture.</p>                                                                                                                                                                                                                                                                                                                                  |
| <p><b>These artefacts can assume different forms and colonize different zones of our home. By 2050, these artefacts may be developed in labs (engineered, programmed, and grown/shaped). The future perspective may be to acquire the culture once and continue growing it in the home environment.</b></p>                                                                                                                                                                                                                                                                                                                                             | <p><b>How does it work (describe the technology)?</b><br/>Microbes' metabolism is programmed/engineered to capture the pollutants and transform them into energy (sugars). New microbial materials are developed and their growth can be controlled (3D printed). The microbial surface of the artefacts capture/absorb the pollutants to prevent them exit from the household environment and it changes chemically, there so visibly inform about the emissions. Captured CO<sub>2</sub> is transformed into energy (sugars).</p> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p><b>Analogies &amp; how it might look like</b></p>  <p><b>Living artefact</b></p>                                                                                                                                                                                                                                                                                                                                                             |

Figure 30: Scenario developed in self-reflection activity

## 6.1.2. Findings and outcomes

The author confirmed that conducting the design and research activities through the Semi-final Protocol can trigger critical thinking regarding the societal issues, technologies, and human behaviour and consequently help design researchers and practitioners design more consciously technological artefacts to tackle aware behaviours.

Throughout all the Protocol stages, critical thinking was triggered regarding different topics, yet not equally through all the stages – not all tools and theoretical concepts were equally efficient in enabling the critical reflection. First, let us see what this means and then introduce how the author decided to refine the Protocol before testing it in sessions with experts.

Analysing the topic through different stages showed that the Protocol with tools stimulated the raising of questions and amplified the spaces for investigation of the subject of study, which probably would not be raised otherwise. At the first stage of the Protocol, the author noticed that the analysis through the Sci-Fi genre (using Tech Inspiration Cards) helped identify some disbeliefs and myths regarding the technologies and scientific development. Tech Inspiration Cards (TICs) help understand how design research and practice could intervene to prevent some catastrophic scenarios and interfere more ethically and with a more critical eye on societal issues.

However, the analysis of the societal dimension in films was not easy with TICs. It required investigating each plot very profoundly to understand the context, and the tool at this stage was a bit limiting in that sense. The author thought of splitting the TICs and the plots into two levels of analysis, one concerned with technologies and societal questions. The second level of cards is called Societal Inspiration Cards (SICs). In this way, the analysis of the societal issue through Sci-Fi would become more explicit and, as a result, more accessible to do. Further on in the text, the author will describe the development of Societal Inspiration Cards.

Besides the envisioning tool, at the first stage of the Semi-final Protocol, some more references were needed to help the analysis on future challenges and technological trends, to transform the societal challenge into a design challenge more easily. The author noticed this because she found the process difficult based on envisioning through Sci-Fi and identifying the design challenge. She noticed that there should be some passage in between.

The second stage of the analysis concerned the scaling of the issue and building of agency still needed improvement. Mapping the individual and collective agency is still very general, and there are required some more guidelines to help the process of thinking and to do the task in a more aware manner. In the Semi-final Protocol, the author left this part without specific tools and guidelines to lead the process, which showed that this part of the analysis

was superficial and even subjective.

At the third stage, the approach for analysing the behavioural concern (how the human behaviour is related to the societal issue, target behaviours, barriers, strategies) is well structured. It enables critical thinking by analysing and anticipating the behaviours and the possible barriers to achieving aware behaviours. Nevertheless, the author noticed some issues also at this stage. First, the connection between stage 2 and stage 3 was weak. The author had some difficulties relating the agency and actors to the Protocol's behavioral concern – the relationship is not evident enough. Second, it was challenging to build conclusions about stage 3. This stage finishes with selecting the strategies (using Design with Intent), but there was a need to conclude before going on stage 4 - sum up the initial design challenge, agency analysis, and behavioural analysis. Using just strategies to inform the next stage was confusing and difficult to manage.

The last stage of the Protocol was still too abstract and complex to use in a pragmatic sense. Combining the TICs with Functional Triad (FT) raises critical thinking and questions regarding the possible implications of technologies, but the task dedicated to perceptions and design scripts needed some more structure and guidelines. The difficulty was also due to the input from the previous stage that was not consistent. The first two tasks within stage four are pretty straightforward to analyse (using Functional Triad to define the role of technology and how to apply the strategies (from the previous task, and TICs to explore the possible ethical implications of technologies). The following two tasks dedicated to Perceptions and Scripts were too difficult to conduct due to their abstractiveness. These two concepts are tightly related, and the author believes there is no need to separate them. To anticipate the human perceptions has the purpose of letting us understand how to design the technological artefacts – how to assign the scripts.

Writing the scenario as the output of the activity conducted through the Protocol was guided better now. Imaging the artefacts through different levels, starting from the Protocol stages to build the complete narration (societal issue – design challenge – scaling the issue – behavioural concern – tech mediation) and searching for the analogies was helpful to create the meaningful scenario; however, the author finds that there were needed some more guidelines to support the process.

The overall perception of the author was that the stages need to be better connected, in a more explicit way, in a sense how do we apply the knowledge gained within the one stage to the next one.

Here and after, the author shows how she decided to refine the Protocol through each of its stages by suggesting some more references, guidelines, and tools. In regard, in the other text, the author will show the development of Societal Inspiration Cards.

The author decided to add more references beyond Green New Deal and Sustainable Development Goals to facilitate the analysis and discussion at the first stage. These references are useful to expand the search about the issue in question and build the relationship between different concepts. The references she added were World Economic Forum Strategic Intelligence to investigate the future trend and interconnectedness between various trends and concepts concern,

from technologies to sustainable development, and many others. Another reference is If You Want To, the platform for searching for case studies or better practices in sustainable development solutions, such as renewable energy, waste management, climate crisis, and others. The author selects these two platforms to offer as support references because they show the real-life innovations in the perspective of sustainable development and use of technologies and give an overview of how different topics within sustainable development are related to expanding the research.

Moreover, the last tool for this stage is the envisioning tool author refined – Societal Inspiration Cards (SICs). The findings from the analysis showed that there would be preferable to suggest the SICs at the first stage of the Protocol instead of Tech Inspiration Cards (TICs). The TICs showed as suitable in the last stage of the Protocol dedicated to technological mediations to analyze technologies' possible ethical and societal implications. The author keeps the TICs at the fourth stage of the Protocol. The author revises TICs to coordinate two levels of cards (technological TICs and societal SICs).

The author explains how the cards were revised. She exploits the results collected during the first tool's development and amplifies the selection of the films, mainly to offer a broader range for societal level - Societal Inspiration Cards (SICs). Starting from the titles collected during the initial stages of the development of the envisioning tool, the author puts in order several parameters to classify cards in two categories: Technological (TICs) and Societal (SICs). She did the classification based on the following parameters: the keywords regarding the societal challenges and technologies from the first analysis and expanded a bit more (tools also used at this stage are Seealsology, Wikipedia, IMDb, and InDATA), titles from 1990 up to today, key topics within Sustainable Development Goals, and as support, and she consulted the Design Fiction literature. All this data was collected from these several tools and ordered manually. The author made two documents, one for TICs and one for SICs, and she visualised data with the online tool RawGraphs. These organised and visualised data collect the titles on two levels, reproduced on the cards. Figure 30 shows the part of the process and the final cards. The author shows the part of generated titles on the left side of the image – 57 titles for SICs and 41 for TICs. There could be noticed that some films have only the societal dimension, neglecting the technologies. The other is overlapping the technology and societal issue – they have two dimensions. In the left part of Fig.31, the author lists the parameters for the classification of titles. For the SICs, the author classifies the year of the film, title, and three levels of tags - tag directly related to the film (keywords defining the plot), tag related to the societal challenge (environmental sustainability, health, and wellbeing, safety), extended relation tag (concepts derived from societal challenge tag). For TICs, the author classifies two levels of Tech tags (the primary technology and the specific use of the technology), year, title, and tag directly related to the film (keywords defining the plot), tag related to the societal challenge (environmental sustainability, health, and wellbeing, safety), extended relation tag (concepts derived from societal challenge tag). These last three are the same for SICs and TICs to identify which titles have a plural dimension. The author illustrates one example of classification in Fig. 32. The collection of cards (<https://milastepanovic.wixsite.com/s4bc/tools>) is an online platform that is constantly updating and

expanding. The current collection of cards can be consulted in the section Appendix.

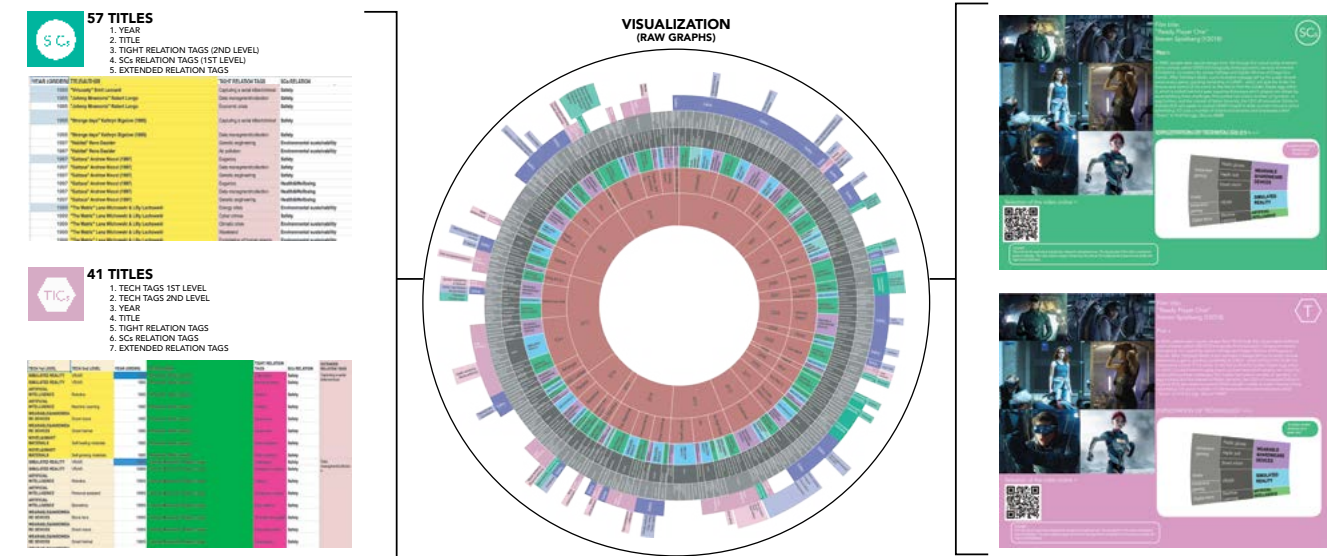


Figure 31: Methodology behind the classification of TICs and SICs

| YEAR (ORDER) | TITLE/AUTHOR                       | SCs RELATION | TIGHT SCs RELATION TAGS            | TECH 1st LEVEL            | TECH 2nd LEVEL              | TIGHT TECH RELATION TAGS        |
|--------------|------------------------------------|--------------|------------------------------------|---------------------------|-----------------------------|---------------------------------|
| 2002         | "Minority Report" Steven Spielberg | Safety       | Crime prevention                   | WEARABLE&HARDWARE DEVICES | Smart helmet                | Neuro-visor                     |
|              |                                    |              | Capturing a serial killer/criminal | WEARABLE&HARDWARE DEVICES | Haptic gloves               | Gestural interaction            |
|              |                                    |              | AI takeover                        | WEARABLE&HARDWARE DEVICES | Clothes embedded technology | Telecommunication               |
|              |                                    |              |                                    | WEARABLE&HARDWARE DEVICES | Bionic lens                 | Recognition and personalization |
|              |                                    |              |                                    | WEARABLE&HARDWARE DEVICES | Biometrics                  | Recognition and personalization |
|              |                                    |              |                                    | WEARABLE&HARDWARE DEVICES | Automised cars              | Intelligent machines            |
|              |                                    | SICs         |                                    | TICs                      |                             |                                 |

Figure 32: Example of classification of titles with tags

Carrying on with the stages of the Protocol, the author arrives at the second stage – agency and scaling the issue. The author tries to deepen and expand this analysis by providing more guidelines, references, and new tools and methods. The author searches for the tools and models that could support the analysis of collective and individual agency concepts. The first model author identifies is the Social Ecological Model - firstly developed by the Chicago School and widely applied to the different problems from sustainability to health concerning human behaviour. This human-development model has the purpose of helping build the interrelations between different

personal (individual) and environmental (social) factors, which makes it suitable for the Protocol in question.

The second model identified by the author is Doughnut Economy Model (author Kate Raworth) to help in defining the thriving societies and conditions on the micro (local) and macro (global) levels. This model is suitable for scaling different societal issues and understanding how the issue impacts the individuals and society and how to plan the action toward more thriving conditions (focus on sustainable development) through different levels.

The third concept remains the Actants mapping which showed very useful for the Protocol to analyse all the actors involved in the processes of change, in direct and indirect ways, and how the change influences these influences.

To summarise. The Social-Ecological Model is for scaling the issue through different levels from the individual to collective/institutional and identifying the crosscutting factors (enablers and barriers in adopting more sustainable behaviours/sustainable development). The Doughnut Economy Model helps define the thriving conditions concerning the specific issue and what it would mean for individuals and societies to thrive in the future. Furthermore, the Actants mapping defines the actors (natural and artificial, human and non-human) that play an active role in processes. Fig. 33 below shows how the tasks are organised now with guidelines.

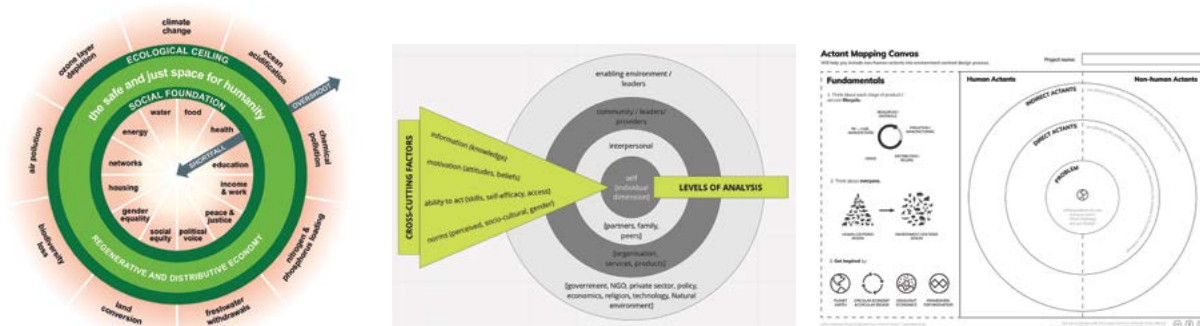


Figure 33: Refined guidelines at the second stage of the Protocol

At the third stage, the author leaves the current structure for analysing human behaviour but slightly modifies the guidelines. To sum up, the author refines the last part of this stage dedicated to the strategies. She suggests finding the most appropriate strategy and defining how it could be applied on the technological artefact and with what purpose – considering the objective (design challenge) set at the beginning of the Protocol. (Fig. 34)

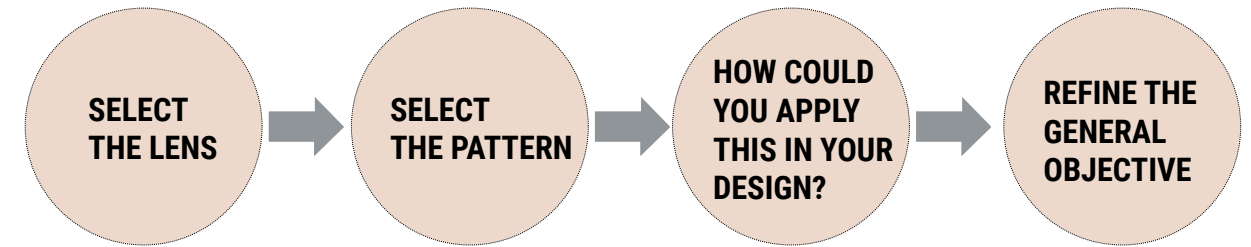


Figure 34: Refined guidelines at the third stage of the Protocol

The author tries to simplify the process a bit at the fourth stage. She leaves the Functional Triad with Tech Inspiration Cards and merges the perceptions and the scripts into one task providing more guidelines. The Figure shows the guidelines for this task. For the rest, the author leaves the space for the scenario writing and refines the guidelines. The scenario guidelines are illustrated in Fig. 35.

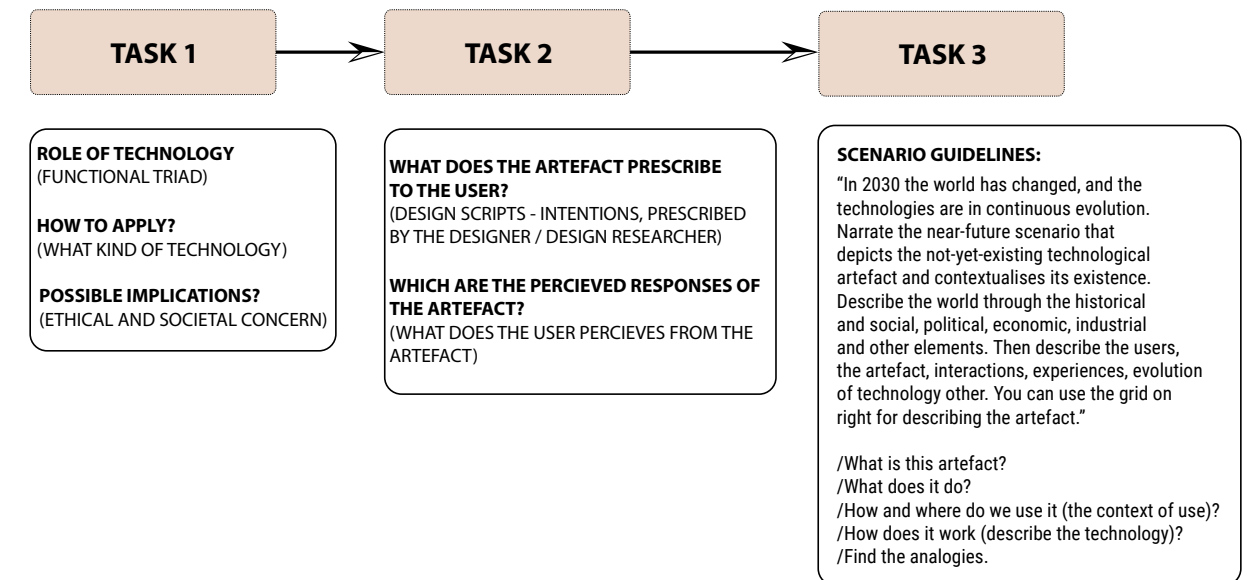


Figure 35: Refined guidelines at the fourth stage of the Protocol



### 6.1.3. Critical points of the activity

The self-reflection activity was a helpful method for understanding how the structure and the tools in Semi-final Protocol can efficiently guide the design researcher and practitioner toward delivering more conscious design for technological artefacts to tackle aware behaviours. The author observed whether the stages and tools are organised in a meaningful and logical way how relevant they are when designing for technological artefacts, human behaviour, and societal challenges.

The author immersed herself into the process in the role of design researcher and practitioner so she could touch the issues of the protocol by her hands, differently from the previous sessions where she could observe it through the eyes of the participants. The self-reflection activity permitted the author to analyse and evaluate the protocol by herself. Besides, she could better understand the past evaluation and comments of the participants on the protocol and tools and why they had some difficulties.

However, the author found that the self-reflection activity is a valuable method of analysis and evaluation, yet there are some weaknesses when it comes to it. Using this method as an in-between or transition method is a good method for reflecting critically upon one's research and output. Nevertheless, it is scientifically subjective; there is not enough reliability in a single-person activity, there is only one point of view, and also there is a problem that the participant is the author herself – the person who is very inside the project. The author was undoubtedly a bit easier to navigate the protocol, knowing the expectations and how different stages are related. However, when the author found the challenging barriers, those signals that the specific stages needed further refinement.

For this reason, the author applied such a method to refine the protocol and revise the tools in the protocol before testing it in a session with experts who will evaluate the tool more objectively, based on their years of experience in different areas of research and design practice. In this chapter (6.2.), the author describes the sessions with the experts.

The author would like to stress another critical point that emerged from the activity: taking so distant year as a reference year to analyse the topic through the protocol. She realised that such a distant year, 2050, has not made much sense because, first, it is too far, and it was challenging to manage and envision factors such as innovation, technological development, societal, economic, political factors so far. The author faced difficulties in scenario writing due to managing all the elements concerning such a distant future, where designing the artefact that is supposed to trigger critical thinking for issues too hard to predict. Thinking of the less distant year would help us deal with more predictable contexts there be even more critical regarding the technological and scientific development.

## 6.2. Design & Research activity II: Reflective activity with experts

The self-reflection activity aimed to identify the criticalities of the Protocol that were further refined and tested with experts. At this stage of the research, the author decided to engage the experts from different fields concerned with the topic of this PhD, both from the Italian and other international institutions, Italian and other nationality.

The session with the experts was an occasion to critically discuss the Protocol by engaging the expert participants in designing the technological artefacts to tackle are behaviours in users concerning sustainability issues.

The author conducted n.2 sessions, engaging a total of six experts. The sessions were structured in the same way, but the topics we (authors and experts) analysed in the two sessions were different. However, both of the topics were related to environmental sustainability. Due to the COVID-19 emergency, the author needed to organise the sessions in an online modality.

The following text introduces the aim and the structure of the activity and the selection of the participants. Then both of the sessions are described in detail, and the author shows the outputs of activities (scenarios).

This session used the evaluation methods such as participants inquiry and questionnaires. The experts use the Protocol for creating the anticipatory scenario and comment on different passages (stages and tools) along the process. They evaluate the Protocol and tools in the questionnaire. The questionnaire investigates whether the experts perceived that the critical thinking was raised long the activity using different tools and theoretical concepts; whether such an approach could enable design researchers and practitioners to design more consciously adopting the critical thinking and pluriversal perspectives; how logical is the approach proposed by the author and relevant to meet the design concerned with the sustainable development, technologies, and human behaviour. The experts had a space to propose the author's changes, tools, and references.

The author compares the questionnaire results with the registrations of the activity (participants inquiry) to understand how to deliver the final version of the Protocol.

After showing the results of the activities, the author discusses the critical points of the activity and shows the final version of the Protocol generated from the findings.

## 6.2.1. Aim of the activity and participants

In February 2021, the author conducted n. 2 reflective activities with experts from different fields to test the refined protocol and investigate its efficacy in triggering critical thinking, whether the selection of support tools is appropriate and if the protocol elements are meaningful and logical. Evaluating critical thinking is not an easy task. There the author decided to confront the experts with long experience in several fields concerned by this PhD research. The role of the author in the activity was both to mediate the activity and to participate actively. Before going on the activities, the author introduces the experts.

The participants were selected and contacted because of their competencies and experiences within different fields covered by the research: Design for Behavioural Change, Neurosciences, Social psychology, Digital Design, Design for sustainability and cultural studies, HCI, and game design. Here is the list of the participants and their institutions (Table 5):

**Table 5: Participants in the reflection activities**

| NAME OF THE PARTICIPANT               | FIELD OF COMPETENCES    | INSTITUTION                                                         |
|---------------------------------------|-------------------------|---------------------------------------------------------------------|
| <b>Anneke van Woerden</b>             | Sustainable Design      | Amsterdam University of Applied Science, Digital Design School (NL) |
| <b>Alberto Gallace</b>                | Behavioural Sciences    | Università Bicocca (IT)                                             |
| <b>Anne-Kathrine Kjær Christensen</b> | Behavioural Design      | Specifii digital agency (DK)                                        |
| <b>Francesco Cara</b>                 | Digital design          | Senior Designer, lecturer at IED, Founder at If You Want To         |
| <b>Simona Sacchi</b>                  | Social psychology       | Università Bicocca (IT)                                             |
| <b>Gabriele Ferri</b>                 | HCI and critical design | Amsterdam University of Applied Science, Digital Design School (NL) |

The activities lasted half-day each in online modality, engaging n.3 participants, divided in a balanced way not to have groups with researchers, scientists, and designers. The objective was to analyse the topic of interest through the protocol and deliver the anticipatory scenario for 2030. This time author decided to reduce the time gap since it showed as not appropriate from the self-reflection activity. We collaborated on the Miro board, where the author uploaded the protocol with all tools. The participants were able to look into the protocol and tools and the topic a few days before the activity to prepare—the author selected in advance the Tech Inspiration Cards (TICs) and Societal Inspiration Cards (SICs) to apply in activities. The selection was made accordingly to the topics of each of the activities and the participants could study the cards before the activity.

During these two days, we collaborated on different topics, both on them inspired by the Green New Deal and Sustainable Development Goals: (1) “Reducing personal and environmental carbon footprint (as user and consumer) through innovative solutions for waste management”, (2) Reducing personal and environmental carbon footprint (as user and consumer) through innovative solutions for energy consumption.” Here and after, the author describes each activity in detail.

The first (half) day activity was on the topic “Reducing personal and environmental carbon footprint (as user and consumer) through innovative solutions for waste management”. The author generated the topic starting from the NGD, focusing on the human (consumer) behaviours and the role of technologies in supporting the changes toward a more sustainable future and thriving societies. Besides the Green New Deal, this topic was empowered by Sustainable Development Goals too. The topic was framed together with several references, as we can see in the figure. The participants that took part in the first-day session were: Anneke van Woerden, Alberto Gallace, Anne-Kathrine Kjær Christensen. Now the author describes the activity through the protocol’s stages.

At the first stage of the protocol, the participants and the author explored the topic in-depth. After an open discussion and critical inquiry using the references, expert’s experience, and knowledge, and subsequently a brief investigation through Societal Inspiration Cards (SICs), we translated the initial topic in the design challenge that is reducing the microplastics waste in water starting from the households. This design challenge is interested in investigating how can we reduce the release of microplastics within the home environment, starting from changing the consumer behaviour when it comes to the use of chemicals, from the shopping cart to the rivers and oceans. The idea here is that one can have an overall image of how consumption habits impact the world and all possible actors that this issue can impact. The participants explored this challenge throughout the protocol to arrive at the final scenario, which wraps up all the processes into an anticipated design idea for 2030.

After setting the design challenge, the participants started the in-depth analysis by building the relationships and scaling the issue. Regarding the topic of interest, the participants identified how different institutional levels are concerned by this issue, which are the cross-cutting factors that enable or disable processes toward change (assuming more aware behaviours), and how this might change in the future achieve more thriving societies in this sense.

Some of the key points in the second stage were creating societies where people find it convenient to assume more aware behaviours, creating convenient norms such as taxes that do not have to be monetary, offering a broader image of reality such an impact. The target behaviours participants set for this issue are mainly concerned with awareness concerning the consumer's habits and, in general, how do we impact the environment starting to form the households, considering some possible barriers such as time and costs of the solution, infrastructure, and preserving the motivation long in time. The participants selected some strategies to apply in their designs, such as communicating through metaphors, real-time feedback, progress bars, transparency of the process, possibility trees. In the last part, the participants questioned the role of technology and possible ethical implications. The participants realised that the technology must have different roles because it needs to measure the microplastic level (tool), it needs to give social proof about the pollution (social actor), and it needs to dialogue to the user (mediator). Some questions raised here were concerning data management and transparency, cognitive overwhelm of the person using a device, freedom of choice, surveillance. Before going on the scenario, the participants tried to define some scripts to assign to the artefact, such as how the system can assist the user both at home and outside the home and how it can understand the typology of the microplastics that colonise our environment. Building on the overall process, they delivered the anticipatory near-future scenario. (Fig. 36)

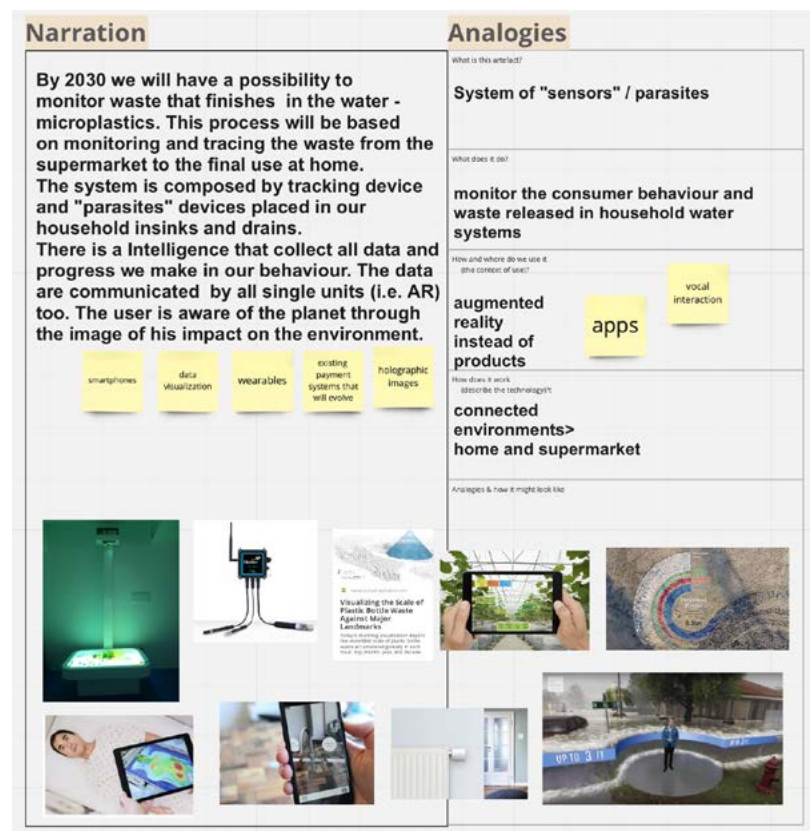


Figure 36: Anticipatory scenario Day 1

The second (half) day activity was on the topic "Reducing personal and environmental carbon footprint (as user and consumer) through innovative solutions for Energy Consumption. In this case, the author framed the topic with references the same way as it was in the first session. The activity's structure is the same as the first one. The participants of the second session were: Francesco Cara, Simona Sacchi and Gabriele Ferri. Here and after, the author describes the activity profoundly.

Starting from the main topic of the activity, the participants focused on the design objective for 2030, which is to let the citizens become more independent when it comes to the energy as a source through engagement with a community and through tools that permit them to transform already existing resources into energy. Just as we could see in the description of the previous activity, after they identified the design challenge, they started the in-depth analysis by building the relationships and scaling the issue. Some of the key points in the second stage include creating societies where families are economic entities, biospheric values, harvesting services rather than distributing energy, valorisation of rural areas, and others. The target behaviours the participants set here concern mainly the community than the individual, so they asked themselves how to build a system that is democratic enough and can motivate everyone in the community to harvest and share the energy. They selected some strategies that might be appropriate here, such as feedback through the form and metaphors, transparency of the process, others. In the last part, we questioned the role of technology and its possible ethical implications. They realised that the selected technology must have different roles because it needs to transform the organic waste in energy (tool), but it also needs to be a part of complex infrastructure and act within the community (social actor). It is also an information system because we need to know how much the community transform, use, and others. Some questions raised here were concerning data management and transparency, especially regarding democratic use of the energy – \_who produces less does not need to be punished. Before going on the scenario, we tried to define some scripts to assign to the artefact where we raised more questions, such as the energy ownership and distribution and how to create the system that knows who owns it. Building on the overall process, the participants delivered the anticipatory near-future scenario that the author shows in the Figure 37.







| Narration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Analogies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Rural communities for/in 2030:</b><br/>By 2030 it will become more common to move from the city centers in rural areas, and there will be founded energetically independent communities. Transforming the organic waste in biogases, on smaller and individual scales, and its sharing within the community will become possible.</p>                                                                                                                                                                                                           | <p>What is this artefact?</p> <p>[un essere "animale" ha fame e lo devi nutrire //se digerisce va tutto bene, da i feedback più naturali animale comune</p> <p>campana e totem</p> <p>totem sulla piazza: il fiore che si trasforma e comunica agli suoi abitanti quanta energia è stata raccolta o deve essere raccolta.</p> <p>+ interfaccia nella casa - feedback individuale</p> <p>multiplicità delle interfacce &gt;&gt;&gt; meno device</p>  |
| <p><b>Life in a rural community in 2030 &gt;&gt;&gt;</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p>What does it do?</p> <p>The system of artefacts described here is transforming the organic waste, such as livestock waste, crops, water waste, food waste into biogases to supply the community of habitants (quarter) with energy (power, heat, etc.)</p>                                                                                                                                                                                                                                                                         |
| <p>At 6 AM the Totem Flower lights up to inform its citizens about the energy level in the community. Just after the bell rings to wake up the Hungry Animals [waste collectors].</p> <p>The system is made of several artefacts: (1) the artificial Hungry Animal who needs to eat the organic waste to survive [AKA collector], (2) Transformer [artefact able to transform the organic waste into biogas], (3) Accumulator [totem that collects biogas and redistributes it to the community], (4) Driver [a system that transport the energy]</p> | <p>How and where do we use it (the context of use)?</p> <p>The Hungry Animal is semi-dependent artificial animal with artificial intelligence that wakes up every morning and it collects the organic waste. Each house has its own Animal that collects waste and brings it to the Transformer.</p>                                                                                                                                                                                                                                  |
| <p>When the Hungry Animal digest the waste it empties the rest in the Transformer. The Totem accumulates the transformed energy and it redistributes it within the community. The totem is changing in color to communicate the energetic state to its community.</p>                                                                                                                                                                                                                                                                                 | <p>How does it work (describe the technology)?</p> <p>INTELLIGENZA ARTIFICIALE E MACHINE LEARNING</p>                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                                                                                                                                                                                                                                                                                                                                                                  | <p>Analogies &amp; how it might look like</p>                                                                                                                                                                                                                           |

Figure 37: Anticipatory scenario Day 2

## 6.2.2. Evaluation method and results

The first evaluation method of this activity is participant inquiry, where the participants, together with the author, used the protocol to explore the topic and create the anticipatory design scenario about the technological artefacts for 2030. In this way, the participants could use the protocol and develop ideas through it and at the same time discuss loudly the different stages of the protocol, tools, methods, and concepts within, share their experiences and knowledge. The sessions were registered so that the author could listen and analyse the activity subsequently.

The second method used for evaluating the activity is the questionnaire—the questionnaire aimed at evaluating all stages of the protocol and tools. The purpose of using the questionnaire was to evaluate the overall protocol, stage by stage, each tool (quantitative analysis to support the previous qualitative analysis through critical and participatory inquiry). The most important aspect to understand was whether the protocol helped trigger critical thinking at all stages and where and how tools impacted this. Then the author wanted to investigate whether the relationship between different stages was clear and structured coherently and logically, as so for the tools used at each of them. Beyond the evaluation, the participants could suggest other tools, methods, and concepts that may be integrated into the author's suggestions or eventually changed. The questionnaire had six sections. The first one was dedicated to the general information about the participant and consisted of very few questions. From the second to the fifth section, the questionnaire evaluated the single stages of the protocol. While the last part was to evaluate the overall impression about the protocol.

The author applied several parameters to evaluate the sections dedicated to the evaluation of the protocol and tool:

- **Level of difficulty of compiling the task;**
- **How effective were the tools for triggering critical thinking;**
- **How effective were the tools to compile the specific task;**
- **How appropriate was the selection of the tools regarding the task;**
- **Whether the approach applied at each stage was identified as meaningful.**

The questionnaire left some space for suggestions and critiques in each section. Through this questionnaire, the author also tested the envisioning tool (Tech Inspiration Cards and Societal Inspiration Cards) integrated parts at stages one and four of the protocol.

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The last part of the questionnaire was about the protocol's overall impression, comparing the stages and explaining where the critical thinking was triggered the most or the least and whether the stages were related comprehensively and adequately. Here and after, the author will summarise the most important results of the questionnaire, while the complete documentation in regard is in the section Appendix of this dissertation.

Following the order of the questionnaire, the tools used at the first stage of the protocol were generally found as valuable, especially Sustainable Development Goals and World Economic Forum Strategic intelligence. Since the participants were experienced experts,

they all had some previous experience that quickly enabled the discussion. At this stage, they also used Societal Inspiration Cards (SICs), which most of the participants found very useful and helpful in triggering the critical reflection through discussion, while someone retained it not so helpful explaining that he/she was not knowledgeable about the genre and titles and this caused some confusion. The suggestion was to give some more time for the analysis and the possibility of going online, which we could not do considering the time. The experts found Stage 2 to be an essential aspect for designing by all the participants (100%), while the tools applied were relevant and trigger critical thinking.

When it comes to the third stage, the results show that the critical is not enough triggered for behavioural concern, yet the way this protocol is proposing to approach the behavioural concern was evaluated as correct by the experts. There, they left some suggestions on providing a more straightforward and more evident overview of the activity by mapping it and providing more guidance. The most helpful tool at this stage was the Design with Intent.

Going to the final section, the participants found defining the role of technology as generally useful (75% - useful, 25% - not so useful), suggesting making this stage more illustrative. When it comes to the use of Tech Inspiration Cards (TICs), most experts found this tool as useful/very useful in triggering the critical reflection about the ethical implications of technologies, while those who did not that much always remarked the same issue regarding not being knowledgeable enough about it.

The last part of the protocol was about evaluating the overall approach. All of the participants (100%) agreed upon the fact that the stages of the protocol are logical, and each stage can inform the upcoming one (“I can find relationships between different concepts and theories”).

The overall impression of the experts is that the use of this protocol can trigger critical thinking and help design more conscious ways technological artefacts able to tackle behavioural change. The suggestion to improve was to make the overall approach more illustrative provide examples on how to reason/analyse. When it comes to the overall impression regarding the ability of this approach to trigger critical thinking and help in designing more consciously technological artefacts to tackle behavioural change, all the experts agreed upon it, regarding the overall impression on how the critical was triggered long the process, including stages and tasks within stages (on the scale 1 – not at all, 5 – very much). The results show that critical thinking was triggered the most at the 2nd stage and in the 4th stage.

The author confirms at this point that the protocol with tools is efficient in triggering the critical thinking and enabling the design researchers and practitioners to design more consciously for sustainable issues, technologies, and human behaviour. However, the author wanted to take into consideration several comments left by the experts and understand how to improve further on the 1st, and the 3rd stage since the experts evaluated a bit lower when it comes to the critical thinking.

### 6.2.3. Final refinement of the Protocol

The results collected from the questionnaires were compared with the audio content registered during the sessions and applied in refining further the Protocol. Several suggestions were applied to tools and methods experts gave to the author to refine the Protocol. The author introduces how she structured the final version of the Protocol (Fig. 38 - the next page) from the results.

Starting from **Stage 1**, the author found that the use of the Societal Inspiration Cards (SICs) and references was appropriate and useful by the participants, so it did not assume any change any more. The references applied at the first stage, confirmed by the participants as appropriate, are:

- / Green New Deal,
- / Sustainable Development Goals,
- / World Economic Forum Strategic Intelligence,
- / If You Want To,
- / SICs.

The approach to the analysis remains the same, consisting in n. 2 tasks:

- 1| Analysis of the Societal Challenge topic through SICs,
- 2| Analysis of the design challenge for the future.

The **Stage 2**, dedicated to scaling the issue and agency building, was appreciated by the experts, both for its importance for designing technological artefacts and for the topics investigating sustainable development. Experts retain that the tools at this stage of the Protocol are appropriately selected and are very efficient. Nevertheless, a bit of confusion was noticed on the passage between stage n.1 (defining the agency) to stage n. 2 (defining the actants) that the author noticed from listening to the registrations. She realised a need to facilitate tools and make the relationships between tools even more evident. There the author maps three concepts within this stage in a new way, considered as more comprehensive and able to establish better connections and, as a result, reduce the possibility of confusion between different stages. The consideration made by the author builds upon the experience from the sessions and registrations. The tools applied in this stage are:

- / Doughnut Economy Model,
- / Social-Ecological Model,
- / Actants Mapping.

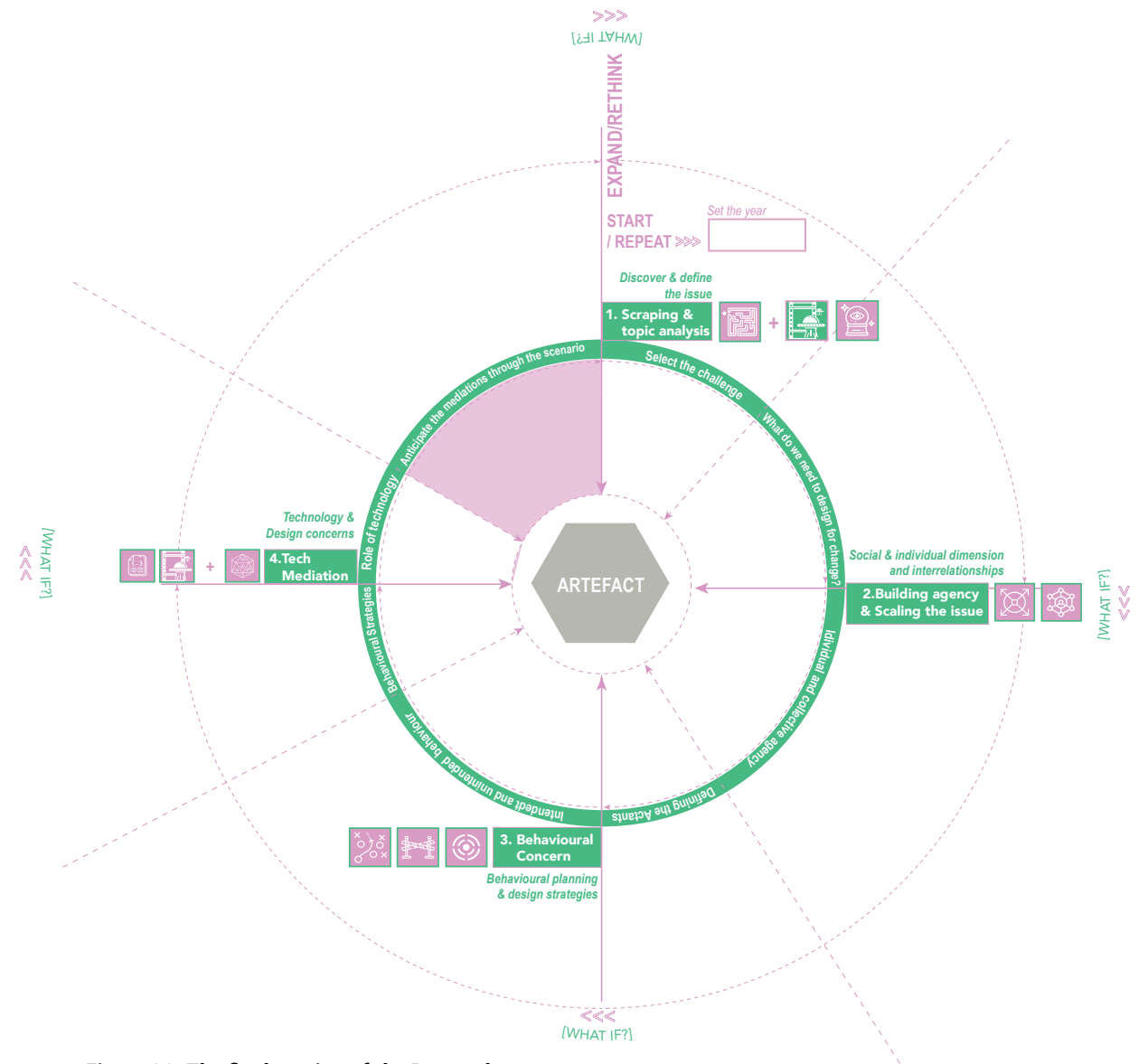


Figure 38: The final version of the Protocol

The tasks to define the agency and scale the issue are the following:

- 1| Thriving societies (individual and collective agency)
- 2| Scaling the issue
- 3| Define the actors involved in the process of change

Fig. 39 shows how stage n.2. is structured (guidelines).

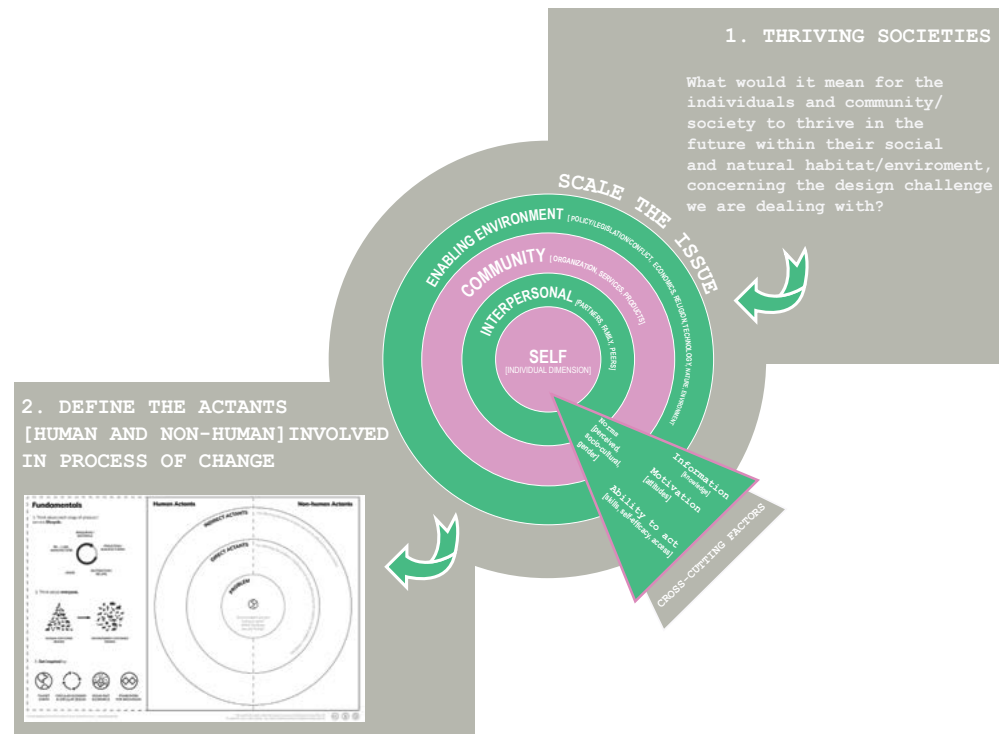


Figure 39: Final Protocol stage 2, task 1 and 2

Regarding **Stage 3**, the author makes some more refinements for stage n.3 of the Protocol according to the expert's suggestions. The refinements concern mainly the integration of some tools and concepts, able to help overcome the issues regarding the mapping of the target behaviours and barriers, using the previous analysis. The author keeps the tasks based on:

- 1) Identifying target behaviours,
- 2) Identification of the barriers,
- 3) Identification of the strategies,
- 4) Verifying the design challenge.

However, she suggests a new way to approach this analysis. One of the participants suggests adding the concept of Stibe's and Cugelman's (2016) model for anticipating the unintended outcomes of behavioural interventions to support the passage between the target behaviour and possible barriers. This Model proposes a way to analyse the intended and unintended aspects of behavioural change to anticipate which impact the interventions or strategies may have. The author reintroduces the Social Ecological Model, and it combines with Stibe's and Cugelman's Model. The reason for combining and applying these two models is because, through Stibe's and Cugelman's Model, we can first identify the intended behaviour where target behaviours to which the intervention should lead, and then possible adverse and unintended outcomes or what may happen if we meet some barriers on the path toward the change. The author puts in between the Social Ecological Model to reflect

on the possible barriers and how these may occur on different levels and potentially lead to unintended adverse outcomes. The social-Ecological Model is applied twice in the Protocol because, as the author explained earlier in this dissertation, it is suitable for defining the agency regarding the sustainability issues and behavioural concerns. It is a bridge that relates to stage 2 and stage 3. To sum up, the first two tasks of stage 3 (identifying the target behaviours and identifying the barriers) are supported by the following tools (see Fig. 40):

- / Model for anticipating the unintended outcomes of behavioural interventions;
- / Social-Ecological Model.

Regarding the strategies selection, the author noticed that it would be better to classify these on two levels, and she proposes a matrix divided into Qualitative, Formal, and Social and functional strategies for behavioural change. The strategies proposed in the previous version of the Protocol (Semi-final Protocol) were too dispersive and challenging to manage. Such a matrix can help us narrow down the research of the strategies. Under the Qualitative and Formal aspects, the author group Lockton's Design with Intent and Dorrestijn's Product Impact Tool. The second half of the circle plots Fogg's Functional Triad and Dorrestijn's Product Impact Tool for technologies' social and environmental aspects. The reason to introduce the Product Impact Tool is to support the analysis of the impact of technologies on society and the environment (ethical implications that the author stresses in this research). This tool explores how human behaviour can be tackled through the formal aspects of the artefact and includes the ethical and societal notions to consider

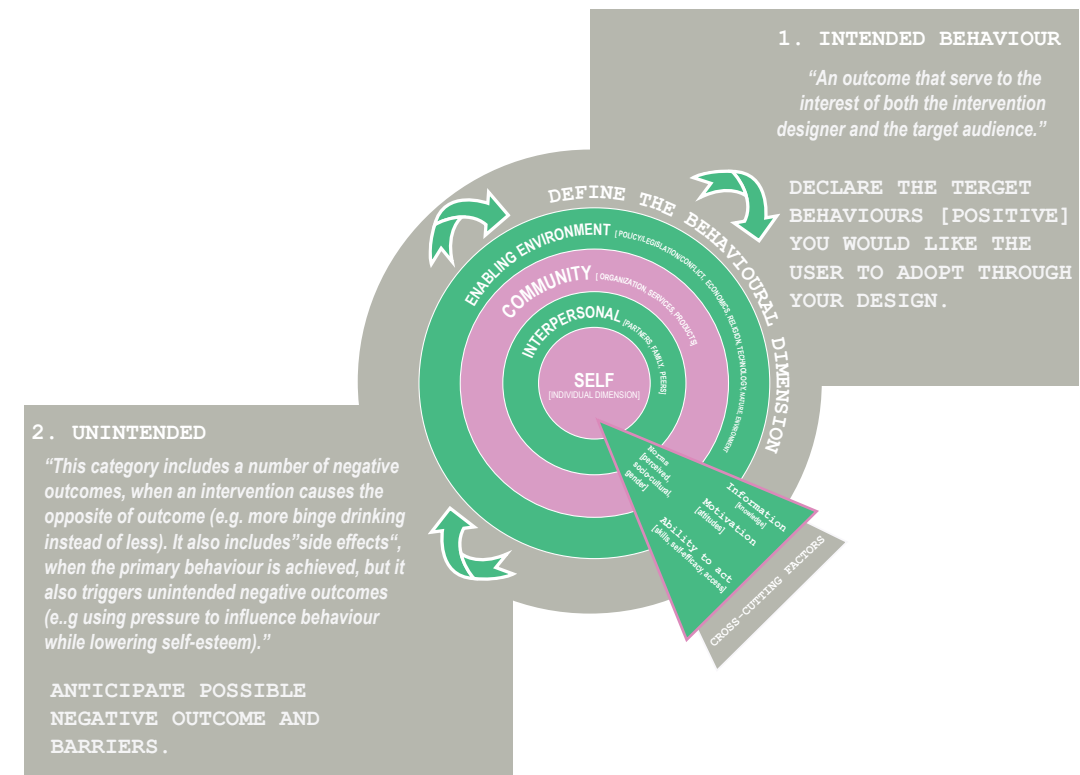


Figure 40: Final Protocol stage 3, task 1

when designing with technologies and for sustainable development. The new classification of strategies provides a more organised approach to selecting the strategies for behavioural interventions, relating all the tools used as the background. For instance, there was some confusion about the Functional Triad and its relation to the rest of the strategies in the previous versions of the Protocol. For this reason, the author decides to divide the strategies into two levels through which one can define and describe the behavioural interventions.

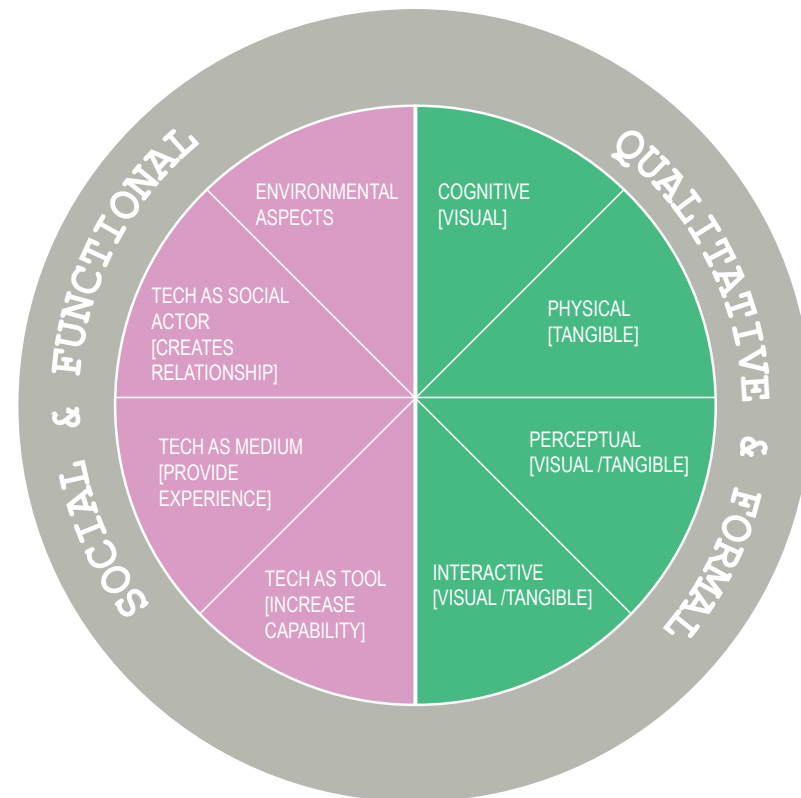


Figure 41: Final Protocol stage 3, task 2

(see Fig. 41).

To summarise, the tools applied in the third task of stage 3 are:

- / Design With Intent (qualitative and formal strategies),
- / Product Impact Tool (qualitative and formal strategies and social and functional),
- / Functional Triad (social and functional).

At **Stage n.4**, the author decided to provide some more guidelines even during the sessions with experts. The experts describe the previous version as a bit abstract. To support this task, the author creates the map suggesting the possible way in which we can use Tech Inspiration Cards (TICs) and analyse future imaginaries, formal and interaction aspects of technological artefact, and possible ethical implications. The approach here is to analyse TICs starting from the findings of stage n. three and analyse utopian and dystopian visions

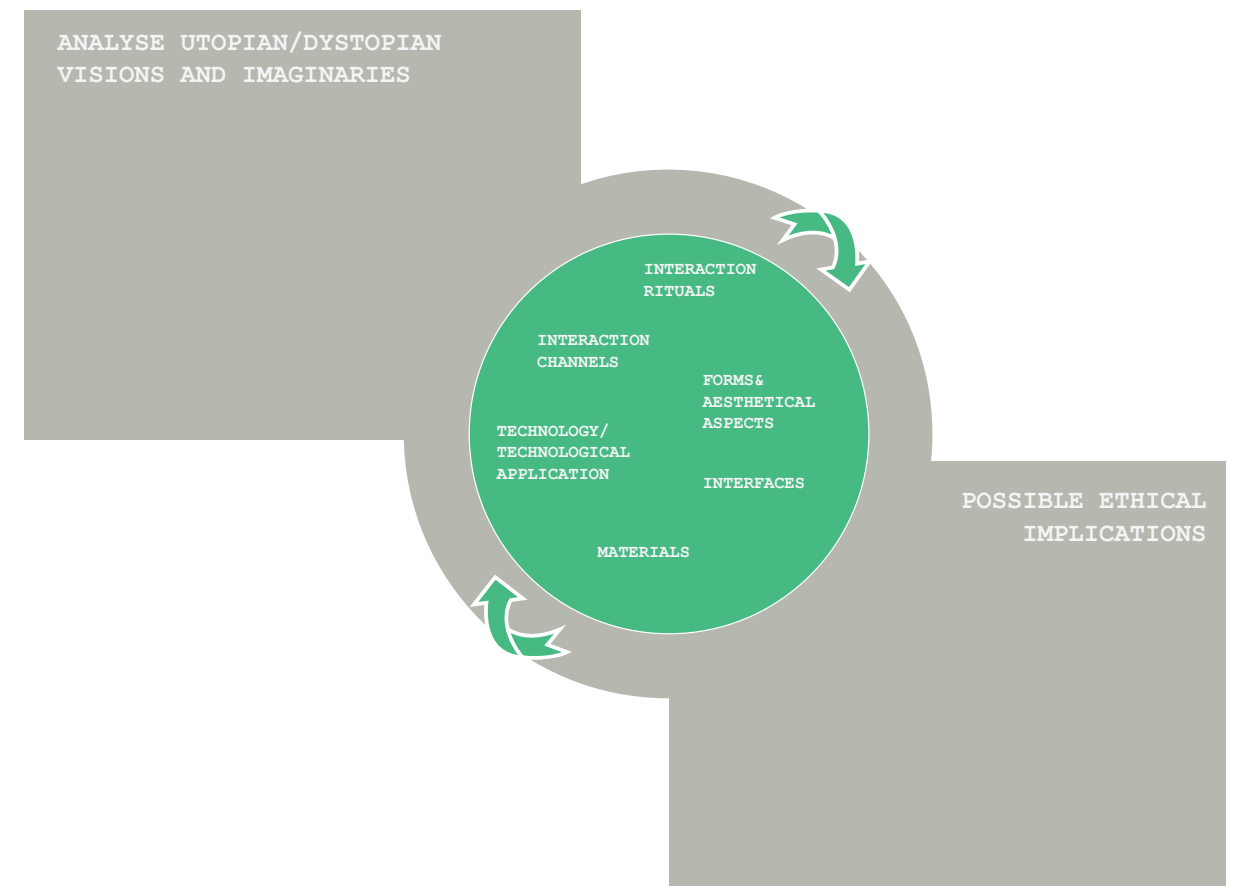


Figure 42: Final Protocol stage 4, task 1

and imaginaries about technological and scientific innovation. Then this stage suggests starting to reason on the technologies that we could use as enablers of the strategies set previously, considering analysed implications. Protocol suggests exploring interaction rituals, channels, novel applications of technologies, interfaces, materials, but it is not limited only to these. Then, this stage suggests exploring possible ethical and societal implications in regard. Fig. 42 is showing the structure of this stage.

Finally, the author refines the guidelines for scenario writing because the experts claimed that it would be better if there were some more instructions on how to build the narration. The guidelines suggest building the narration describing how the society evolved meanwhile, what are the “new normal” of this society, describe how the technology was evolving, systems of relations (human/society/other actants-technology-environment), human behaviour, and others. Afterward, the guidelines suggest describing a near-future artefact by explaining what this artefact (configuration, system, others) is, what does it do (principle of functioning), how does technology perform, how it interacts with the user, how and where do we use it in terms of the environment and context of use. Once we describe the artefact, what remains is to visualise it through sketches, analogies, and others. (see Fig. 43)



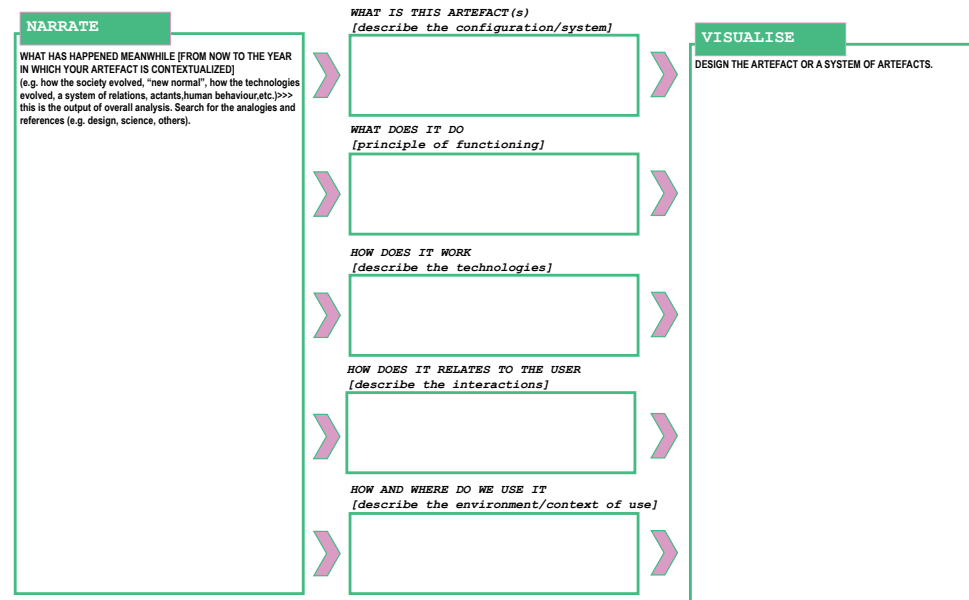


Figure 43: Final Protocol stage 4, task 2

### 6.2.4. Critical points of the activity

The activity with experts showed essential importance for this PhD research. It was an opportunity to confront the people with a long year of experience in different areas concerning this research and, among all, test the protocol to understand whether it can trigger critical thinking. The activity with the experts was conducted online due to the COVID-19 emergency. The online modality showed both as an opportunity and a barrier. It was an excellent opportunity to engage the experts from different nationalities and international institutions, which otherwise would be difficult to manage. The weakness of the online modality is due to the lack of comprehension that was caused on several occasions because of the distance, not having a possibility to interact and engage directly, in person. Another issue that participants claimed was that they are getting tired more easily and lose concentration in online modalities because of the lack of engagement. The author noticed a particular lack of concentration in the last part of the activity – scenario writing. These factors perhaps influenced the validity of the protocol evaluation.

Another criticality when it comes to this activity is that it was short, so in this way, we can observe only one possible application of the protocol. This application would suit the brainstorming, explorative and short activities well, and we can confirm that the protocol is valid in that sense. However, the author needed to investigate how we can use and apply this protocol in a different context and for a longer duration.

In Chapter 8 of this dissertation, the author shows how we can apply this protocol to long term activities and use it several times at different stages of the research or project.

## 6.3. Conclusions

This chapter described the activities conducted in the transition from the second to the third year of the PhD research. These activities were a crucial point in which the author delivered the semi-final version of the protocol and dedicated entirely to refining the protocol and envisioning tool. First in the self-reflection activity and then engaging the experts from different fields interested in the topics and field included in the protocol.

Throughout Chapter 6, there can be noticed how the protocol and applied tools were maturing and always becoming more schematic and connected.

The semifinal protocol was firstly delivered in September 2020 and tested in a self-reflection activity. At that time, it was still very generic, not offering many guidelines, and the tool within it was not systematised. The author noticed some difficulties and improved these before testing them with the experts in February 2021. In the period before February, she refined also envisioning tool that now consists of two dimensions – societal and technological. This refined version of the semifinal protocol and envisioning tool was tested in two sessions, each lasting half-day. The purpose was to test the protocol with tools and collect the anticipatory scenarios that were subsequently materialised – diegetic prototypes (the subject of Chapter 7).

Building on the evaluation of the protocol made by the experts and analysing the output of the activities (scenarios), the author realised that the protocol needed some more refinements, and finally, in March 2021, she delivered the final protocol. The final protocol makes the guidelines more precise at each stage, and it systematises all the tools in the protocol to make more visible the connection between the stages and tasks. On the suggestions from the experts, the author revises and integrates some tools like Stibe's and Cugelman's model and Product Impact tool in stage 3 dedicated to the behavioural concern that was identified as the one that needed more refinements concerning the others. Another critical point was the scenario production that the author revises and offers more detailed guidelines (Fig. 45).

Confronting the experts at this stage of the research was essential. All the experts are experienced researchers or professionals, so the confrontation was meaningful and objective. They had much to offer in terms of knowledge and experience. Nonetheless, these sessions were cases showing the short-term use of the protocol; they were significant for the research. However, the author also needed to apply the protocol in a long-term design research activity from this point on. This activity is described in Chapter 8. Before going there, in Chapter 7, the author describes

the development of the diegetic prototypes from the scenarios constructed in sessions with experts and testing these in focus groups with people.

- Berger, L.P., and Luckman, T. (1968). *The Social Construction of the Reality*. Golden City, New York, Doubleday and Co.
- Bleecker, J. (2009). *Design Fiction: A short essay on design, science, fact and fiction*. Near Future Lab, March, 103–114. <https://doi.org/10.1145/1516016.1516021>
- Carroll, J. M. (2000). Making use: scenario-based design of human-computer interactions. In *Zeitschrift Fur Bibliothekswesen Und Bibliographie* (Vol. 48). <https://doi.org/10.1145/347642.347652>
- Dorrestijn, S. (2009). Design and Ethics of Product Impact on User Behavior and Use Practices. *Proceedings of the 5th International Conference on Intelligent Environments*, vol. 4, pp. 1–8.
- Dunne, A., and Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press.
- Escobar, A. (2018). *Designs for the Pluriverse*. Duke University Press.
- Feenberg, A. (1999). *Questioning the Technology*. Routledge
- Fogg, B.J. (2003). *Persuasive Technology: Using Computers to change what we think and do*. Morgan Kaufmann Publishers
- Janssen, M. A., & Ostrom, E. (2006). Chapter 30 Governing Social-Ecological Systems, L. Tesfatsion and K. L. Judd (eds.); Vol. 2, pp. 1465–1509. Elsevier. [https://doi.org/10.1016/S1574-0021\(05\)02030-7](https://doi.org/10.1016/S1574-0021(05)02030-7)
- Kirby, D. (2010). The future is now: Diegetic prototypes and the role of popular films in generating real-world technological development. *Social Studies of Science*, 40(1), 41–70. <https://doi.org/10.1177/0306312709338325>
- Klenk, M. (2020). How Do Technological Artefacts Embody Moral Values? *Philosophy & Technology*. <https://doi.org/10.1007/s13347-020-00401-y>
- Lockton, D., Harrison, D., Neville, A.S. (2010). The Design with Intent Method: A design tool for influencing user behaviour. *Applied Ergonomics*, vol.41(3), pp. 382–392. [http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx\\_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&article=The+Desi](http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L50669053%5Cnhttp://dx.doi.org/10.1016/j.apergo.2009.09.001%5Cnhttp://sfx.bibl.ulaval.ca:9003/sfx_local?sid=EMBASE&issn=00036870&id=doi:10.1016%2Fj.apergo.2009.09.001&article=The+Desi)
- Latour, B. (2005). Reassembling the Social - An Introduction to ANT. In *Journal of Chemical Information and Modeling*, Vol. 53 (9). <https://doi.org/10.1017/CBO9781107415324.004>
- Loughborough University Institutional Repository. (2017). *Creating sustainable innovation through design for behaviour change: summary report* (Vol. 91). (To check the reference go: )
- Maldonado, T. (1972). *Design, Nature & Revolution*. University of Minnesota Press Mineapolis, 2019.
- Niedderer, K., et al. (2016). Design for Behaviour Change as a Driver for Sustainable Innovation : Challenges and Opportunities for Implementation in the Private and Public Sectors. In *International Journal of Design*, vol.10(Sepember), pp. 67–85. <http://www.ijdesign.org/ojs/index.php/IJDesign/article/viewFile/2260/733>
- Raworth, K. (2017). *Doughnut Economy. Seven Ways to Think Like a 21st-Century Economist*. Cornerstone
- Sanders, M.S. (2009). *The philosophy of Science Fiction Film*. The University Press of Kentucky.
- Stibe, A., and Cugelman, B. (2016). Persuasive backfiring: When behavior change interventions trigger unintended negative outcomes. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 9638, 65–77. [https://doi.org/10.1007/978-3-319-31510-2\\_6](https://doi.org/10.1007/978-3-319-31510-2_6)
- Verbeek, P. (2006). Materializing Morality Design Ethics and. *Science, Technology and Human Values*, 31(3), 361–380.
- Verbeek, P. (2005). *What things do: Philosophical reflections on Technology, Agency, and Design*. Pennsylvania State University Press

# S\_03 > RESEARCH THROUGH DESIGN



# 7

## TOWARD MATERIALISATION: DEVELOPMENT OF DESIGN CONCEPTS AND DIEGETIC PROTOTYPES

The approach behind the Protocol suggests using the future as a space for critical inquiry and production of anticipatory scenarios and produces diegetic prototypes as outputs of that process. The Protocol guides the design researcher and practitioner in building the future to build the elements for the construction of the scenario.

This research defines anticipatory scenarios as intangible forms of design fiction, while the diegetic prototypes are the tangible forms of design fiction.

The purpose of scenarios and the diegetic prototype is to narrate the future and contextualise the not-yet-existing technologies in the 'real' world. Only in this way, the author considers that we can communicate and test the not-yet-existing technologies and artefacts to identify possible societal and ethical implications and, as a result, design more consciously in the present. Design more consciously in the present at the same time means building more thriving futures, giving us a possibility to prepare better in times of uncertainty by considering all actors involved in processes of change toward sustainable development and technological transformation. The Protocol and approach this PhD research to provide a practical way to use the future and speculative design and design fiction principles.

The author suggested one possible way to build the future, through four stages, using several tools, models, and methods, as we could see in the previous text. Until now, this dissertation showed how we could generate anticipatory scenarios from the Protocol, but it did not tackle the materialisation aspects; thus, the initial testing stages were too brief and concentrated on the building of the Protocol, setting the theoretical background.

Initially, the author intended to organise the session to test the Protocol in a format of hackathons during which the participants (design researchers and experts from the field) would materialise the scenarios – deliver diegetic prototypes. Due to the COVID-19 emergency, the author had to

revise the activities because there was no possibility to engage the participants in hands-on activities.

The author decided to organise the sessions to test the Protocol with experts and create scenarios that she would subsequently transform into future concepts and produce diegetic prototypes. This chapter introduces and describes the concepts generated from the scenarios about the technological artefacts able to tackle aware behaviours and materialise these ideas. The last part of this chapter describes the user tests. The author tests the diegetic prototypes with potential end-users to understand whether the technological artefacts embed the values generated through the Protocol and how we could appropriate according to the users. The end-users, in this case, are people who would potentially use these technological artefacts; in a broad sense, they can be defined as technology consumers. These people came from different fields of occupation (also included design), age scale very ample between 20 and 50 years old.

Here and after, the author describes the prototypes, and in the conclusion of this chapter, the focus groups.

## 7.1. *Concept generation and prototyping*

The scenarios developed together with the experts during the reflection activities informed the concept generation. Generation of design concepts is the transition phase between the narrative, intangible design fiction and the creation of diegetic prototypes<sup>[14]</sup>. Beyond the reflective activities with experts, the author also included her scenario, developed during the self-reflection activity, for the prototyping. In the following text, the author re-introduces three scenarios to show how these were transformed into diegetic prototypes.

The first scenario was located in 2050, while the other two were in 2030. These concepts explore new ways to engage the users, influence their behaviour, and study how the technologies can help this process, considering its evolution in time, possible new applications and configurations, interaction rituals and channels, and others. In conclusion to this research stage, author studies the impact of diegetic prototypes on the perceptions of the people and how they can actively participate in co-designing technological artefacts.

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[14] For the author the diegetic prototypes from the material perspective are the physical and non-functional prototypes contextualized in the video (digital mediums) to show the interactions between the human and artefact, and simulate the possible technological applications and developments.

## 7.1.1. Concept 0

Concept 0 comes from the scenario developed within the self-reflection activity, where the reference year was 2050. The topic on which the author did the analysis is “Reducing personal and environmental carbon footprint (as user and consumer) through innovative solutions for air pollution.” The design challenge was preventing the household CO<sub>2</sub>, and other hazards exit the environment.

The analogies upon which the author inspires and build this scenario is the research developed by Israeli researchers on how to genetically modify the metabolism processes of e.coli to transform CO<sub>2</sub> into sugars, which can be transformed into energy, intended as power/fuel, food (human or soil), and even chemicals.

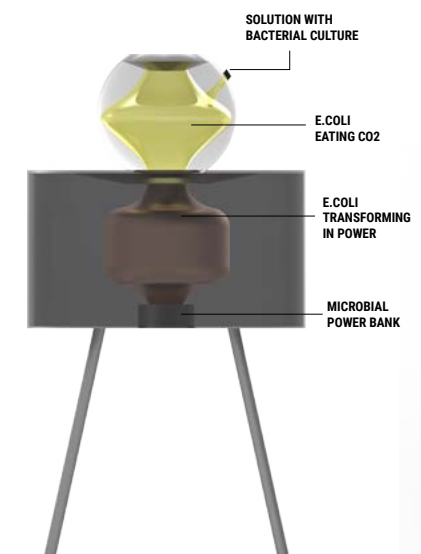
This scenario introduced the Living Artefacts. Living artefacts are, in this case, two artefacts, but there can be even more. These two artefacts can live together or separate. The idea behind developing two of them was to suggest different ways to exploit this technology in 2050s households. The idea here is to give the user the instruments that support sustainable development (engage the user in the process) and at the same time motivate and provide the user with the data. The technology of reference is a metabolic process and genetically modified organisms (GMO), imaging a microbial solution and microbial materials in a house environment. The scientist sees several applications when it comes to this process, where the author selects to focus on two speculative proposals: (1) Transforming CO<sub>2</sub> into house chemicals (detergent tablets), and (2) Transform CO<sub>2</sub> into power to use at your home or share with others. Both concepts explore new technology and technological applications, accompanied by the hypothesis on the new production processes. Besides, the concepts explore how these new technologies and materials will generate new possibilities for interaction modalities and rituals (i.e., using microbial propagation instead of screens). The author will start to introduce the Artefact n.1. The Artefact n.1 within this concept is concerned with the transformation of CO<sub>2</sub> into power. This artefact is a piece of the furniture – living furniture (Fig.44)

The ball containing the microbial solution inhales air from the environment to feed e.coli, producing sugars that are subsequently transformed into power. The transformation system is inside the furniture, and the power gets stored in a power bank. The home has a central unit where we need to leave a full power bank, asking the user how does he/she want to use the power. The possibilities given by the system are to store the power and use it later, use it immediately, or share it with someone from the surroundings.

All the interaction occurs on and around the artefact. The ball changes colours to communicate in an unobtrusive way to the user that there is a notification. The user can interact with the artefact through holographic images and interfaces. The artefact communicates air

quality, gives suggestions on how to improve the habits within the household, when the process is over, and others.

### LIVING ARTEFACT: THE SYSTEM



COMMUNICATING THE BENEFITS OF TRANSFORMING  
"THE BATTERY IS FULL"  
"USE MORE OFTEN THE BATTERY TO POWER THE APPLIANCES"



### MICROBIAL POWER BANK

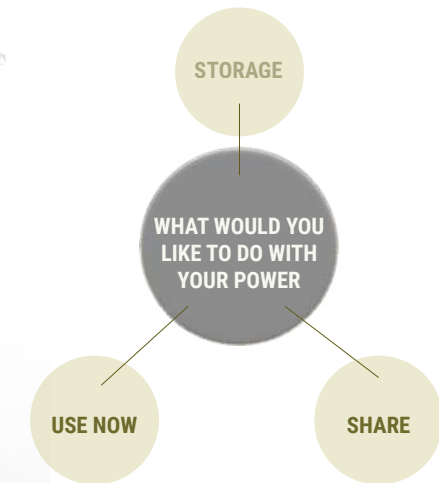


Figure 44: Concept 0, Artefact 1 the system

Also, it was impossible to simulate the diegetic prototypes realistically in this case, so the author went for post-production. She made aesthetical, non-functional prototypes, and she contextualised them in the real world, simulating the interaction in the video and postproduction techniques (Fig. 45).



Figure 45: Concept 0, Artefact 1 video cut (diegetic prototype)

The Artefact n.2 transforms CO2 into tablets for house cleaning or tablets for personal hygiene. It inhales the air from the environment, the inhaled air contains CO2 and even methane, which is feeding the e.coli, and subsequently, this concept suggests transforming the sugars into chemical tablets. In Fig.46 author illustrates a sectioned view of the artefact to show how this technology may function.

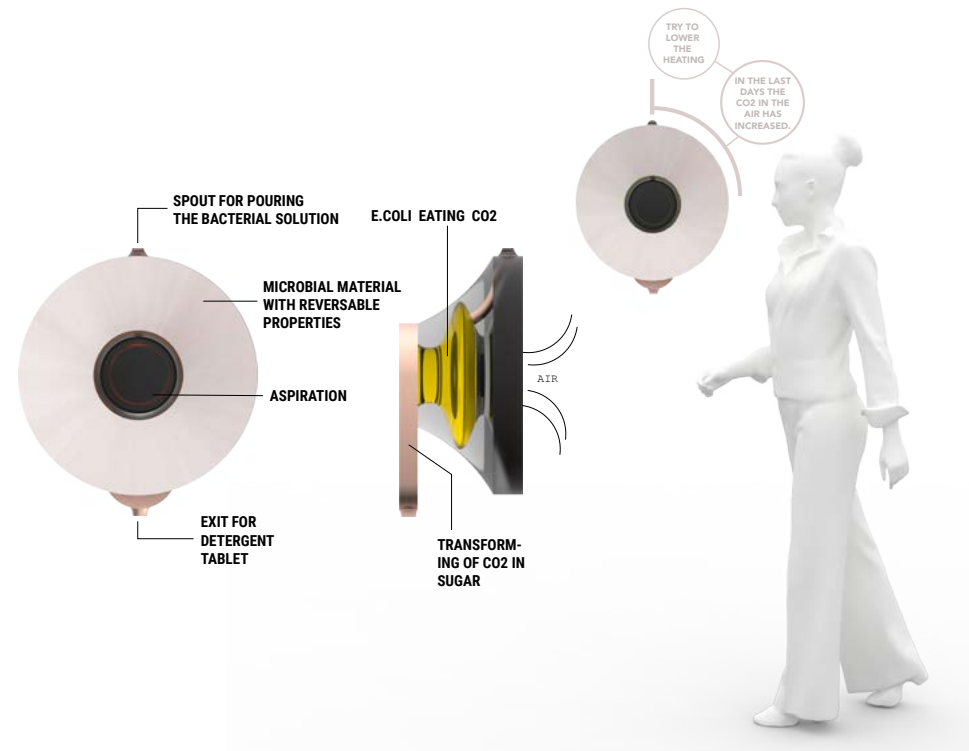
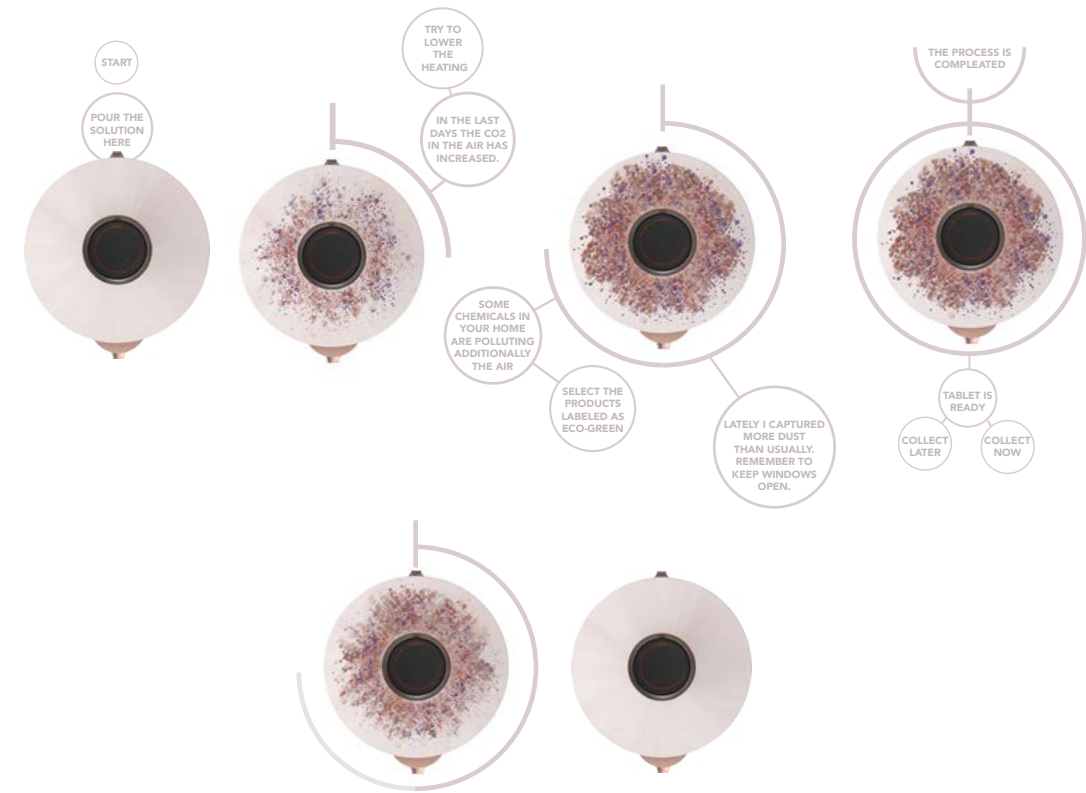


Figure 46: Concept 0, Artefact 2 the system

The artefact has a microbial surface on the front side, which is communicating with the environment. It captures the hazards and reversibly changes its properties – microbes propagate, expanding and reducing on the surface. We can see what is intended by the microbial propagation in Fig. 47.

This concept introduces a new way to communicate unobtrusively through microbial propagation to influence human behaviour. Microbial propagation is reversible, and the more the user exploits the artefact, in a sense, feed the e.coli, the propagation reduces and lets us notice that the air is of better quality. The artefact is performing unobtrusively, yet the user has engaged actively in the process. The process of feeding e.coli (or air inhalation) gets activated by pouring the solution into the artefact. Then the artefact is activated, and during the process, it informs the user about the air quality, giving different suggestions on how to improve one's environment.

POLLUTANTS INCREASING - SURFACE IS SATURATED



POLLUTANTS DECREASING - THE SURFACE IS LESS SATURATED

Figure 47: Concept 0, Artefact 2 interaction and interface aspects

There, the influence on the behaviour is through active engagement in the process, real-time feedback and on-wall interfaces at different stages of the process, and suggestions on how to act in a more aware way. Considering that this artefact lives in our home environment with a passing time, we start to notice the benefits of using tablets and the changes in our habits due to adopting more aware behaviours. The microbial solution eats CO2 while the microbial surface can recognise even VOCs, excess in humidity beyond the first two.

All the interaction is located on the artefact and around the artefact. This concept is imaging that there will be somewhat the multiplicity of the interfaces and new interaction rituals, artefacts that are alive and co-habit our environment, rather than numerous hardware devices and on-screen interfaces in the future.

The author creates the prototypes through the process of sketching, making mock-ups and 3D models. In this case, we have a very distant future, and the technology nowadays exists only in experimental stages, with no applications. Even the interfaces are advanced. For this reason,

the author decides to use the technique of post-production to give life to these prototypes, which become diegetic prototypes. They exist in that scenario and communicate to the user.

To observe how an organism is changing and how the environment influences this we are living in can be a new frontier to establish the dialogue with the environment, understand better our impact, and as a result, take more conscious decisions in the future.

Beyond the artefacts, this concept is imagining all the infrastructure behind such solutions. To support the users or consumers in changing their habits does not consider only the artefacts and interaction aspects but also the conditions for which this is beneficial and accessible. Such a system would require labs to modify the e.coli and produce the solutions. Then this has to be accessed by the users.

The diegetic prototype in question is shown in Fig. 48.



Figure 48: Concept 0, Artefact 2 video cut (diegetic prototype)

When it comes to tackling aware behaviours in users, these artefacts operate on several levels. First, they are both ideated to actively engage the user in the process without keeping him too attached to data and information. These artefacts exist on their own do not connect to the apps of other devices – all the interaction is happening on and around the objects. The concept of circularity behind these artefacts is the crucial factor and strategy in engaging the user in the process and guiding the user in adopting more aware behaviours through education and information. The user learns long in time what practices are causing pollution in the household and how to prevent it. The interactive surfaces (microbial surface and illuminating ball) show in real-time the situation in the environment in an intuitive way through microbial propagation or colors. .

### 7.1.1. Concept 1

Concept 1 comes from the scenario generated in the first reflective activity, focusing on the 2030 as the reference year. The scenario is on the topic “Reducing personal and environmental carbon footprint (as user and consumer) through innovative solutions for waste management”. The design challenge was to monitor the water waste from microplastics, from the shopping cart to the final use of products in households.

The concept represents a device (Doughnut) able to detect the presence of microplastics in chemicals used in a home environment, placing it in kitchen and bathroom sinks, bathtubs, dishwashers, washing machines, and others. The idea is to provide the user with a set of small devices embedding sensors and the mobile app to scan the chemical products, create products’ libraries and consumer stories based on they purchase, understand which products release more or fewer microplastics, and influence consumers’ behaviour. Fig.49 shows the ideation of the concept – device Doughnut with avatar and mobile app.

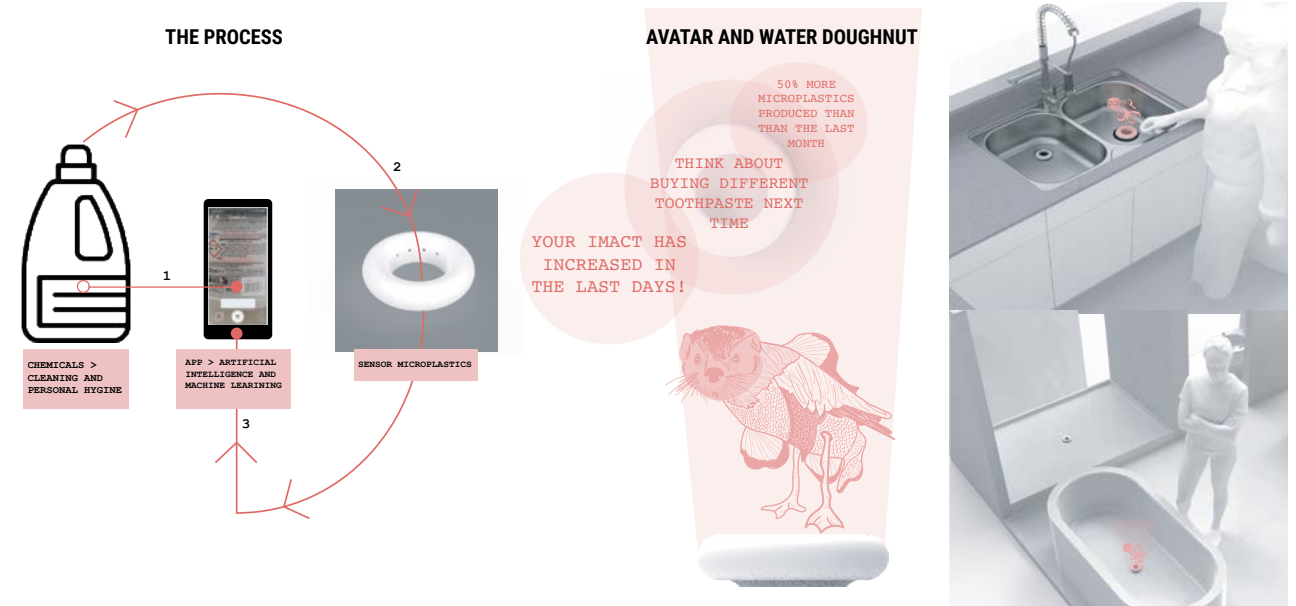


Figure 49: Concept 1, the system



The device uses a holographic avatar (that can be personalized) which appears from the device and speaks to the user. The Avatar has a role in explaining to the user how microplastics impact the rivers, seas, and oceans and give feedback about his/her behaviour. The intensity of the Avatar's presence corresponds to the quantity of the microplastics. The more microplastics are present, Avatar will speak more, and vice versa.

The Avatar is a hybrid animal, a result of the polluted planet. He tells us our story and asks us to change our habits to avoid such mistakes in nature. The strong influence of this concept is storytelling and the active engagement of the user.

Besides the device and the Avatar, this system uses a mobile app. The mobile app helps the user consult and manage data about the cleaning and hygiene chemicals used in a household, monitor his/her consumer behaviour, and others.

The author made a diegetic prototype in a 3D printing technique (Doughnut) and simulated the mobile app (in Figma program). The Avatar and other augmented graphics were subsequently integrated into video as a post-production technique (Fig. 50).

Behaviour, in this case, is influenced by the active engagement of the user with the system. The system provides the knowledge about the products and explains how to choose more wisely (aware) the chemicals. The system works on monitoring consumers' habits and providing suggestions. This concept aims to make the user more aware of his impact on the environment – make an invisible issue visible. The avatar tells the stories to the user about how the microplastics pollute the environment and modify ecosystems. The avatar itself is a hybrid animal resulting from a damaged ecosystem. Beyond supporting and tackling more aware behaviours, this concept explores the new configuration and application of sensors for microplastics. These sensors exist today, but their applicability is still limited and not applied in the household environment, a significant producer of microplastics.

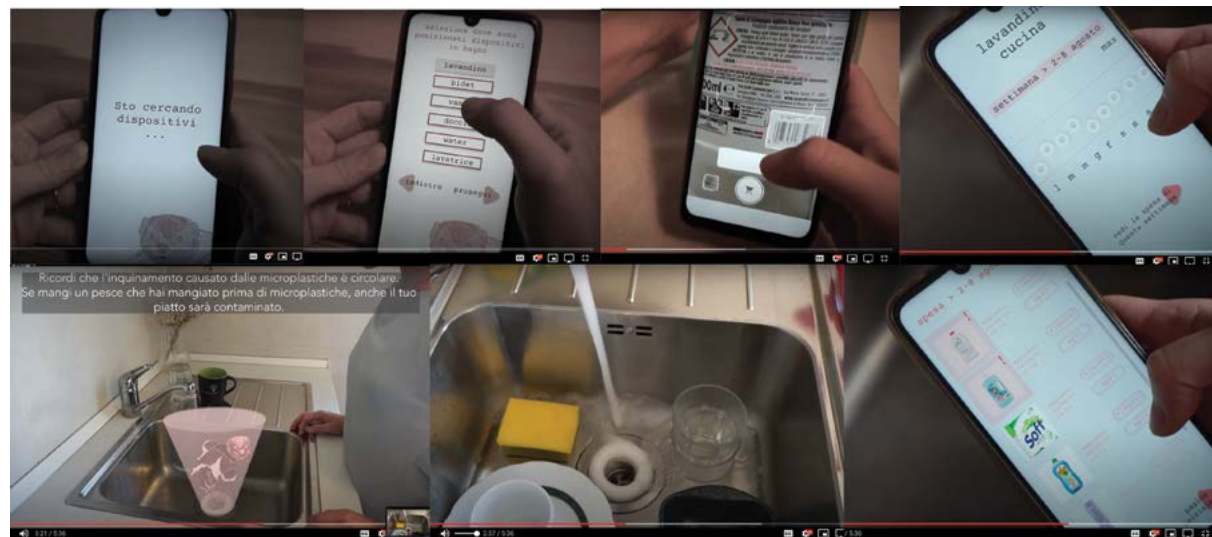


Figure 50: Concept 1 video cut

## 7.1.2. Concept 2

Concept 2 results from the scenario developed in the second reflection activity, focusing on 2030 as a reference year. The topic of this session was “Reducing personal and environmental carbon footprint (as user and consumer) through innovative solutions for energy consumption”, and the design challenge in regard was reducing the energy consumption through the new practices based on energetic independence: I use only what I already have! In specific, the scenario is about the solutions able to transform organic waste into energy. The system then consists of The Animal – Totem – home interface (integrated into the home environment). Fig. 51 illustrates the system.

Through this scenario, the author and experts explored how societies will change in the near future by moving toward rural areas and becoming independent in the energetic sense. The objective here is to design an independent robot for organic waste collection and the totem for collecting the harvested waste and transform it into energy for the community. The general idea is that each family has a robot that is a sort of artificial domestic animal. The Animal harvests the organic waste produced from the other animals and by humans. Once that the Animal is full, it goes to the totem to fill it out. The totem is transforming the waste and distributing the energy equally within the community. Besides, the totem gives feedback about the energy to the community about the progress, distribution, other data.

This concept explores the scaling of the technology and new applications, ideation of the new interaction rituals. However, it also questions how such a solution may impact the infrastructure of the municipalities in rural areas, the interaction between robots and humans, robots, and other animals.

Here the author developed a diegetic prototype as a scenography that puts together all the elements, scaling the context to show how the world with these actors would look like. The author animates the scenography in a video, including also some post-production techniques to show interaction aspects (Fig. 52).

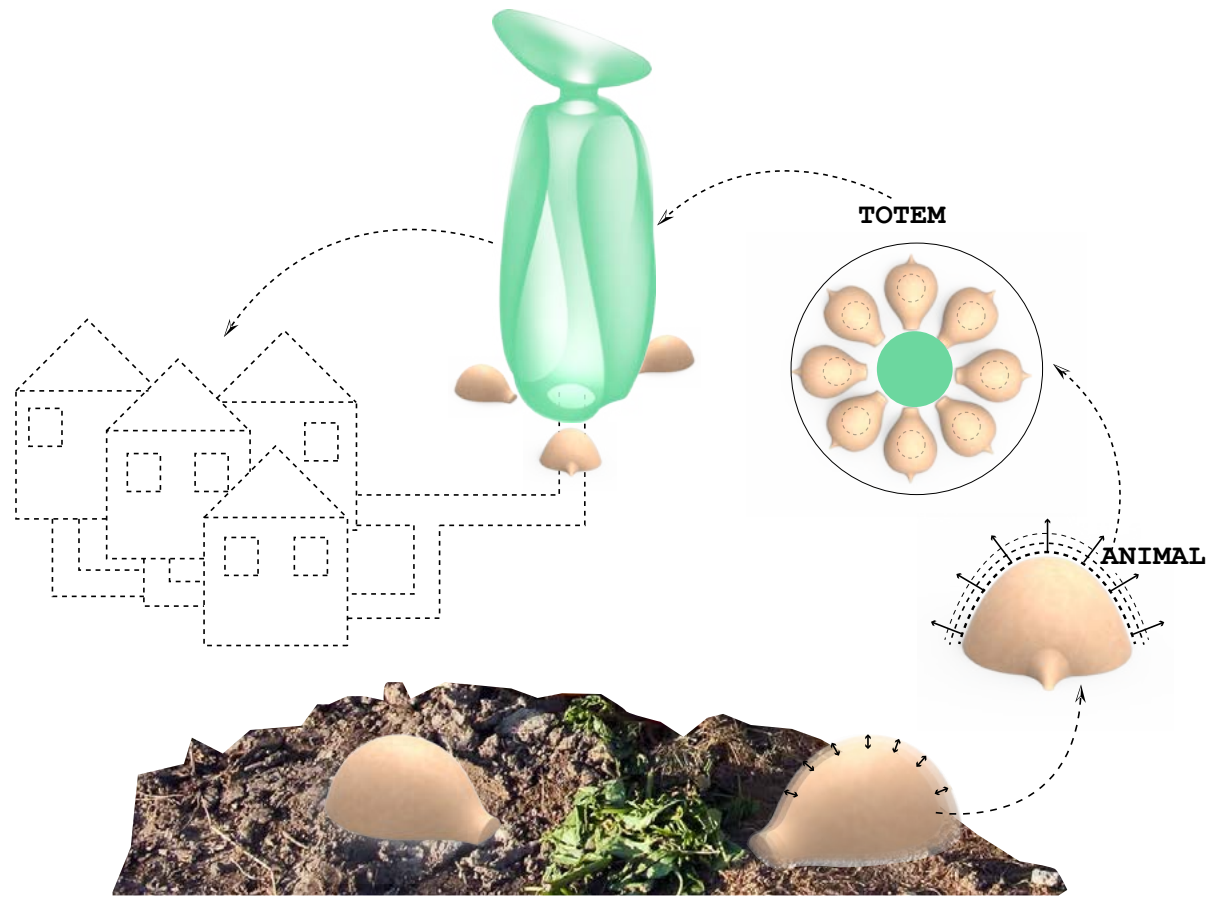


Figure 51: Concept 2, the system

This concept, differently from Concept 0 and Concept 1, explores the system that does not engage the user directly. Here we are speaking more about the service that is operating independently, without the user. This system influences the users long in time by showing him/her the benefits of being a part of such a process. The feedback is personal, and one cannot know how much energy other members produced to avoid conflict situations. The user cannot have much impact on the process. The only way he/she can contribute is with the waste produced in the house. The rest of the waste collected by the Animal is from the fields and other animals. Experts discussed a lot about human behaviour, and their position was that to influence human behaviour is needed first, to provide proper instruments and infrastructure. We notice that such an approach to a problem differs from the first session with experts, even though they used the same protocol with tools.



Figure 52: Concept 1 video cut

## 7.2. User testing

This chapter describes the last stage of the systematized approach, dedicated to the materializations and testing of the diegetic prototypes. Diegetic prototypes have the purpose of communicating the not-yet-existing artefacts and technologies to the broader public, open discussions and debates among the researchers, practitioners, and ordinary people on what our future might be like, suspending the disbelief about the future and the technological, scientific development. This research suggests using the Protocol for researchers and practitioners to trigger critical thinking while designing technological artefacts, exploiting the future as a space for critical reflection and investigation. Building on the Protocol, researchers, and practitioners can deliver the anticipatory scenarios and subsequently materialize these scenarios into diegetic prototypes and use them to discuss how these can be appropriated according to the people's perceptions and rethink the way we are designing nowadays.

Here the author introduces the user testing of the diegetic prototypes generated from the previously described concepts. This user testing has a dual purpose.

The first is to understand whether these artefacts embed the values prescribed by the Protocol in sessions with experts, so the author wants to question if the people perceive the intentions scripts behind the artefacts. This test level concerns the transformation of the scenario in the diegetic prototypes – whether the values expressed in the scenario throughout the Protocol are embodied in these materialisations. Said so, the purpose of this part of the testing was to understand better the quality of the production of scenarios and subsequently diegetic prototypes from the Protocol, in other words, whether the knowledge generated throughout the Protocol is providing the consistent and meaningful material for producing the scenarios and materialisations, and how the existence of these artefacts contribute to critical thinking in design research and practice concerned with technological artefacts and human behaviour.

Secondly, this session demonstrates how we can use these prototypes to open a discussion with a broader public and understand how to appropriate these future visions. In this way, we engage the people in the designing process toward the more thriving and desirable futures. This concern is present in the approach in the Protocol's background (see Fig. 16). To

remind the reader, at the beginning of this research, the author proposes the critical approach for designing technological artefacts to tackle aware behaviours founded on envisioning (using the future as a space for critical inquiry), production of the diegetic prototypes (hands-on), test diegetic prototypes (with users), adapt/develop (reflect on how fiction can inform the present). (see Fig. 16) The author believes such an approach can help design researchers and practitioners design consciously technological artefacts to tackle aware behaviours in the present.

This level of analysis (focus groups) relates to the research question in terms of showing and proving how the passages proposed by the approach and Protocol trigger critical thinking in design research and practice. It relates tightly to the first subquestion that is 'Which principles and theories of Design Fiction (as a critical and speculative design practice) can be implemented and used to trigger critical thinking in research and practice concerned with the design of technological artefacts able to tackle aware behaviours?' since it observes the potential of diegetic prototypes as a tool for triggering critical thinking.

Here and after, the author introduces the aim of user testing. Then she describes the focus group and how the interview was structured to stimulate the discussion. The findings that emerged from the focus group are introduced, and finally, the author will discuss the test's weaknesses with a critical eye.

### 7.2.1. Aim of testing

The aim of doing user tests was to understand two main things. The first is whether the diegetic prototypes generated through the Protocol embed the values prescribed throughout the Protocol. The second is to show whether the diegetic prototypes generated throughout such an approach with Protocol can go beyond mere communicating of the future ideas for the wider public and open the critical discussions and reflections with the people (citizens) who can help us build more thriving and desirable futures together (participatory design and citizen's science).

The author introduced building the scenario through the Protocol, materialising the scenario, and generating diegetic prototypes.

With the materialisations, the author engages the users (technology consumers - people who would possibly use the fictional technologies), as the last part of the approach proposed within this research, to understand what they perceive from these future concepts (design fictions) and learn how to appropriate these visions. The appropriation concerns the critical reflection upon the technologies and systems about its ethical and societal issues, interaction rituals, acceptability of technology, and others, and applying this knowledge into the present research and design projects. The author is evaluating in parallel the production and testing of diegetic prototypes as a

part of the design approach (demonstrate how the entire process of the design and research conducted through the Protocol looks like and bring the conclusions about it), and diegetic prototypes as the output of the Protocol (evaluate the part of the process – conclusions about generating the diegetic prototypes from the Protocol).

For this reason, the author organises focus groups to test three diegetic prototypes. Knowledge generated from the focus groups will also show the Protocol's criticalities, which will be discussed later in this chapter. Therefore, the knowledge generated from the focus groups was essential to show the relationship between the Protocol and diegetic prototypes - how we can "assign the scripts" (Verbeek, year) to the artefact throughout the Protocol. Also, the user testing permitted the author to show an entire design process based on the approach with the Protocol she is suggesting and map all the possibilities that could come afterward in that sense (Protocol application scenarios).

## 7.2.2. Focus groups

The author organised n. 3 focus groups engaging different participants in each. The focus groups were conducted in September 2021 at Politecnico di Milano (campus Bovisa, classrooms of Poli. design) on three dates (10th, 17th, and 24th). The session was in Italian because the participants were mainly Italian citizens or fluent Italian speakers. The focus groups lasted from one hour to one hour and a half each, founded on the same structure and conducted in person. The structure of the focus groups was the following:

- **Introduction into the research and objectives of the focus group,**
- **Watching the video contextualising and narrating the diegetic prototype,**
- **Evaluation of the diegetic prototype through the questionnaire and open discussion.**

The author created three profiles corresponding to each scenario to select the participants. The reason for this is that the concepts were quite different in terms of technologies and the (fictional) context in which the technological artefacts exist, so they were considering a slightly different end-user profile. Another factor was the participants' age since, in the first concept, we are envisioning the year 2050, and in the second and third concept, the reference year was 2030.

There were n.5 participants engaged in the first session, the second n.7, and the third n.9. The participants could see the diegetic prototype in the room, get closer to it, touch it. The video uses techniques that enhance the prototype, showing its functioning, interaction rituals, modalities, and channels – how it engages actively with the user and establishes a dialogue with the environment.

The participants had a chance to evaluate the diegetic prototypes through several parameters introduced here and discuss critically with the author and other participants about the artefacts of the future, their perceptions about it, and suggest how to adapt these according to their experiences and desires needs.

The questionnaires provided in three sessions had the same structure; only the specifications of the prototypes to evaluate were changing. Here the author introduces the questionnaire's structure very generally. All three versions are in the Appendix section included within this dissertation. The questionnaire has three sections:

- 1 | Evaluation of the formal and interaction aspects,**
- 2 | Evaluation of the applied technology,**
- 3 | Sum up.**

Besides this main structure of the questionnaire, the author provided one introductory sheet to collect some general information about the participants. Each of three sessions had this sheet where the participant had to state the age, employment sector, describe his/her ability with technology (how able they believe to be when it comes to the use of the technological devices we have nowadays) on the scale: expert, comfortable, medium, not comfortable, newbie.

Now let us see how these evaluation parameters the author set are related to the Protocol, or better, how the findings from this questionnaire can help the author understand whether the prototypes (as Protocol's output) embed values prescribed by the Protocol.

The first section of the questionnaire, investigating the formal and interaction aspects of the diegetic prototype, wants to understand whether the participants appreciate the interaction rituals, modes, and channels proposed by the concepts how acceptable and comprehensible these are. Besides, the author wants to understand if the users see this prototype as a future artefact and how distant the future is (in line with an initial proposal) regarding the aesthetical appearance and interaction aspects. The first section serves the author to understand whether the formal and interaction aspects assigned to the artefact communicate properly to the user. This refers to the fourth stage of the Protocol, where the task is to design the scripts and understand whether this artefact communicates its purpose properly through the form and interaction aspects.

The second section of the questionnaire investigates the technological aspects of the artefact, such as analysing the primary technology applied in the diegetic prototype and the lateral technologies like interfaces. The author wanted to understand how the users perceive technologies in terms of technological advancement and collocate the technologies applied in the artefact on the time scale to evaluate whether this prototype belongs to the future, and if yes, how distant. This is a matter of acceptability of technology. The author also questions what kind of impression these prototypes give users from the societal and ethical perspective, like positive and negative benefits and possible implications, both on a personal and collective level. This section grasps the elements present in all sections of the Protocol, putting more focus on parts 2 and 4 of the Protocol. It puts the accent on the ethical and societal questions and application of technologies, scaling the issue on different levels. The author wanted to investigate whether the scenarios and diegetic prototypes embodied the values prescribed by the design researchers and experts regarding the ethical and societal concern of technologies – if the participants in the focus group perceived the artefacts as trustworthy beneficial from the societal point of view, and others.

The third section is a sum-up, but it concerns the ability of these diegetic prototypes to support one's behaviour. The author calls it this way because she finds that this ability of the artefact depends on the first two layers: formal and interaction, and technological. Here, the author wants to investigate if the users perceived that the artefact could support more aware behaviours (regarding specific issues) and evaluate single aspects of the prototype

designed with this purpose, like feedback typology, information typology, quality, and quantity of information. The author also investigates whether the users perceived any ethical or social implications regarding how the prototype influences one's behaviour. This section is mainly concerned with part 3 of the Protocol that investigates human behaviour (target behaviours and barriers).

While completing the questionnaires, the participants in the focus group discussed loudly with the author, and the session was registered. After each section of the questionnaire, the author asked the participants to discuss their evaluation of the artefact and explain why they perceived it in a certain way. The questionnaires are in the Appendix section of this dissertation.

### 7.2.3. Findings

During all three focus groups, the participants discussed proactively, building on the questions set by the author and other participants' observations. The objectives of this testing were to understand whether the diegetic prototypes generated from the anticipatory scenario embed the values prescribed to the artefact through the protocol. Moreover, to understand whether the diegetic prototypes can be used with the users to open the critical discussion upon the aware behaviours, technological and social implications, and let the users participate actively in designing the future (adapting the diegetic prototypes according to their needs and desires) as a part of the approach proposed by this PhD research.

Both aspects were satisfied. The diegetic prototypes tested with the participants of the focus groups embed almost all values prescribed by the protocol. The objective of these artefacts was to offer new interactions, interaction rituals, technologies, addressing the sustainability questions and helping the users participate actively in building more thriving societies adopting aware behaviours (become more aware of their environment, how they (they behaviours) impact the environment and others, and how to make a change. Besides, these artefacts are employed in offering a proposal considering important ethical aspects of using technologies to influence human behaviour. The participants in focus groups recognised the proposed technological artefacts – interactions and interaction rituals – as able to engage the users actively in adopting more aware behaviours, as trustworthy and beneficial both for the individual and society. However, the participants were critical and engaged in discussing and reasoning how these scenarios and prototypes could be appropriated to the real world how they could evolve in the technological and social sense, which the author shows in the following text.

From the proactive discussion with the participants, the author identified some frictions or barriers regarding the offered scenarios and diegetic prototypes. The author compared these findings to the sessions in which these diegetic prototypes were generated. This observation aimed to identify how the activities conducted through the protocol impacted the output. The author confirms that

the diegetic prototypes stimulated the critical discussion among the participants who actively analysed the artefacts. The questionnaire results (evaluation) confirmed that the participants perceived the values prescribed to the artefact through the protocol.

Here and after, the author will show the evaluation and describe the findings from each focus group, introducing the participants' profile, the evaluation of the diegetic prototypes, and insights from the loud discussion.

The participants are acknowledged in the section Acknowledgements of this dissertation.

**FOCUS GROUP 1** [Concept 0: Living Artefacts] | The first focus group was conducted with n.5 participants (users) from different fields of occupation and profession (environmental chemist, industrial designer, design researcher, musician, physicist). All of them represent young Italian adults aged from 27 to 34. Three of five participants consider themselves experts when it comes to describing one's own ability with technology, while two of them feel not more than just comfortable when it comes to their ability to use current technological devices. The author will describe how the participants perceived the artefacts for 2050 and how they contributed to their appropriation through critical reflection and discussion.

The Living Artefacts represent two diegetic prototypes. We first analysed is transforming the CO<sub>2</sub> into energy and another into chemicals (tablets) for cleaning and personal hygiene. The author provided two questionnaires, one dedicated to analysing the prototype and another to analysing the second prototype. The questionnaires had the same structure; they were just divided in two to facilitate the evaluation process for the participants.

The author introduced the concept of living artefacts and showed the participants the video – design fiction representing the diegetic prototypes contextualised in the space with the person.

In the case of both Living Artefacts, the participants evaluated the entire interaction aspects of the objects, like interfaces, gestural interaction, and general usability of the artefact. Starting from the first prototype we analysed (transformation of CO<sub>2</sub> into energy), most of the participants were already familiar with some of the interaction modalities of this diegetic prototype. This diegetic prototype interacts with the user through the sound, augmented interfaces, gestural interaction (applied with augmented interfaces), change in color. Within this section, participants showed appreciation when it comes to the immediate feedback modalities (colour-changing ad sound) and also when it comes to the use of augmented and dynamic interfaces (evaluation 4,2 from 5). The third aspect concerning the interaction was regarding the gestural interactions where the author proposes five different modalities associated with a specific action with an augmented interface. This aspect of the prototype was appreciated less than the previous (evaluation 3,5 from 5). The participants did not appreciate some of the gestural modalities combined with some augmented interface and required actions.

When it comes to comprehending the combination of the actions required by the object and information provided by the object and interaction modalities, the participants expressed that most of the cases were comprehensive (evaluation 4,2 from 5). The case they found less comprehensive was the interaction with the power bank (see Fig. x). Generally, all the participants stated that the use of the artefact is not demanding in terms of interaction aspects and overall usability concerning the turning on-off, using the microbial liquid, using interfaces, and others. However, they made a very interesting notion in regard. This artefact is demanding when it comes to its dimensions and integration within the existing house environment, and they found this an essential factor because it depends on how the homes of the future will evolve.

When it comes to evaluation of aesthetical aspects, the participants stated then when in a passive state, the prototype looks like a present artefact; while when the product pass to the active state, with the interfaces, they would collocate it in 20 e 30 years from now, which is coherent with the initial scenario.

Regarding the evaluation of technological aspects of the prototype, the author asked the participants to explain how advanced are these technologies appear to them (metabolic processes, augmented interfaces, energy transformation, and encapsulation, possibility to use the energy you produce) for what they are familiar with today. The most advanced technology for them was the metabolic process, and in terms of technological advancement, the participants stated that they would collocate this artefact between 2030 and 2040. The participants made an interesting observation regarding the possible ecosystem that should be built around this artefact, from the labs to produce and distribute the microbial solution to the design of other technological artefacts in our home which could exploit the energy produced by our prototype. They discussed the criticalities of such a system and how we could build something like this. When it comes to evaluating the trustworthiness of this artefact, there were no particular issues in regard. Some notions made by the participants from their personal experience are that sometimes they are not sure if the technology is monitoring for real and if it is doing that properly. The benefits of this artefact were recognised both on the individual and collective level. Mainly the participants stated the educational aspects of this artefact through the interaction (notifications and information) and the circular process, and the possibility to contribute on a larger scale (share the energy). They noticed that the sharing needs to be adequately solved to avoid ethical implications due to network access, which may be possible. All the participants agreed that this kind of artefact could help them adopt aware behaviours, yet they said that one's impact on the outer world should be more visible.

This artefact influences one's behaviour through several interaction modalities and activities engaging the user actively. The author asked the participants to evaluate the ability and efficacy of this artefact to influence the user's behaviour. As the most efficient way to influence the user's behaviour, participants found it possible to transform and reuse something, giving their contribution. Also, sharing the energy was appreciated here, so the benefits are pretty visible. Another notion they made is that they would not like others to see the feedback about their environment. If the artefact shows the data in front of others, it could be embarrassing; there is instead a barrier than a motivator.

The diegetic prototype 2, representing an on-wall artefact able to capture CO2 and transform it into tablets for cleaning, uses the augmented and projected interfaces and gestural interaction modalities, which the participants appreciated. When it comes to the proposal to use microbial material as an interface, where the microbial propagation and reduction is an indicator of air pollution, two of three participants as a “too alive” solution is even repulsive. Three of them, on the contrary, were very positive about it. The comprehensiveness of the interfaces concerning the specific task of information provided was average (3,2 from 5). They claimed some segments of the interaction, such as the progress line indicating when the process will finish, as not valuable and necessary. Almost all the participants found this artefact as slightly demanding to use, but this was more related to the formal aspects such as pouring the microbial solution was found as uncomfortable and the fact that in this case, the solution is constraining the final product we will obtain. Most of the participants collocated this artefact between 2030 and 2040 regarding its aesthetical qualities (form and interaction aspects), while from the technological point of view, they found it very advanced (almost Sci-Fi).

The participants recognised some benefits on a personal and collective level, such as using fewer plastics reducing the emissions from the companies producing chemicals. Nonetheless, they found this artefact less educational and more personal than we first analysed. When it comes to the implications of this artefact, the only one they wanted to mention was that this kind of artefact should pass to passive states or sleep modes when we have other people in our home. The participants did not find any unethical or obtrusive ways to influence one's behaviour.

In conclusion, they particularly appreciated that these artefacts do not look like the technological ones nowadays – they are not explicitly technological. Only when they pass to active states can we realise that they are technological. They see this as a challenge for the future of technological artefacts, and they like the perspective to make the artefacts more like co-habitants rather than just artificial objects in the space.

From this first session, the author can confirm that the values assigned through the protocol were quite satisfied. Not fully satisfied because the participants noticed some weak points, mainly concerning the aspects of the artefacts' ecosystem (more in the second prototype than in the first one). When it comes to influencing the user's behaviour, possible ethical and societal implications, interaction aspects, the values were recognised by the users, as we could see from the evaluation. The author would like to stress one issue here: the reference year, too far. This issue occurred already in the scenario building, and the author verified it again through prototype testing. Some aspects of diegetic prototypes showed a time disjoint, and even the participants stated that the year was too distant to imagine. For instance, when we came to how the artefact influences behaviour, they made an interesting observation. They said that it was hard to evaluate this aspect because they also believe human attitude will change in 30 years, so perhaps we will need different information.

The author brings some assumptions in conclusion to this part of the text. First, from what the participants said, these design fictions lacks some explanation of the broader system, such as where the microbial solutions are produced, how and where the user can buy them, the proportion between the quantity of the microbial solution and the quantity of the chemicals one can obtain from the single process, and others. The participants said that understanding the system better would be helpful to understand its complexity and how it could be contextualised in the real world. Another essential notion concerns privacy issues – the artefacts should not always be inactive. An interesting aspect is that the participants appreciated the overall interaction with these artefacts, but the microbial propagation left some doubts. These notions are essential to let the design researchers and practitioners understand how to appropriate the artefacts, how to reason more holistically about the systems and infrastructures, distribution, understand better the user's perception about the relationship to the artefact and society, and very important how to make the technology and interactions more acceptable.

**FOCUS GROUP 2 [Concept 01: Water Doughnut] |** Focus group 2 was conducted with n.7 participants, almost all Italian nationality (6 of 7), aged 27 to 42. Most of them come from different fields of occupation and professions, such as kindergarten teacher, flight attendant (2), artisans (2), designer, design research. Most of the participants stated that they feel comfortable when using technologies. The session's structure was just like the previous one, and it lasted around one hour. After the author's introduction and video watching, the participants started filling in the questionnaire through which the discussion has started. Here and after, the author describes the findings from this session.

Regarding this artifact's interaction and formal aspects, most participants appreciated the interaction modalities presented here. (evaluation 4,2 from 5) Some of them evaluated a bit lower the fact that there is a speaking hologram, yet they appreciated the part of the storytelling behind it and how the avatar provides information. When it comes to comprehending the combination of the actions required by the object and information provided by the object and interaction modalities, the participants expressed that most of the cases shown in the video were comprehensive. Some parts of the mobile app were less comprehensive than others, like monthly and weekly data about the level of microplastics released in home and the possibility of monitoring the device in real-time through the app (evaluation four from 5). Most of the participants stated that this artefact (on its whole) is slightly demanding to use, and this is for two reasons. The first is related to the use of the mobile app that the participants said was complex, and the second is concerning less the general usability and more the functional aspect of this proposal, and it is the fact that we need to have several water doughnuts all over our home if we want to monitor the release of microplastics accurately. Most of the participants placed this artefact regarding its formal and interaction aspects on the time scale ten years from now, coherent with the initial scenario. Two of them see this artefact further on the time scale (20 years from now). What generally made them think about this artefact was the device with the hologram; regarding the app, they felt it was something present. On the questions of how advanced this technology seems to them concerning what we have nowadays, they agreed that the device (Water doughnut) is as advanced as technology as so for the holographic images. Two of them stated that they perceive it as science fiction, while the rest can imagine dealing with these technologies in the near future.

Regarding the app, the perceptions were, of course, different. They found it medium-advanced since it reminds them of some of the nowadays apps. Also, from the technological point of view, they collocated this artefact mostly on the time-scale ten years from now, even though they claimed some difficulties in evaluating since they found a big gap between the mobile app and holographic interface.

The benefits were evident to the 6 of 7 participants. The participant that did not see particular benefits stated that if someone buys already bioproducts and biodegradable packages, they probably would not need this.

Some of them perceived more benefits on the personal level and less on global, and opposite. They recognized a sort of educational aspect of this artefact - this particularly related to the personal benefits.

When it comes to implications, participants claimed two potential issues. The first is the politics regarding the producers and chemical companies because if this artefact suggests acquiring based on “this is a good product” and “this is a bad product,” this may cause some conflict. However, it depends on how the environmental regulations will evolve by that time. Regarding the behavioural aspects investigated in section 3 of the questionnaire, all participants believe that such an artefact may help them adopt more aware behaviours regarding the presence and release of microplastics in waters. There were several notions in regard, such as that making the objective more clear (to clean the planet from the microplastics) and evident, and to ensure that the motivation does not decrease long in time (considering that the more the user becomes independent, the avatar is less present). Regarding the different ways in which this artefact tries to support aware behaviours, like storytelling through the avatar, mobile app content, and others, the participants found as the most efficient having a piece of specific information for the specific place of the house (i.e., bath tab), so very factual information. Having data related to the monthly and weekly signs of progress were less effective because participants claimed it is too demanding to check the app. The rest of the strategies, like narration through the avatar and programming the upcoming shopping cart, were quite efficient (evaluation four from 5). Then the author discussed with the participants whether this artefact tends to influence ethically and socially appropriate behaviour or perceived some implications. They did not find any particular issue since the app elaborates data only on what one scans, yet they would like to see something that ensures that third parties will not use the data regarding the consumer’s habits. The experts also raised this concern in the protocol as a possible implication of this artefact, and as we can see, the participants confirmed it in the focus group. There was one more thought expressed by some participants here, even if it is not directly related to the artefact but more to the overall concept, and that is what should we do with the detergents signaled by the device; should we throw them away, leave them around. For the participants, this may be discouraging and possibly a barrier in using this artefact because they need to use the detergent even if they know it is not good for the environment. On the question, if this artefact could help them establish better the dialogue with the environment and let them understand better their impact on the planet, the opinions were divided. Almost all answered yes (5 of 7) in regard,

yet when it comes to establishing the dialogue, not all of them are sure about this aspect, and they explained (2 of 5) that they found it was more about getting information about the environment, but they did not perceive establishing a dialogue. While two participants were very explicit in saying that they did not perceive this aspect and the reason for that is because they could not understand the real impact they have, how much they effectively pollute the environment, and what happens on a larger scale. Building on this, we opened up a discussion on how this artefact may evolve and become more socially relevant, such as managed by the communities, or become a service (we mentioned the thermostat Nest), provide information about the collective use of microplastics. They stated that they recognized that this technology could have many applications beyond a household.

Almost all of the participants (5 of 7) stated that they are not sure if they could imagine themselves using this artefact ten years from now, that this depends on many factors. For sure, something widely shared is that if this kind of artefact becomes more society or community-relevant, it would be easier to imagine it.

The author draws several essential findings from this session. The first is regarding How the interactions offered in this design fiction to influence human behaviour. This design fiction stresses the importance of active engagement of the user in the home and outside the home (differently from Concept 0, where the entire interaction was in the home and on the artefacts), which was found as increasing the user’s cognitive load and may create the barriers in adopting the aware behaviours. The participants claimed the app’s complexity (in terms of the passages that need to be completed, like setting the devices and others) and the fact that the user needs to manage every part of this system. This can be an insight for appropriating the design in terms of service and interaction rituals that could be simplified to reduce the cognitive load. In regard, treating the issue of microplastics on a larger scale would let the users perceive their impact better due to social proof – making sense of the community rather than just involving the individuals.

**FOCUS GROUP 3 [Concept 02: The Animal]** The third focus group was conducted with n.9 participants, almost all Italian nationality (6 of 7), aged 31 to 37. The participants were all design researchers and design professionals from different fields of study, such as industrial design (3), interaction design (2), UX and service design (1), game design (1), fashion design, and sustainability (1), materials for design (1). Most participants stated that they feel comfortable using technologies (6), while others find them expert users (3). The session’s structure was just like the previous one, and it lasted around one hour. Here and after, the author describes the findings from this session.

Regarding the interaction and formal aspects of this artefact, the participants evaluated it as relatively positive in terms of how the artefacts interact with the user (3,9/5), and they found the artefacts functioning, feedforwards and feedbacks as comprehensive (4,4/5). When it comes to the complexity of the artefact (intended as a system and service), regarding the general usability, more than half of the participants did not find it demanding to use since the system is mainly autonomous, which they found as positive. The other two participants found it slightly demanding, and another two demanding explaining this concerns more functional and infrastructural aspects



of this system such as maintenance and service, integrating the Animal in the pedestrian zones. When it comes to the artefacts' aesthetical appearance, almost all participants stated that they would collocate it in the present; another two answered 10 and 20 years from now. The two participants who answered differently explained that this perception has mainly to do with the robot's appearance (The Animal), which is zoomorphic, and this is not typical for the present and most common conceptions about the robots. What caused some doubts in the aesthetical sense is that the interfaces were found too simple; they expect that in 10 years from now, there will be a possibility of more dynamic interactions in that sense. The fact that the participants did not see any interface on the Animal made them bring some troubling conclusions, such as what if we need to turn it off for security reasons, but there is no way to interact; or what if the Animal is behaving in a strange, unexpected way and we do not know how to intervene. The participants would like to establish the dialogue with the Animal because, according to them, it is risky to make it completely independent. Regarding the interfaces each user has at home, they find it too simple and poorly engaging – not in line with the advancement with the rest of the system.

Here we arrive at the second part of the evaluation, which is about the technological aspects. When it comes to the perceptions on how advanced the technologies are represented in this design fiction, participants defined it in its whole between advanced and very advanced. They had some notions in regard. For instance, they wanted to stress that some parts of the system are, according to them, more or less advanced. They found the projected interfaces as not advanced, and they would collocate it in the present.

Regarding the totem, they see this technology as 2030, while The Animal is the most advanced, and they see it more realistic in 2040. There were no particular remarks about these artefacts' trustworthiness; however, the participants had something to add for The Animal. Firstly, considering the nowadays technologies, they had some doubts regarding the autonomy in a practical sense – for how many hours The Animal will be able to operate, and they had some suggestions on how to solve this issue. Still, this aspect was not relevant for this research so we will focus on the second. The second remark was about The Animal's independence in a technological sense (exploitation of AI and ML). The participants stated that they, as users, would prefer to have some minimal interaction with The Animal in order to perceive that they have power over technology – which was not considered in the current concept.

When it comes to whether the benefits and what kind of benefits participants recognise from this concept, all participants agreed that the benefits are recognisable both from the personal (individual's) point of view and social (collective or local). The benefits are particularly evident through the circularity of the system. They even expanded the perspectives throughout the discussion on how such a system of artefacts could help create more natural and sustainable breeding and be expanded from the rural households to the agricultural lands. As the possible ethical and societal implications of this scenario, the participants went back to the trustworthiness of The Animal; this is the only aspect that they find potentially critical. The last part of the focus group was about evaluating the ability of this system of artefacts to

support the user in adopting more aware behaviours regarding energy consumption.

The concept we analysed emphasizes that the people will adhere to the service only if they already have the intention and will to participate; there, we assume that the first passage toward adopting more aware behaviours is already present. The participants agreed upon whether this kind of system or service would support the users in adopting more aware behaviours – they were all optimistic about it. Nevertheless, some potential barriers emerged. The participants were doubtful that the energy in this concept is equally redistributed to the community of interest. They believe that this may create some conflicts in the long term. Their suggestion was to build a more personalised system tailored to one's needs in the energetic sense. When it comes to the strategies used in this concept to influence one's behaviour (autonomous system, information about the community's productivity, personal productivity), the participants found as very efficient the aspect that they do not have to engage much with the process neither with the artefacts. The strategy they found the most impactful is the illuminating totem. However, they prefer to have feedback that does not require reading the data but rather the chromatic changes or some other visual feedback. They added that having the feedback every day at home may be too much information, so they suggested the feedback on request that contains some other tips on consuming less energy beyond productivity.

Regarding the persuasion, the participants identified a few implications and those are mainly regarding the redistribution of the energy – managing produced and distributed energy in terms of potential conflict. Another one is that some of them found the interface at home intrusive. They would prefer it if it were only on request.

All of the participants perceived that this artefact would help them better dialogue with the environment. However, when asked to imagine themselves using this service and artefacts ten years from now, most of them expressed that they were not sure about it because they still see many complexities that do not concern only the artefact itself but rather infrastructures. What they mean by this is the integration of the Animal in society, for instance, in the pedestrian zone or concerning the traffic, also, concerning dogs who would perhaps attack the Animal and others. Also, how the potential failures of the system can be managed – who takes care of it, is it a part of the service, tracking the Animal, and others.

## 7.2.4. Critical points of the study and test

Here and after, the author comments on the critical points of the study described in this chapter. This study let the author comprehend how some of the Protocol's weaknesses influenced the final output (diegetic prototypes) and participants' perceptions about the technological artefacts, interactions, behavioural concerns, and others.

These diegetic prototypes were generated from the scenarios developed in the self-reflection activity and sessions with experts. To remind, the self-reflective activity and sessions with experts aimed at testing the semi-final Protocol and in parallel to develop the scenarios to translate in diegetic prototypes and in this way demonstrate how the entire design approach using the Protocol with design fiction principles can be applied to design technological artefacts to tackle aware behaviours. The author observed the entire process of applying the Protocol and producing and testing the diegetic prototypes as a part of the critical approach and how the analysis conducted through the Protocol shapes the diegetic prototypes – how the prototype embodies the values prescribed in scenarios throughout the Protocol.

It is essential to underline that the diegetic prototypes developed at this stage were the output of the semi-final version of the Protocol. Subsequently, the final Protocol was generated and applied in design and research activity with ITU Copenhagen, described in Chapter 8. The design and research activity with ITU Copenhagen produced the diegetic prototypes on the final version of the Protocol, which are tested again.

In Chapter 6, the author showed that after the sessions with experts emerged, the semi-final Protocol needed to be slightly modified. There were some issues concerning the stages of the Protocol and some of the tools applied in the Protocol. For this reason, the author considered the issues that emerged in the Protocol and observed how this impacted the final output – the diegetic prototypes. Indeed the author noticed that there were relations between these; for instance, the participants in the focus groups claimed several times that the design fictions did not take into consideration the broader context of use such as infrastructures, actors, distribution of the technology, how the individual behavioural concern is related to the social concern, and others. This issue is tightly related to stage 2 of the semi-final Protocol and the passages between stages 2 and 3 – building the agency and scaling issue and behavioural concern. However, this issue was solved in the final version of the Protocol.

Regarding the focus group and participants, there were no particular issues or difficulties when it came to the participant's activity and engagement in critical discussion. Nevertheless, some critical aspects deserve to be mentioned. The author noticed during the testing that what could be improved is the narration dimension in videos. The participants claimed that the narrative part could be more detailed on several occasions. This factor may impact the general understanding of the diegetic prototype and influence its evaluation. The author

considered the claims for improving the guidelines on building narration in the Protocol. Still, this issue cannot be solved entirely because building the narration with digital media also concerns one's capacity to use this media. It can be noted that diegetic prototypes made in this way are a bit limiting because they require specific skills and knowledge.

Another point that the author would like to stress regarding the study is concerning the methodology where perhaps a discontinuity in the process can be noticed in terms that not the entire process was conducted with experts. The experts participated in brainstorming and scenario building, not in the making of diegetic prototypes. The author conducted this part of the activity individually; there it may be said that there is some subjectivity in such a process because the diegetic prototypes are the author's interpretation of what was set with experts. From the methodological point of view, this could have been perfected by consulting the experts long the generation of prototypes. However, this aspect was less critical at this stage of the research, and it did not impact the study particularly.

## 7.3. Discussion

The materialisation of design fiction is the last stage of the critical approach proposed by the author in this PhD research. In Chapter 7 author described how the diegetic prototypes can be generated through the protocol and finally 'used' to discuss with the people to understand how they perceive these anticipations of technologies to tackle aware behaviours toward societal challenges. Besides, this chapter demonstrates how design researchers and practitioners could consciously design the technological artifact, engaging people to build more ethical technologies and thriving futures.

In Chapter 6 author showed the critical points of the semifinal Protocol, as the need to guide more scenario writing (the narration) and establish a better connection between some elements such as the scaling of the issue and human behaviour, behavioural strategies, and technologies. It is essential to remind that the overall evaluation of the semifinal protocol was good, yet it needed some improvements. The improvements are always reported in Chapter 6 and its application further in Chapter 8.

Some of these weaknesses were also evident in diegetic prototypes, especially the narrative structure, regarding the relationship between different elements of the artifacts' systems, like in the case of Concept 2 (The Animal). The participants claimed that the way the Animal is integrated into the society is not deepened enough and there were lacking the thoughts about possible system's failure in a practical sense, and some other. This example shows some gaps between the protocol stages faced in improving the final protocol.

Although the semifinal protocol needed some improvements, this study shows how meaningful the participation of the citizens (citizens) in this approach is for designing more consciously technological artifacts. People (participants of the focus groups) analysed the diegetic prototypes critically, observing different issues that the experts did not consider during the session. The discussion with people opened some crucial questions regarding technologies and human behaviour, based on their experiences, knowledge, expectations, culture, and others. Focus groups are a powerful method to apply when it comes to anticipating the technologies and behaviours (mediations). The people get very engaged; they build upon the speculative proposals in an expressive way, they tend to stimulate one another to debate, raise 'what-if' questions and provide important insights for design researchers and practitioners to appropriate the technologies, anticipate the possible ethical and so-

cial implications and deliver the conscious design of technologies for human behaviour. For instance, the evaluation of diegetic prototypes through questionnaires and open discussion can be analysed to revise the speculative proposals and understand how to appropriate these in terms of interactions, application of technologies, contextualising in the real world to design more consciously in the present by understanding better the experiences people live in relation to the diegetic prototypes (regarding adopting aware behaviours, using technologies to adopt aware behaviours toward sustainable development).

In this study can be observed entire process with both experts and people involved - from interacting with experts and generating the first level of knowledge through 'making' - production of scenarios, design spaces, and diegetic prototypes, to co-designing with people (users - technology consumers) through understanding their dreams and needs, fears and beliefs about the technologies to tackle aware behaviours.

# 8

## COLLABORATION TO THE PROJECT “FUTURE OF MOBILE TECHNOLOGY” WITH ITU COPENHAGEN

In March 2021, the author started the period abroad with Copenhagen ITU, within IxD Lab, in a remote modality due to the COVID-19 emergency. The IxD lab conducts research interested in a physical exploration of new forms of interaction, new materials and computational expressions (<https://ixdlab.itu.dk>).

For the author, it was a chance to test the protocol within the actual research activity, with experienced researchers interested in this PhD topic. Unlike the previous sessions, this activity demonstrates how the protocol can be used beyond the short one-day brainstorming activity, as we see in the previous chapters.

The objective of this collaboration was to develop the research project about the “Future of Mobile Technology” using the author’s approach and protocol with tools.

The team of two ITU professors (assistant professor Tom Jenkins and associate professor Laurens Boer) wanted to investigate possible actions and solutions that might bring smartphone users to less problematic use of these technologies and technological devices in the near future.

In this chapter, the author describes the activity, which lasted almost one year. We will see the background and methodology established in this research, how the approach and the protocol with tools were applied, and finally, discuss the results and give a critical overview of the use of the protocol.

## 8.1. Aims of collaboration and design activity

This research aims to explore the Future of Mobile Technology, focusing on the prevention of problematic behaviours and possible mental health issues related to smartphones' (mis) use. In specific, the authors explore how the smartphone as a physical artefact (portable and easily accessible) with its dynamic and interactive content (i.e. Social Networks and related applications, Internet), impact human behaviour. In conclusion, the authors want to suggest new ways to think about the smartphone to avoid problematic behaviours, such as Social Networks addiction and Internet Addiction found as the most widely spread nowadays.

This research is conducted through several stages and activities founded on the approach proposed by the author and the use of the protocol with tools to trigger critical thinking when it comes to design this typology of technological artefacts.

For the author, this activity was a case study through which she could test the final version of the protocol and tools spread over the whole research activity. Authors together want to explore how the material properties of the smartphone and interaction rituals could be designed to help the user avoid problematic behaviours, adopting the critical approach throughout the research. During the development of this research, the protocol was used several times at different stages of development.

Firstly, to create the anticipatory scenarios (intangible artefacts) and identify possible design spaces for 2030. From this stage, the authors also set the survey. Secondly, the authors use the protocol to refine the research, starting from the survey's results and generate different design directions (design concepts). Once that the authors defined design concepts, they moved toward the materialisation of the artefacts, producing diegetic prototypes.

The final output of this research are diegetic prototypes - smartphone able to prevent problematic behaviours. Here and after, the author describes more in detail the project through the background and detailed research methodology.

## 8.2. Project description

The fundamental concept of this research topic is to raise awareness, engage, and empower the users with concrete tools (software, app, hardware, others) to monitor their behaviour and enable them to change their behaviour concerning the use of mobile technologies - to prevent the problematic behaviours in the use of smartphones - through individual and social action and innovation. These actions may include developing new or improved technologies and artefacts concerning the sensors, applications, data collection and management, Operative System, included physical properties of the smartphone and interaction rituals (HCI foundations), and others.

Through this topic, the authors investigate how the smartphone's material characteristics and embodied interactions can influence the user's behavior and design them to prevent problematic behaviours. The idea to focus on problematic behaviours concerning the smartphone as a technological artefact came from the finding that many issues concerning this phenomenon were identified in the last years, specifically Social Networks and Internet Addiction. However, no medical protocols are treating these issues yet, differently from gaming disorder that has recently become recognised as a health problem by the international community, neither it is widely considered a problem by ordinary people. (Ting and Chang, 2020)

The authors explored in-depth this issue through the literature review, mainly to understand and map what kind of problematic behaviours we are treating, what causes them, what kind of social and personal problems these addictions may cause, but also current studies on how the design of smartphone in its real influence the occurrence of these behaviours.

Literature review results helped authors set the research topic in a more narrowed way, and from this point on, they started using the Protocol. The idea was to use the Protocol at different stages of development for envisioning and designing, passing from the intangible form of design fiction (anticipatory scenario) to the tangible design fiction (diegetic prototype).

At the first level, the use of the Protocol had a purpose to help in exploring further the research topic and identify possible design spaces. The output of the first activity was an anticipatory scenario from which the authors identified possible design spaces for the future. Besides, the authors

set the survey through which they wanted to test the literature review findings and people's perceptions about smartphone use, the future of mobile technology, and collect personal experiences and rituals regarding one's use of this technological artefact. The authors obtained around 125 answers, analysed and used them to refine the research, and inform previously defined design spaces.

The survey results were used to revise the first analysis conducted throughout the Protocol (the second Protocol use) and discussed how to generate concepts. The output of the second use of the Protocol was n.4 design concepts for the future, proposing different ways to deal with problematic behaviours concerning smartphone use. These concepts were further refined and materialised.

In the text below, the author introduces the theoretical background behind this research and applied methodology. Then she describes more in detail the application of the Protocol in research and the benefits of its use. The author describes all the results obtained from the research activity and discusses the Protocol critically in terms of its efficacy in triggering critical thinking, advantages, and weak points when it comes to its use in long-duration activities.

## 8.2.1. Background

Mobile communication is the most pervasive technological tool, deeply embedded in our everyday practices and all aspects of our lives, where mobile phones have been the most rapidly disseminated technology in human history. (Arminen, 2007) Mobile (communication) has contributed to socio-economical and socio-technical development by connecting and trade on distance. (Green, 2002) We witnessed the fundamental change and evolution of mobile technology, in the last years, due to the pervasive development and implementation of advanced technologies, where micro-technologies, and nanotechnologies, novel materials. Smartphones are an inseparable part of our lives and activities.

The Mobile technology “[...] unfolds new ways of organising and conducting everyday practices in different spheres of life. Mobile technology and artefacts are more and more apparent and visible. The use of mobile phones and other portable media devices are increasingly a part of the construction of identities and collectivities.” (Ek, 2012)

We use mobile apps for payments, entertainment, work, orient the space, understand and control our environment. These activities are enabled thanks to the numerous apps and sensors embedded in our smartphones.

Mobile applications make our lives easier in a certain sense. Beyond already mentioned applications, smartphones offer promising ways to prevent and control numerous diseases, such as non-communicable diseases (diabetes, cardiovascular, and others), and improve general well-being (weight control, healthy eating habits, sleeping control, and others). From this brief introduction, we can observe that smartphones and mobile apps may have a role to reduce negative behaviours. However, its overuse may lead to addiction and several problems of physical and mental nature. The most common physical issues caused by the overuse of the smartphone are sight problems, neck and joint pain, and sedentary. The mental issues are even more concerning than the physical ones. Smartphone overuse may lead to addiction which sleeping disorders can accompany anxiety, depression, damaging social interaction and conversations, management (organisational) and attention problems (i.e. school or academic learning problems), and many others. (Wilmer, Sherman, and Chein, 2017)

Mobile technologies, wherein particularly smartphones with their pocket-size dimensions, gave us an easy and instant way to access an enormous amount of information due to persisted network connectivity, which fosters the “repetitive inspection of dynamic content quickly accessible

on the device” (Oulasvirta, Rattenbury, Ma and Raita, 2012). This phenomenon enabled the development of new habits related to the Internet and Social Media use, and the two main origins of smartphone addictions are Internet Addiction Disorder (IAD) and Social Media Addiction (SMA). An addiction in terms of smartphones is: “a repetitive habit pattern that increases the risk of disease and associated personal and social problems, often experienced subjectively as “loss of control.” (Oulasvirta, Rattenbury, Ma and Raita, 2012)

Digital technologies, specifically Social Network Systems (SNS), are designed to be addictive. These technologies use a set of pervasive and motivational techniques to keep the users attached. Like Ali, Arden-Close, and McAlaney explain: “[...] “scarcity” (a snap or status is only temporarily available, encouraging you to get online quickly); “social proof” (20,000 users retweeted an article so you should go online and read it); “personalisation” (your news feed is designed to filter and display news based on your interest); and “reciprocity” (invite more friends to get extra points, and once your friends are part of the network it becomes much more difficult for you or them to leave).”

*Fear of Missing Out (FoMO)* and *Checking Habit* is the most common phenomenon concerning the overuse of the internet and social media. Therefore, smartphone addiction is associated with different factors, such as personal habits and loneliness, and the typical symptom caused by this condition is feeling uncomfortable and irritated when the smartphone is not accessible. (Mohammad, Arash 2013)

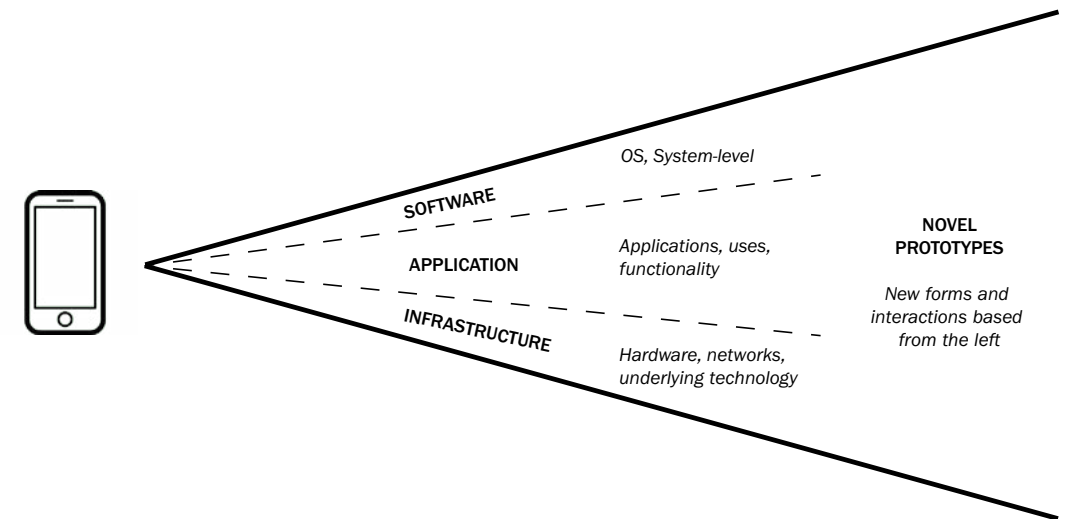
The World Health Organization (WHO) is putting a particular focus on the problematic use of mobile technologies by children and teenagers, and young adults. The WHO explained that the excessive use of mobile technologies might replace healthy behaviours and habits such as physical activity and sleep and leads to harmful habits such as reduced sleep or day-night reversal, malnutrition, headaches, neck pain, and others; lead to the development of gaming disorder and encourage migration to gamble as some games have gambling-like elements.

Excessive smartphone use has adverse effects on our social relations and our mental and psychological health. Recently there are some solutions developed to help the users control their use of social media and the internet, generally in the form of mobile apps that monitor the behaviour and help to prevent problematic behaviours through the limited use/access to apps (*AppDetox*, *Lock n’ lol*, *The SAMS*, *NUGU*).

Some focus on the particular context like classrooms and studying in general (*FOCUS*), family time (*FamiLync*), and others. The principle on which these apps work is most of the time founded on restricting users, and they are not always successful, since in some cases, it may cause the opposite effect, as some research demonstrated on young adults. Another case, a bit different than previously introduced ones, is Google platform *Digital Wellbeing* (<https://wellbeing.google>) that helps users test their attachment to the technology through the questionnaire and suggest how to find a balance with technology through the guidelines and toolkits (one of them is dedicated to the digital wellbeing during COVID-19: <https://static.googleusercontent.com/media/wellbeing.google/en//static/pdf/digital-wellbeing-tips.pdf>).

Building on these findings and several case studies, the authors decide to explore the future of the smartphone through the lens of preventing problematic behaviours such as Social Networks Addiction and Internet Addiction.

This collaboration aims to explore the interplays between the individuals and mobile technologies, and societies and mobile technologies, to understand better the issues behind its problematic use (behaviour), and how we as designers and design researchers might anticipate the design spaces through anticipation of technological development and novel applications within this sphere. In conclusion, the authors want to suggest several speculative proposals and diegetic prototypes that represent the near-future fictions about how we could deal with these issues with the new technologies and interaction modalities and rituals. The ITU proposed the framework for exploring this issue that was expanded and explored throughout the project. (Fig.53)



| Contemporary social concerns      | Material exploration                                                         | Future scenarios                                                 | Articulate Future Concerns                            |
|-----------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------|
| Problematic smartphone use        | Alternate forms?                                                             | What kinds of futures could unchecked social challenges lead to? | What is the future of personal and mobile technology? |
| addictive qualities of technology | Where does technology diverge? How could innovation affect future materials? |                                                                  | Future forms?                                         |

**Figure 53: Framework for exploring the Future of Mobile Technology by IxD lab (ITU Copenhagen)**

## 8.2.2. Methodology

The methodology of this research was tailored according to the approach proposed by the author that exploits the use of design fiction principles for the design of technological artefacts to tackle behavioural change. There, the researchers established the methodology in the following way:

- 1| **Desk research (literature review),**
- 2| **First use of the protocol (brainstorming),**
- 3| **Survey,**
- 4| **Second use of the protocol (expanding the desk research),**
- 5| **Concept generation,**
- 6| **Materialisation,**
- 7| **User tests.**

The research started with desk research, considering a detailed literature review on problematic behaviours related to the use of smartphones, such as Social Networks Addiction, Internet Addiction, Technology Addiction, and others. Firstly, the authors tried to analyse and identify the problematic behaviour, the causes and adverse outcomes for the individuals and society. They observed different case studies to understand how the problematic behaviours are related to the specific context of use or the smartphone's content (digital content such as apps, internet, and others).

Finally, the authors analysed also some works that investigate how the material properties of the smartphone and other experiential aspects such as interaction rituals and modalities influence the use of this artefact. All the results of the literature review were summarised and applied in the first use of the Protocol. The objective of the first use of the protocol was to identify possible design spaces within this topic by expanding the research and identifying the specific design challenge on which to focus and explore the unknowns of this topic, reflect and discuss the subject of interest critically. This stage was explorative, so the author set the brainstorming half-day activity, which took place at the end of March 2021. To remind, also this activity was conducted in a remote modality.

The output of this first activity within the project was the anticipatory scenario, describing 2030 and the person's relationship to the smartphone, how the technologies and societies evolved. This anticipatory scenario helped the researchers set the design spaces. The researchers explored design spaces on three levels starting from the anticipatory scenario: Normative, Technological, and Metaphorical (formal). The author describes design spaces more profoundly in section 8.2.3.

Once the authors set design spaces, they decided to conduct the survey to confirm or con-

tradict the desk research findings and the first output generated through the protocol. The survey was structured into three sections. The first section is general questions about the survey's participants, like age, occupation, gender, and evaluation of one's technology ability. The second part of the survey was about usage patterns. The researchers wanted to understand better how the users use the smartphone concerning the context of use and what kind of content they tend to use the most; for how long they use it; what draws their attention to the smartphone; if there are any adverse effects of the smartphone use, they recognise and senses of guilt; whether there is anything that the person would like to change about the smartphone.

The third part of the survey is about the device stories. Here, the authors wanted to investigate the current interaction rituals and modalities (what kind of interaction the person mainly uses and what depends on). Besides, through this section, the authors focus on some specific technologies, emerged from the first activity as those that will be the most exploitable in the near future, such as Artificial Intelligence (AI), but also data management and collection; this to understand how the people perceive these technologies today and how knowledgeable they are in regard. Then the authors wanted to explore how people imagine the future of the smartphone where some analogies and descriptions were provided. The last part was about the person's stories, such as describing the routines and stories about how they use smartphones. The complete survey is in the section Appendings of this dissertation.

The authors reached 125 answers which were analysed and organised in a way to expand the first analysis conducted throughout the Protocol, such as to verify whether the design objective is relevant, investigate the context of use, behavioural patterns, interaction rituals and mediations, verify the potential of the previously identified design spaces to answer the design research objective (propose the new interaction rituals and forms that could prevent the problematic use of the smartphone).

The authors organise the second activity to apply the survey findings to the Protocol to refine the research nourished with the people's stories. The objective of this activity was to generate the design fiction concept as the output. The activity lasted another half day. The authors discussed the findings using the protocol. The purpose of the second use of the Protocol was to expand the design spaces and translate them into a concept. Four abstract ideas were generated from this activity. Starting from this, the authors continued developing the design fiction concepts, narrowing the selection on three concepts (later in the text the author explains why).

These concepts were then materialised and represent the final research output of this research project. Fig.54 illustrates the methodology applied to this research project.



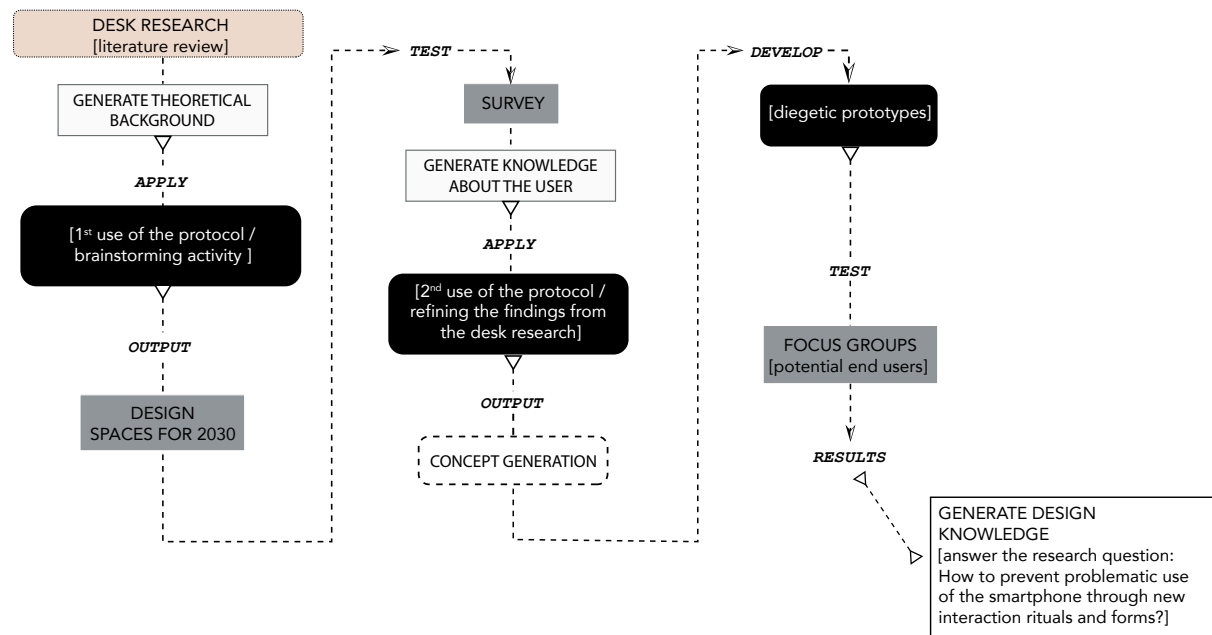


Figure 54: Using the protocol through the research

### 8.2.3. Application of the Protocol described

Here and after, the author will describe in detail the use of the protocol within the design research activity with ITU. The authors used the protocol several times to brainstorm, set the topic, and refine the data. However, the protocol was continuously present in our research because it was a background to consult long the process.

In the first use of the protocol, the objective was to explore the starting topic and identify possible design spaces for mobile technologies in 2030. The team wanted to explore both the material and interaction properties of the smartphone and its influence on human behaviour. The findings generated through the literature review were narrowed down and used as a starting point in the protocol. The societal challenge, in this case, is human mental health and wellbeing about technology use.

For the activity, the author selected in advance Societal Inspiration Cards (SICs) and Technology Inspiration Cards (TICs) that are tightly related to the mobile technologies (such as pervasive use and presence of Social Networks, Internet, information, technology, and others, but also to the mental health and wellbeing concerning SNS addiction, Internet Addiction, Technology Addiction.

Within the SICs and TICs library, the author found nine titles matching these topics, where: “Nosedive” (2014, by Joe Wright), “Her” (2013, by Spike Jonze), “Ready Player One” (2018, by Steven Spielberg), “The Circle” (2017, by James Ponsoldt), “Hang Out the DJ” (2017, by Tim Van Patten), “Upgrade” (2018, by Leigh Whannell), “Arkangel” (2017, by Jodie Foster), “Be right back” (2013, by Owen Harris), “Rachel, Jack and Ashley too” (2019, by Anne Sewitsky).

At the first stage of the protocol, the authors explored the Sci-Fi genre. They discussed the imaginaries showing the human relationship to the technologies and the risks of the pervasive and advanced technological application and solutions – fictional in this case since we speak about diegetic prototypes. Here, through the exploration of SICs, the researchers focused mainly on the imaginaries treating mental health and wellbeing issues. From these titles, we can observe some typical fears and disbeliefs about the technologies.

Here the author will mention some of the titles (found as the most relevant by the all authors) analysed within this activity, using SICs.

“Nosedive” (2014, by Joe Wright) focuses specifically on the use of Social Networks and offers

a dystopic scenario in which the people are measured socially concerning how much other people like them. People can use a specific app to evaluate others daily, just from their impression of someone. We can see through this scenario how such a technological solution may bring us to the emotional brake down.

“**Arkangel**” (2017, by Jodie Foster) is a system for surveillance of the children consisted of a brain implant and app for monitoring the child’s activities. It does not leave the space for privacy, and it prevents the child from seeing the reality as it is due to the system that blurs the “sensitive content”. Everything works well for the mom controlling her daughter until one-day daughter rebels.

“**Her**” (2013, by Spike Jonze) is about the lonely men falling in love with and OS overcoming divorce.

“**The Circle**” (2017, by James Ponsoldt) shows the world in which we will have apps to monitor one’s life and show it to the world 24/7 to give transparency to the world.

The activity was very productive, and both researchers from ITU stated that they had a chance to explore some aspects of the project, which otherwise they would not do, which was very useful. The researchers tried to build the connections between the research topic founded on facts and the SCI-FI imaginaries and identify the design challenges for 2030.

Starting from the results of the desk research and exploration of SICs, we narrowed down the topic and several design objectives for 2030:

- / **Explore the barriers and micro-boundaries in the use of a smartphone;**
- / **Explore the autorship over technology;**
- / **Explore the technology that poses questions about use;**
- / **Explore norms;**
- / **Foster more intentional use of this specific technology.**

From the analysis through SICs, the authors identified some typical imaginaries such as obsessive tracking and surveillance, the need to escape from the enchanted world, search for social and existential approval, and the control of technologies for emotional engagement. This critical discussion stimulated What if? Questions. Figure 55. shows the output of the first stage of the protocol which represents setting of the first objectives for our future design.

Arrived to the second stage of the analysis, the authors start to raise some important questions:

- How will the entities and technologies change by 2030 to support prevention of problematic behaviours concerning the addictive use of mobile technologies?*
- How we, as design researches can exploit this as an opportunity?*
- How the individuals' behaviour will change toward this technology?*

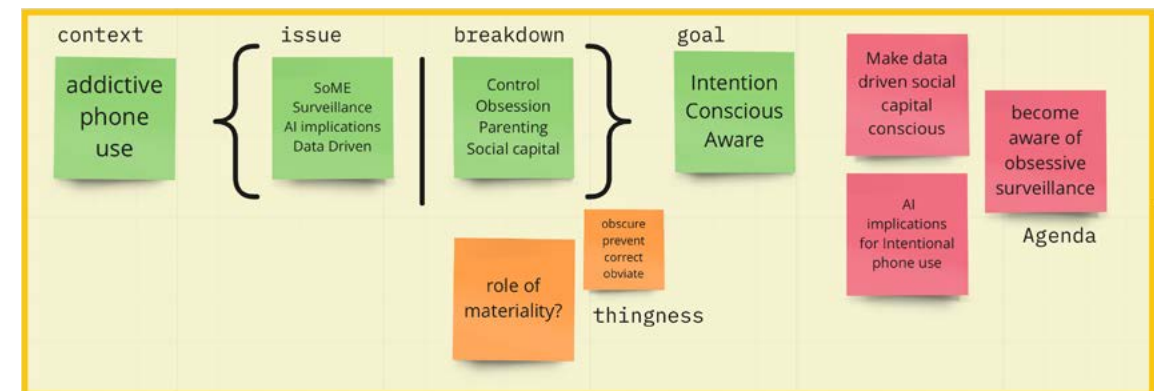


Figure 55: First use of the protocol – first stage analysis output

*How the artefact will change so support the behaviour?*

The key points that emerged from the discussion at the second stage of the analysis (dedicated to the agency building and scaling the issue) showed a need to raise the awareness of the individuals and institutions regarding the problematic use of a smartphone and create protocols and treatments for Social Network Addiction and Internet Addiction. Another essential element emerged during the analysis, is the importance of raising the digital literacy for future societies – empower the users to become aware of the technologies they are using. The last element of the system that we found very important is norms and policies regarding data and data ownership. From this the authors identified possible actors that may take a part in building more thriving societies from the perspective of how the people use technologies, with the focus on mobile technologies. In conclusion to this stage, we established the system of relations founded on these three elements:

- / **Health System (how it can act as an institution);**
- / **Knowledge, education and information (how it can act to increase the digital literacy in users);**
- / **Tech Governance and policies (how it can act to face this challenge as a global or continental issue).**

The authors map the relationship between the action, actors and design challenge in conclusion to this stage (Fig. 56).

Regarding the behavioural analysis, the authors did not focus much on selecting the precise strategies since we were brainstorming, there we were in a field of hypothesis. The authors analysed and organised the findings from the desk research regarding observing some case studies dealing with the problematic behaviour of smartphones. These findings brought us to some interesting points, such as the issues concerning the smartphone technology observing the technology itself (how it operates to keep us attached to smartphones), which are the problems that occur due to



Figure 56: First use of the protocol – second stage analysis output

use of this technology, and which are the negative effects. From this analysis the authors map the possible action in terms of behavioural concern, where target behaviours, possible barriers, the objective in terms of design, and preliminary strategies (Table 6).

Table 6: Mapping the behavioural concern

| PROBLEMS [why]                                                                                                                                                                                                                                                                                                                                     | TARGET BEHAVIOURS [define]                                                                                                                                                                                           | POSSIBLE BARRIERS [define]                                                                                                                                                                              | INTENDED OUTCOME [what]                                                                                                                                                                                                                                                                                                                                                                                                                                       | POSSIBLE STRATEGIES [how]                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BEING AVAILABLE EVERYWHERE - ANYTIME<br>BRIEF AND REPETITIVE SESSIONS LONG IN TIME (SPREAD THROUGHOUT THE DAY)<br>IMMEDIATE AND SIMPLIFIED INTERACTIONS (TOUCHING/ SCROLLING/VOCAL)<br>QUICK ACCESS TO DYNAMIC CONTENT AND ACCESS/ ABSORPTION OF HUGE AMOUNT OF DATA<br>THE USAGE IS ASSOCIATED TO TRIGGERING CONTEXT (i.e. bus, classroom, other) | Intentional use of the smartphone [exploiting the tech potential instead of abusing it].<br>Become more aware of what does it mean problematic use - be able to recognize it and control it - know the consequences. | Frustration and sense of guilt because I question all the time whether my behaviour is problematic or not.<br>Beliefs and disbeliefs of people about what they are doing (suspend the old habit/belief) | Reduce a distraction/gap between the outer world and digital one.<br>Build the meaningful relationships between the direct user of the mobile technology and mobile technology, founded on conscious, intentional and dedicated use of the device.<br>Build the meaningful relationships between the direct user, mobile technology and the outer world (network of people using the mobile technology and the environment (CONTEXT AWARENESS & SOCIAL TIES). | Analogies & metaphors (DECONTEXTUALIZE, COGNITIVE METAPHORS)<br>Tailoring (DEVICE ADAPTS TO THE ENVIRONMENT/CONTEXT AWARENESS i.e. modes)<br>Choice and nudge (THE REAL WORLD AS A CHOICE, i.e. cognitive framing) |

In the last part (stage 4 of the Protocol), the authors questioned the role of technology in influencing human behaviour and possible ethical implications. They went through Technology Inspiration Cards (the titles are the same used at the first stage just the lens is different) to discuss how these titles establish and try to articulate the technologies within the context of future, in which the technological devices and social networking are pervasive? The author found some future perspectives for smartphones and Social Networks, such as simulated

reality, holograms, actual footage, and questioning the data issues and how these technologies let us perceive the reality. These ideas were critically analysed through its formal and experiential dimension and functional concerning the possible ethical implications. Basing on this, we started to define the scenario and design spaces.

The output of this first activity is a scenario and map of possible design spaces to explore in further analysis. Authors organised the design spaces into three pillars starting from the normative sphere and translating this into the technological level and finally to a metaphorical or formal level. These pillars are based on the results of the analysis done through the stages of the Protocol. The normative and communitarian pillar focuses on exploiting the possibilities within the EU social platforms, for instance, how the regulations will change by that time and how this could affect the design of smartphones. The second pillar concerned with technologies is trying to translate how the normative changes may influence the use and application of technologies, which will be the new frontiers to explore in that sense. The metaphorical level employs in giving a meaningful form to the previous two through interaction rituals and materialisations. The scenario and pillars are in Fig. 57.

SCENARIO

In 2030, smartphones are not like they are now in 2021. The bandwidth of interacting with technology has increased: people can now integrate technology in their brainstem, enabling them to process 150x more information per second. Faced with increasing concerns about their addictiveness and obsessions with social media, in 2024 the EU extended GDPR to let all social media users forget their own data. The human right to know oneself as one wishes to know creates new venues for technologies. Smartphones no longer have a pretence to capture some sort of objective truth. Instead, reality is simulated to reflect the needs of the individual. Patrolling selfie drones offer the best possible shot for bitcoin, offering individual "ownership" of these images as blockchain verified NFT. Understanding social relevance of a place comes from finding where people are swarming. The more phones that are in a certain place, the more interesting it is, leading more people to come check out what is going on...

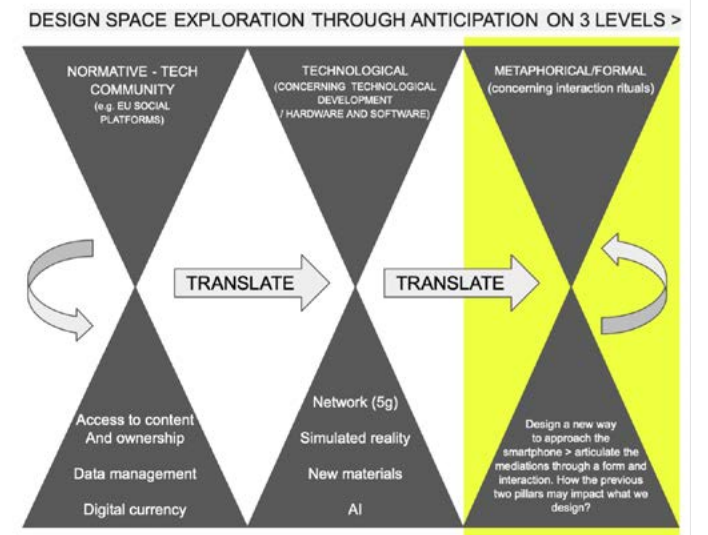


Figure 57: Scenario and Design spaces - output of the first use of the Protocol

Building on this output, the authors decided to investigate the findings that emerged from the brainstorming (the first use of the protocol) and understand better the people and the ways to use smartphones today and how they see the future of this technology. Therefore, the authors set the survey and collected the results in regard. The results from the survey were analysed and mapped once again in the protocol.

The second use of the protocol was about revising and refining the desk research and brainstorming output, according to what we found out about the people's habits, routines, usage stories, and perceptions about the future. The authors took again the protocol and went through each stage, discussing and refining the analysis. In the first two stages, authors observed whether the objectives and challenges they set align with what they found about the peoples' relationship with the smartphone-like what behaviours should be reduced and, on the contrary, which aspects should be emphasized. These findings helped the authors find a focus and verify what they concluded from the literature. The first part of the analysis (stage 1 in the Protocol) dedicated to defining the design challenge did not change since the survey results showed that it is quite in line with what users think and would like to solve in relationship to the smartphone.

Regarding the second stage of the Protocol dedicated to defining of the agency and scaling the issue the authors map how different levels of possible action are related to the users' needs and current problems occurring in smartphone-user interaction. The survey results confirmed that the possible actions and actors identified at the first level of analysis are in line with the real needs of the smartphone users. (Fig. 58)

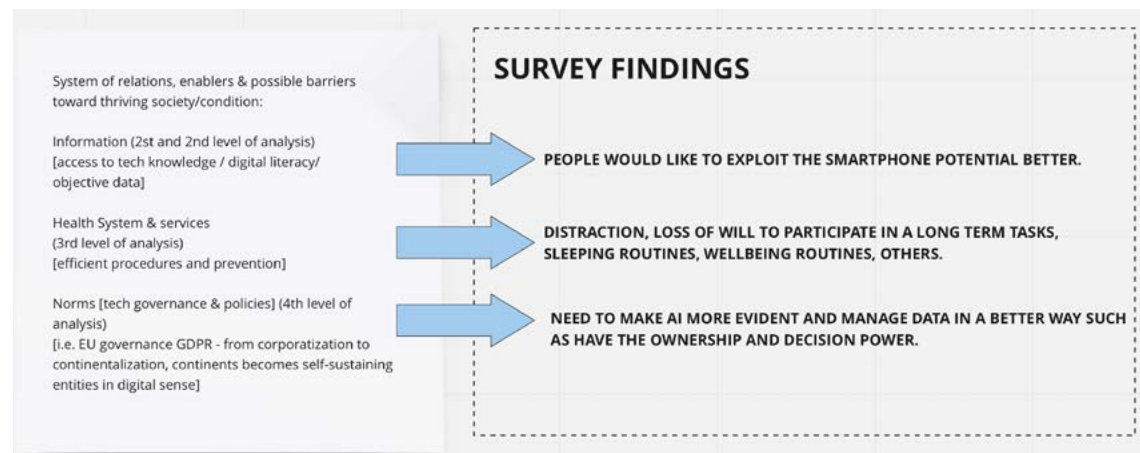


Figure 58: Elaborating the survey findings regarding the agency, structures and actants

The survey's most significant impact was probably the third stage of the protocol dedicated to behavioural concern. During the first use of the protocol, the authors observed this aspect superficially since, at the moment, they had only the findings from the literature and case studies. Now they had information about how people use their smartphones, how the use is related to the context, content, what tempts them to look at the smartphone, if there is any sense of guilt after using their smartphone, and if they perceive any adverse effects in regard. Analysing all this data helped the authors set the target behaviours and identify the most suitable strategies to apply in a project.

In the survey the authors set the parameters to investigate the user's habits, usage patterns

and issues in relation to the smartphone use. These parameters emerged from the desk research and are the following:

- / **Triggering context (particular situation in which the person is more tented to use the smartphone)**
- / **Recognised problematic behaviours (the behaviours users establish in relation to the smartphone which they recognise as problematic)**
- / **Temptations (the specific cases in which the use is triggered)**
- / **What drives the attention to the smartphone (smartphone properties and other factors)**
- / **Recognised negative effects (feelings provoked by the smartphone overuse)**
- / **Sense of guilt (what provokes the sense of guilt in relationship with our smartphone).**

The authors analyse the results of the survey and map for each parameter the most important findings (Table 7.)

Table 7: Relationship between the context of use and usage pattern

| PARAMETERS                                                                                                                           | ANSWERS/RESULTS                                                          |                                                                  |                                                |
|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------|
|                                                                                                                                      | ON PUBLIC TRANSPORT                                                      | WHEN I AM ALONE                                                  | WHEN I AM ANNOYED                              |
| Triggering context (particular situation in which the person is more tented to use the smartphone)                                   |                                                                          | WHEN I AM ALONE                                                  | AT HOME                                        |
| Recognised problematic behaviours (the behaviours users establish in relation to the smartphone which they recognise as problematic) | NEED TO BE LESS ATTACHED TO THE PHONE                                    | USE IT LESS FREQUETLY                                            | USE IT MORE INTENTIONALLY                      |
| Temptations (the specific cases in which the use is triggered)                                                                       | HABITUAL CHECKING                                                        | DON'T WANT TO LOSE NOTIFICATIONS (FoMO)                          | BE UPDATED ON WHAT THE PEOPLE I KNOW ARE DOING |
| What drives the attention to the smartphone (smartphone properties and other factors)                                                | EASILY ACCESSIBLE                                                        | NOTIFICATIONS                                                    | DYNAMIC CONTENT                                |
| Recognised negative effects (feelings provoked by the smartphone overuse)                                                            | DISTRACTION- LACK OF CONCETRATION                                        | STRESS OF BEING ALWAYS REACHABLE                                 | ANXIETY OF BEING CONNECTED ALL THE TIME        |
| Sense of guilt (what provokes the sense of guilt in relationship with our smartphone).                                               | Antisocial behaviours<br>Losing time and not investing in something else | Escape from the reality<br>Lack of concentration and distraction | Using too much Social Networks                 |

Another important finding from the survey was the user's stories about smartphone usage. The users narrated their favorite ways to use the smartphone and some daily routines on and with the smartphone. This helped the authors understand better the users and how they daily routines relate to what they defined as problematic behaviours, with what they would like to change in relation to their smartphone, and other statements. The author shows some quotes in Figure 59.



Figure 59: Users' stories

In conclusion, the authors investigate how the survey findings answered the three pillars defining the design spaces, identified during the first level of analysis. These data were applied to refine the fourth stage of the protocol dedicated to mediations. In this section, people told how they feel about the data collected by their smartphone (normative level), about advanced technologies like Artificial Intelligence (technological level), which kind of interactions they prefer and how this is depended on the context and environment (metaphorical level. Table 8. shows the most important answers.

Table 8: Users' perceptions and visions about the norms, technology and interactions embedded in a smartphone

| PARAMETERS                                    | ANSWERS/RESULTS                                                       |                                                          |                                                                                  |
|-----------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------|
| Normative level [data management]             | <b>KEEP IT ONLY FOR MYSELF AND BE THE ONLY PERSON THAT CAN SEE IT</b> | <b>MANAGE IT MORE INTENTIONALLY</b>                      | <b>BE ABLE TO SELECT THE DATA I WANT TO KEEP, SHARE, SHOW (SELECTIVE MEMORY)</b> |
| Technological level [Artificial Intelligence] | <b>BECOME MORE AWARE OF AI</b>                                        | <b>HAVE MORE CONTROL OF AI</b>                           | <b>MAKE IT MORE VISIBLE AND INTERACT WITH IT IN A MORE OBVIOUS WAY</b>           |
| Metaphorical level [interactions]             | <b>PHYSICAL INTERACTION IS MORE NATURAL TO ME</b>                     | <b>I FEEL MORE COMFORTABLE WITH PHYSICAL INTERACTION</b> | <b>I DON'T LIKE SPEAKING TO THE SMARTPHONE</b>                                   |

The last part of the survey was dedicated to the evaluation of analogies – how the current future visions about the smartphone future meet the people's needs and perceptions. People showed us their visions about the future of the smartphone, regarding the materiality of this artefact, interaction modalities, applied technologies. Figure 60 shows how the users see the (preferable) future of the smartphone.

The second use of the protocol was essential in setting all requirements for the concept generation phase. The final output of this stage was the first three concept hypotheses that used the previous scenario as a basis but trying to revise it through different lenses, based on what the authors found out from the survey.

These hypotheses use analogies and keywords describing the concept, yet they were not concrete and material. (Fig.61 - 63) The authors generate three different analogies: Data waste, Wear and Contextual. Data waste is interested in exploring how data impact one's usage patterns. Wear is thought as something that can last in time, change respect to the context. The contextual is concerned with the different use cases, lived experiences...how the smartphone can adopt to us and environment. This output was an input for the next stage that is concept generation and prototyping.

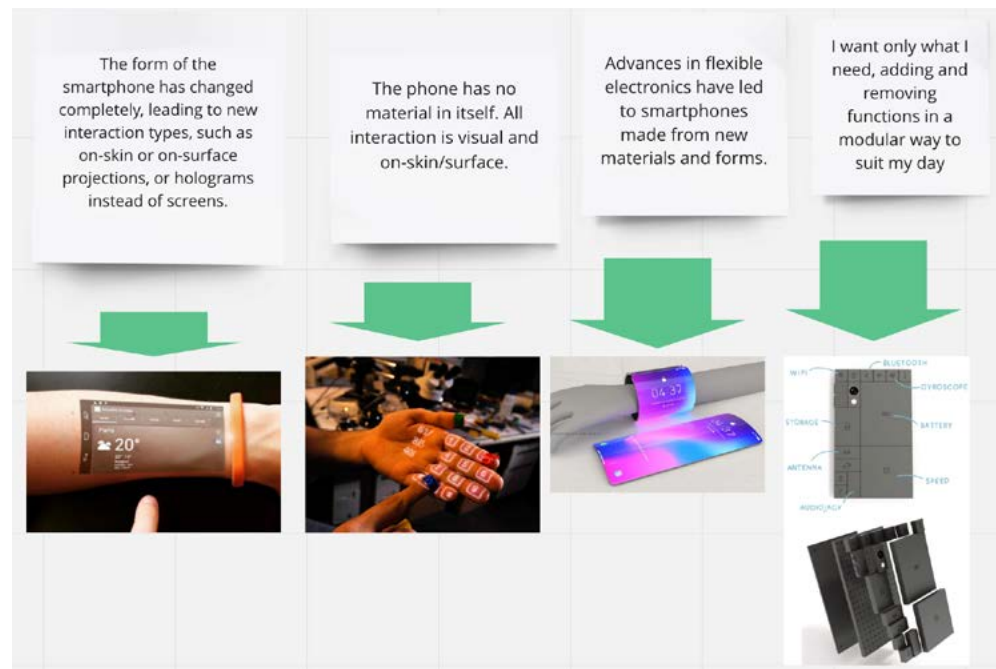


Figure 60: How users see the future of the smartphone

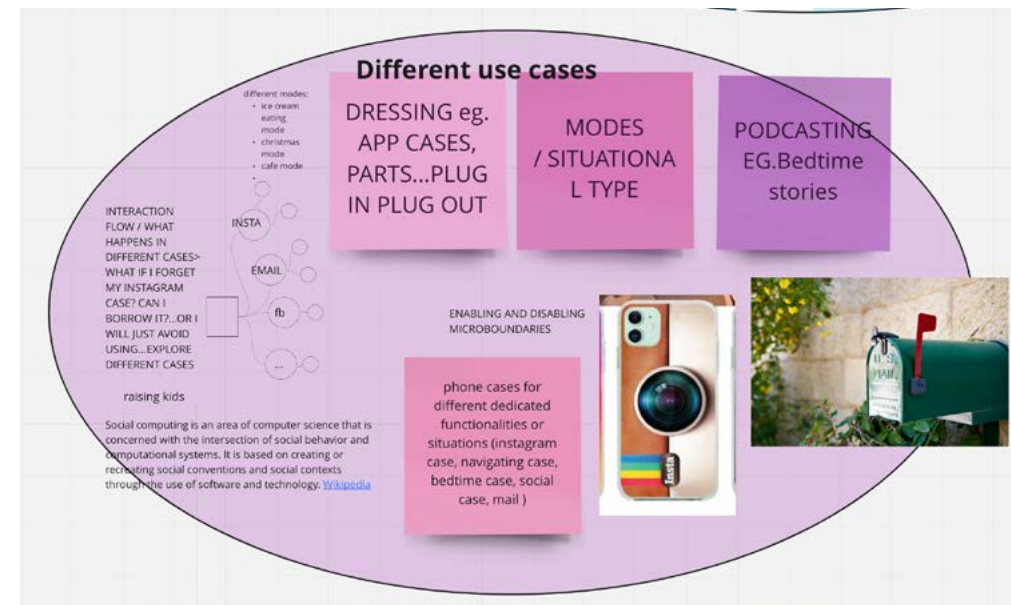


Figure 62: Contextual concept

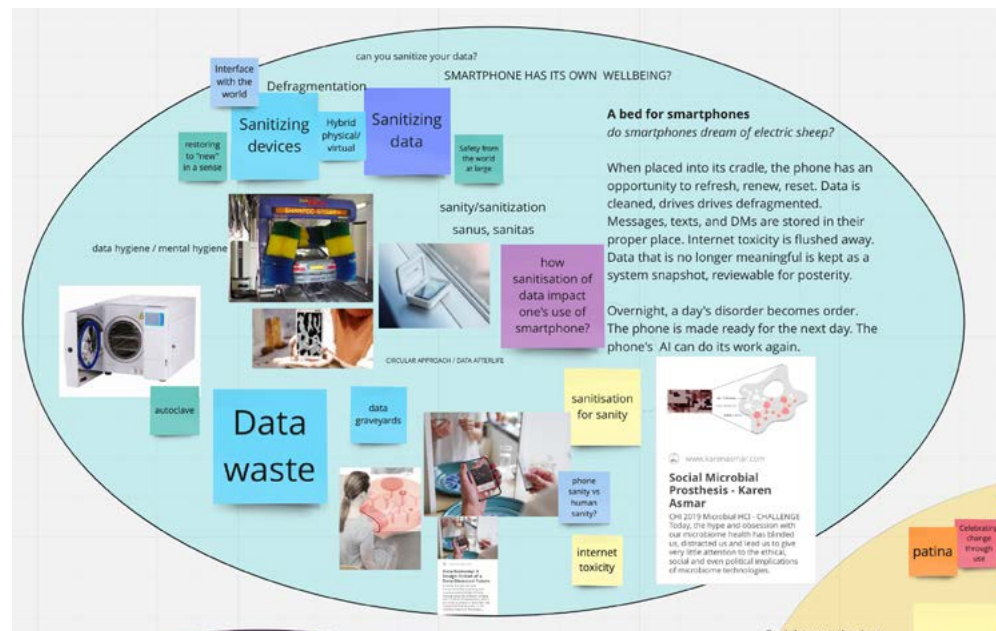


Figure 61: Data waste concept

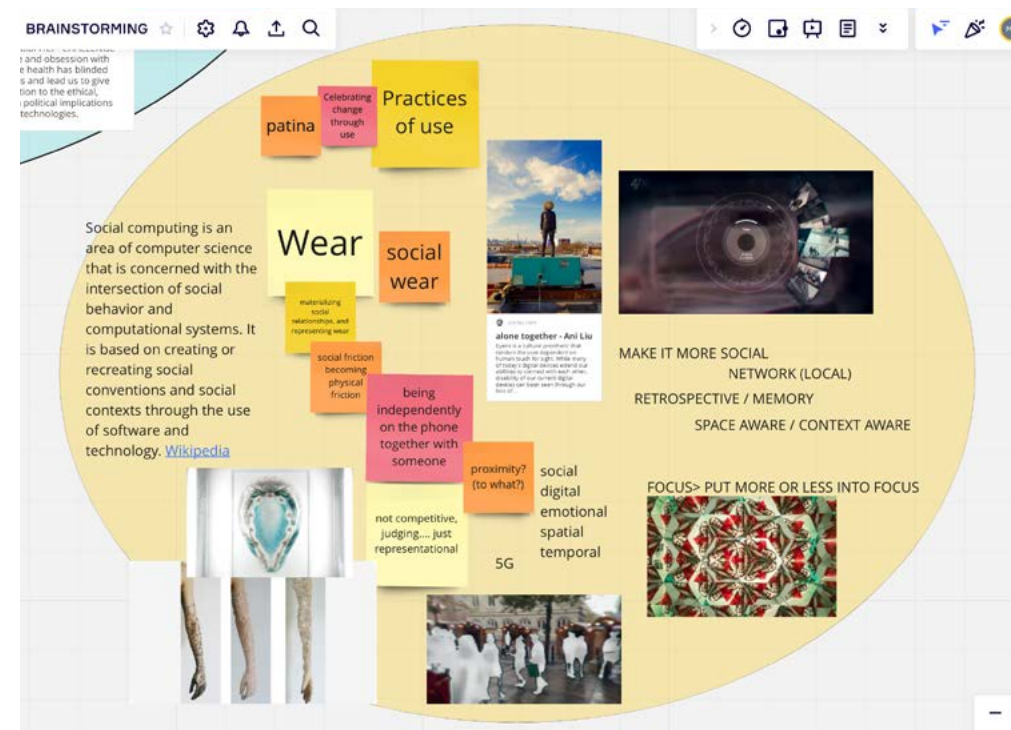


Figure 63: Social wear concept

## 8.2.4. Concept generation and prototyping

Starting from the hypothesis on concept generation, authors brought as the output from the second use of the protocol. They started to generate concepts. First of all, the authors organized very abstract ideas into the three representations of the concept system. (Fig. 64)

The first idea is about enabling and disabling the smartphone's functions based on one's needs at a specific moment. In this case, the user has only what he/she needs. The authors imagine a set of parasites that we can attach and detach from our smartphones.

The second is exploring the impact of data on one's smartphone use and suggests sanitizing the data as a part of a process of "mental hygiene". The idea behind it is to measure one's stress during smartphone use and manage the data in regard. In this way the information one gets from his smartphone are tailored to support the more intentional and less stressful use.

The third idea was about making the smartphone more context-aware and socially relevant.

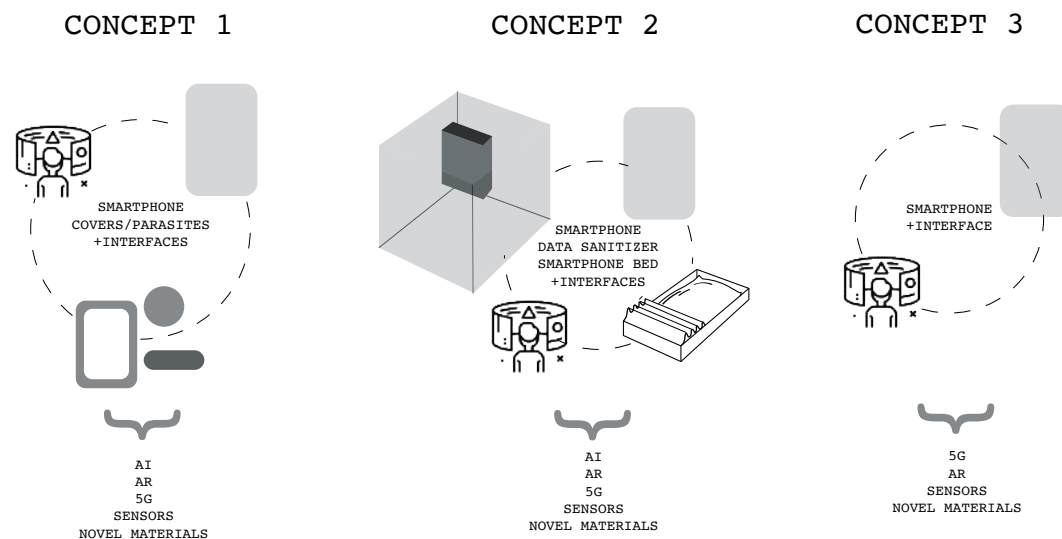


Figure 64: Setting the design fictions – first ideation

The authors wanted to investigate the smartphone's materiality and the possibility of controlling its performance concerning the environment.

These were the main ideas to follow, yet thorough concept generation; the authors came up with more spaces to explore, producing n.4 design fictions. The authors first decided to make the digital diegetic prototypes and test them with the users before passing them to the tangible prototypes.

Here and after, the author introduces design fiction and diegetic prototypes generated from this approach through the protocol.

### Design fiction 1 | Pogo

Pogo phone (Fig. 65) is a parasitic smartphone that operates with fundamental functions when there are no parasites attached. It allows access only to calls, simple messaging and settings. The parasites give access to the Social Networks and Internet. The idea here is to give the three levels of bandwidth to allow the user to expand the use of Social Networks and Internet if needed, yet it is not unlimited. The parasites show the countdown related to the use of the specific content to inform the user, at which point it will not be possible to use the specific function anymore. The parasite needs charging before use. This fiction materialises how we use the smartphone;

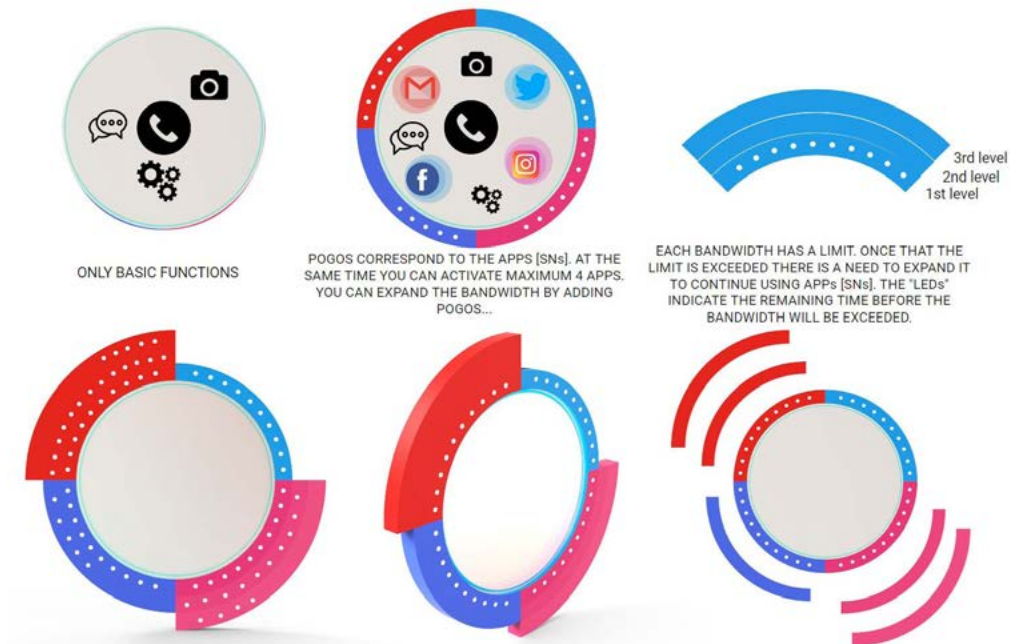


Figure 65: Setting the design fictions – Pogo

it makes it visible and more interactive. It wants to form a culture about using only what we need and when we need it, there creates intentional uses rather than compulsive ones.

### Design fiction 2| Parasite phone

Parasite phone was always born from the initial idea behind the parasitic phone, but at some point, it became even more provocative. The authors imagine having a phone that changes in material sense during the use. The more we use the smartphone, the more it grows, inflates and becomes challenging to manage. To use it again there, we need to leave it for a while to decrease in size. The authors wanted to communicate through the artefact's materiality and make the user more aware; we as users need to learn how to manage the use. Fig. 66 shows this design fiction.

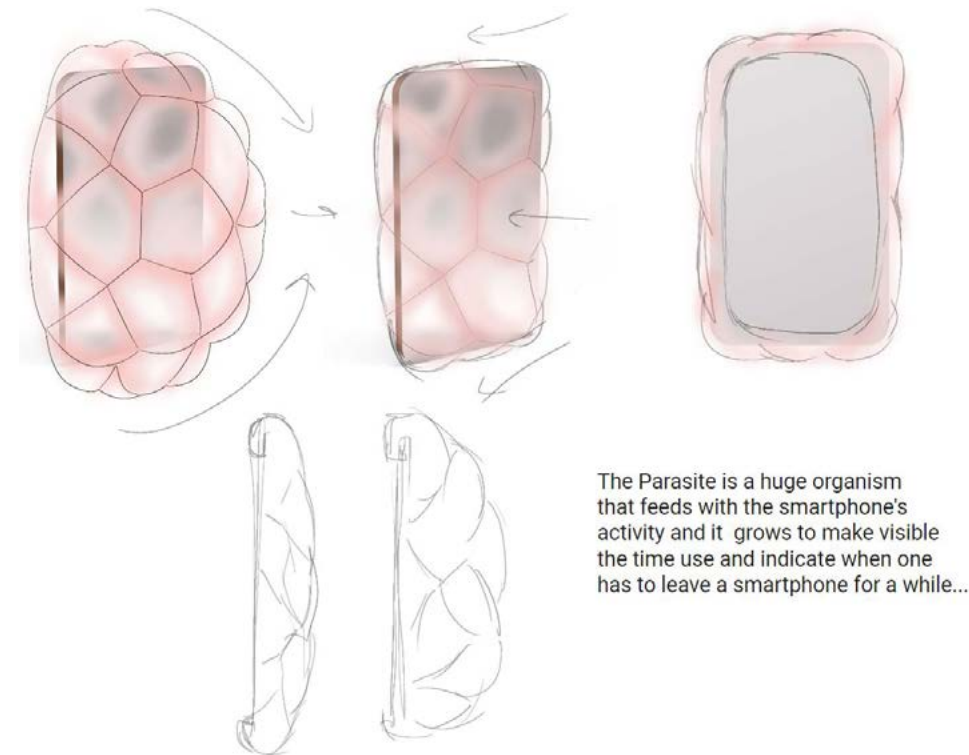
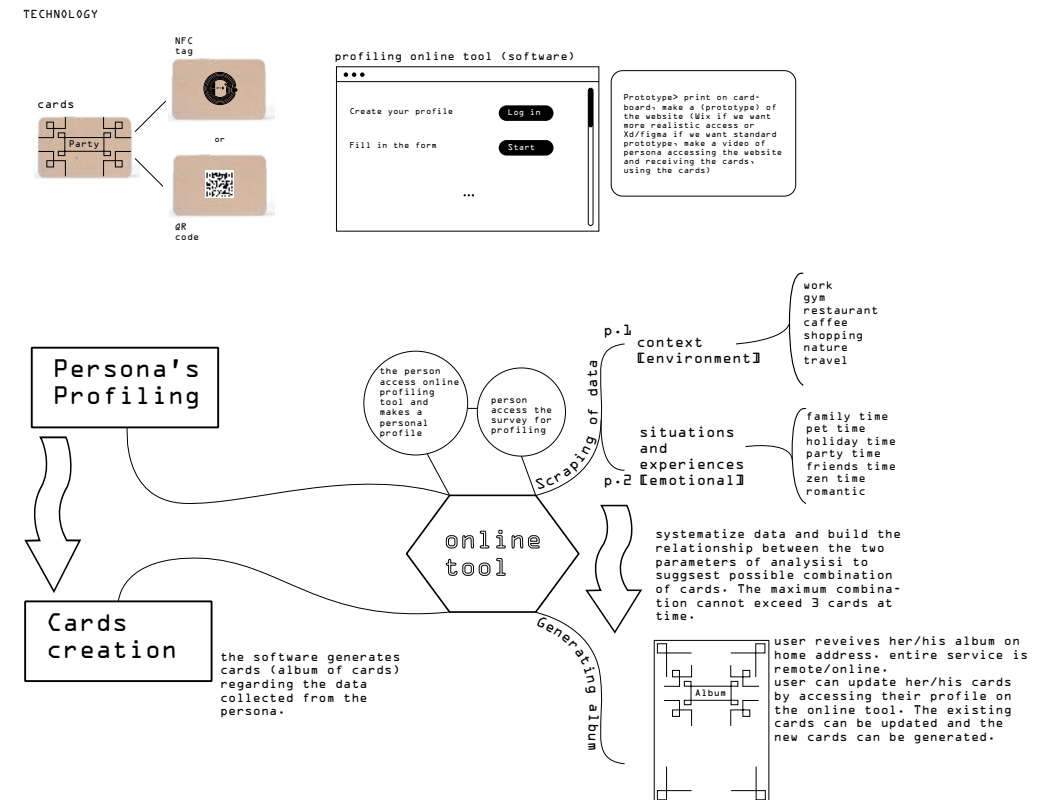


Figure 66: Setting the design fictions - Parasite

### Design fiction 3| Placeful phone

Placeful phone is concerned with context awareness, and it proposes the set of cards enabling the smartphone's content and functions regarding the environment. There are two categories of cards. The first is strictly related to the context as the environment (spatial or virtual), for instance, "work", "restaurant", "gym", "shopping", "nature", "travel", and others. The second is related to the specific experiences and situations, like "family time", "pet time", "romantic", "holiday", "party", "zen time", and others. The cards are personalised, and they

can be even combined. The combinations depend on matching between the context and experience. For instance, "work" cannot be combined with "party", but it cannot match with "restaurant". This design fiction is more about the service than the actual smartphone. The authors are not designing the new smartphone but rather a new way to use it and a new service. Fig. 67 shows this concept.



CARD'S ALBUM > collection of cards with description, suggestion on combinations. [ n. of pages depends on how many cards user have]

|                                                                                                                                                                                                                                                                                            | CONTEXT                                                                 | SITUATION AND EXPERIENCE                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------|
| <p>Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna</p> <p>Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna</p> <p>Access your profile</p> | <p>Lorem ipsum dolor sit amet, consectetur</p> <p>Work</p>              | <p>Lorem ipsum dolor sit amet, consectetur</p> <p>Holiday</p>          |
|                                                                                                                                                                                                                                                                                            | <p>Lorem ipsum dolor sit amet, consectetur adipiscing</p> <p>Travel</p> | <p>Lorem ipsum dolor sit amet, consectetur adipiscing</p> <p>Party</p> |
|                                                                                                                                                                                                                                                                                            | <p>Lorem ipsum dolor sit amet, consectetur</p> <p>Coffee</p>            | <p>Lorem ipsum dolor sit amet, consectetur</p> <p>Family</p>           |

Figure 67: Setting the design fictions - Placeful



### Design fiction 4| Data sanitiser

Data sanitiser is a box able to sanitise our smartphone concerning users' needs to provide mental well-being. The sanitising box can organise the data to keep those relevant for the future, while the less valuable, irrelevant, or embarrassing content is deleted. This artefact operates by the very advanced AI able to predict one's needs. When it comes to the smartphone, the authors imagine no screen interactions but projections. Now we have a tiny device that can be wearable, and all the interfaces are on-surface. Fig. 68 shows this design fiction.

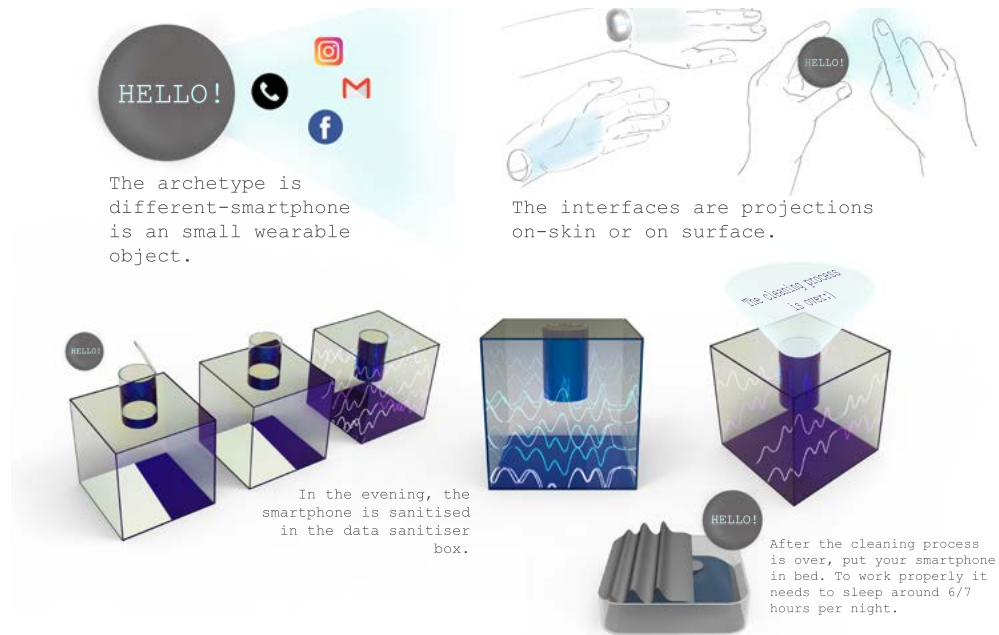


Figure 68: Setting the design fictions - Data sanitiser

The authors analysed all four design fictions by comparing them and observed how these answered the findings generated from the second protocol use and general objectives of the research project.

The Data sanitiser was found as a bit too distant on the time scale of reference (2030) compared with the other three. In this design, fiction authors were more envisioning and abstract. For this reason, the authors decided to continue the first three design fictions. The further development consisted of prototyping and testing these design fictions.

The diegetic prototypes were made as animations showing the use cases and interactions. Unlike the diegetic prototypes introduced by the author of this dissertation in Chapter 7, these diegetic prototypes are entirely digital. The following figures are showing some frames of developed videos. (Fig. 69-71) For each design fiction authors develop a scenario. Scenarios are introducing the context, the issue to solve (behaviour related), the technology, and other. The scenarios are followed up with the animations, storyboards and use cases.

In the beginning of the November 2021 the authors tested the three scenarios with diegetic prototypes in a focus group. The following text introduces the testing of the diegetic prototype, and the findings emerged.

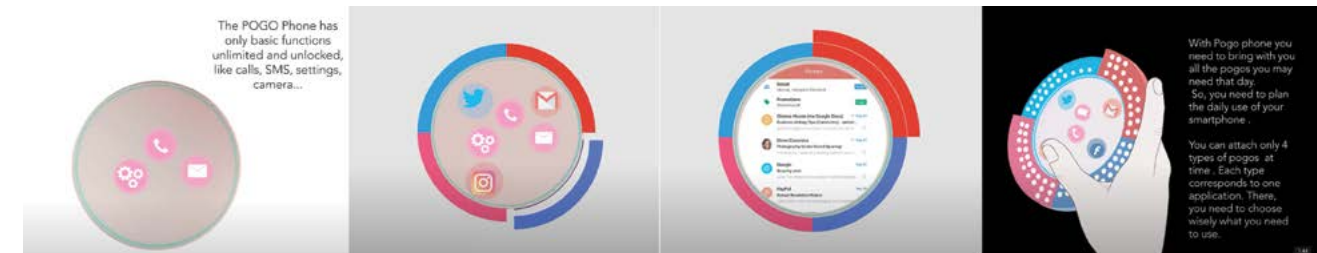


Figure 69: Pogo phone diegetic prototype (video cut)

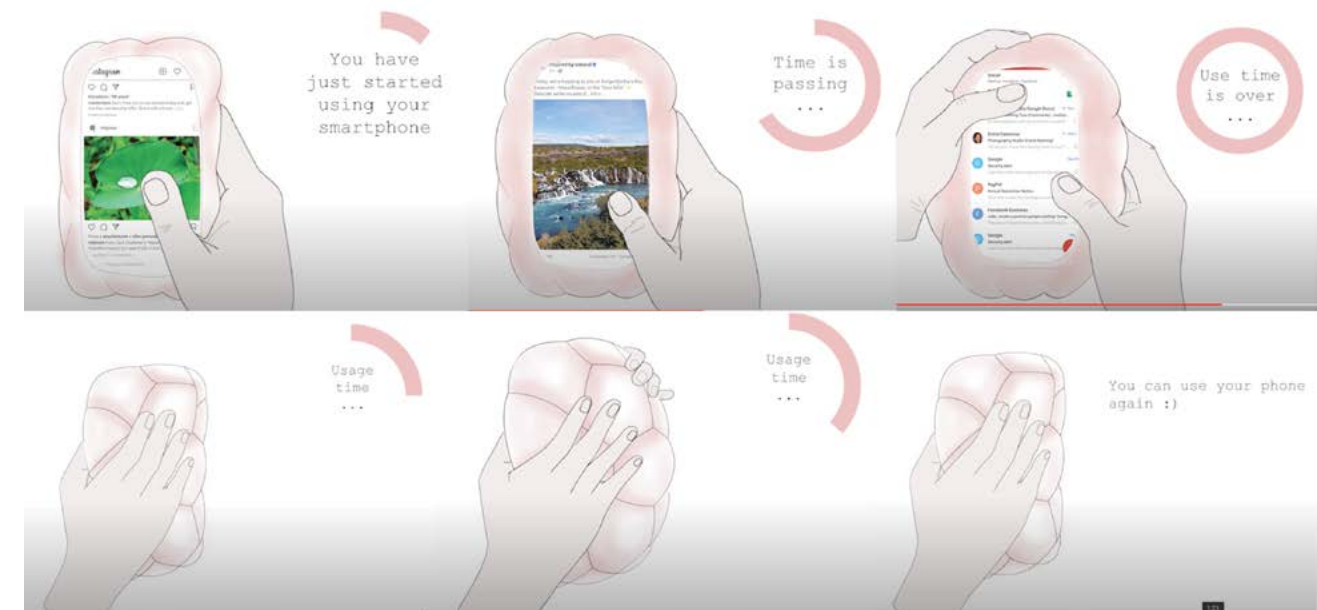


Figure 70: Parasite phone diegetic prototype (video cut)

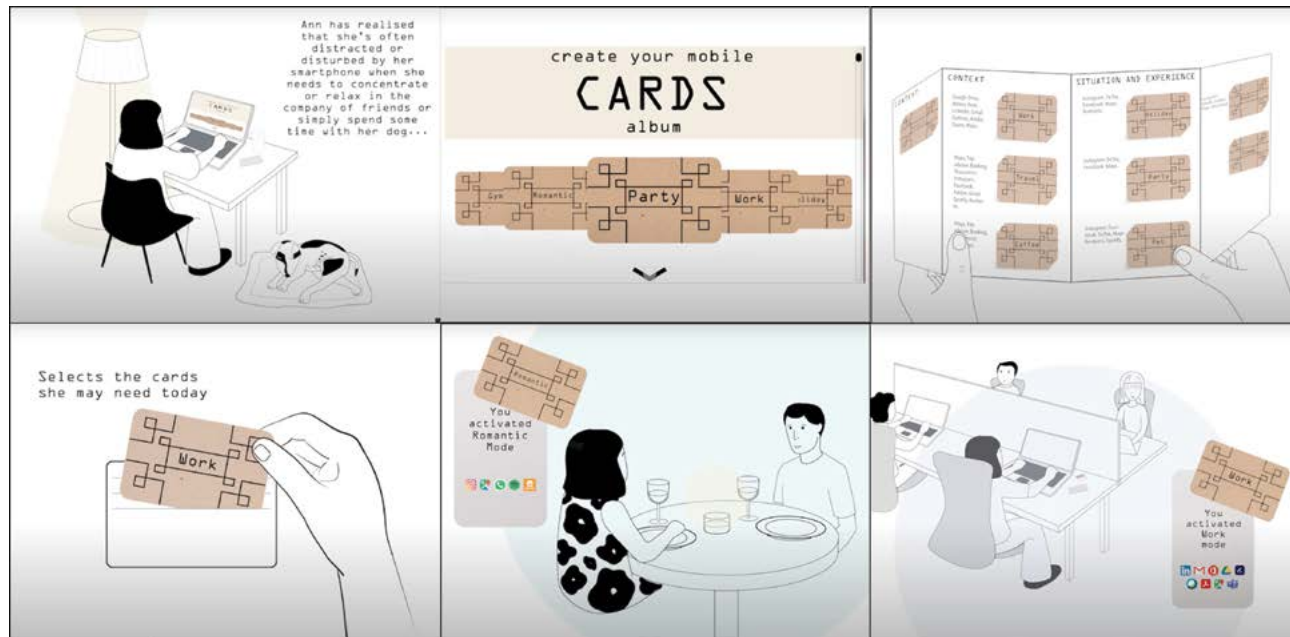


Figure 71: Placeful phone diegetic prototype (video cut)

## 8.3. User testing: Objectives and aim

Throughout this research project, the authors wanted to understand whether and how the new formal and interaction aspects can influence how people interact with smartphones or interact with Social Networks (SNS) and the Internet. The authors wanted to analyse whether it would be possible to establish more intentional and aware usage patterns and habits (regarding the usage time, context of use, and others) through the new material forms and interactions. The previous text introduced designed fictions developed by the authors – scenarios and corresponding diegetic prototypes that imagine possible new ways to interact with the smartphone. The objective of the focus group was to test these design fictions. This focus group aims to understand whether these new interactions and forms are perceived as valuable and meaningful by the people, in terms of whether it would be possible to enable them establish more intentional and aware use of their smartphones concerning the use of SNS and Internet. The upcoming text describes the focus group.

### 8.3.1. Focus Groups

The focus group was organized with n.6 participants, aged 20 to 40, coming from different fields of occupation (students, researchers, manager and owner of digital agency, and flight assistant) and different nationalities (Italy, Denmark, India, Egypt). All the participants took part in a previous survey, and the focus group was conducted online, and it lasted around one hour and a half. During this time, firstly, the participants were briefly introduced to the research project and then into each design fiction. Right after, the authors showed the video and provided the corresponding questionnaire. The questions investigated how the participants perceived some specific aspects of human behaviour concerning smartphones (its interaction and formal aspects). For instance, how efficient these are in making the use of the smartphone more intentional, preventing antisocial behaviours, lack of concentration, making the user more aware about the context and usage time, exploiting better the potential of this technology rather than mindless use, preventing com-

pulsive checking, and others. The complete questionnaires are in the attachments section of this dissertation. Besides the questionnaires, the authors discussed loudly with the participants. They were asked to explain the perceived benefits and frustrations of the diegetic prototypes we showed to them. The loud discussion was very proactive, and the participants provided valuable insights to let us understand the new ways to approach smartphones and SNs. Participants found the diegetic prototypes provocative and made them initiate a critical discussion of different aspects of smartphone use.

What does it mean to be smart and who is supposed to be smart in phone-user relation; who is supposed to assume the responsibility in relationship human-smartphone; should the smartphone be aware of us or it is opposite; But also, how the role of policymakers should be integrated into the design of smartphones? These are just some of the questions that emerged from the discussion. The conversations were registered and subsequently used to explain the results of the questionnaires.

### 8.3.2. Results of questionnaires and insights from discussion

Here and after author introduces the findings from the questionnaires and discussion. Firstly the participants evaluated one by one the design fictions, and then there were discussed all three together. Here the author follows the same order to describe the findings.

**Evaluation of POGO |** Regarding this proposal's interaction aspects, the participants agreed that using a limited amount of content would make the person select more intentionally what s/he needs to use to avoid mindless use of a smartphone (evaluation 4 / 5 on scale 1-false, 5 true). Regarding the limit of use time, the participants were a bit less convinced that this strategy could make them use their phones more intentionally (evaluation 3,2 / 5 on scale 1-not efficient, 5-very efficient).

When it comes to the efficacy of specific interaction modalities and rituals in making the user more aware of her/his use, the participants found this proposal as very efficient in reducing compulsive checking and attachment to the smartphone itself (evaluation 3,8 / 5), become aware of the time one spends on the smartphone (evaluation 3,7 / 5). They found a bit less efficient this proposal in terms of becoming aware of the context of use and antisocial behaviours (evaluation 3,4 / 5). The participants found that this proposal would be very efficient in letting them stay more connected to the reality there, less attached to the social networks and internet (evaluation 3,8 / 5). In terms of permitting one to stay focused and concentrated on the daily activities, the participants found it slightly less efficient (evaluation 3,5 / 5) and in reducing the stress due to being always reachable and connected (evaluation 3 / 5). As the most appropriate interaction modality to influence aware behaviours was found the fact that you can use only the content you selected (evaluation 4 / 5). However, the fact that you need to attach and detach the Pogos (bandwidth) was recognised as less appropriate (evaluation

3 / 5). The rest of the interactions, such as the possibility to select and apply only 4 pogos, using time indicator, receiving only the notifications from the active pogos, were evaluated as entirely appropriate (evaluation 3,5 / 5). On the question of whether such an artefact with its formal and interaction properties could allow one to become more aware of smartphone use and how this artefact conditions everyday life relations, 5 of 6 participants answered positively (answer: 5 - "Yes", 1 "Not sure").

During the conversation, the participants stated that one has limited time of use would make a person start using the smartphone more intentionally and avoid habitual, compulsive checking. Making the time factor more tangible ("**touch the time through interacting with pogos**") and immediate feedback (LED dots) was found as a good approach. Besides, they found that the circular form would be more challenging to use in scrolling the Social Networks (SNs) and accessing information that they believe would make one less motivated to pass the time on a smartphone. Another recognised benefit and enabler of aware behaviour is that the apps are categorised, so one is aware of how he/she uses the smartphone, what for, and how the time factor is related to the content.

The concerns that emerged regarding this proposal are related to the cognitive load due to planning of smartphone's use, predicting our behaviour or daily situations. The participants said that sometimes it is challenging to stick to daily plans, and on these occasions, some frustrations in regard may emerge in this specific case. Another possible barrier identified by the participants is the notifications that one cannot receive when a specific pogo is not attached and a possible concern about what happens if we attach it after a while, for instance, a day later. In that case, one could become more anxious because we would have an overload of notifications and information and fear of losing something important.

Continuing the conversation, the authors asked the participants how making evident the use habits (through the form and LED progress dots) may impact the social relations and one's perception about himself/herself, would that make them feel embarrassed or violate their privacy? Some of the participants think this may make them feel uncomfortable. However, the barrier could be overcome if there would be "social proof" about how such a smartphone improves one's usage habits and how this may positively influence social relations.

Besides the observation and analysis of the proposal, some more provocative questions emerged regarding the smartphone. First, how much time spend on the smartphone is too much; how do we compare the use time to the content offered by this technology, and how this is dependent on the context and individual using a smartphone?

**Evaluation of PARASITE |** The fact that the smartphone changes the form to enable and disable the user and make visible the time use was found to help the users use this technology more intentionally (evaluation 3,8 / 5). When it comes to the efficiency of this proposal's interaction modalities and rituals to make the user more aware of how they use the smartphone, the participants found that this proposal is very efficient in raising awareness regarding the time of use (evaluation 4,5 / 5). Still, also it was found as efficient in reducing the compulsive checking (evaluation 4 / 5).

It was found as a bit less efficient in reducing the attachment to the smartphone's content (evaluation 3,7 / 5), and poorly when it comes to helping the user be aware of accessing the irrelevant information and being mindful of the context to use leading to antisocial behaviours.

The participants think that this way of interacting could be relatively efficient in helping the person stay focused on the daily activities (evaluation 3,7 / 5) while a slightly less on staying connected to the reality and the environment, and reducing the attachment to the social networks and internet. The participants did not find it efficient in reducing the stress of being reachable and connected (evaluation 2,4 - 5).

When it comes to the pacific ways this proposal is trying to influence the user's behaviour, the participants found as entirely appropriate the fact that one needs to leave the smartphone to deflate before using it again (evaluation 3,8 / 5) and that the smartphone inflates to show the time use (evaluation 3,7 / 5). In contrast, they find the usage disabling due to the difficulty to handle the form as slightly less appropriate (evaluation 3,5 / 5).

On the question of whether such an artefact with its formal and interaction properties could allow one to become more aware of the smartphone use and how this artefact conditions everyday life relations, 4 of 6 participants answered positively (answer: "Yes"), one participant was not sure about it (answer: "Not sure"). In contrast, one answered negatively (answer: "No").

The first comment regarding this proposal is that the formal aspects were odd, ugly, and funny. In the case of some participants, this was recognised as a barrier because it would be hard to integrate such an odd artefact and interaction in everyday life; while some others found it as adequate to limit one's use: **"I would limit the use because I do not want it to inflate."** Participants stated that this kind of proposal would certainly make them aware of their time on their smartphones. They believe there would be a need to learn how to use this smartphone in the initial stages, which can be good for learning to use it more intentionally. Nevertheless, there were identified one barrier regarding this proposal, and that is that the learning process may be frustrating because, at the initial stages of its use, one may not know how to manage time properly: **"What if my smartphone needs to deflate and I need it for some emergency?; What if I need to use the maps because I need to arrive at some point and suddenly my smartphone is off?"** The proposal could be more context and content-aware instead of treating only the time factor; distinction of the activities and content could emphasise the importance of the quality of time passed on the smartphone rather than quantity of time.

**Evaluation of PLACEFUL** | The participants were generally optimistic that this proposal's interaction aspects could help them use the smartphone more intentionally. Especially concerning the possibility to have a personalised album with enabling/disabling content cards (evaluation 4 / 5), and the possibility to have cards that can match one's daily activities and a possibility to match a limited number of cards there a limited number of apps (evaluation 3,7 / 5).

When it comes to the efficacy of the specific interaction modalities and rituals in helping the people use more aware the smartphone and its content, it was found as the most efficient in

letting one understand how much time one spends on the smartphone and the context of use, so prevent antisocial behaviours (evaluation 3,4 / 5). Slightly less, it was evaluated for preventing attachment to the smartphone (evaluation 3,2 / 5), compulsive checking (evaluation 3 / 5), and accessing irrelevant information. This proposal was found as relatively efficient in letting the person stay more focused on the daily activities (evaluation 3,4 / 5), while slightly less staying connected to the reality and environment and reducing the stress of being always reachable (evaluation 3 / 5). This proposal was poorly evaluated in its efficacy to let the user stay less attached to the social networks and internet. Regarding the specific principles this proposal exploits to influence one's behaviour, the fact that the smartphone let one receive only those notifications that are enabled with card(s) was found as relatively appropriate, especially to let the person interact more intentionally with the smartphone (evaluation 3,4 / 5). The possibility to use only those contents enabled with cards was slightly less evaluated (evaluation 3 / 5). [personalisation factor]. Planning the use of the smartphone was the one that the participants perceived as less appropriate (evaluation 2,8 / 5). On the question of whether such an artefact with its formal and interaction properties could allow one to become more aware of the smartphone use and how this artefact conditions everyday life relations, 4 of 6 participants answered positively (answer: "Yes"), one participant was not sure about it (answer: "Not sure"). In contrast, one answered negatively (answer: "No").

The participants commented that this proposal was the one that they found the most "pragmatic" in terms of interaction, use cases, materiality, one's needs, and others. It was found as highly beneficial in letting one not be reachable all the time and connected. Having only three possible combinations at the time was found limiting by some participants because they could have difficulty selecting for the day (the same issue we faced in Pogo); it would make them feel worried. However, some participants found that this apparently "inconvenient" factor as good - the limit is the opportunity to learn how to act more intentionally. Some of the participants discussed why the cards are physical and not just an app where one can select what to use; while others said that the materiality was an added value because it makes evident what we want to do, what we want to put into focus, and make a sort of Statement: **"Now I do this, and I do not need anything else."**

When the conversation regarding the Placeful Phone was finished, the research authors asked the participants to give a final comment comparing all three proposals regarding how different interaction modalities and new interaction rituals and forms are efficient in triggering more intentional use and aware user habits and patterns. Besides, it was essential to understand how acceptable these proposals are and how the participants see them integrated into everyday life.

First of all, the participants observed that the diegetic prototypes were provocative enough to reflect on smartphone use and raise questions about which they had never thought about before. The overall comment upon the smartphone's use and necessity to make its use more intentional, and researchers' tentative to propose new interaction modalities and rituals, and materialities as the answer to this concern, the participants said that this kind of approach needs to be put side by side to the 'inner' functions of the smartphone and questions of policies. The role of the diegetic prototype in recognising these broader issues was found as essential. Another point

raised by the participants is that there are probably some content, apps, and functions that are more likely to develop an addiction. They gave an example Google maps, or Google translate compared to Instagram: “**Hardly we would develop an addiction to the Google maps**” – they stated.

The participants stated that what they appreciated very much in these three proposals is that the question of ‘social’ regarding how the smartphone conditions our relationship to the outer world and human-human relations was tackled.

For this reason, most of them confirmed that this aspect was primarily perceived in the third proposal (Peaceful Phone) and that for this reason, they find this one the most acceptable one.

Generally speaking, the participants showed appreciation that in all three proposals, the issues regarding smartphone use were materialised and made visible (content and time in Pogo, time in Parasite, declaring the social/human activity with Placeful phone).

## *8.4. Findings from the research: Generated design knowledge*

The findings within this research can be analysed on different levels. What is meant by this is that the authors can generate different design knowledge out from it. The author explains these different levels that may become a starting point for the new explorations.

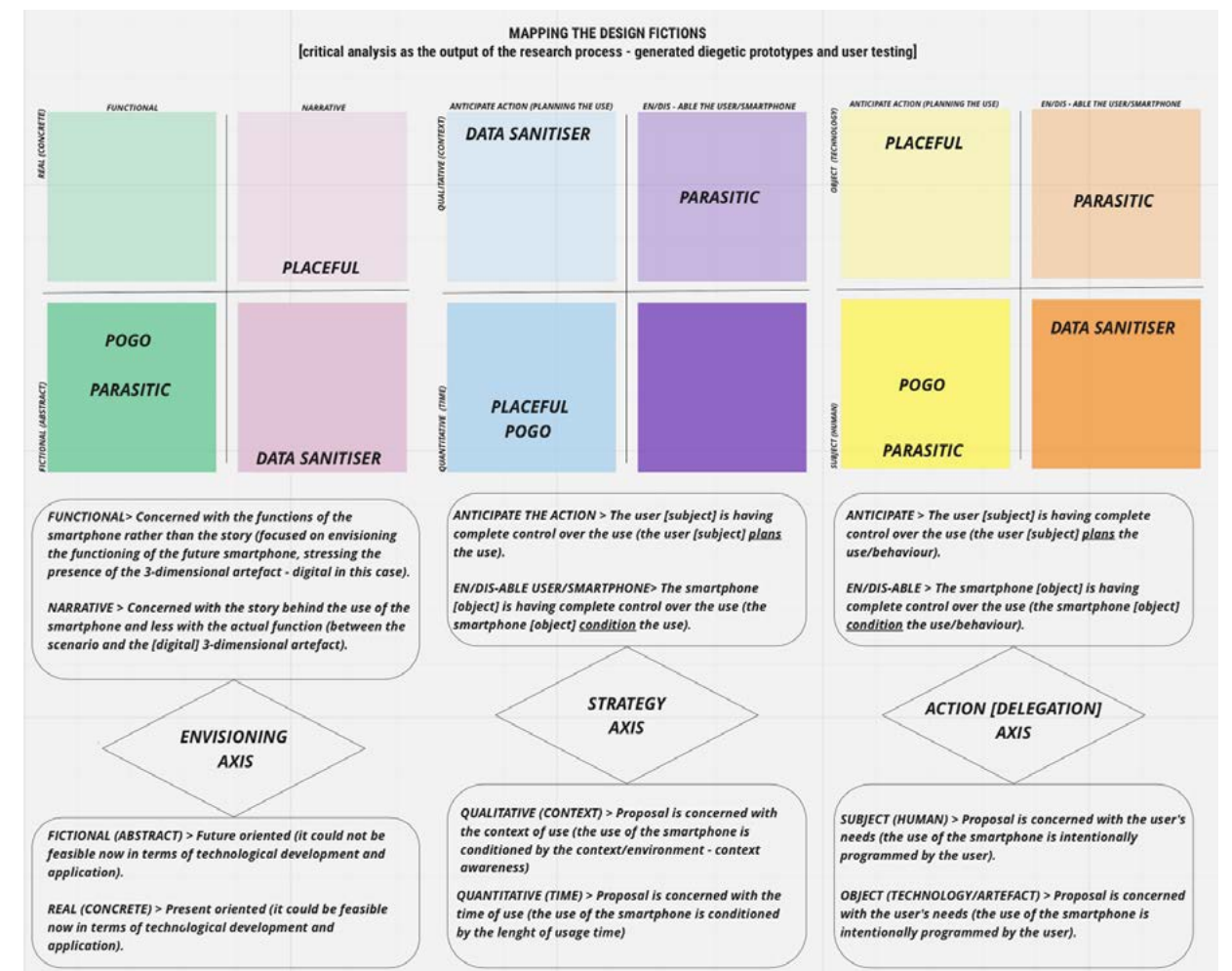
The first level is regarding the protocol use and studying the application of the protocol in the long-term activities. This level is more relevant for the author of this dissertation. Throughout this research, the author can confirm that the protocol for designing consciously technological artefacts is suitable for all design research processes and for different purposes from brainstorming and envisioning to survey setting, generating ideas. The protocol enabled the profound research on human behaviour, technologies and context. Throughout the iterative approach it was interesting to observe how the exploration and collected data were matching and extending to expand the research. Something that the author could observe from this exploration is how the surveys can be set out from the protocol. The authors of the project set the survey regarding the stages of the protocol which permitted to explore the issue in question in-depth. The protocol showed appropriate for mapping the desk research and in the end for generating the design spaces and ideas.

The second level of findings is related to the understandings regarding the smartphone usage patterns and human behaviour concerning the smartphone and identification of the design spaces. These findings emerged from the first use of the protocol. The authors generated robust findings regarding this task, starting from the desk research they observed, investigated, and expanded the findings of the subject. The authors researched how the behavioural patterns are related to our environment and context of use, which are the rituals people establish due to smartphone’s use, how they interact with this artefact and on which this is depended, how they imagine the future of the smartphone, what they would like to change in relation with their smartphone. The authors tried to explore the subject from many perspectives, and this was possible because the analysis done through the protocol helped us structure the survey, which was subsequently applied in the protocol to refine the research, as the author stated before. The knowledge generated at this level is the insights about smartphone use and mapping human behaviour in regard. This knowledge permits us understand better the issue in question, define problematic behaviours and subsequently identify the most suitable strategies to address this problem through design.

The next level considers the findings from the diegetic prototypes and the findings of the diegetic prototypes. The first is concerning the knowledge from prototype's testing in the focus group with people, and it is interested in investigating the usage patterns. Testing the diegetic prototypes opened some more questions and critical reflections regarding what is meant by intentional and aware use. Some of these questions were mentioned in part 8.3.3. The focus group helped the authors better understand how human behaviour could be influenced through the smartphone's form and new interaction rituals, which are possible barriers and perceived as enablers of more intentional and aware usage patterns. However, the discussion opened more space for investigation, such as the role of policies in preventing users from developing addictive usage patterns and others. Besides, the conversation with the participants made the authors reflect upon some ideas in terms of how they can be applied for different purposes such as in the case of Parasite phone where they suggested that it could be instead used for the children to learn how to use the smartphone more intentionally.

When it comes to the findings of diegetic prototypes, the authors noticed that even though they approached all three, in the same way, these three proposals are pretty different in terms of interaction rituals they are proposing and regarding its material properties and the level of envisioning or abstractness. The mapping of these proposals can demonstrate the potential of design fiction principles in enabling different ways to observe the same problem and enrich the design research. This is something that will be discussed later on in the research group, since this collaboration will continue. In Figure 72. the author gives just an preliminary idea about how the knowledge generated from the sessions and diegetic prototypes can be used to inform the design of the smartphones in perspective of preventing the problematic use. However, this will be ulteriorly discussed.

When it comes to tackling aware behaviours in users, these artefacts operate on several levels. First, they are both ideated to actively engage the user in the process without keeping him too attached to data and information. These artefacts exist on their own do not connect to the apps of other devices – all the interaction is happening on and around the objects. The concept of circularity behind these artefacts is the crucial factor and strategy in engaging the user in the process and guiding the user in adopting more aware behaviours through education and information. The user learns long in time what practices are causing pollution in the household and how to prevent it. The interactive surfaces (microbial surface and illuminating ball) show in real-time the situation in the environment in an intuitive way through microbial propagation or colors.



**Figure 72: Preliminary mapping of how the generated knowledge could inform the design of the future smartphones in perspective of preventing the problematic use**

## *8.5. Identified advantages and limitations (critical points) of the research approach and Protocol use*

The researchers from ITU and the author of this dissertation recognised the potentialities of applying the protocol for designing consciously technological artefacts in this research activity. It was evident that the protocol and overall approach behind this research helped the authors open some spaces for exploration that extended the research so that it would not be possible through the traditional design research approaches. It helped the authors get to 'know the unknowns' of the subject in question. This kind of approach brought three design fiction materialised in digital form, through which the authors could explore how the new materialities and interaction rituals can influence usage patterns and habits related to the smartphone's use.

Even though the entire research was conducted online, the authors followed the research plan as initially predicted. The only aspect that was revised was the making of the diegetic prototypes and focus groups.

The initial idea was to make physical prototypes, make videos that contextualise the prototypes, and animate them with postproduction technique – just in the case of diegetic prototypes introduced in Chapter 7.

The authors needed to abandon this idea due to several reasons. The authors conducted the entire collaboration in an online modality due to the pandemic situation, and at this stage, there was needed to find a way to produce the diegetic prototypes collaboratively. These diegetic prototypes were animations, as was shown in the previous text, so it is less realistic in terms of materiality compared with the previous one. The diegetic prototypes produced within this collaboration are animated scenarios; they could be collocated between the intangible design fiction (scenarios) and tangible design fiction (physical fictional prototypes that simulate functioning). It would be hard to say whether this would impact somehow differently the research. However, the author of the thesis retains importance to make this notion. For the same reason, the focus groups were conducted online.

In conclusion, the author would like to make a notion regarding the 'fidelity' of diegetic prototypes proposed in design fictions about the smartphone use. These diegetic prototypes can be defined as low fidelity one, they are not material neither contextualised in the real world. Having these diegetic prototypes in material form and giving the possibility to the participants to interact with them would permit us probably have more accurate responses.

Indeed, this is an opportunity that the author would like to explore further on. For instance, explore the nature and role of diegetic prototypes in critical design research and practice and how the medium and format influence this. However, the participants agreed upon the facts that the representations proposed by the authors were provocative and made them raise many questions and opened a new space for reflection and ideation. Yet, some use cases and storyboards needed more refinement and detailed explanations.

Also, in this case, the authors noticed that the role of people was significant in deepening the critical discussion and reflection upon the smartphone use and how the new technologies could permit us to reason on new forms and interactions, how acceptable are the proposals generated throughout this research, and how the borders of exploration could be expanded.

## 8.6. Discussion

With every new approach to the protocol, the authors were opening new questions and possibilities to explore. For the author of this thesis, this research was an opportunity to apply and test the protocol in long-term design research activities. For the research group, it was a new way to approach the research and make diegetic prototypes to explore the subject in question.

Both of these aspects are satisfying – the protocol is suitable for long-term design research activities. The findings obtained from the research are robust, and the output in the form of diegetic prototypes is extensive in terms of exploration of the relationships between humans and the smartphone, materialities and interaction rituals and how these could be designed to tackle more intentional usage patterns.

This chapter described the entire research development process, including every time the researchers approached the protocol, the output of each use of the protocol, and the final results.

At the beginning of this collaboration, the researchers established the design research methodology accordingly to the protocol. Figure 75 shows how these objectives were set at each stage of the protocol used.

Figure 75 illustrates the iterative process behind the protocol – how the outputs produced through the protocol can be used as a new input to trigger critical and reflective thinking and expand the borders of research space. This aspect of the protocol was just a hypothesis before this research collaboration. The previous cases described one-day activities, focusing on brainstorming or refining the specific aspects of one's research. Thanks to this research collaboration, it can be confirmed that the protocol is also valid in this case in terms that it can help design researchers enlarge the fields of investigation and imagination and trigger critical thinking.

Previously there was shown how such a research process generated varied knowledge. Each of the outputs generated through the protocol used represents a piece of knowledge about the topic in question. The authors extended the findings of the desk research. They provided exhaustive material on the subject, building on the existing literature that was analysed, explored through the protocol and compared with the people's experiences and

perceptions regarding mobile technology. The researchers came with the three design fiction proposals and diegetic prototypes, exploring factors that may influence one's behaviour, such as smartphone forms, interaction modalities, established interaction rituals, social context, human-human relationships, and others. These diegetic prototypes demonstrate a significant variety in form, or better on how the form could tackle more intentional uses – from playful and odd ways to interact with the artefacts to more rational and functional proposals, exploiting different materialities and aesthetics. Significant findings were brought from the focus groups where the people contributed to building the knowledge generated through the prototypes. The people gave some important insights when it comes to understandings about what would they find as efficient, acceptable and meaningful different interaction mo.

Each of these levels opened some new questions and possibilities to expand the research in the future.



- Arminen, I. (2007). Review essay mobile communication society? *Acta Sociologica*, vol.50(4), pp. 431–437. <https://doi.org/10.1177/0001699307083983>
- Donner, J. (2009). Blurring Livelihoods and Lives. In *Innovations*, pp. 91–101.
- Ek, R. (2012). Topologies of Human-Mobile Assemblages. In *Mobile technology and place*, Wilken, R., and Goggin, G. (eds.) pp. 39-54, Taylor&Francis
- Green, N. (2002). On the move: Technology, mobility, and the mediation of social time and space. *Information Society*, vol. 18(4), pp. 281–292. <https://doi.org/10.1080/01972240290075129>
- Jones, M., et al. (2017). Beyond “yesterday’s tomorrow”: future-focused mobile interaction design by and for emergent users. *Personal and Ubiquitous Computing*, vol. 21(1), pp. 157–171. <https://doi.org/10.1007/s00779-016-0982-0>
- Malpas, J. (2020). The Place of Mobility and Individualization. In *Mobile technology and place*, Wilken, R., and Goggin, G. (eds.) pp. 27-38, Taylor&Francis
- Mervyn, K., and Allen, K. D. (2013). Sociospatial Context and Information Behaviour: Social Exclusion and the Influence of Mobile Information Technology. *Journal of the American Society for Information Science and Technology*, vol. 64(July), pp. 1852–1863. <https://doi.org/10.1002/asi>
- Salehan, M., and Negahban, A. (2013). Social networking on smartphones: When mobile phones become addictive. *Computers in Human Behavior*, vol. 29(6), pp. 2632–2639. <https://doi.org/10.1016/j.chb.2013.07.003>
- Ting, C. H., and Chen, Y. Y. (2020). Chapter 8 - Smartphone addiction. In C. A. Essau & P. H. Delfabbro (Eds.), *Adolescent Addiction (Second Edition)* (Second Edition, pp. 215–240). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-818626-8.00008-6>
- Wilhelm, M., Hutchins, M., Mars, C., and Benoit-Norris, C. (2015). An overview of social impacts and their corresponding improvement implications: A mobile phone case study. In *Journal of Cleaner Production*, vol.102, pp.302–315. <https://doi.org/10.1016/j.jclepro.2015.04.025>
- Wilken, R., and Goggin, G. (2020). Mobilizing Place. *Conceptual Currents and Controversies*. In *Mobile technology and place*, Wilken, R., and Goggin, G. (eds.) pp. 4-25, Taylor&Francis

# S\_04> CONCLUSIONS AND FINDINGS

# 9

## FINAL DISCUSSION

This PhD starts from the hypothesis that the current research and practice concerned with the design of technological artefacts to tackle aware behaviours in users need more critical and pluriversal approaches to help design researchers and practitioners deal with the complexities of the contemporary societies, anticipate the possible ethical and societal implications of technologies and human behaviour, and participate actively in building more sustainable and thriving societies.

Design discipline should offer new approaches and methods able to grasp a broader context of events and actors involved in the processes of change, consider the changes in an individual's life circumstances. (Grand and Wiedmer, 2010; Rapp, Tirasa, and Tirabeni, 2019) Often the technologies and strategies for influencing the users' behaviour are framing the user as "merely an executor of behavioural programs" (Rapp, Tirasa, and Tirabeni, 2019) rather than an active participant (actor) in social and technological transformations, where "[...] most behavioural change approaches assign too much responsibility to agency and self-efficacy without much consideration to variables of a social or contextual nature." (Jun, Carvalho, & Sinclair, 2018)

Building on this, the PhD research in question aims to propose the new and more critical approaches for designing technological artifacts to tackle aware behaviours. Approaches to trigger critical thinking in design researchers and practitioners to engage in a different kind of thinking that includes complex concepts and specific criteria. (Jacobsone, 2012)

The author employs researching and answering: How can critical thinking be triggered in design research and practice to design more consciously technological artefacts to tackle aware behaviours?

Throughout this research author explores and exploits the critical design theories and practices such as Design Fiction and Speculative design, offering the principles and approaches that can be applied to trigger critical thinking and stimulate critical discussion among the researchers and practitioners. This research is exploring and experimenting with the principles and theories of Design Fiction (as a critical and speculative design practice), such as anticipatory scenarios and diegetic prototypes, that can be implemented and used

to trigger critical thinking in research and practice concerned with the design of technological artefacts able to tackle aware behaviours. In this research, the author wants to understand how these principles and theories can be systematized and operationalized to design more consciously technological artefacts to tackle aware behaviours.

This research employs observing the phenomena of critical thinking and the efficiency of different approaches, tools, and methods in triggering critical thinking. The author aims to understand how to interpret the acquisition level of critical thinking by the researchers and practitioners through critical design principles and theories. This research finds its foundations in interpretivism as a scientific paradigm of reference to investigate this phenomenon. The author establishes the Research Through Design based methodology, considered suitable for addressing the problems that need to integrate the knowledge and theories from different disciplines and investigate “preferred states as an intentional outcome of the research.” In such research, the artefacts become the key element for building the knowledge, and the design researchers and practitioners actively contribute to the design research knowledge. (Zimmerman, Forlizzi, and Evenson, 2007) Such an approach has its foundations in Applied (design) research[1] and Action research[2], which enables researchers and practitioners to reflect on and evaluate their work (Muratovski, 2016). It is characterized by a systematic inquiry directed towards acquiring, converting, or extending knowledge in particular applications.

In this dissertation, the author illustrated how the design research methodology is established starting from building the theoretical knowledge in desk research within three main areas: Design for Behavioural Change, Critical Design Practices, and HCI and Emerging Technologies (Section 1). Then the author shows how this knowledge was systematised and operationalised into a provisional (pilot) Protocol and Envisioning tool that offers a possible way on how to trigger the critical thinking for designing technological artefacts to tackle aware behaviours – a set of tools and theoretical models and concepts exploiting the design fiction principles where the building of the scenarios and diegetic prototypes (Section 2, chapter 4). Here the author shows how the Protocol and Envisioning tool were tested and refined through several stages to build the PhD knowledge (Section 2, chapter 5 and 6). The Protocol and Envisioning tool were applied in two design research activities to demonstrate how it can be used in design research and practice (Section 3, chapters 7 and 8).

The author showed that the participants were actively involved in the research process throughout the dissertation. The participants engaged at different stages of this research had an important role in contributing to the PhD knowledge. The author engages the design researchers and design students in all the stages of development of the Protocol and Envisioning tool. Besides the experts and students author also engages the people (defined as users) in testing the outputs generated from the design research activities. The role of the researchers, experts, and design students were to evaluate the protocol (at different stages of its development) to understand how much the stages of the protocol with tools triggered critical thinking during different design (research) activities; suggest how to improve the protocol; evaluate the tools, models, and theories applied in it.

The people (users) were engaged in the final stages of this PhD research, and the scope of

their engagement was to test the scenarios and diegetic prototypes generated throughout the protocol in sessions with experts and researchers. Engaging the people in the research process was essential to demonstrate several things. The author wanted to confirm whether the diegetic prototypes and scenarios embody the values as intended by the protocol, in other words, whether such a design research approach can generate technological artefacts perceived by the users as able to tackle aware behaviours towards the sustainability issues; whether the technologies and its application are found as reliable in terms of trustworthiness and addressing the possible ethical and societal issues of it; how these proposals are relevant and beneficial for the individual and community in terms of sustainable development.

In this chapter, the author observes how the knowledge within this PhD was generated on different levels to offer one possible answer on how to design more consciously technological artefacts to tackle aware behaviours. The first level of knowledge generation concerns the one generated from the literature review and sessions held with researchers, students, experts.

The second level of knowledge generation concerns the one generated from the user sessions (focus groups and surveys) where the people (citizens) contributed to building the knowledge through discussions. Here and after, the author discusses both of these levels and lists the main findings from this PhD research. Besides, the author also puts a critical eye on the research development, declaring the possible limitations of the protocol and envisioning tool.

## 9.1. Main findings

This part of the dissertation describes the PhD research findings conducted in three years, from November 2018 to November 2021. The main research question of this PhD is how critical thinking can be triggered for the design of technological artefacts to tackle aware behaviours in users. The author studies different theories and identifies tools, methods, models, and theoretical concepts to understand the most relevant, to support design researchers and practitioners design more consciously, adopting the critical thinking. Building on this, the author establishes a new and more critical approach for designing founded on identifying and analyzing the design problems starting from the societal challenges through a four-stage protocol combining several theories and tools, exploiting the future as a space for critical inquiry. The approach considers building the anticipatory scenarios and developing diegetic prototypes from the Protocol, which can be tested with a broader public and used to reflect the technologies, human behaviour, and societal challenges.

The findings within this research are categorised into two dimensions. The first dimension concerns the findings from the desk research conducted by the author and the research activities conducted to prove the author's assumptions generated from the theoretical foundations. There is the systematisation of the theoretical knowledge into the approach with Protocol (understanding which theories, tools, and methods can be applied to help design researchers and practitioners adopt critical thinking) and ideation of Envisioning tool. This level also includes the design research activities during which the Protocol and Envisioning tool were applied to generate the anticipatory scenarios and diegetic prototypes. The author discusses the potential of the use of anticipatory scenarios and diegetic prototypes in design research and practice for anticipating technological artefacts, mediations, interactions, and innovation.

The second level on which the author introduces the findings is the findings that emerged from the user sessions in which the anticipatory scenarios and diegetic prototypes were tested. The approach established by the author in this research suggests that the scenarios and diegetic prototypes developed through the Protocol can be tested with the people to empower the critical reflection, understand whether the anticipated mediations, interaction rituals, and new applications and forms of technologies are found as meaningful, appropri-

ate, trustworthy, and beneficial to let the user adopt aware behaviours. The tests conducted with people had two objectives. First, to test whether the scenarios and diegetic prototypes effectively embed these values (generated through the Protocol) – understand whether the people perceive these values as such. In those terms, it was about understanding the Protocol's effectiveness to guide the design researcher and practitioner in delivering technological artefacts that prescribe these values and can let the user adopt aware behaviours.

Secondly, the scope of the testing was to understand and describe the entire approach proposed by the author, which includes testing of scenarios and diegetic prototypes as a part of the reflective design research activity – prove the importance of communicating the not-yet-existing technologies and technological artefacts to the broader public, engage the participants in a design research processes actively.

Here and after, the author describes the findings generated throughout this research that constructed the PhD knowledge in question.

### 9.1.1. From research and design research activities

In the following text, the author introduces the first level findings that emerged from this PhD research. The first level of findings concerns the results from the in-depth literature review and the design research activities with researchers, students, and experts, which lead to the construction of the approach with the Protocol.

Building on the literature review, the author found that the design research concerned with the design of technological artefacts able to tackle aware behaviours needs new approaches to help design researchers and practitioners deal with the world's complexities, support them in adopting pluriversal perspectives and understand the processes and transformations occurring in the contemporary societies, including the uncertainties such as pandemics or environmental. Section 1 and Section 2 of this dissertation describe the theoretical background on which the author establishes a new approach for designing technological artefacts to tackle aware behaviours in users.

The new approach suggested by the author proposes a new way for designing technological artefacts to tackle aware behaviours, exploiting the future as a field for critical inquiry and critical design principles. The approach suggests identifying and analysing design problems starting from the analysis of the Societal Challenges, supported with the four-stages Protocol, an assemblage of different theories, tools, methods, and models found as relevant to the design of this typology of artefacts.

The approach finds the future space as an opportunity to reflect critically through anticipation. The Protocol gives guidelines and rules to anticipate the not yet existing technologies, mediations, and interactions, applying critical thinking, considering different elements constructing our society and environment in which the technologies play an essential role. The output of this analysis is anticipatory scenarios and diegetic prototypes – artefacts (materialisations) that contextualise and, in a certain sense, prove the existence of the not-yet-existing technologies. These materialisations are the instruments to provoke a discussion, provide the knowledge about what kind of future is the most plausible and acceptable, and let the design researchers and practitioners understand how to design for more desirable futures starting from the present. In this way, the researchers and practitioners use the future to anticipate and reflect on the present. It is an iterative process exploiting the feedback loop between the future and the present as two inseparable entities.

The author finds a way to marry several theoretical concepts found essential when dealing with complex issues in a contemporary world. The foundation of such an approach, concerned with the environmental questions and the role of technology in shaping our societies acting as a mediator between the individual and the society, refers to modern and contemporary philosophy (20th and 21st century). The author referees to the scholars

such of Max Weber, Hannah Arendt, Ulrich Beck, Gilles Deleuze, Felix Guattari, Bruno Latour, Don Ihde, Andrew Feenberg, Arturo Escobar, Paul Veerbek, and several others. The author tries to put the knowledge from these theories into the Protocol, a ready-to-apply approach for design research and practice, combining it with behavioural sciences and the design for behavioural change theories and strategies and several other theories coming from the field of social psychology and economy concerned with the sustainable development (Social-ecological model, Doughnut economy model, Actants mapping).

The knowledge of this PhD research was generated through interacting and making with participants.

The author tests the Protocol in several activities with design researchers, design students, and experts to prove its validity when it comes to triggering critical thinking and stimulating its users toward the critical discussion and exploration of the unknowns of their design proposals. Applying the Protocol in design and research activities showed that the design researchers and practitioners found an appropriate way to approach the design of the technological artefacts and adopt pluriversal perspectives. The participants observed that such an approach with Protocol enabled them to explore the spaces, which otherwise they would not be able to, mainly because they did not have a practical way to do it. Indeed, this finding has a different meaning depending on the category of the participants and the activity.

The expert participants (researchers and other experts from the field) were already knowledgeable about the theoretical concepts included within the Protocol and the relationship and relevance these concepts have when designing technological artifacts, human behaviour, and sustainable development. They could evaluate objectively the validity of how the theoretical concepts, models, and tools were selected and applied in the Protocol to provide the practical guidelines and set of rules for designing adopting the critical thinking. Besides this, they could tell their experience while exploring the topics throughout the Protocol.

When it comes to the use of the Protocol in activities with students, another observation could be made. The students were not familiar with the theoretical concepts on which the Protocol is founded, so they could not objectively evaluate the relevance of the specific concepts, models, and tools. Their role was to tell what they experienced from using the Protocol and observe whether the critical thinking was triggered to let them adopt the pluriversal perspectives, pushing them to explore more in-depth topics in question.

From the design and research activities, the author finds that the Protocol with tools and the Envisioning tool with the Protocol is an appropriate way to approach the design of technological artefacts to tackle aware behaviours. In other words, the assemblage of the theoretical concepts, methods, models, and tools proposed by the authors offers to the design researchers and practitioners optimal knowledge, resources, and guidelines to design more consciously technological artefacts. Such a design and research approach, exploiting the design fiction principles and future as a space for critical inquiry, enable design researchers and practitioners to adopt holistic perspectives concerning the societal challenges and different events like political, economic, historical, and others, anticipate the possible ethical and social implications, to design more intentionally the human-technology-society mediations.

The Protocol and Envisioning tool are the one possible way to help design researchers and practitioners adopt critical thinking and deal with the complexities of contemporary societies. The Protocol is the output of a long theoretical study and debate with the participants, investigating the theories, tools, and methods that the design research and practice can combine to design more consciously with and for technologies, taking into consideration human behaviour, societal and ethical issues in regard. After several testing of the Protocol, or better methods, tools, models, theories, the author established the final Protocol that marries several concepts and already existing models and tools. Besides, each session produced the outputs that could be analysed and tested – the artefacts (scenarios and diegetic prototypes), which became the means of study through which the author generated the PhD knowledge.

Diegetic prototypes have a significant role and multiple functions in this research to understand what we can do with them and how they can be practically used in design research and practice. This research finds two ways to 'use' and 'define' the diegetic prototypes.

One way is to produce the diegetic prototypes as an output of the research and 'use' them to communicate to the broader public and as a tool to engage the people in design processes. These prototypes become powerful tools to open a critical discussion and debates on some crucial questions concerning the technologies, interactions, society, and others.

In Chapter 7 and Chapter 8 author shows how the diegetic prototypes were materialised from the anticipatory scenarios and the purpose of these prototypes. Throughout the case studies, the author shows how and what one can anticipate using this approach and the design fiction principles such as anticipatory scenarios and diegetic prototypes. In Chapter 7 author introduces three design fictions (scenarios and diegetic prototypes), each answering a different topic. Concept 0: Living Artefacts is proposing a new application for the technology of microbial engineering (modification of the e.coli metabolic process to produce biomass Carbon). This design fiction is imagining how to scale the technology, thinking of the entire production and distribution of the new technology, how to configure the new technology in terms of shaping the artefact, how to appropriate the technology to the user, and many more others. In this particular case, the author thought of exploiting the microbial technology at maximum, transforming the polluted air into energy and cleaning chemicals, and the new way to use microbial propagation as an interface.

Concept 1: Water Doughnut is proposing the scaling of the current sensors for microplastics and applying them in a household, together with the app that can help the user change the consumer habits. In this case, the author is thinking of the system, proposing the scaling of the existing technology and its application, and exploiting the Augmented Reality field to provide more engaging interaction. This concept raised the interest of the Politecnico di Milano Technology Transfer Office for its potential to become a patent. Microplastic sensors are continuously evolving, and their use will become more expected soon. This design fiction anticipates a near and plausible future with a genuine interest in

the market. From this example, the author deduces essential findings of the importance of diegetic prototypes and critical approaches such as the one suggested by this PhD in anticipating innovation and creating the new design and technology spaces.

The last concept introduced in Chapter 7, Concept 2: The Animal has a different scale than the previous two. Here the author imagines the new system and service for collecting and transforming the organic waste into energy for the community. This concept is imagining the robot (Animal) for collecting the organic waste, the Totem for transforming the waste into energy, the system of distribution, and the interfaces for the user. The author suggests a new scale for the existing technologies, new applications, and an entirely new kind of service. This concept is not only imaging the technologies and services, but at the same time, it is giving a vision of how the future communities may look like and how the infrastructures and our ways of living would evolve in regard.

In Chapter 8, the author describes the activities conducted in collaboration with ITU Copenhagen and the diegetic prototypes that came from the research on the Future of Mobile Technologies. The diegetic prototypes explored different design spaces identified throughout the protocol, proposing new interaction rituals that could change how people interact with smartphones to prevent unintended and addictive usage patterns. In this case, the diegetic prototypes were a tool to communicate, investigate and map the possible strategies, scenarios, interactions, and forms that could lead the smartphone user to the more intentional use of this technology. The diegetic prototype also, in this case, was used in focus groups with people, and the findings gathered from the sessions were transformed into knowledge that could be used to design more consciously mobile technology.

The second way to 'use' the diegetic prototypes in this research is proposed by the envisioning tool TICs & SICs ideated by the author. These are different kind of diegetic prototypes, that are not produced as a research output, but borrowed from Sci-Fi films (commonly known as Props). These prototypes are the technological artefacts coming from some other (fictional) worlds where they perfectly belong and adapt to its historical, political, social context. With this envisioning tool, one can study the relationships between the technologies (diegetic prototypes) and worlds, analyse the collective imaginaries about the future, and technological and scientific development. The use of TICs and SICs in design research activities and brainstorming sessions showed that thanks to these diegetic prototypes, participants (researchers and practitioners) were stimulated to observe the technologies as an inseparable part of the society, in all its complexity, and it helped in opening the critical discussions and reflections in regard.

The author concludes the PhD research process with user sessions in which she tested the diegetic prototypes produced from the design and research activities. The findings of this part of the research are introduced in the following text.

## 9.1.2. From users' sessions

The author introduces the second level of findings generated from diegetic prototypes and user sessions (focus groups) with people. This knowledge is closely related to the 'use' diegetic prototypes produced as the research output, as the author shows in Chapter 7 and the last part of Chapter 8 describing the research output conducted in collaboration with ITU Copenhagen.

Engaging the people in focus groups was an essential contribution to this research. The findings that emerged from this activity are concerning several things.

The approach for designing consciously technological artefacts proposed by the author in this research suggests using the Protocol to generate the scenarios and materialise the scenarios in diegetic prototypes. For such an approach, diegetic prototypes aim to visualise the not-yet-existing technologies and perceive how they 'could be' in the real world now. The benefits of such an approach lie in understanding how the user perceives the not-yet-existing technology and how the user would behave about it. This kind of knowledge can help design researchers and practitioners appropriate these technologies and, as a result, design more consciously starting from today. Design researchers and practitioners can start building more thriving and sustainable futures by designing more consciously today and understanding how to adapt the technologies to build meaningful mediations. Understanding how people perceive the artefacts, new interaction modalities, and rituals, how much they are ready to accept new technologies is essential to deliver more conscious design and research of technological artefacts.

Diegetic prototypes have an essential role in opening discussions and exploring the unknowns of our design and research proposals. These prototypes operate within the sphere of fictional, raising the "What if?" questions rather than searching for functional solutions.

In the users' sessions organised by the author, the users did not evaluate the functional aspect of prototypes; indeed, they actively participated in a debate and critical reflection upon the technologies, the role and impact of the technologies on society, possible future scenarios, and many other.

Differently from the focus groups focusing on testing the prototypes' functionality and usability aspects (a common approach in 'traditional' design processes using the present as a space for exploration), the author noticed that with the diegetic prototypes' participants felt much more engaged; they felt the urgency to participate and build upon the researcher's (speculative) proposals, employing the critical thinking and reflection.



This kind of interaction can help the design researchers and practitioners amplify the field of exploration, understand the people's disbelief and fears about the future, predict their behaviours, understand how to build trustworthy technological artefacts and interactions to support the user in adopting aware behaviours.

In the focus groups organised within the collaboration with ITU, the researchers observed that the participants (users) raised some important questions regarding the diegetic prototypes authors demonstrated. In this session, the authors collected some essential insights regarding human behaviour and how to contextualize the technologies (mobile technology) into one's everyday life. People told their everyday rituals, schedules, habits, and everything that may come in a potential conflict with the technology, but also opened many new paths for the researchers to explore. As it can be seen in Chapter 8, the discussion with the people gave many ideas on how to adopt proposed technologies and interactions to fit better in their lives; they observed which could be the possible barriers in interaction with those technologies, but also opened new design spaces in terms of how some of these technologies can be used for different purposes/applications (in case of the Parasitic phone the participants made observation that such a technology could be helpful for letting the kids learn how to use more intentionally smartphones), which otherwise probably would not have emerged.

Diegetic prototypes are, at the same time, the protagonists and mediators in discussion between the researchers and people. Findings from the users' sessions are founded on critical discussions and reflection in focus groups with participants, who actively build the knowledge upon one's other opinion and experience.

It was observed both from the focus groups described in Chapter 7 and the focus group described in Chapter 8 that through the discussion among the participants, the researchers discovered some unknowns that they did not explore previously through the research. Testing the diegetic prototypes with users is beneficial because it helps support and expand the research conducted throughout the Protocol. The author confirms that the diegetic prototypes are an excellent tool to test people's perceptions about the technologies and the future, suspend disbelief by actively participating in the processes of transformation, and co-designing with people as a part of reflective design and approach.

## 9.2. *Limitations of the Protocol*

The Protocol for designing consciously technological artefacts to tackle aware behaviours was tested and evaluated several times in design and research activities to verify whether such an approach is valuable for letting the design researchers and practitioners adopt critical thinking and pluriversal perspectives. The sessions with researchers and experts proved the validity of the Protocol in terms of how different theoretical concepts, methods, and tools were selected and applied by the author to trigger critical thinking for the design of technological artefacts.

The Protocol offers one possible way to consciously approach the design of technological artefacts and the complexities of designing such artefacts and systems in a contemporary world. The author noticed some weaknesses during the design and research activities where the Protocol was applied.

How the one supports the research with the Protocol will depend on many factors. First of all, it depends on the purpose of integrating the Protocol in everyday practice – whether it is for brainstorming, analysing data, ideation, or other. Another important factor is the one's background – this was observed comparing the sessions conducted with students and subsequently with experts. Besides, even cultural factors can impact the final output of what one delivers throughout the Protocol – researchers and practitioners may perceive differently some concepts included in the Protocol such as the concept of agency and scaling, actants mapping, others. However, even though the Protocol sets rules and guidelines for designing, the analysis made through the Protocol will always contain some dose of subjectivity.

The author observes that the diegetic prototypes generated from the scenarios developed through the Protocol do not always consider all possible factors involved in designing new technological artefacts and their integration in the real world. Several factors may impact the quality of the final output generated through the Protocol. Some of these are related to the duration of the activity since the author noticed that the one-day activities might bring less thoughtful proposals than, for instance, the long-term research activities. However, the author observes that some issues emerged in one-day and long-term use of the Protocol.

During the activities, it was impossible to comprehend all the factors that influence the use of technology/technological artifacts and how they will influence one's behaviour. In the design fictions described in Chapter 7, there were noticed some gaps in imaging the infrastructure behind the technological artefacts, for instance, in the case of the Living Artefacts how the microbial solutions would be managed in the market, how much energy of chemicals one can obtain from the one cycle, and others. In the case of Water Doughnut, there were observed some issues regarding privacy and the big producers of chemicals. In Chapter 8, the authors noticed that not all proposals were taking equally into consideration one's life circumstances, for instance, the Parasitic phone that was neglecting the qualitative and contextual aspect (when and what for one is using the smartphone) of smartphone use and it was focusing too much on the quantitative aspect (usage time).

The Protocol gives the researcher and practitioner the elements that need further examined and researched. To solve the issue of subjectivity in such an approach, the author suggests verifying the analysis done throughout the Protocol using surveys and focus groups. To illustrate this, the author refers to the activities described in Chapter 8. In Chapter 8 author showed how the researchers of ITU used the Protocol to identify the design spaces and map the usage patterns concerning the use of the smartphone. To verify the findings, they set the survey and obtained 125 answers that helped verify how true or false their findings were, which helped them objectify the research. These findings generate design fictions proposing the new forms and interaction rituals for the future smartphone and verifying the focus group's output. The findings from the focus group once again were used to reflect on how to appropriate proposed design fictions to establish more meaningful mediations and interactions between the user and the technology.

There, the use of the Protocol is not strict – the analysis and researches made through the Protocol will always contain some dose of subjectivity that can be adjusted through surveys or by engaging the people in co-designing. For this reason, the approach behind the Protocol suggests the iterative process founded on analysis and critical reflection, but also discussion and debate.

### 9.3. *Limitations of the Envisioning tool*

Even though the envisioning tool (TICs and SICs) were found as an enabler of critical discussion and reflection throughout all sessions, the author recognized several limitations and some margin for improvement.

First, this tool is developed manually due to several stages of development, involving some digital tools aiming to make the process more objective and precise. However, the process behind the tool making is mainly supported by the literature review on Sci-Fi within the field of Design Fiction (referring to the researchers like Kirby, Tanenbaum, and some others) and the philosophy behind Sci-Fi genre (authors like Freedman and Sanders).

The first notion author would like to make is that such an approach to a tool's creation resembles some subjectivity. The author thought about the possible ways to solve this issue, but this will become the further development. To solve this issue author thought first to make the process less manual and search for some help in algorithms - development of the platform to create cards through several parameters (the same the author used to conduct the manual search). Another way to refine the research may be to engage the people knowledgeable about the topic in the making (exploit the citizen's science). The first does not exclude another. The solution may be that the citizens use the platform to enrich the collection of cards, something like the open platform for collective science.

Another notion concerns copyright. Current cards contain the images collected from the internet. Until we are operating within the field of education or workshops and internal research, this problem does not exist because the cards have only the purpose of helping the process of research or study. Still, they cannot be used for commercial purposes, considering their current form. Perhaps with the digital tool, this could be overcome too. The digital tool could be scraped and collect the images only from open-source websites. On the other side, this would probably narrow the collection of images, so there would be a need to think of a sort of hybrid system able to collect open-source images when possible and, in other cases, rely on some other platform

under subscription.

Furthermore, the author feels the necessity to say that the collection of TICs and SICs at this moment contains almost entirely the titles belonging to the Western cultures, so it somehow imposes that particular way of thinking and perceiving the future. It would be opportune to explore what other cultures offer in Sci-fi cinematography and even compare. Engaging the citizens in the card-making process (or better evolution) finds its purpose here in the author's opinion.

# 10

## CONCLUSIONS

In this last chapter of this dissertation, the author provides the conclusions and introduces design knowledge generated through the three years, including design and research activities and focus groups with peers and other people who contributed to knowledge construction through participating.

Firstly, the author discusses the relevance and contribution of this PhD to the design research, introducing the generated design knowledge. The knowledge within this research was generated through making and interacting, employing the critical reflection, and analysing the outputs of the activities to deliver the Protocol for designing consciously technological artefacts to tackle aware behaviours and Envisioning tools. The author discusses the benefits of using the Protocol and design fiction principles (anticipatory scenarios and diegetic prototypes) for design research and practice and explains why this approach is advantageous compared to the existing tools, methods, and models for designing technological artefacts to tackle aware behaviours (referring to the desk research described in Section 1, Chapter 3).

Developing this PhD research opened several new questions and ideas for further development. The further development concerns the evolution of the Envisioning tool and study about the potential development of the Water Doughnut (Chapter 7) in collaboration with the Technology Transfer Office of Politecnico di Milano. Also, the insights of this research opened the possibilities for further exploration of the use of Design Fiction in design research. These developments may include other actors in the future research process or open collaboration between different departments at Politecnico di Milano.

Besides, in three years period, the author established several relations with other universities and agencies, which opened up spaces for new collaborations, and was interested in the knowledge produced within this research.

Here and after, the author explains the generated design knowledge and further developments more in-depth.

## *10.1. Relevance and contribution of the research (generated design knowledge)*

This research starts with the question: “How can we trigger the critical thinking in design research and practice to design the technological artefacts able to tackle aware behaviours?” The author hypothesises that the design fiction and speculative design offer principles (use the future as a space for critical inquiry to deliver anticipatory scenarios and diegetic prototypes) able to trigger critical thinking when designing technological artefacts to tackle aware behaviours. Here the author started to explore design fiction and speculative design principles through the Research Through Design methodology - generating the knowledge through making and interacting with students, researchers, and experts from the fields of study within this PhD, but also people engaged in focus groups to test the design and research outputs (scenarios with diegetic prototypes).

Throughout this dissertation, the author describes all the design research activities that had as a purpose to help the author build the approach with the Protocol and Envisioning tool, from those with PhD students and research fellows, with MSc students, self-reflection activity, reflection activities with experts and finally, collaboration with ITU Copenhagen. The author generated, tested, and delivered the Protocol for designing technological artefacts to tackle aware behaviour as the main output of this PhD research and the Envisioning tool exploiting the Sci-Fi genre.

This Protocol marries several theoretical concepts, tools, and methods with design fiction and speculative design principles to help design researchers and practitioners trigger the critical thinking toward the design with and for technologies to tackle and support the aware human behaviour concerning the sustainability issues (environmental sustainability, health and well being, other).

From research and design activities, the author confirmed the validity of the initial hypothesis set by this PhD research - the approach founded on design fiction principles such as anticipatory scenarios and diegetic prototypes could help design researchers and practitioners trigger critical thinking when it comes to the design of technological artefacts to tackle aware behaviours. The combination of the theories, methods, models, and tools proposed in the Protocol was recognised as relevant and essential by the experienced

researchers and professionals, there able to inform scenarios and materialisations (diegetic prototypes) and generate meaningful technological artefacts.

The findings generated from the user sessions show that the diegetic prototypes generated throughout the Protocol are enablers of the critical discussion among the common people (what the author called users), too. The critical discussion about the technological artefacts and their ability to influence human behaviour recognised benefits for the society and individuals and all other values that design researchers and practitioners can generate into the artefacts using the Protocol. Through the interaction with the Diegetic prototypes, users recognised almost all the values prescribed through the Protocol, which confirms that the Protocol enables design researchers and practitioners to design more consciously by applying critical thinking.

Such an approach with Protocol offers a practical way and guidelines for creating the anticipations of technological artefacts while employing critical thinking – use the future as a space for critical inquiry. It tries to provide the design researcher and practitioners with several crucial theoretical concepts when designing with and for technologies and human behaviour. It provides the researchers with interdisciplinary insights and pluriversal perspectives on the design (and) research projects. It provides the researchers and practitioners with the necessary methods and tools to deal with contemporary societies' complexities and societal issues, better understand the uncertainties, and design for more thriving futures.

In Chapter 3 of this dissertation, the author maps different theories, tools, models, and methods already used in behavioural sciences and Design for Behavioural change research and practice and discusses its applications, limitations and identifies those that could be implemented in the approach proposed by the author. This PhD is not offering new tools and models, but it searches for a way to marry the existing ones and to expand the limits of the existing behavioural models by combining them with some other theories derived from social sciences and philosophy.

The author wants to let the researchers and practitioners adopt holistic knowledge and pluriversal perspectives to deal with the complexities of the contemporary world. The current behavioural interventions using the technologies to impact human behaviour often neglect the broader context in which the person lives, the changes in society that inevitably impact the individual, the significant impact of the technologies on the society, the mediations generated between the individual and technology and society. Most of the models and theories introduced by the author effectively solve very particular issues like quitting smoking, losing weight, and some others, that have a short-term impact. Design for Behavioural Change interventions tends to grasp some more aspects and actors involved in change, especially when dealing with sustainability issues.

However, they are very much strategy-oriented, focusing on the problem to solve and do not consider other aspects like those listed by the author. Some existing tools consider the ethical aspect of technology and sustainability issues (like Dorrestijn's Product Impact Tool);

some others suggest the anticipation of potential barriers in guiding the human behaviour and preventing the unintended behavioral outcome (like Stibe and Cugelman, 2016); still, these do not provide tools through which the researchers and practitioners can analyse the society, identify the potential disablers and enablers of sustainable development and human behaviour, build the relationships between the actants involved in processes of change.

The Protocol developed by the author wants to give instruments to guide the thinking and research process of the researchers and practitioners. Support them in understanding different kinds of implications of technologies, like ethical and societal, social structures and relationships, identify the possible barriers and enablers of adopting aware behaviours towards sustainable issues, and understand all the actors involved in technological development and implementation processes.

The Protocol can be used for different use cases. The author intended to build an approach for design researchers interested in applied research and design practitioners, both within product, interaction and service design. Moreover, when the Protocol can be applied? As design and research activities are shown, the Protocol can be used in workshops and brainstorming activities (educational or professional), it can be used in design and research activities to conduct and refine the research about a specific topic, but also in educational activities, since it showed as effective in activities with students. Using the Protocol in a one-day envisioning and brainstorming activities may have a purpose to nourish the ideas and open design spaces or refine design briefs putting a critical eye on it.

Otherwise, the Protocol can be used in long-duration design research activities, as proved in collaboration with ITU Copenhagen. In this case, it can support different stages of design and research process from topic analysis (desk research analysis), idea generation, and others. The Protocol and Envisioning tool approach are suitable for topics dealing with sustainable development concerning human behaviour and for design and research concerned with emerging technologies.

The author would like to mention that this research has a strong interest in ethical and societal concerns since it is one of its main interests. The outputs of this research aim at supporting the processes toward sustainable development (Sustainable Development Goals), and it supports the objectives of building more thriving, resilient, and sustainable societies and conditions, exploring both micro (local) and macro (global) levels. It is founded on the values of the EU such as Human Dignity, Democracy, Human Rights, and goals oriented toward promoting the well-being of the citizens, sustainable development, social progress, promoting scientific and technological growth, and others, and it raises the questions on how the design discipline and design knowledge can contribute and support these processes.

Thou, dealing with human behaviour is always a delicate issue, especially regarding technologies. This Protocol aims at guiding the design researchers and practitioners on the path toward creating more ethically and socially aware design artefacts. However, it would be too optimistic to think that this Protocol can bring the ideal artefacts or that every researcher or

practitioner will use it in the same way. There is an individual component in each process that cannot be controlled.

Regarding the achievements within this PhD research, the approach with the Protocol and envisioning tool are protected by the Trademark at the Technology Transfer Office (TTO) of Politecnico di Milano. (See section Appendix)

## 10.2. Further development

Here and after, the author comments on the research opportunities and perspectives that emerge from this PhD research. In the three years, the author developed the Protocol and Envisioning tool for designing consciously technological artefacts to tackle aware behaviours. The Protocol and Envisioning tool were tested long the development and finally in the design research collaboration with ITU Copenhagen. The author observed the potentialities and benefits of applying the critical approach proposed in this PhD research in several cases (for different research topics and technological artefacts).

However, after this PhD the objective is to apply the Protocol and Envisioning tool to other activities. Here the author makes an overview of the possible scenarios.

In this dissertation, the author mentioned that the Protocol and Envisioning tool is suitable for educational activities beyond the design research and practice context. This aspect was not explored in-depth in the last three years since it was the secondary context of interest for the author. Nevertheless, the author recognised its potential as described in Chapter 5 in the workshop with students from the Interaction Design course. Beyond the courses where the Protocol and Envisioning tool can be applied in a short-term activity (like in the case of the workshop that lasted one day and had as objective to revise the design briefs), the author finds a potential to apply it also in a long-term activity such as Master of Science thesis. Building on the findings of this PhD research, the author wants to propose to develop a student's thesis using the Protocol and Envisioning tool long the process of thesis development. This process can be imagined like the design research project developed in collaboration with ITU (Chapter 8), applied in the educational context.

Another potential recognised by the author concerning the educational context is framing the advanced training courses that use the approach proposed in this PhD research and the theories, methods, and tools included in the Protocol. Such training courses (Master courses) may have as objective to form the professionals working in the sphere of design concerned with human behaviour, technologies, and sustainable development, covering a wide range of topics such as those proposed by the EU Commission (i.e., environmental sustainability, health and wellbeing, the safety of citizens, and others). Such a course could

train the young professionals to deal with the complexities of the contemporary world, learn how to adopt pluriversal perspectives, and answer the emerging topics in design practice. To provide an example, such advanced training courses could be integrated into the contexts like Poli.design<sup>[15]</sup> (a consortium of Politecnico di Milano).

Throughout this PhD research, several other questions for further research development opened. First, the author would like to continue developing envisioning tools (TICs and SICs) and create a more refined online platform and system for generating cards supported with algorithms. This development also can establish interdisciplinary or inter-departmental, national or international collaborations and stress the importance of the citizen's science since the author would like to engage the people in enriching this tool.

Another aspect author found essential to continue investigating are the diegetic prototypes - how to make and contextualise them and how the scenario itself condition how the researchers and practitioners will produce the diegetic prototype. The author noticed that the different scenarios were generating different typologies of the prototype (Chapter 7). The author would like to experiment also with some other mediums beyond the one used in this PhD, such as virtual, augmented reality.

Regarding the possible fields of application of the protocol and research developments, the author believes such an approach with protocol has considerable potential in Artificial Intelligence (AI). The AI is one of the most emerging technologies in the last years and its evolvement and pervasive application is opening not only many possibilities but also questions regarding the possible ethical and societal issues and concerns. In the workshop with students in Interaction Design course "Envisioning AI through Design" (see Chapter 5) there were observed advantages of the protocol use and envisioning tool showed that the Sci-Fi is offering an exhaustive analysis on the topic of AI. One of the further developments would be to identify the potential research opportunities and collaborations in that sense. One of the possibilities in this sense are the student's thesis.

Additionally, several other opportunities from this PhD research emerged in terms of design research activities and collaborations.

Firstly, the collaboration with IxD lab of ITU Copenhagen will continue next year since both parties recognised the potentialities of this collaboration and the project in question.

Another potential collaboration is with the Danish digital agency Specifici®, which deals with behavioural design tools that are more oriented toward strategic design solutions. They showed their interest to collaborate, merging the pieces of knowledge produced within this PhD with their know-how and tools. The owner of the agency participated in one of the sessions organised with experts, she had a chance to use the protocol with tools, and after this,

she expressed interest in collaborating.

The scenarios generated with experts and subsequently diegetic prototypes generated by the author opened up some questions regarding future evolutions in terms of products and services development. The author, with the supervisor, is currently discussing with the TTO the further development of one of the concepts generated from the scenario on the topic of microplastics (Concept 1). This idea in its origin is believed to have the potential to become a patent in the future.

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[15] <https://www.polidesign.net/en/>.



COMPLETE LIST  
OF REFERENCES

- Abraham, C., and Michie, S. (2008). A Taxonomy of Behavior Change Techniques Used in Interventions. *Health Psychology*, 27(3), 379–387. <https://doi.org/10.1037/0278-6133.27.3.379>
- Akrich, M. and Latour, B. (1992). A Summary of a Convenient Vocabulary for the Semiotics of Human and Nonhuman Assemblies. In *Shaping Technology/ Building Society, Studies in Sociotechnical Change*, Bijker, W.E., and Law, J. (eds.), pp. 259-264, The MIT Press
- Araiba S. (2019). Current Diversification of Behaviorism. *Perspectives on behavior science*, vol.43(1), pp. 157–175. <https://doi.org/10.1007/s40614-019-00207-0>
- Arendt, H. (1958). *Vita activa. La condizione umana*. Bompiani. 2014
- Arminen, I. (2007). Review essay mobile communication society? *Acta Sociologica*, vol.50(4), pp. 431–437. <https://doi.org/10.1177/0001699307083983>
- Avin, U., and Goodspeed, R. (2020) Using Exploratory Scenarios in Planning Practice, *Journal of the American Planning Association*, 86:4, pp. 403-416, DOI: 10.1080/01944363.2020.1746688
- Axon, S., , et al, (2018). The human factor: Classification of European community-based behaviour change initiatives. *Journal of Cleaner Production*, 182, 567–586. <https://doi.org/10.1016/j.jclepro.2018.01.232>
- Bardzell, J., Bardzell, S., and Stolterman, E. (2014). Reading critical designs. 1951–1960. <https://doi.org/10.1145/2556288.2557137>
- Bardzell, J., Bardzell, S., & Stolterman, E. (2014). Reading critical designs. 1951–1960. <https://doi.org/10.1145/2556288.2557137>
- Beck. U. (1986). *La società del rischio. Verso una seconda modernità*. Carocci editore, 2000
- Berger, L.P., and Luckman, T. (1968). *The Social Construction of the Reality*. Golden City, New York, Doubleday and Co.
- Berry, T. (1999). *Thw Great Work: Our Way into the Future*. New York, Bell Tower
- Bina, O., Mateus, S., Pereira, L., and Caffa, A. (2017). The future imagined: Exploring fiction as a means of reflecting on today's Grand Societal Challenges and tomorrow's options. *Futures*, 86, 166–184. <https://doi.org/10.1016/j.futures.2016.05.009>
- Bleecker, J. (2009). Design Fiction: A short essay on design, science, fact and fiction. *Near Future Lab, March*, 103–114. <https://doi.org/10.1145/1516016.1516021>
- Bleecker, J. (2010). Design Fiction: From Props to Prototypes. *Proceedings of the 6th Swiss Design Network Conference*, 58–67. <https://doi.org/10.1002/glia.20282>
- Boon, B., Rozendaal, M. C., and Stappers, P. J. (2018). Ambiguity and Open-endedness in Behavioural Design. *Proceedings of the DRS 2018 International Conference: Catalyst*, 2075–2085. <https://doi.org/10.21606/dma.2018.452>
- Bryant, L.R. (2011). *The Democracy of Objects*. Open Humanities Press
- Burnam-Fink, M. (2015). Creating narrative scenarios: Science fiction prototyping at Emerge. *Futures*, 70,

48–55. <https://doi.org/10.1016/j.futures.2014.12.005>

Burnam-Fink, M. (2015). Creating narrative scenarios: Science fiction prototyping at Emerge. *Futures*, 70, 48–55. <https://doi.org/10.1016/j.futures.2014.12.005>

Carroll, J. M. (2000). Making use: scenario-based design of human-computer interactions. In *Zeitschrift Fur Bibliothekswesen Und Bibliographie* (Vol. 48). <https://doi.org/10.1145/347642.347652>

Cash, P. J., Hartlev, C. G., and Durazo, C. B. (2017). Behavioural design: A process for integrating behaviour change and design. *Design Studies*, 48, 96–128. <https://doi.org/10.1016/j.destud.2016.10.001>

Consolvo, S., McDonald, D. W., and Landay, J. A. (2009). Theory-driven design strategies for technologies that support behavior change in everyday life. *Proceedings of the 27th International Conference on Human Factors in Computing Systems - CHI 09*, 405. <https://doi.org/10.1145/1518701.1518766>

Cooper, S. (2003). Technoculture and Critical Theory. In *Technoculture and Critical Theory*. <https://doi.org/10.4324/9780203167021>

Corbetta, P. (2014). *Metodologia e tecniche della ricerca sociale*. Il Mulino

Coskun, A., Zimmerman, J., & Erbug, C. (2015). Promoting sustainability through behavior change: A review. *Design Studies*, 41, 183–204. <https://doi.org/10.1016/j.destud.2015.08.008>

Dainton, M., and Zelle, E. D. (2005). Explaining Theories of Persuasion. *Applying Communication Theory for Professional Life*, 103–131. <https://doi.org/10.1177/0191453708090332>

Darnton, A. (2008). An overview of behaviour change models and their uses. *Health* (San Francisco), July, pgs. 10-15. [https://doi.org/https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/498065/Behaviour\\_change\\_reference\\_report\\_tcm6-9697.pdf](https://doi.org/https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/498065/Behaviour_change_reference_report_tcm6-9697.pdf)

De Medeiros, J. F., Da Rocha, C. G., & Ribeiro, J. L. D. (2018). Design for sustainable behavior (DfSB): Analysis of existing frameworks of behavior change strategies, experts' assessment and proposal for a decision support diagram. *Journal of Cleaner Production*, 188, 402–415. <https://doi.org/10.1016/j.jclepro.2018.03.272>

Donner, J. (2009). Blurring Livelihoods and Lives. In *Innovations*, pp. 91–101.

Dorrestijn, S. (2009). Design and Ethics of Product Impact on User Behavior and Use Practices. *Proceedings of the 5th International Conference on Intelligent Environments*, vol. 4, pp. 1–8.

Dunne, A. and Raby, F. (2013). *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press

Dunne, A. and Raby, F. (2006). *Hertzian Tales. Electronic Products, Aesthetics, and Critical Design*. The MIT Press

Ek, R. (2012). Topologies of Human-Mobile Assemblages. In *Mobile technology and place*, Wilken, R., and Goggin, G. (eds.) pp. 39-54, Taylor&Francis

Elsden, C., et al (2017). On speculative enactments. *Conference on Human Factors in Computing Systems - Proceedings, 2017-Janua*, 5386–5399. <https://doi.org/10.1145/3025453.3025503>

Erlhoff, M., Bruce, L., and Lindberg, S. (2008). *Design Dictionary*. In *Design Dictionary*. <https://doi.org/10.1007/978-3-7643-8140-0>

<https://doi.org/10.1007/978-3-7643-8140-0>

Escobar, A. (2018). *Designs for the Pluriverse*. Duke University Press.

Feenberg, A. (1999). *Questioning the Technology*. Routledge

Feenberg, A. (2005). Critical Theory of Technology: An overview. In *Tailoring Biotechnologies*, vol. 1(1), pp.47-64.

Fogg, B., et al., (2008). *Persuasive Technology*. 5033(June), 35–46. <https://doi.org/10.1007/978-3-540-68504-3>

Fogg, B. J., Cuellar, G., & Danielson, D. (2008). Motivating, Influencing, and Persuading Users. *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, 133–146. <https://doi.org/10.1201/9781410615862>

Fogg, B. J. (2009). Creating persuasive technologies: an eight-step design process. *Proceedings of the 4th International Conference on Persuasive Technology - Persuasive '09*, 1. <https://doi.org/10.1145/1541948.1542005>

Fogg, B.J. (2003). *Persuasive Technology: Using Computers to change what we think and do*. Morgan Kaufmann Publishers

Follet, J. (2014). *Designing for Emerging Technologies*. O'Reilly

Freedman, C. (2000). *Critical Theory and Science Fiction*. Wesleyan University Press

Friedman, K. (2003). Theory construction in design research Criteria: Approaches, and methods. *Design Studies*, 24(6), 507–522. [https://doi.org/10.1016/S0142-694X\(03\)00039-5](https://doi.org/10.1016/S0142-694X(03)00039-5)

Gaßner R., and Steinmüller K. (2018) Scenarios that tell a Story. Normative Narrative Scenarios – An Efficient Tool for Participative Innovation-Oriented Foresight. In: Peperhove R., Steinmüller K., Diemel HL. (eds) *Envisioning Uncertain Futures. Zukunft und Forschung*. Springer VS, Wiesbaden. [https://doi.org/10.1007/978-3-658-25074-4\\_3](https://doi.org/10.1007/978-3-658-25074-4_3)

Ghajargar, M., and Wiberg, M. (2018). Thinking with Interactive Artifacts: Reflection as a Concept in Design. *April*. <https://doi.org/10.1162/DESI>

Gieryn, T. F., Bijker, W. E., and Law, J. (1994). Shaping Technology/Building Society: Studies in Sociotechnical Change. In *Technology and Culture*, Vol. 35, (2). <https://doi.org/10.2307/3106331>

Godet, M., and Roubelat, F. (1996). Creating the Future: The Use and Misuse of Scenarios. *Long Range Planning*, 29(2), 164–171. [https://doi.org/10.1016/0024-6301\(96\)00004-0](https://doi.org/10.1016/0024-6301(96)00004-0)

Gonzatto, R. F., van Amstel, F. M. C., Merkle, L. E., & Hartmann, T. (2013). The ideology of the future in design fictions. *Digital Creativity*, 24(1), 36–45. <https://doi.org/10.1080/14626268.2013.772524>

Grand, S., and Wiedmer, M. (2010). Design fiction: a method toolbox for design research in a complex world. *Designresearchsociety.Org*, 1–25. <https://doi.org/10.1145/1141911.1141937>

Green, N. (2002). On the move: Technology, mobility, and the mediation of social time and space. *Information Society*, vol. 18(4), pp. 281–292. <https://doi.org/10.1080/01972240290075129>

Guattari, F. (1995) *Chaosmosis: An Ethico-Aesthetic Paradigm*, trans. Paul Bains and Julian Pefanis, p.4, Bloomington: Indiana University Press,

Hailes, K. (1999). *How we became Posthumans*. The University of Chicago Press

Hall, A. (2011). Experimental design: Design experimentation. *Design Issues*, 27(2), 17–26. [https://doi.org/10.1162/DESI\\_a\\_00074-Hall](https://doi.org/10.1162/DESI_a_00074-Hall)

Hardeman, W., et al. (2002). Application of the theory of planned behaviour in behaviour change interventions: A systematic review. *Psychology and Health*, 17(2), 123–158. <https://doi.org/10.1080/08870440290013644a>

Hideg, É. (2007). Theory and practice in the field of foresight. In *Foresight*, vol. 9 (6), pp.36–46. <https://doi.org/10.1108/14636680710837299>

Hongladarom, S. (2013). Don Ihde: Heidegger's Technologies: Postphenomenological Perspectives. *Minds and Machines*, 23(2), 269–272. <https://doi.org/10.1007/s11023-012-9296-9>

Hummels, C., and Frens, J. (2012). Designing Disruptive Innovative Systems, Products and Services: RTD Process. *Industrial Design - New Frontiers*, May 2014. <https://doi.org/10.5772/22580>

Hummels, C., and Frens, J. (2009). The reflective transformative design process. January, 2655. <https://doi.org/10.1145/1520340.1520376>

Ihde, D. (2000). Putting technology in its place. *Nature*, 404(6781), 935. <https://doi.org/10.1038/35010184>

Ihde, D. (2008). Introduction: Postphenomenological research. *Human Studies*, 31(1), 1–9. <https://doi.org/10.1007/s10746-007-9077-2>

Ihde, D. (2000). Technoscience and the “other” continental philosophy. *Continental Philosophy Review*, 33(1), 59–74. <https://doi.org/10.1023/A:1010092421546>

Ihde, D. (2012). Postphenomenological Re-embodiment. *Foundations of Science*, 17(4), 373–377. <https://doi.org/10.1007/s10699-011-9244-9>

Ihde, D. (2011). Stretching the In-between: Embodiment and beyond. *Foundations of Science*, 16(2–3), 109–118. <https://doi.org/10.1007/s10699-010-9187-6>

Ihde, D. (1997). Structure of technology knowledge. *International Journal of Technology and Design Education*, 7(1–2), 73–79. <https://doi.org/10.1023/A:1008809019482>

Ilstedt, S., and Wangel, J. (2014). Altering expectations: How design fictions and backcasting can leverage sustainable lifestyles. *Proceedings of the Design Research Society International Consortium (DRS)*, pp.1–12. <http://www.drs2014.org/media/654245/0265-file1.pdf>

Jakobsone, L. (2017). Critical design as approach to next thinking. *The Design Journal*, vol. 20(sup1), S4253–S4262. <https://doi.org/10.1080/14606925.2017.1352923>

Janlert, L.E., and Stolterman, E. (2008). Complex Interaction. *ACM Trans. Comput.-Hum. Interact.*, 17(2). <https://doi.org/10.1145/1746259.1746262>

Janssen, M. A., and Ostrom, E. (2006). Chapter 30 Governing Social-Ecological Systems, L. Tesfatsion and K. L. Judd (eds.); Vol. 2, pp. 1465–1509. Elsevier. [https://doi.org/10.1016/S1574-0021\(05\)02030-7](https://doi.org/10.1016/S1574-0021(05)02030-7)

0021(05)02030-7

Jones, M., et al. (2017). Beyond “yesterday’s tomorrow”: future-focused mobile interaction design by and for emergent users. *Personal and Ubiquitous Computing*, vol. 21(1), pp. 157–171. <https://doi.org/10.1007/s00779-016-0982-0>

Johnson, D.G., et al. (2009). *Technology and Society. Building our Sociotechnical Future*. Inside Technology

Jun, G. T., Carvalho, F., and Sinclair, N. (2018). Ethical Issues in Designing Interventions for Behavioural Change. *DRS2018: Catalyst*, 1. <https://doi.org/10.21606/drs.2018.498>

Kirby, D. (2010). The future is now: Diegetic prototypes and the role of popular films in generating real-world technological development. *Social Studies of Science*, 40(1), 41–70. <https://doi.org/10.1177/0306312709338325>

Kivisto, P., Kuklick, H., & Long, E. (1988). Knowledge and Society: Studies in the Sociology of Culture Past and Present, Vol. 6. *Contemporary Sociology*, 17(6), 813. <https://doi.org/10.2307/2073617>

Klenk, M. (2020). How Do Technological Artefacts Embody Moral Values? *Philosophy & Technology*. <https://doi.org/10.1007/s13347-020-00401-y>

Koskinen, L. (2011). Design research through practice. In Morgan Kaufmann (Issue 3).

Kroes, P., Vermaas, P. E., Light, A., and Moore, S. A. (2008). Philosophy and Design. In *Philosophy and Design*. <https://doi.org/10.1007/978-1-4020-6591-0>

Kymäläinen, T. (2019). Science Fiction Prototypes as a Method for Discussing Socio-Technical Issues within Emerging Technology Research and Foresight. *Athens Journal of Technology & Engineering*, 3(4), 333–348. <https://doi.org/10.30958/ajte.3-4-4>

Kymäläinen, T. (2015). Science fiction prototypes as design outcome of research: Reflecting ecological research approach and experience of things (Issue February).

Kymäläinen, T. (2019). An approach to future-oriented technology design - with a reflection on the role of the artefact. *DRS2016: Future-Focused Thinking*, 4 (September). <https://doi.org/10.21606/drs.2016.87>

Langrial, S. (2012). From Digital Interventions to Behavior Change Support Systems: Understanding Persuasive Systems' Development and Evaluation Process. *Proceedings of IRIS*, 2012, 1–16. [http://iris.im.uu.se/wp-uploads/2012/08/iris2012\\_submission\\_14.pdf](http://iris.im.uu.se/wp-uploads/2012/08/iris2012_submission_14.pdf)

Latour, B. (1992). Where are the Missing Masses: The Sociology of a Few Mundane Artifacts. In Bijker, W. E. and Law, J. (eds.), *Shaping technology/building society: studies in sociotechnical change*. Vol. Inside tec. pp. 225-258. Cambridge: MIT Press.

Latour, B. (2005). Reassembling the Social - An Introduction to ANT. In *Journal of Chemical Information and Modeling*, Vol. 53 (9). <https://doi.org/10.1017/CBO9781107415324.004>

Leonardi, P. M. (2010). Digital materiality? How artifacts without matter, matter. *First Monday*, 15(6). <https://doi.org/10.5210/fm.v15i6.3036>

Lockton, D., Harrison, D., and Stanton, N. A. (2010). The Design with Intent Method: A design tool for influencing user behaviour. *Applied Ergonomics*, 41(3), pp.382–392. <https://doi.org/10.1016/j.apergo.2009.05.004>

apergo.2009.09.001

- Loughborough University Institutional Repository. (2017). Creating sustainable innovation through design for behaviour change: summary report (Vol. 91).
- Maldonado, T. (1972). *Design, Nature & Revolution*. University of Minnesota Press Mineapolis, 2019.
- Malpass, M. (2017). *Critical Design in Context: History, Theory, and Practices*. Bloomsbury Academic. <https://books.google.it/books?id=QpGWDQAAQBAJ>
- Malpas, J. (2020). The Place of Mobility and Individualization. In *Mobile technology and place*, Wilken, R., and Goggin, G. (eds.) pp. 27-38, Taylor&Francis
- McVeigh-Schultz, et al, (2018). Immersive design fiction: Using VR to prototype speculative interfaces and interaction rituals within a virtual storyworld. *DIS 2018 - Proceedings of the 2018 Designing Interactive Systems Conference*, 817–830. <https://doi.org/10.1145/3196709.3196793>
- Mervyn, K., and Allen, K. D. (2013). Sociospatial Context and Information Behaviour: Social Exclusion and the Influence of Mobile Information Technology. *Journal of the American Society for Information Science and Technology*, vol. 64(July), pp. 1852–1863. <https://doi.org/10.1002/asi>
- Michel, R. (2015). *Design Reserch Now*. Birkhauser
- Michie, S., Ashford, S., Sniehotta, F. F., Dombrowski, S. U., Bishop, A., & French, D. P. (2011). A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALO-RE taxonomy. *Psychology and Health*, vol. 26 (11), pp.1479–1498. <https://doi.org/10.1080/08870446.2010.540664>
- Michie, S. Stralen, M.M., and WEST, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, vol. 6 (42). <https://doi.org/10.1001/archderm.1985.01660070119033>
- Miller, R. (2015). Learning, the Future, and Complexity. *An Essay on the Emergence of Futures Literacy*. *European Journal of Education*, 50(4), 513–523. <https://doi.org/10.1111/ejed.12157>
- Rotolo, D., Hicks, D., & Martin, B. R. (2015). What is an emerging technology? *Research Policy*, vol. 44(10), pp. 1827–1843. <https://doi.org/10.1016/j.respol.2015.06.006>
- Miltenberger, R. G. (2001). Behavior modification: Principles and procedures (2nd ed.). In *Behavior modification: Principles and procedures* (2nd ed.). <https://doi.org/10.1080/01431161.2016.1204478>
- Muratovski, G. (2016). *Research for Designers*. Sage
- Nathan, L. P., Klasnja, P. V., and Friedman, B. (2007). Value scenarios: A technique for envisioning systemic effects of new technologies. *Conference on Human Factors in Computing Systems - Proceedings*, 2585–2590. <https://doi.org/10.1145/1240866.1241046>
- Niedderer, K., Clune, S., and Ludden, G. (2017). *Design for Behaviour Change: Theories and practices of designing for change*. Taylor & Francis. <https://books.google.it/books?id=WFsyDwAAQBAJ>
- Niedderer, K., et al (2014). *Joining Forces: Investigating the influence of design for behaviour change on sustainable innovation*. *NordDesign*, April, 620–630.
- Niedderer, K., et al (2016). *Design for Behavioural Change as a Driver for Sustainable Innovation: Chal-*

enges and Opportunities for implementation in the private and public sectors, in *International Journal of Design*, vo.10 (2), pp. 67-85

- Pierce, J., Sengers, P., Hirsch, T., Jenkins, T., Gaver, W., & Disalvo, C. (2015). Expanding and refining design and criticality in HCI. *Conference on Human Factors in Computing Systems - Proceedings*, 2015-April(May 2016), 2083–2092. <https://doi.org/10.1145/2702123.2702438>
- Preece, J. J. (2010). I Persuade, They Persuade, It Persuades! [technology-mediated social participation applications]. In *Persuasive Technology Proceedings 5th International Conference PERSUASIVE 2010*. [https://doi.org/10.1007/978-3-642-13226-1\\_2](https://doi.org/10.1007/978-3-642-13226-1_2)
- Prost, S., Mattheiss, E., and Tscheligi, M. (2015). From Awareness to Empowerment: Using Design Fiction to Explore Paths towards a Sustainable Energy Future. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15*, 1649–1658. <https://doi.org/10.1145/2675133.2675281>
- Rapp, A., Tirassa, M., and Tirabeni, L. (2019). Rethinking Technologies for Behavior Change. *ACM Transactions on Computer-Human Interaction*, 26(4), 1–30. <https://doi.org/10.1145/3318142>
- Raworth, K. (2017). *Doughnut Economy. Seven Ways to Think Like a 21st-Century Economist*. Cornerstone
- Reddiar, W. E. (2010). *The Object Speaks : Connecting the Post- Optimal Object Design with New Media Arts Discourse*. February.
- Rhodes, D. H., & Ross, A. M. (2010). *Shaping Socio-technical System Innovation Strategies using a Five Aspects Taxonomy*. *Incoase*, 1999, pp.1–15.
- Rozendaal, M. M. C., Keyson, D. V., and de Ridder, H. (2007). Product behavior and appearance effects on experienced engagement during experiential and goal-directed tasks. August, 181. <https://doi.org/10.1145/1314161.1314178>
- Salehan, M., and Negahban, A. (2013). Social networking on smartphones: When mobile phones become addictive. *Computers in Human Behavior*, vol. 29(6), pp. 2632–2639. <https://doi.org/10.1016/j.chb.2013.07.003>
- Sanders, M.S. (2009). *The philosophy of Science Fiction Film*. The University Press of Kentucky.
- Schon, D.A. (1991). *The Reflective Practitioner*. Ashgate Publishing.
- Shedroff, N., Noessel, C. (2012). *Make it so*. Rosenfeld media.
- Simon, H.A. (1996). *The Science of the Artificial*. The MIT Press
- Sterling, B. (2006). *La forma del futuro*. Apogeo editore.
- Sterling, B. (2002). *Tomorrow Now*. Mondadori
- Stibe, A., and Cugelman, B. (2016). Persuasive backfiring: When behavior change interventions trigger unintended negative outcomes. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 9638, 65–77. [https://doi.org/10.1007/978-3-319-31510-2\\_6](https://doi.org/10.1007/978-3-319-31510-2_6)

Stienstra, J., Alonso, M. B., Wensveen, S., & Kuenen, S. (2012). How to design for transformation of behavior through interactive materiality. Proceedings of the 7th Nordic Conference on Human-Computer Interaction Making Sense Through Design - NordiCHI '12, 21. <https://doi.org/10.1145/2399016.2399020>

Somerville, I. (1999). Agency versus identity: Actor-network theory meets public relations. In *Corporate Communications: An International Journal*, vol.4(1), pp. 6–13. <https://doi.org/10.1108/13563289910254525>

Suchman, L., Trigg, R., and Blomberg, J. (2002). Working artefacts: Ethnomethods of the prototype. *British Journal of Sociology*, 53(2), 163–179. <https://doi.org/10.1080/00071310220133287>

Tanenbaum, J., Pufal, M., and Tanenbaum, K. (2016). The limits of our imagination. September, 1–9. <https://doi.org/10.1145/2926676.2926687>

Tanenbaum, J. (2014). Design fictional interactions. *Interactions*, 21(5), 22–23. <https://doi.org/10.1145/2648414>

Tanenbaum, J., Pufal, M., and Tanenbaum, K. (2017). Furious futures and apocalyptic design fictions: Popular narratives of sustainability. *Interactions*, 24(1), 64–67. <https://doi.org/10.1145/3022123>

Tang, T.; Bhamra, T. (2009). Understanding consumer behaviour to reduce environmental impacts through sustainable product design. Loughborough University. Conference contribution. <https://hdl.handle.net/2134/8375>

Tanyoung, K., and DiSalvo, C. (2010). Speculative visualization: a new rhetoric for communicating public concerns. Design Research Society. <http://www.designresearchsociety.org/docs-procs/DRS2010/PDF/066.pdf>

Torning, K., and Oinas-Kukkonen, H. (2009). Persuasive System Design: State of the Art and Future Directions. 1–8. <papers2://publication/uuid/1941731C-F23D-46B6-8BCB-A1D676F7F485>

Tromp, N., Hekkert, P., and Verbeek, P.-P. (2011). Design for Socially Responsible Behavior: A Classification of Influence Based on Intended User Experience. *Design Issues*, 27(3), 3–19. [https://doi.org/10.1162/DESI\\_a\\_00087](https://doi.org/10.1162/DESI_a_00087)

Tuinen, van Sjoerd, (ed). (2017). *Speculative Art Histories. Analysis at Limits*. Edinburgh University Press

Verbeek, P. (2006). Materializing Morality Design Ethics and. *Science, Technology and Human Values*, 31(3), 361–380.

Verbeek, P. (2005). *What things do: Philosophical reflections on Technology, Agency, and Design*. Pennsylvania State University Press

Weber M. (1946) Science as a Vocation. In: Tauber A.I. (eds.) *Science and the Quest for Reality. Main Trends of the Modern World*. Palgrave Macmillan, London. [https://doi.org/10.1007/978-1-349-25249-7\\_17](https://doi.org/10.1007/978-1-349-25249-7_17)

Wilhelm, M., Hutchins, M., Mars, C., and Benoit-Norris, C. (2015). An overview of social impacts and their corresponding improvement implications: A mobile phone case study. In *Journal of Cleaner Production*, vol.102, pp.302–315. <https://doi.org/10.1016/j.jclepro.2015.04.025>

Wilken, R., and Goggin, G. (2020). Mobilizing Place. *Conceptual Currents and Controversies*. In *Mobile technology and place*, Wilken, R., and Goggin, G. (eds.) pp. 4-25, Taylor&Francis

Zimmerman, J., and Forlizzi, J. (2008). The Role of Design Artifacts in Design Theory Construction. *Arti-*

*fact*, 2(1), 41–45. <https://doi.org/10.1080/17493460802276893>

Zimmerman, J., Forlizzi, J., and Evenson, S. (2007). Research through design as a method for interaction design research in HCI. *Conference on Human Factors in Computing Systems - Proceedings*, January, 493–502. <https://doi.org/10.1145/1240624.1240704>

Zimmerman, J., Stolterman, E., and Forlizzi, J. (2010). An analysis and critique of research through design: Towards a formalization of a research approach. *DIS 2010 - Proceedings of the 8th ACM Conference on Designing Interactive Systems*, January, 310–319. <https://doi.org/10.1145/1858171.1858228>

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Matteo Buffoli  
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APPENDIX 

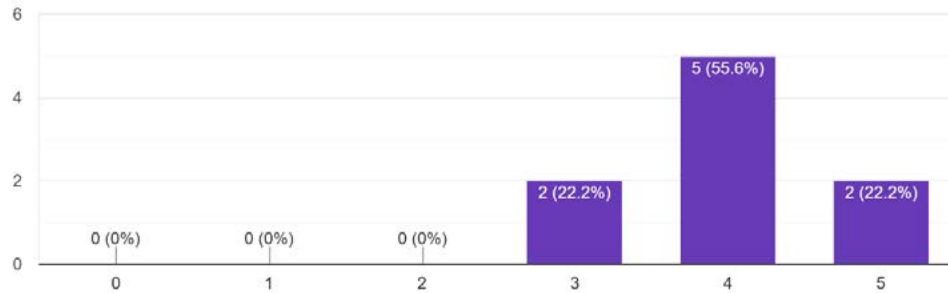
# QUESTIONNAIRES

# Questionnaire A: First experimentation' Speculate4 Behavioural Change' [January 10th 2020]

## ACTIVITY EVALUATION

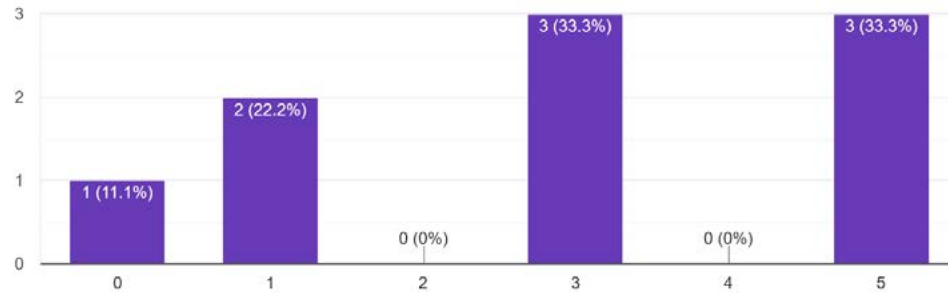
Were you able to relate the different topics of the workshop? (evaluate from 0 to 5)

9 responses



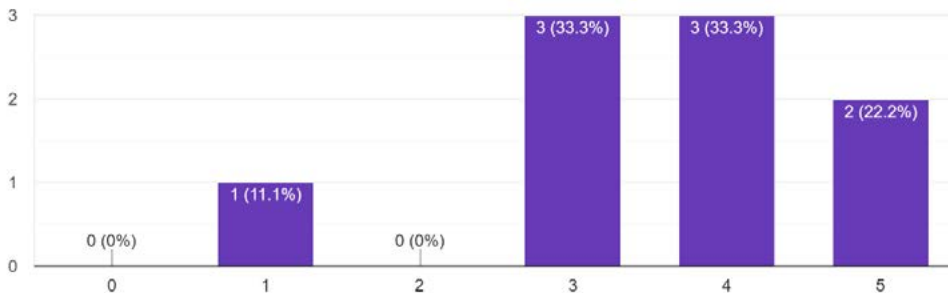
Was it challenging to think about technologies for behavioural change by starting from the facts related to societal issues and challenges? (evaluate from 0 – 5)

9 responses



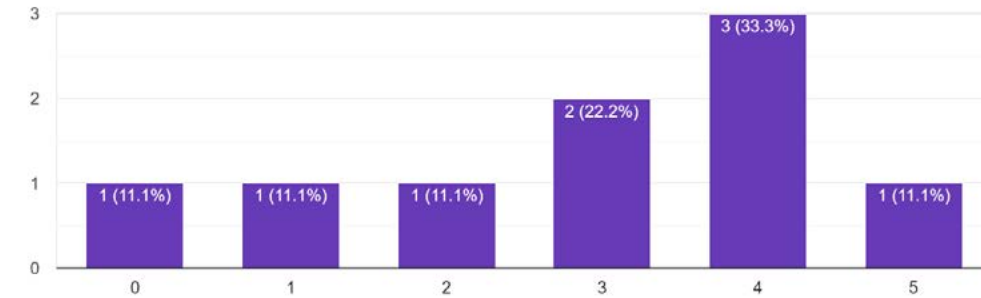
How much the societal challenge topic you selected helped you in envisioning the near future technologies and applications for behavioural change? (evaluate from 0 – 5)

9 responses



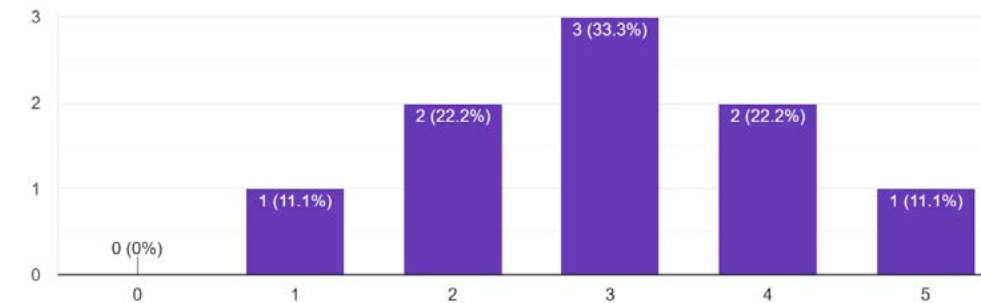
How much the SCI-FI contents helped you to think about the near future? (evaluate from 0 – 5)

9 responses



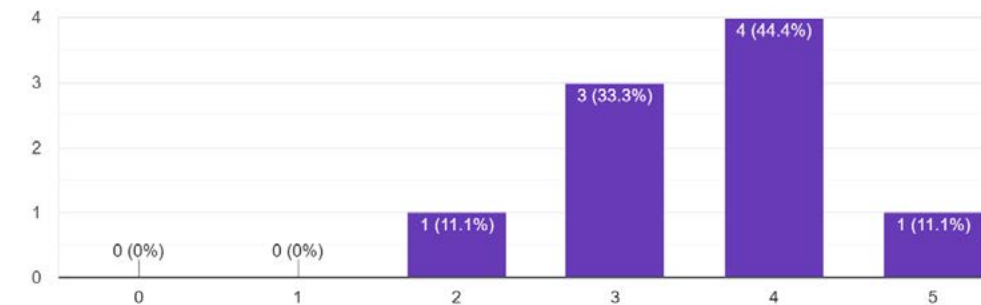
Have you perceived that you navigated through different kinds of future in this path? (evaluate from 0 – 5)

9 responses



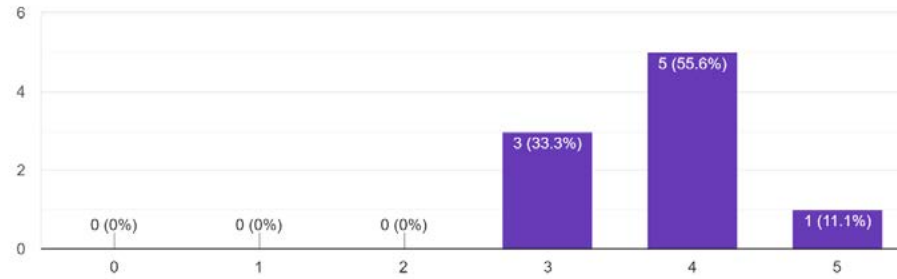
Did you find it useful for your activity? (evaluate from 0 – 5)

9 responses



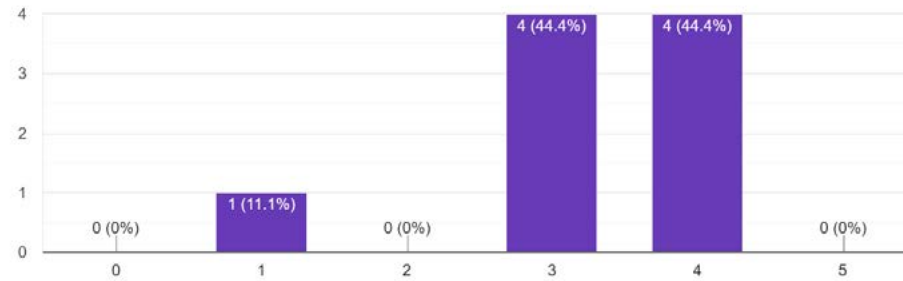
How this kind of activity influenced the critical thinking regarding the selection of strategies for designing for behavioural change? (evaluate from 0 – 5)

9 responses



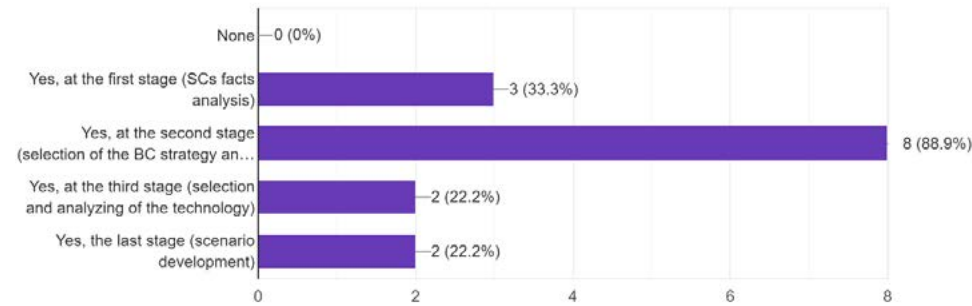
How this kind of activity influenced the critical thinking regarding the shaping of technology for the near future? (evaluate from 0 – 5)

9 responses



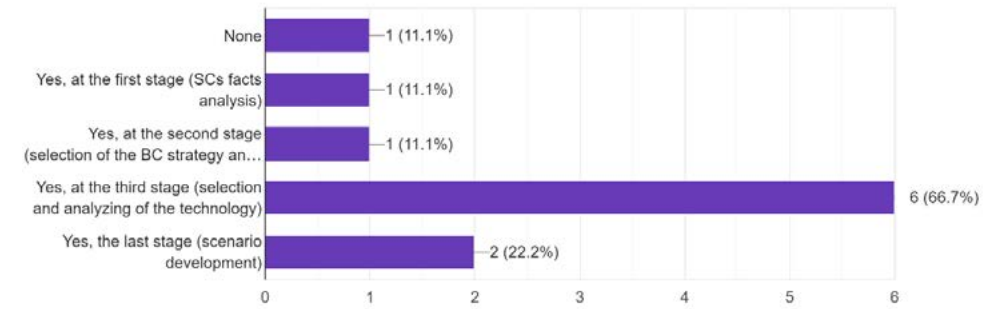
Were you able to identify at which point you started to think more critically regarding the behavioural change issues (check the box/es)

9 responses



Were you able to identify at which point you started to think more critically regarding the technology for behavioural change issues (check the boxes)

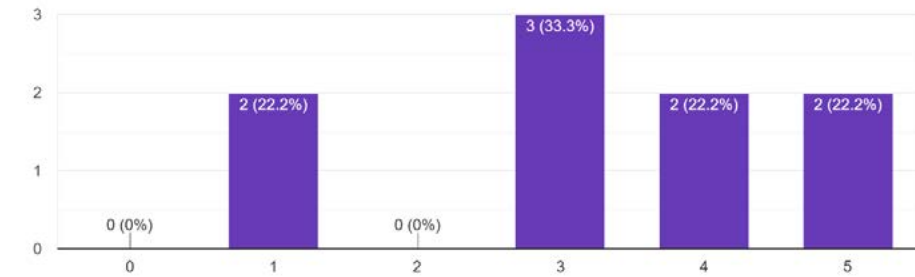
9 responses



### EVALUATION OF THE ACTIVITY'S OUTPUT

How much taking the inspiration from SCI-FI genre helped you in creating more envisioning design scenarios related to the technologies for behavioural change?

9 responses

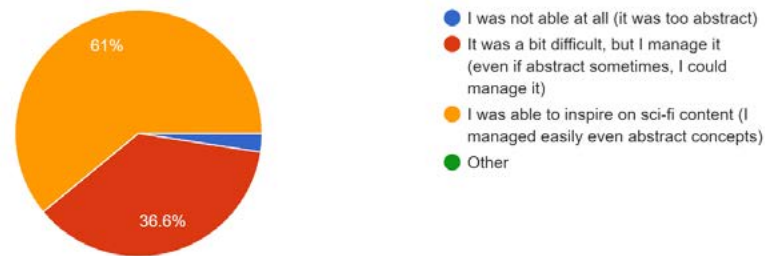


## Questionnaire B: Workshop at course: Envisioning A.I. through Design [activity April 15th 2020]

### ACTIVITY RELATED QUESTIONS

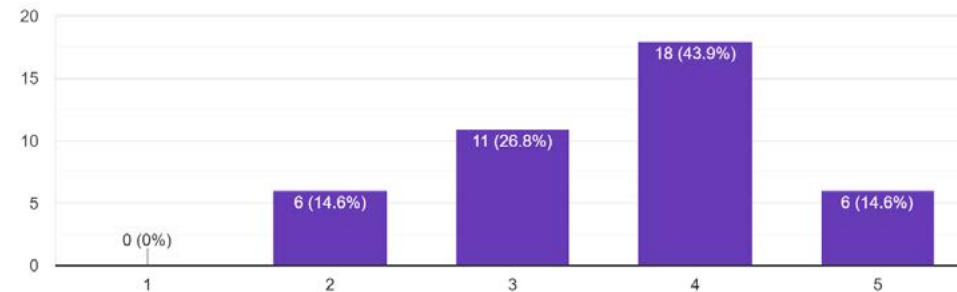
Can you define how much you were able to inspire on SCI- FI content (Watching of the film + Tech inspiration cards) for your topic?

41 responses



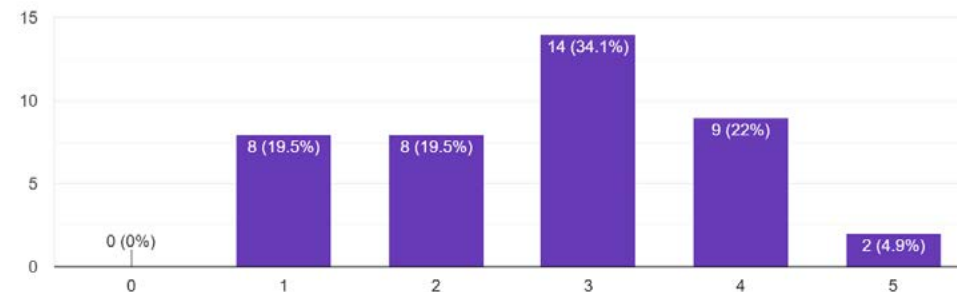
How much the Tech inspiration cards helped you to think about the near future? (evaluate 0-5)

41 responses



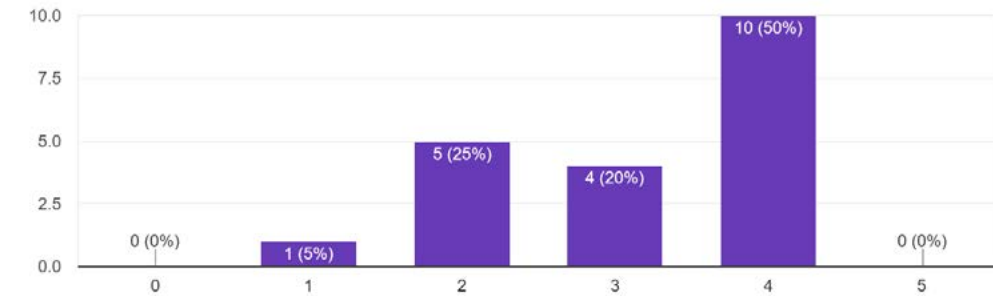
How much the Tech inspiration cards helped you to think critically about the use and application of A.I. related to your topic? (evaluate 0 - 5)

41 responses



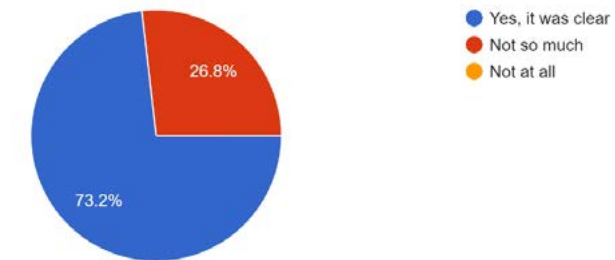
(EXTRA QUESTIONS FOR THOSE DEALING WITH BEHAVIOURAL CHANGE ISSUES) How much the Tech inspiration cards helped you to think critical...ted to behavioural change issues? (evaluate 0 - 5)

20 responses



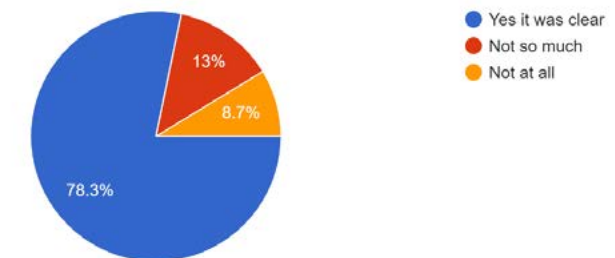
You used several steps in developing the near future scenario. Were you able to identify the relation between the proposed concepts and how t...ide - Role of technology - Shape of technology):

41 responses



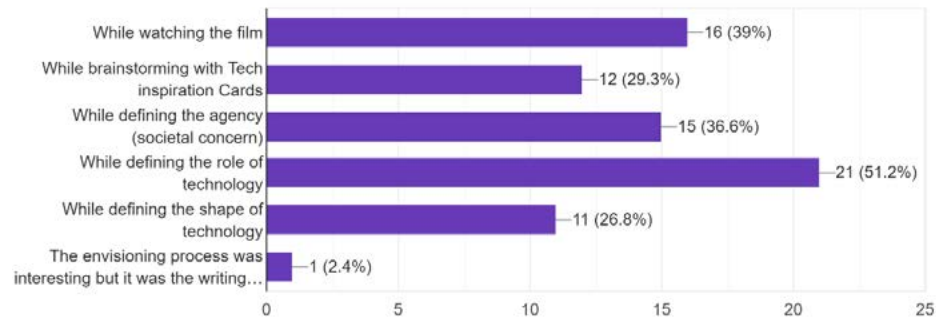
(EXTRA QUESTIONS FOR THOSE DEALING WITH BEHAVIOURAL CHANGE ISSUES IN THEIR PROJECTS) Was the Design with Intent tool useful ...behavioural change strategy for your application?

23 responses



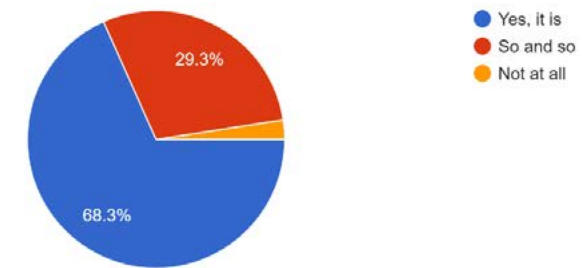
Are you able to identify at which point you started to think more critically regarding the use and application of (A.I.) technology? (check boxes)

41 responses



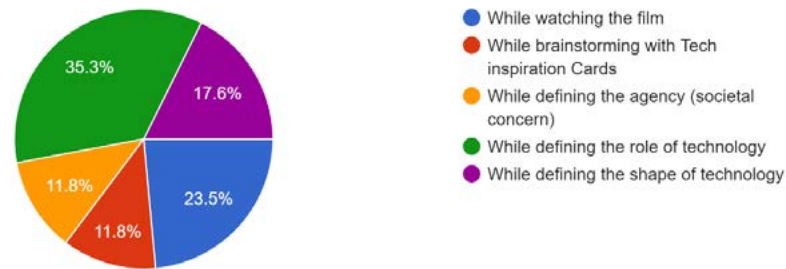
Do you think it is useful for the objectives of your course (Envisioning A.I. through Design)?

41 responses



(EXTRA QUESTIONS FOR THOSE DEALING WITH BEHAVIOURAL CHANGE ISSUES) Are you able to identify at which point you started to think more critically regarding the behavioural change strategy?

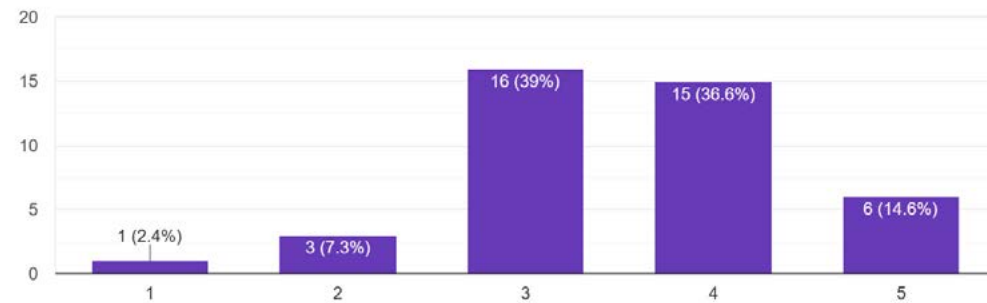
17 responses



### IN CONCLUSION

How this kind of activity generally influenced the critical thinking regarding the shaping of the A.I. technology for the near future? (evaluate from 0 – 5)

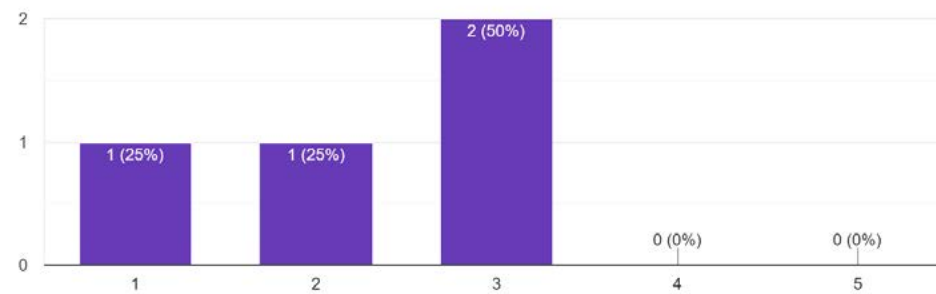
41 responses



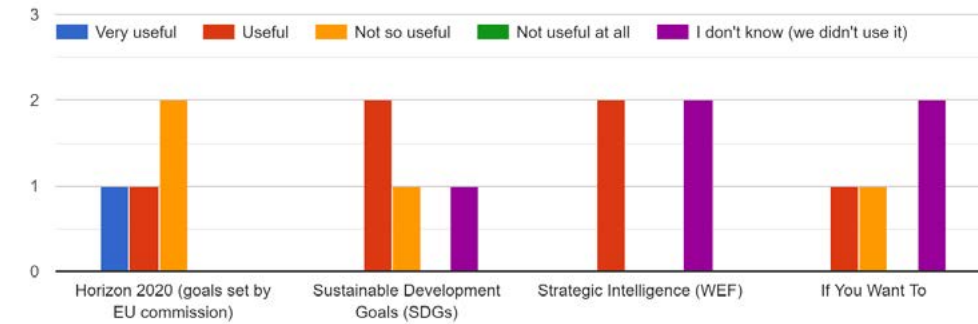
## Questionnaire C: Evaluation of the semifinal Protocol with experts [activity February 2021]

In the first part of the protocol we analysed the topic and set the design challenge and design requirements for 2030. How difficult/easy was for you...allenge(s)? (rate on scale 5- too difficult, 1-easy)

4 responses

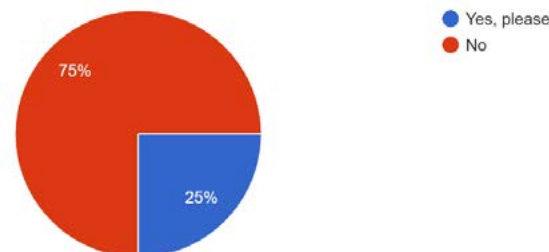


There were given several references to use for analysing of the topic. Rate them according how useful/not useful they are for defining the design challenge?



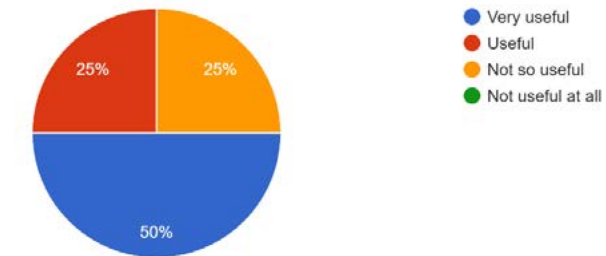
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



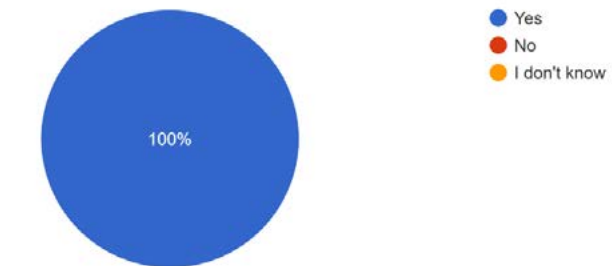
At this stage, we took a brief look into the SCI-FI genre to analyse the imaginary created by filmmakers and designers, about how the future mi...aking our reason critically on design challenges?

4 responses



Do you think that defining the agency and scaling the issue is useful for reasoning more critically about the design challenge?

4 responses



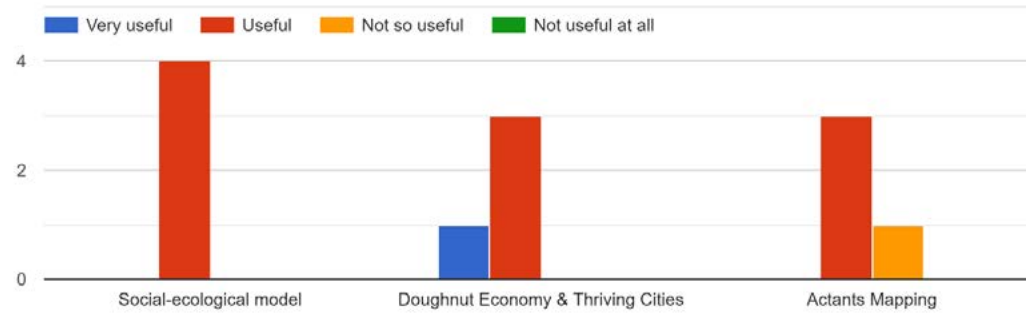
The way in which this protocol suggests building the agency and scaling the issue was correct and useful, and it triggers critical thinking.

4 responses



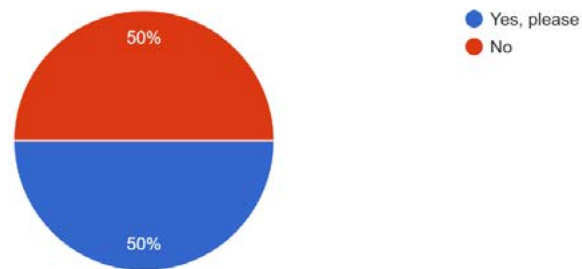


Rate how useful were the tools suggested in the protocol :



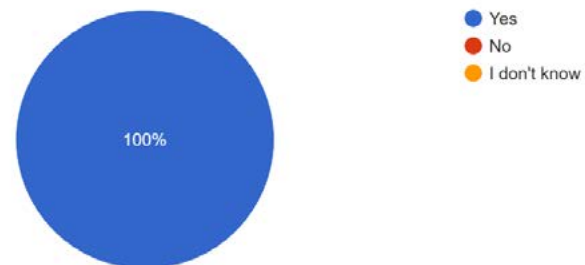
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



Do you think that defining the agency and scaling the issue is useful for reasoning more critically about the design challenge?

4 responses

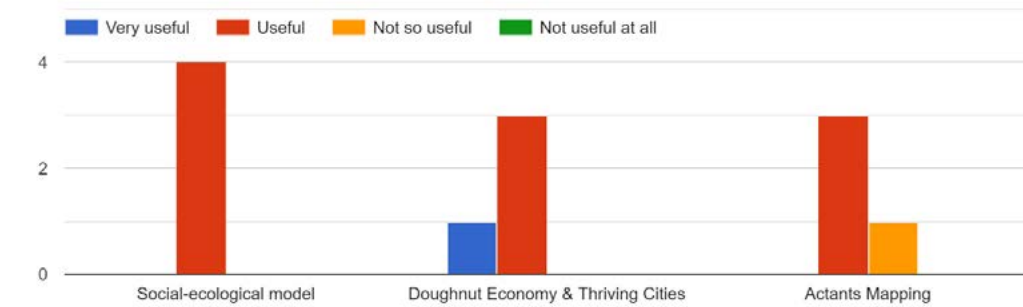


The way in which this protocol suggests building the agency and scaling the issue was correct and useful, and it triggers critical thinking.

4 responses

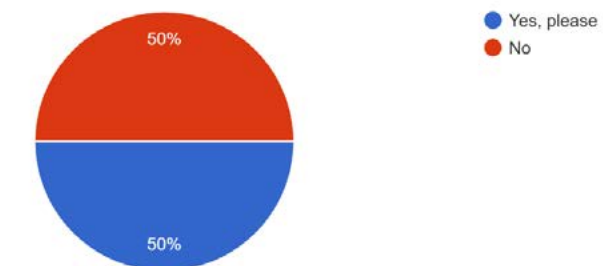


Rate how useful were the tools suggested in the protocol :



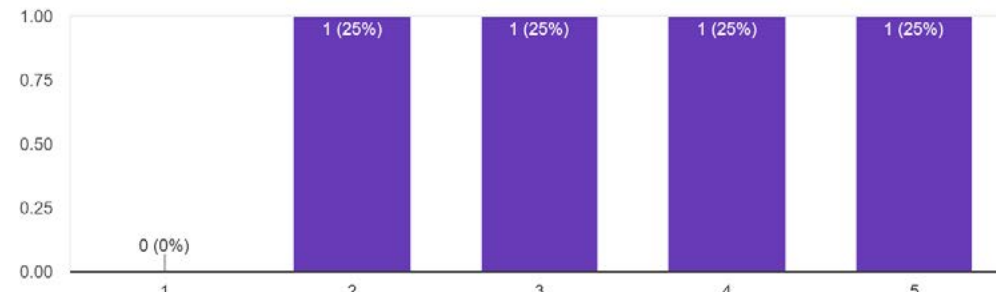
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



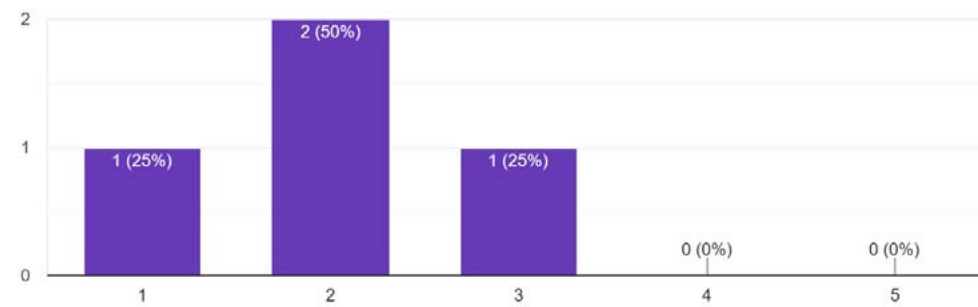
How difficult/easy it was to define the target behaviours and possible barriers arrived at this point (considering the work done in Part 1 and Part 2)? (1 - easy, 5 - difficult)

4 responses

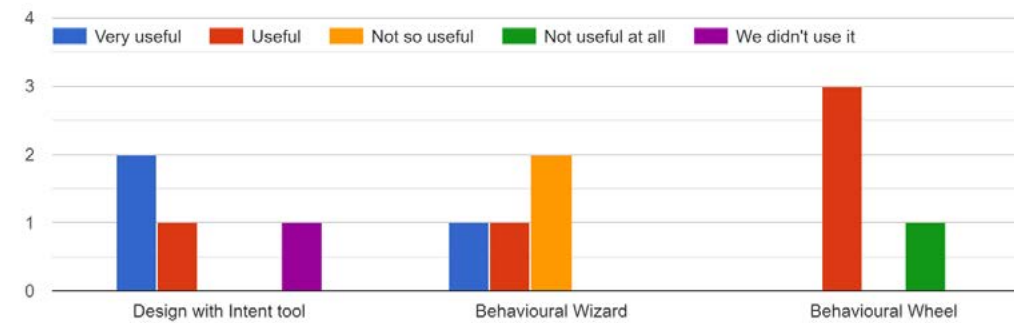


How difficult/easy was defining the behavioural change strategies (overall approach in Part 3)? (1 - easy, 5 - difficult)

4 responses

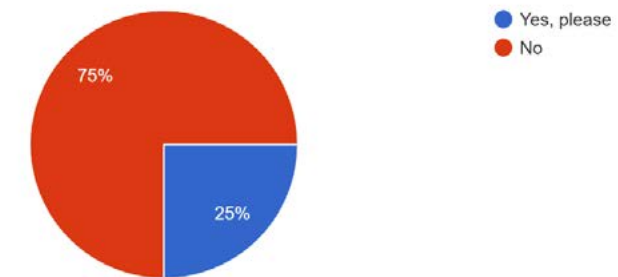


How useful were the tools used for defining the behavioural change strategies?



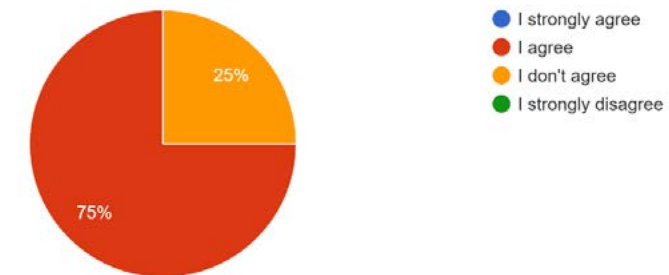
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



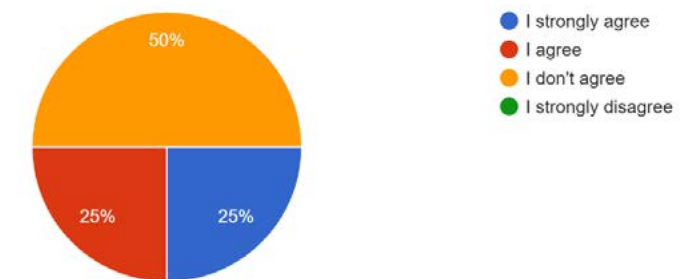
The approach based on defining the behavioural concern in order Target behaviours - Barriers - Strategies is appropriate/useful.

4 responses



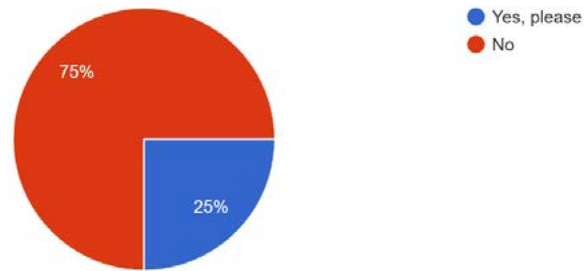
The critical thinking was triggered while redefining the design challenge requirements, according to behavioural strategies.

4 responses



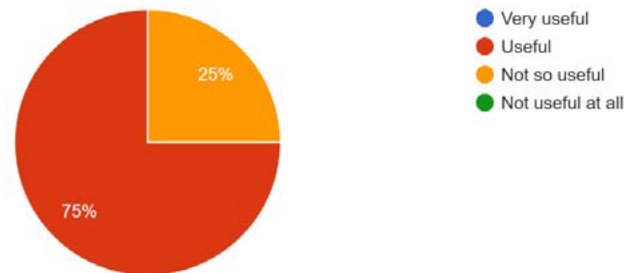
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



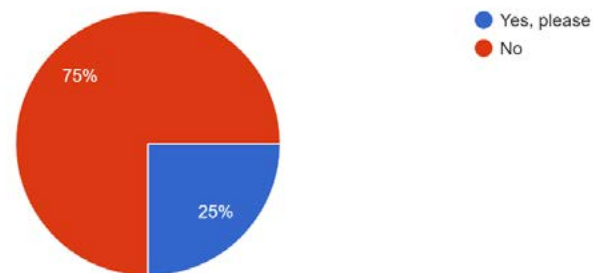
How useful was defining the role of technology (according to the use of Fogg's Functional Triad) to translate the behavioural strategies into concrete technological functions and solutions?

4 responses



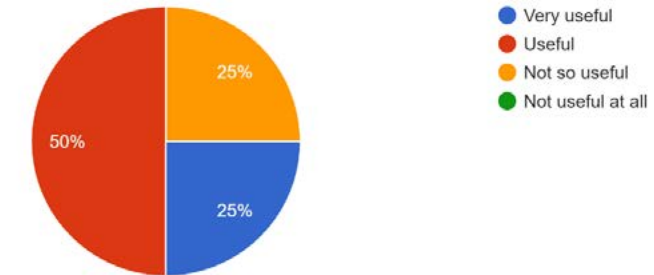
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



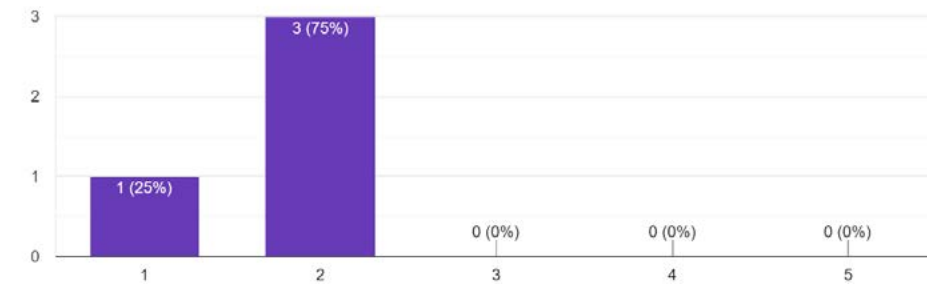
At this stage, we took a brief look into the SCI-FI genre to analyse the imaginary created by filmmakers and designers, concerning the technology to tackle the behavioural change?

4 responses



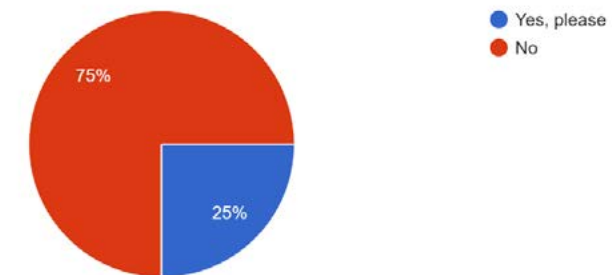
At this point, how difficult/easy was it to identify possible ethical implications of the technological artefact able to tackle the behavioural change?

4 responses



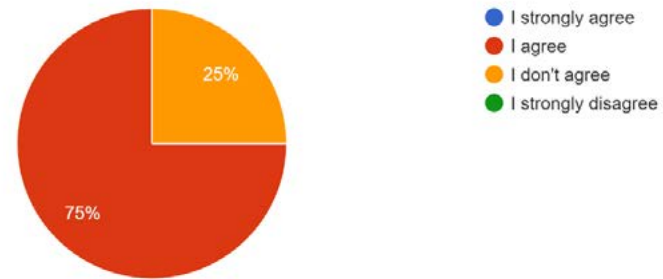
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



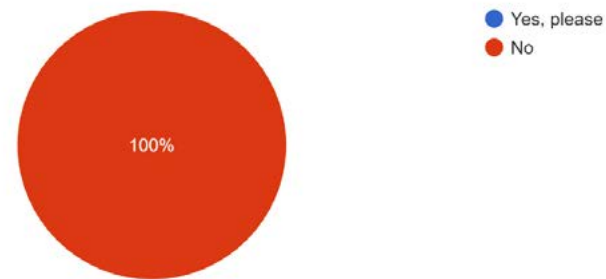
Defining the design scripts (artefact's delegations) and anticipating all possible interactions/mediations between the user - artefact...ts (concerning societal and ethical implications).

4 responses



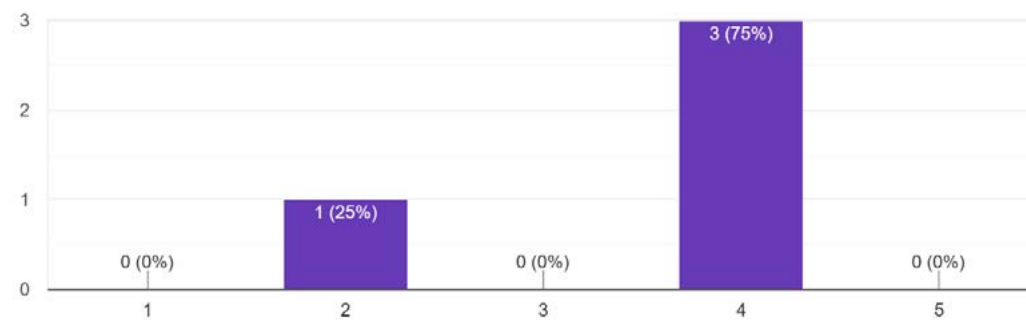
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



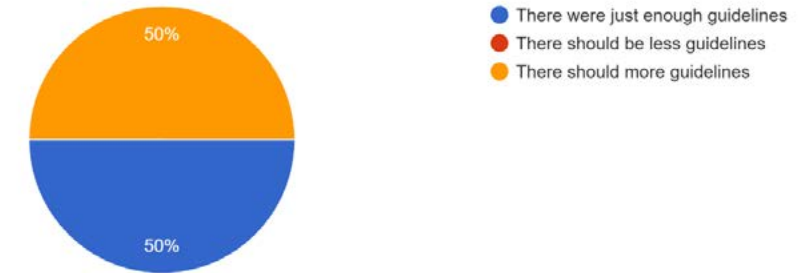
At this point, given the guidelines, how difficult/easy was it to build an anticipatory scenario about the technological artefact for 2030?

4 responses



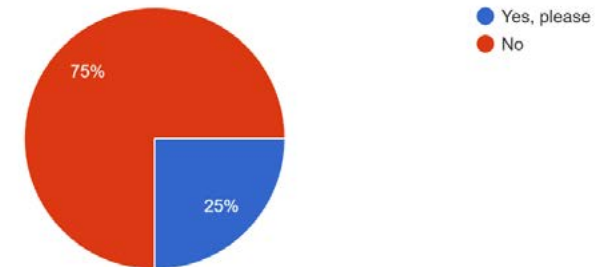
Do you think that the guidelines for scenario building were enough for anticipating and describing the technological artefact for 2030?

4 responses



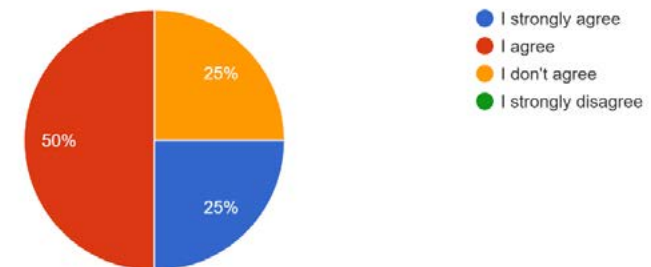
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



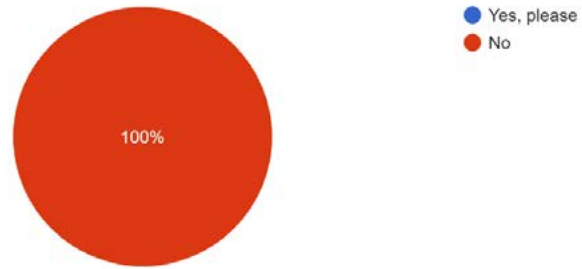
While building the anticipatory scenario for 2030, critical thinking was triggered (I was able to reason upon the possible ethical and societal implications).

4 responses



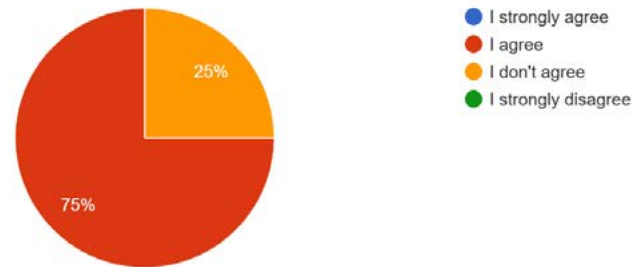
Given your expertise, would you suggest other tools/approaches recognized (i.e. in literature) as more effective and give references?

4 responses



The protocol is suitable for designing technological artefacts able to tackle the behavioural change toward more sustainable behaviours.

4 responses



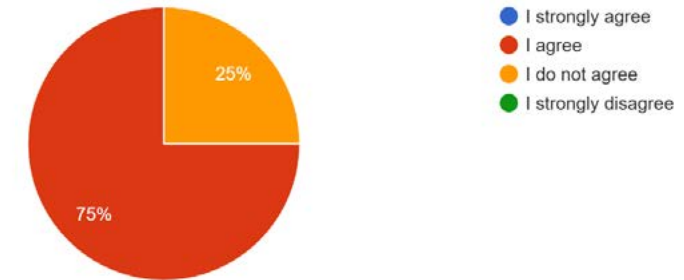
The stages (parts) of the protocol are organized in a logical way and each stage is able to inform the upcoming one (I am able to find relationships between different concepts and theories)?

4 responses



The tools used at different stages of the protocol are appropriate and they support the theory in a coherent way.

4 responses

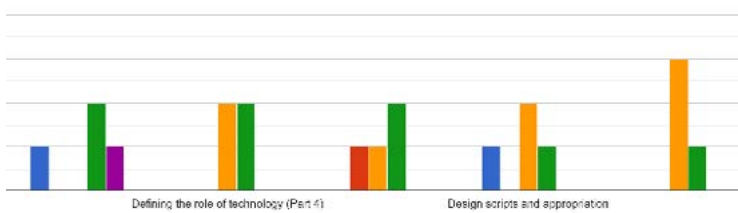
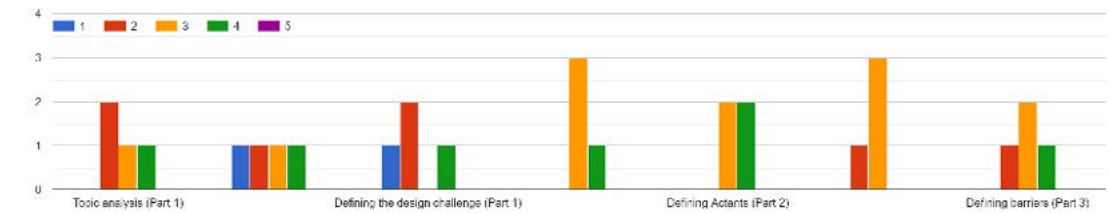


The overall impression is that the use of this protocol can trigger critical thinking and help in designing more conscious way technological artefacts able to tackle behavioural change.

4 responses

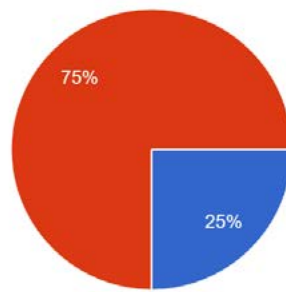


Rate how much the critical thinking was triggered at different stages according to you (critical thinking at 1 - not at all triggered, 5 - very much triggered):



Would you like to give some advice or make an ulterior remark? Maybe you didn't have chance to do it previously or you forgot something?

4 responses

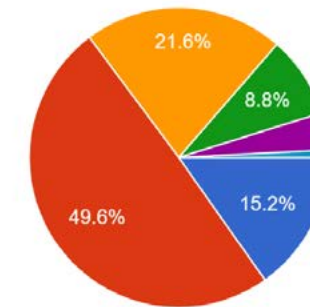


- Yes, please let me do it
- No, I would like to finish here

## Questionnaire D1: Future of Mobile Technologies 'Smartphone use' [May 2021]]

How old are you?

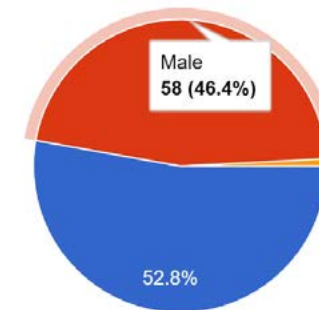
125 responses



- 18 - 25
- 25 - 35
- 35 - 45
- 45 - 55
- 55 - 65
- Over 65

Gender

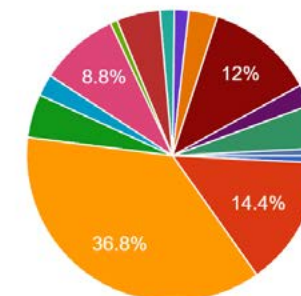
125 responses



- Female
- Male
- Non-binary
- Prefer not say

Which is your employment sector?

125 responses

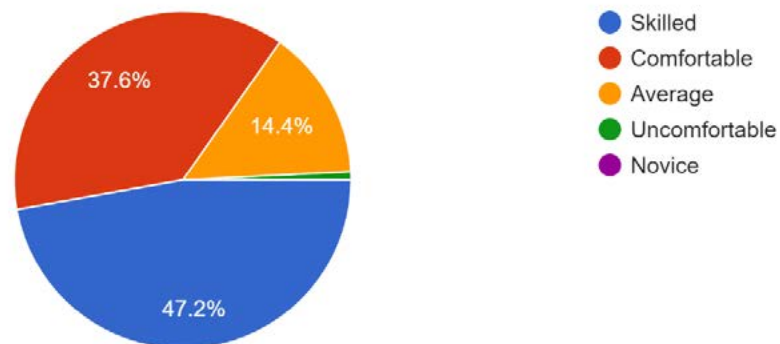


- Agriculture
- Architecture and Engineering
- Arts, Design, Entertainment, and Media
- Business, Executive, Management, and Administration
- Community and Social Service
- Computer Programming and Development
- Education, Training, and Library
- Food Service

▲ 1/3 ▼

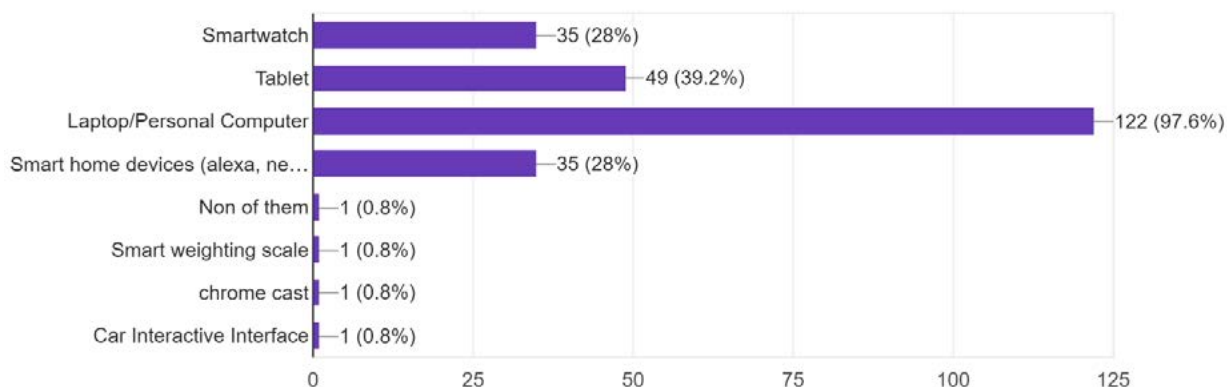
How would you describe your ability with technology?

125 responses



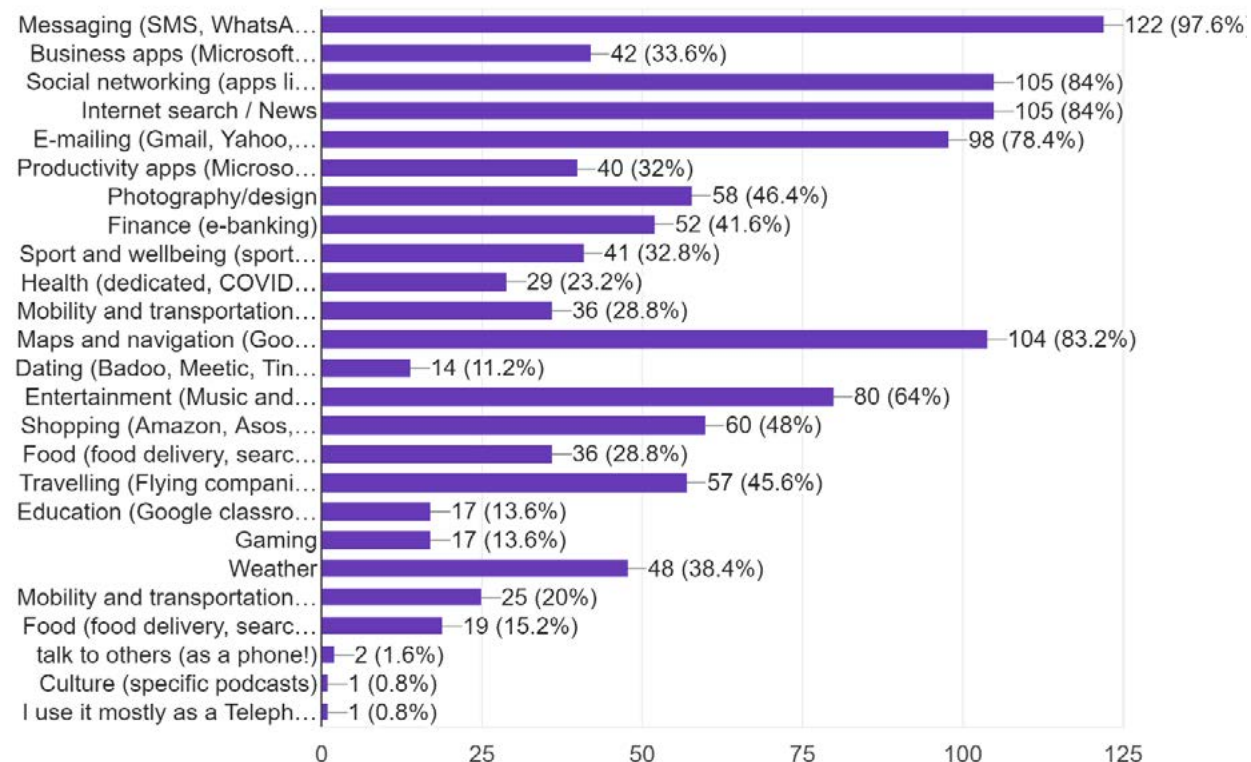
Other than your smartphone, what personal devices do you use on a daily basis?

125 responses



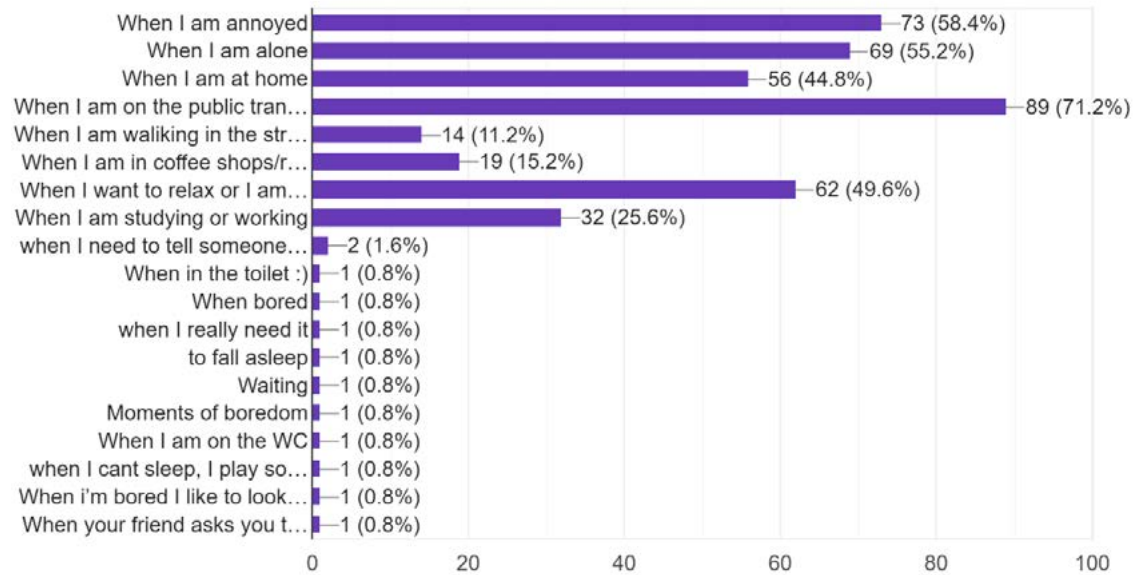
What do you use your smartphone for most often? Select all that apply:

125 responses



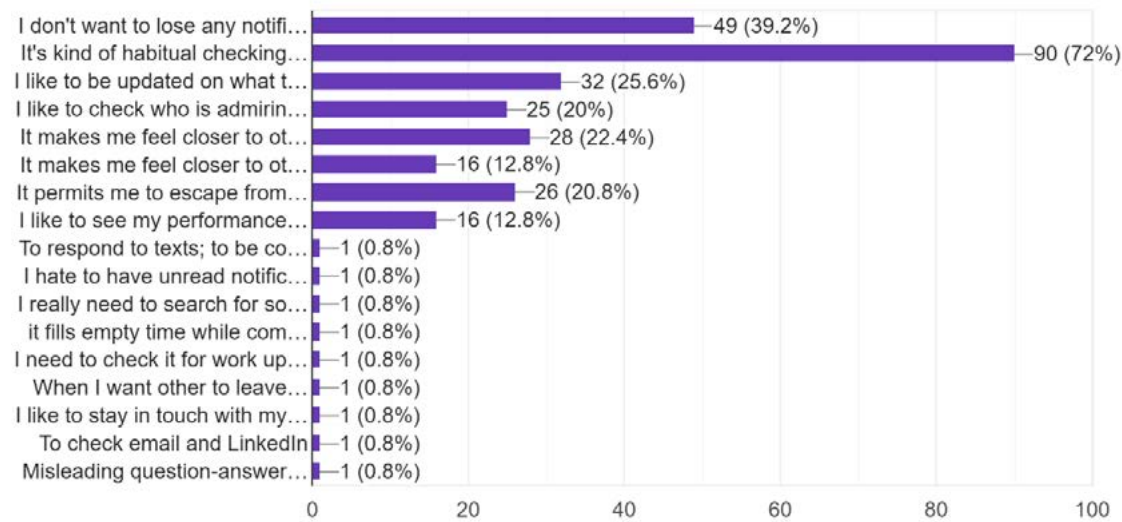
Is there any particular situation and/or context in which you are most tempted to use your smartphone? Select any that apply:

125 responses



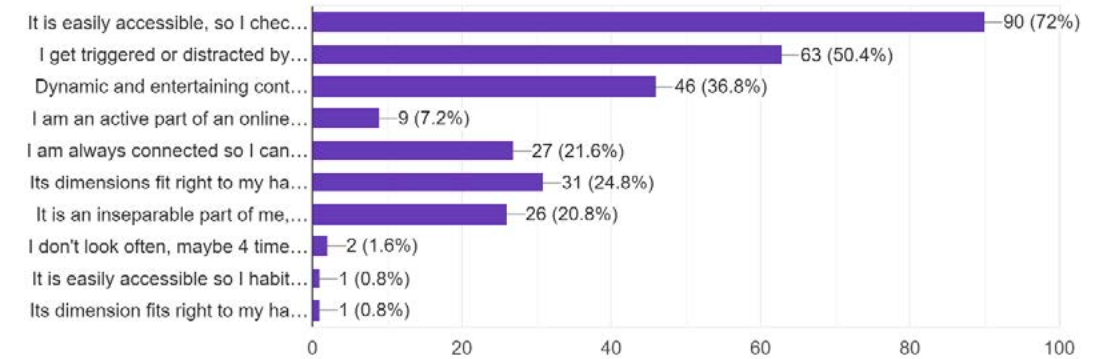
Why are you tempted to use or look at the smartphone more often? Select all that apply:

125 responses



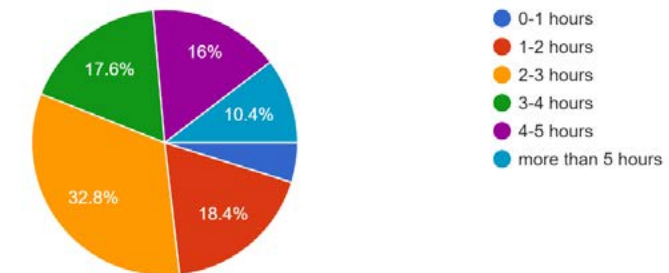
What draws your attention to the smartphone? Select any that apply:

125 responses



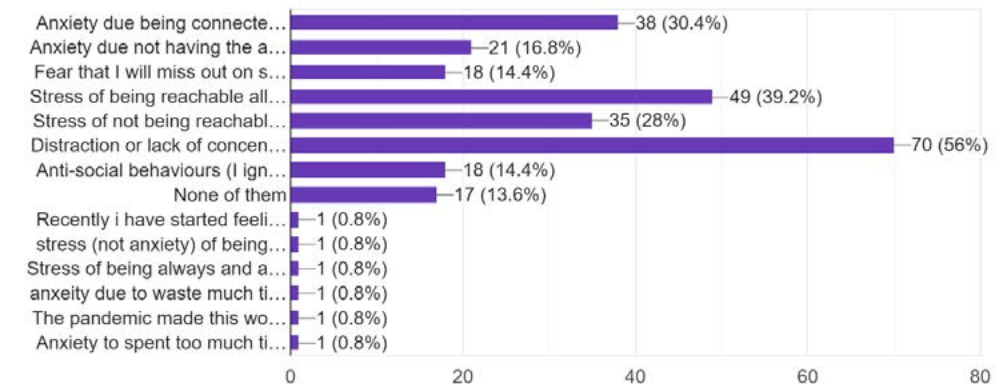
How long do you think use your smartphone per day?

125 responses



Do you feel any of these negative effects from your smartphone use? Please select any that you find relevant.

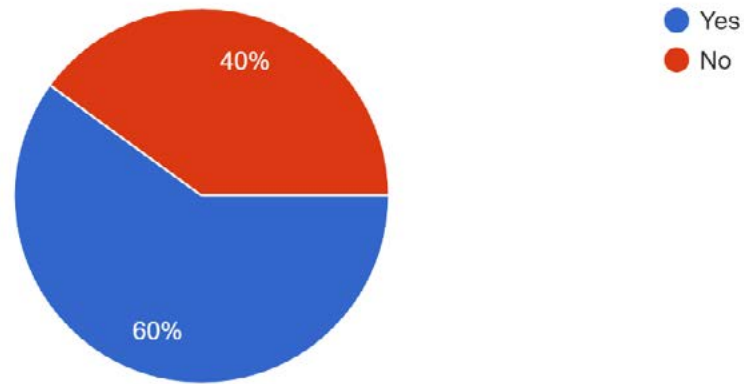
125 responses





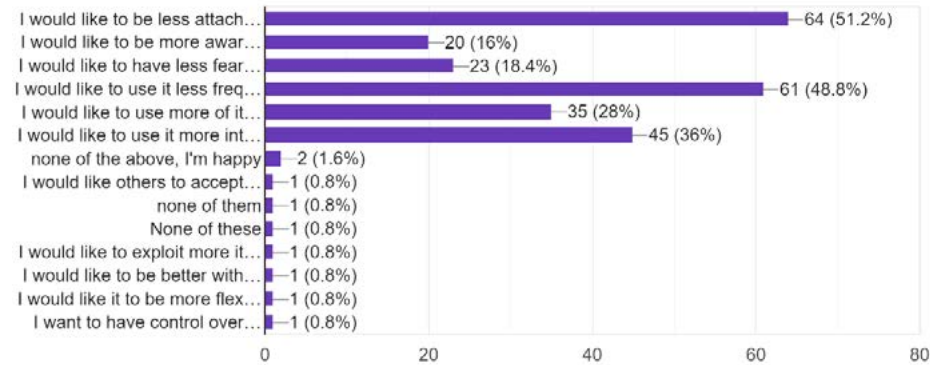
### Are there times you feel guilty for using your phone?

125 responses



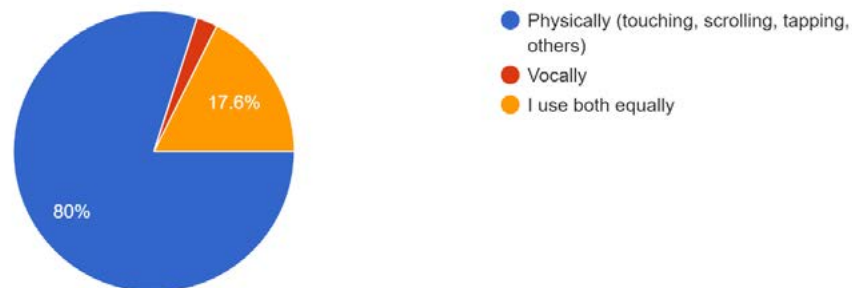
### Is there anything that you would like to change with your relationship to your phone? Select all that apply:

125 responses



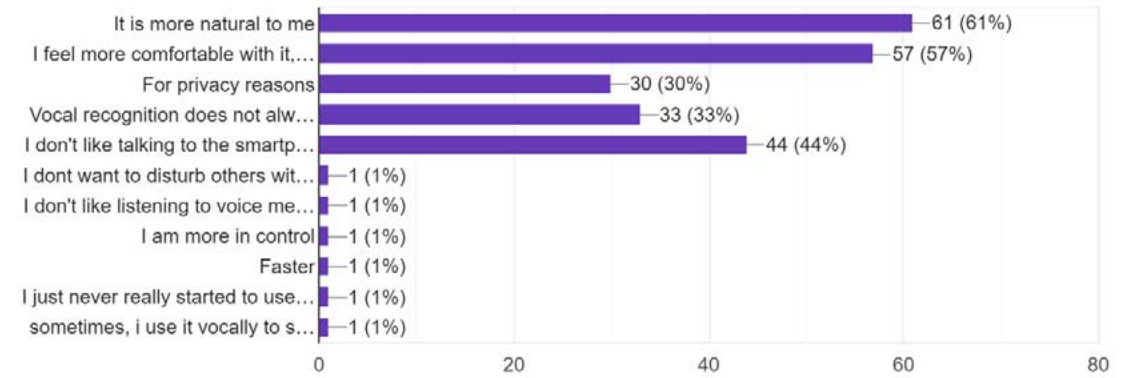
### How do you prefer interacting with the smartphone?

125 responses



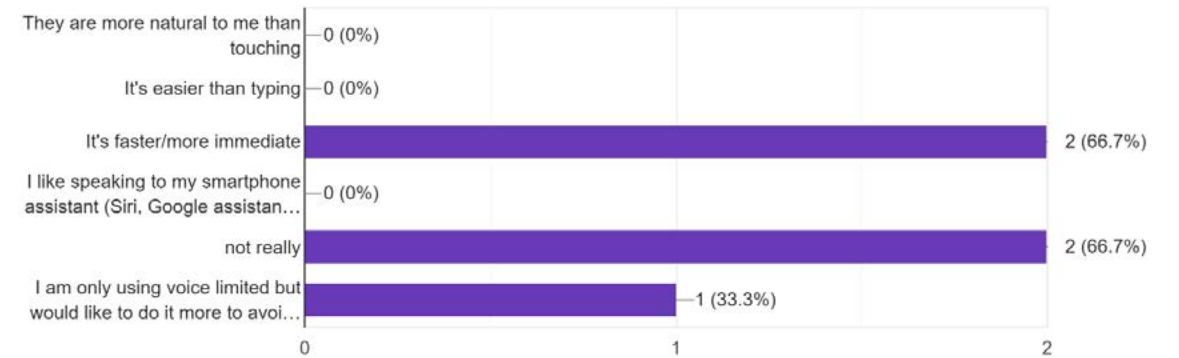
### Why do you prefer physical interactions?

100 responses



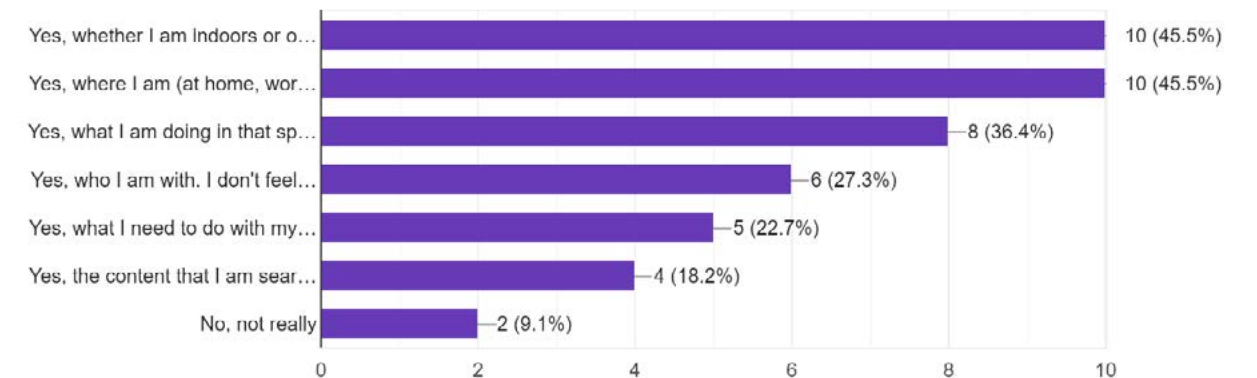
### Why do you prefer conversational interfaces?

3 responses



### Are there situations that change how you interact with your smartphone?

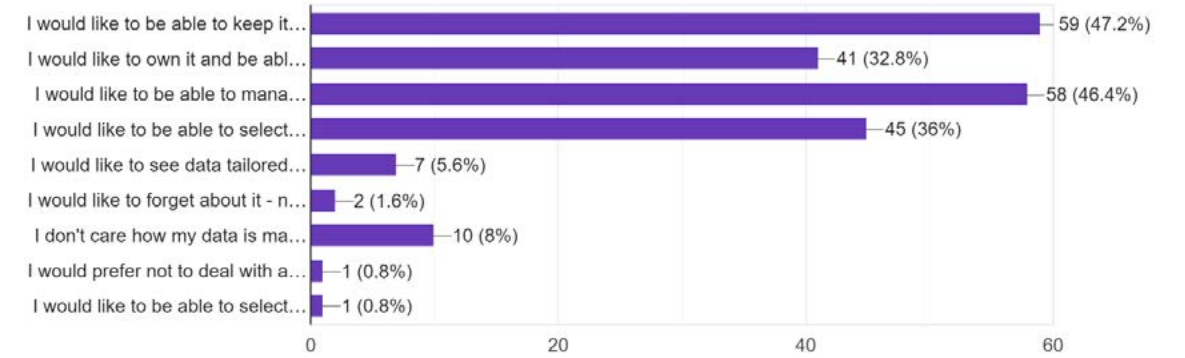
22 responses



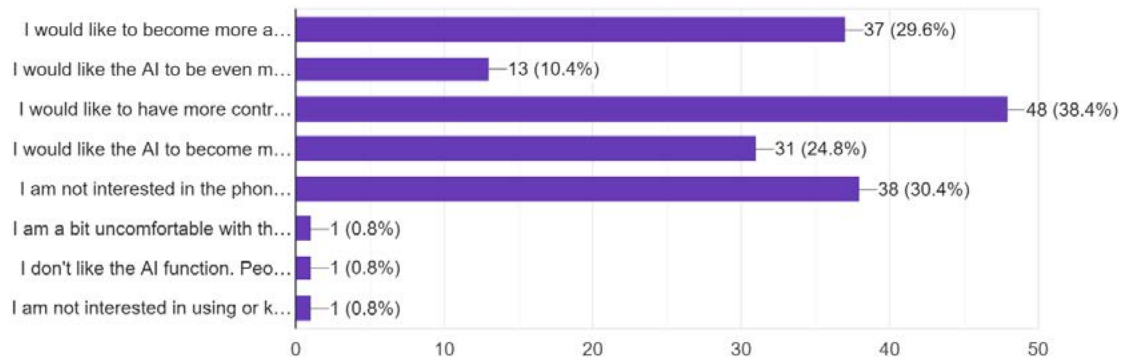
Are you aware of the Artificial Intelligence (AI) in your smartphone and how it works?  
125 responses



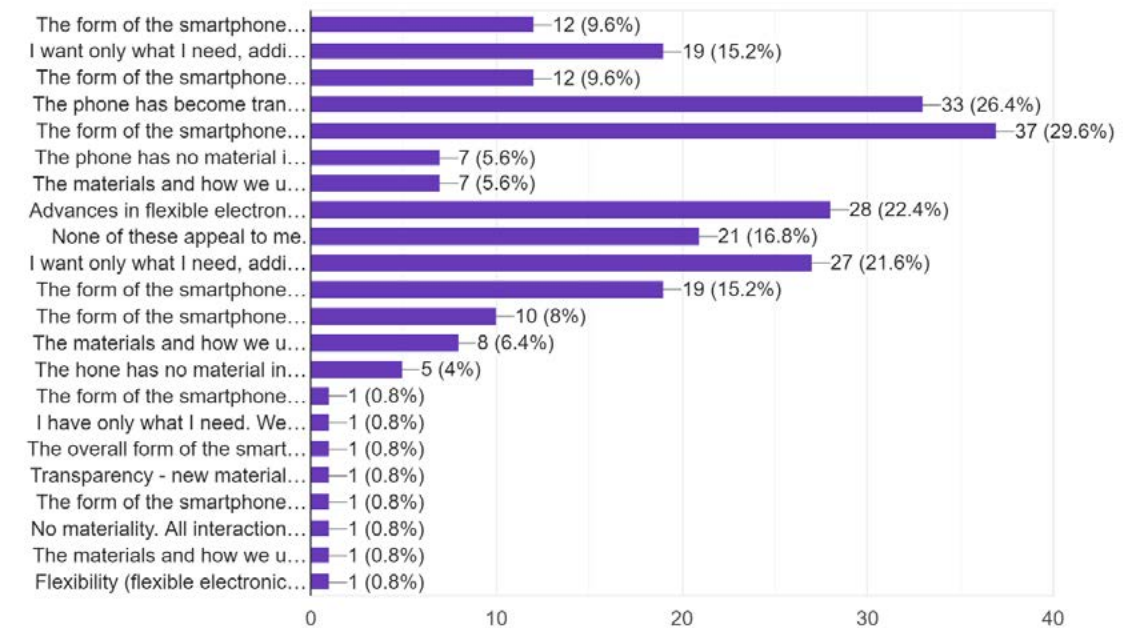
Are there ways you would like to manage and see data collected by your smartphone?  
125 responses



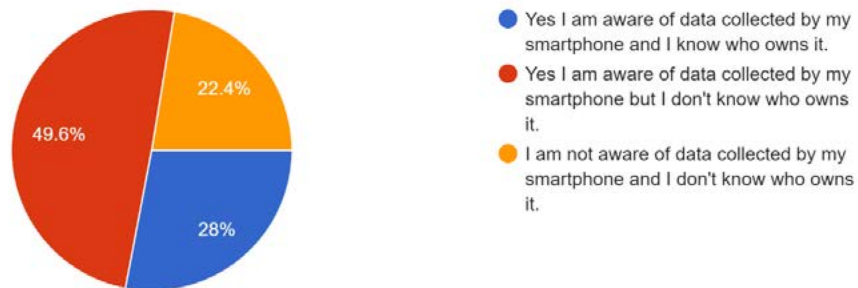
Would you like to build a relationship with the AI of your phone? Select any that apply:  
125 responses



Below we show and describe several concepts for future smartphones. Are any of these solutions ones you would like to use in the future? Select all that apply:  
125 responses



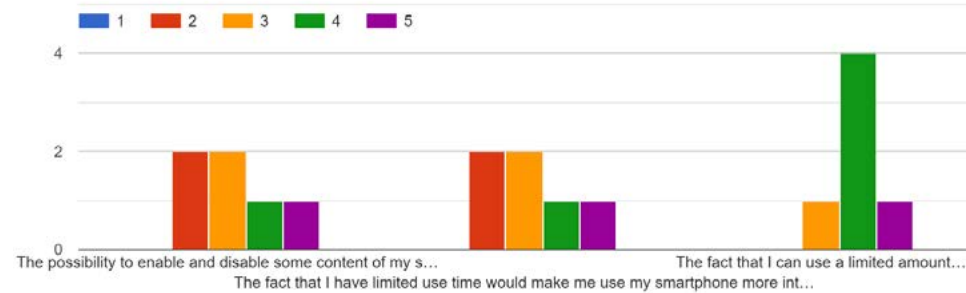
Are you aware of the data collected by the smartphone and who owns it?  
125 responses



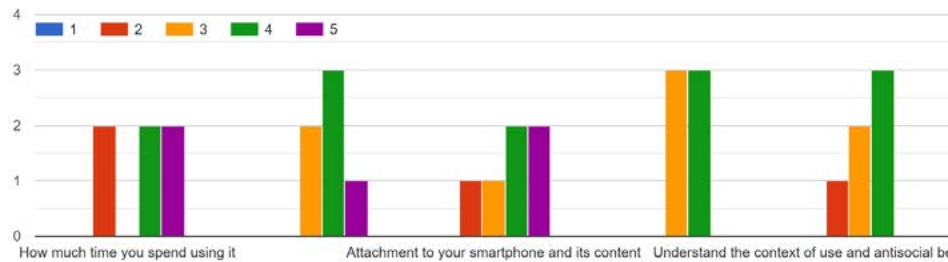
## Questionnaire D2: Future of Mobile Technologies 'Focus group' [November 8th, 2021]

### Evaluating the design fiction 1: POGO Planner Phone

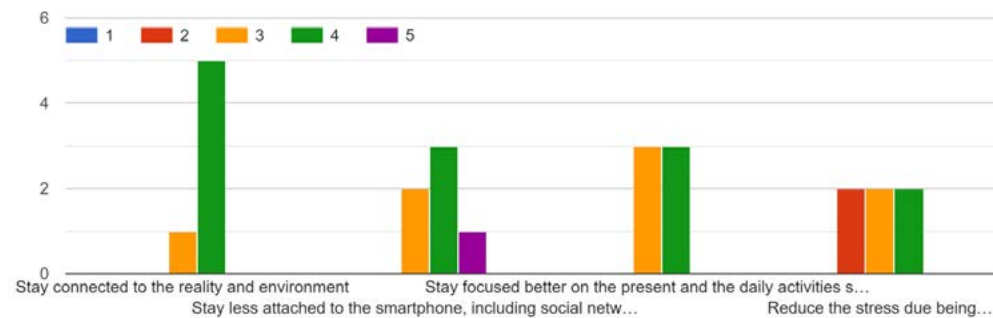
Do you think that this kind of interaction could help you use the content of your smartphone more intentionally (apps, social networks, internet) and e...l better, instead of mindless use? [1- False, 5-True]



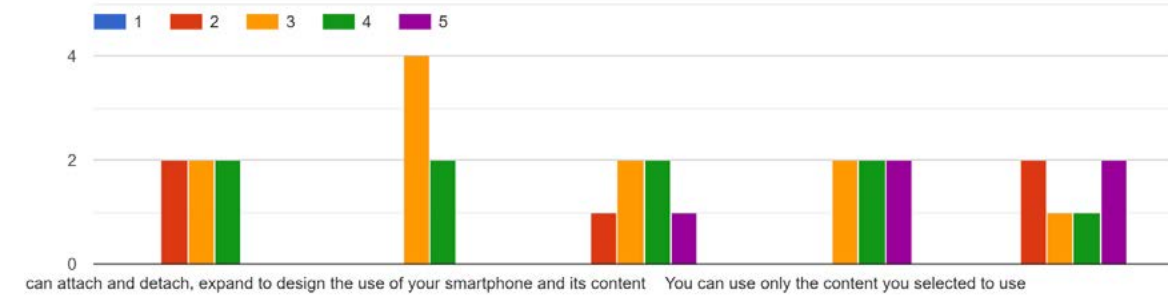
How efficient do you find these interaction modalities and rituals in helping you become more aware of how you are using your smartphone in terms of [1- not efficient, 5- very efficient]:



How efficient do you find these interaction modalities and rituals in letting you [1- not efficient, 5- very efficient]:

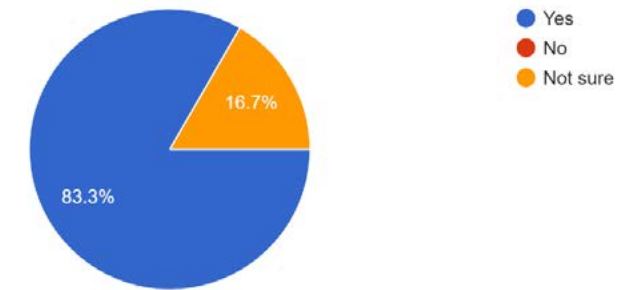


Do you find appropriate the way in which the artefact interacts with the user to prevent the problematic usage patterns with respect to [1-not at all, 5-very much]:



Do you think that this kind of artefact could allow you to become more aware of how your relation to the smartphone influences your social relations and everyday life?

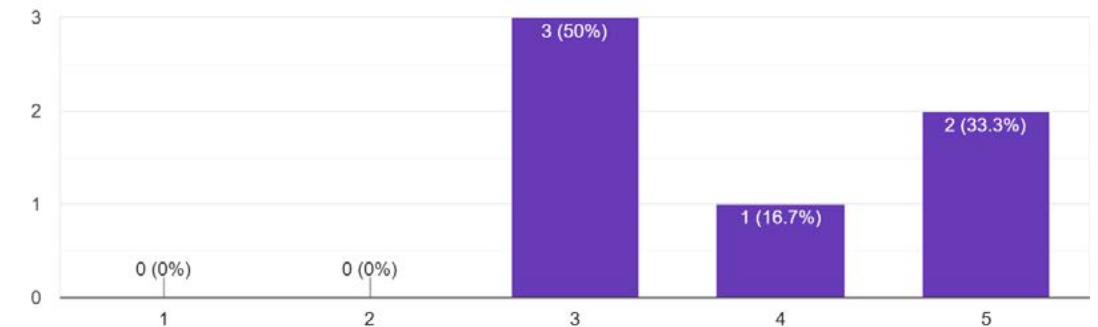
6 responses



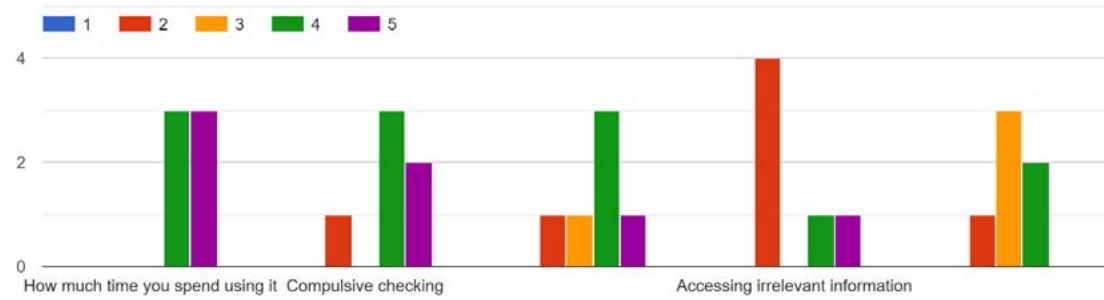
### Evaluating the design fiction 2: PARASITE Phone

Do you find the fact that your smartphone changes the shape to indicate your use time and enable or disable its use could help you use the content of ...ploit its potential better, instead of mindless use?

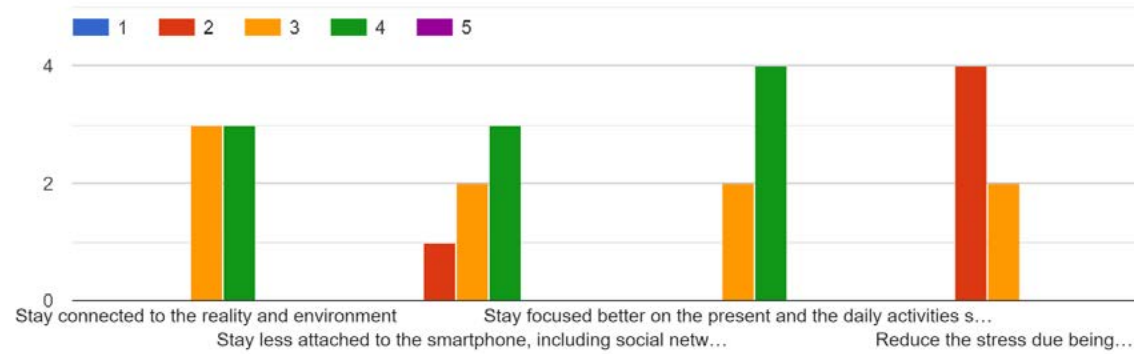
6 responses



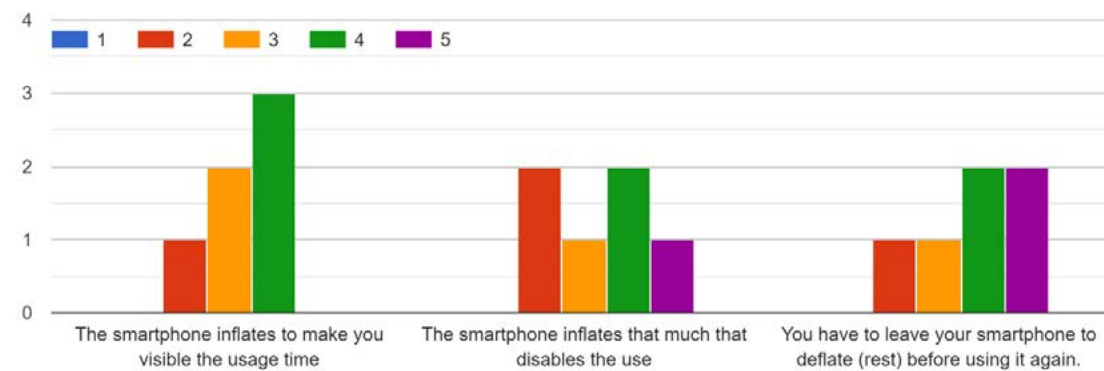
How efficient do you find these interaction modalities and rituals in helping you become more aware of how you are using your smartphone in terms of [1- not efficient, 5- very efficient]:



How efficient do you find these interaction modalities in letting you [1- not efficient, 5-very efficient]:

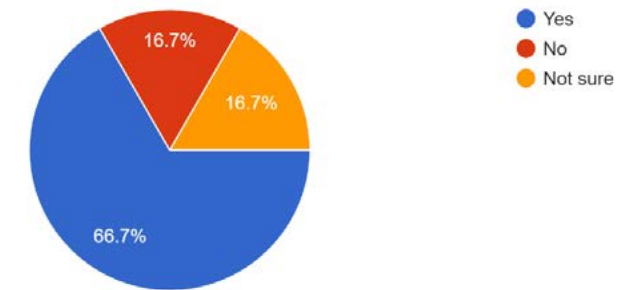


Do you find appropriate the way in which the artefact interacts with the user to prevent the problematic usage patterns respect to [1-not at al, 5-very much]:



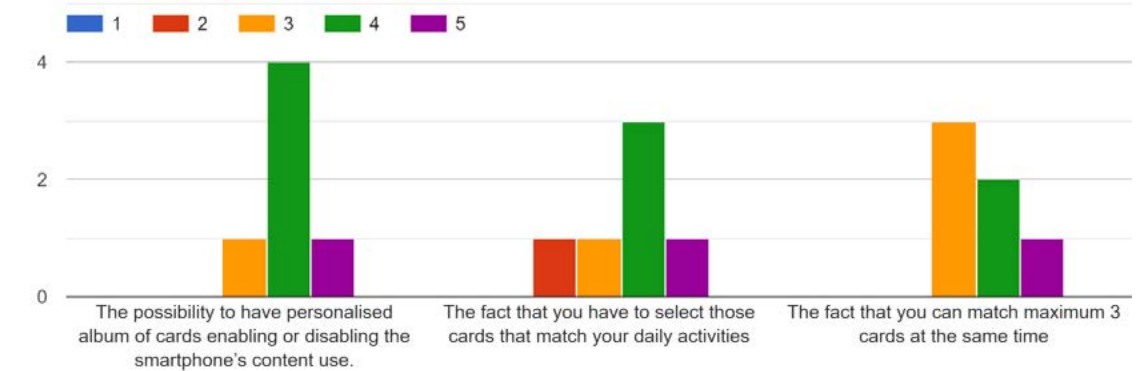
Do you think that this kind of artefact could allow you to become more aware of how your relation to the smartphone influences your social relations and everyday life?

6 responses

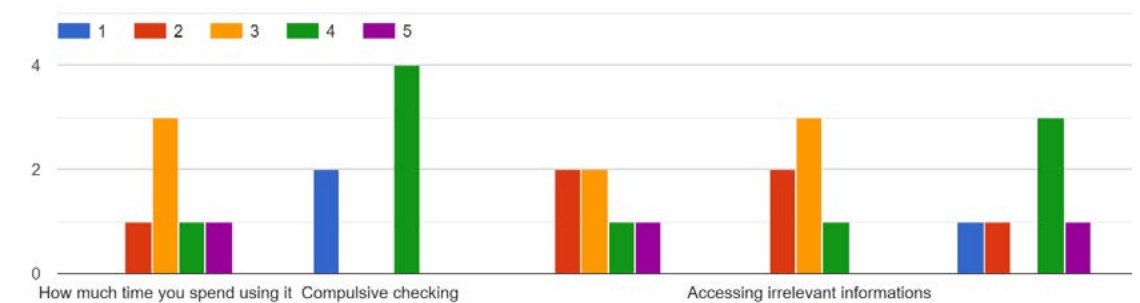


### Evaluating the design fiction3: PLACEFUL Phone

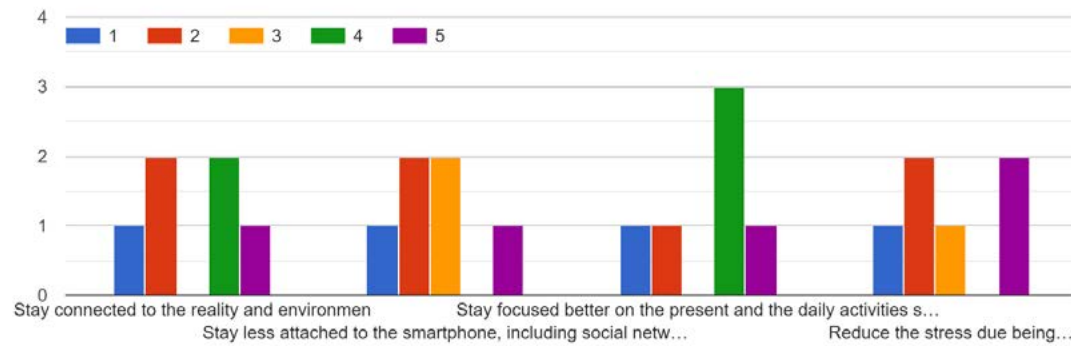
Do you think that this kind of interaction could help you use the content of your smartphone more intentionally (apps, social networks, internet) and ... better, instead of mindless use? [1- FALSE, 5-TRUE]



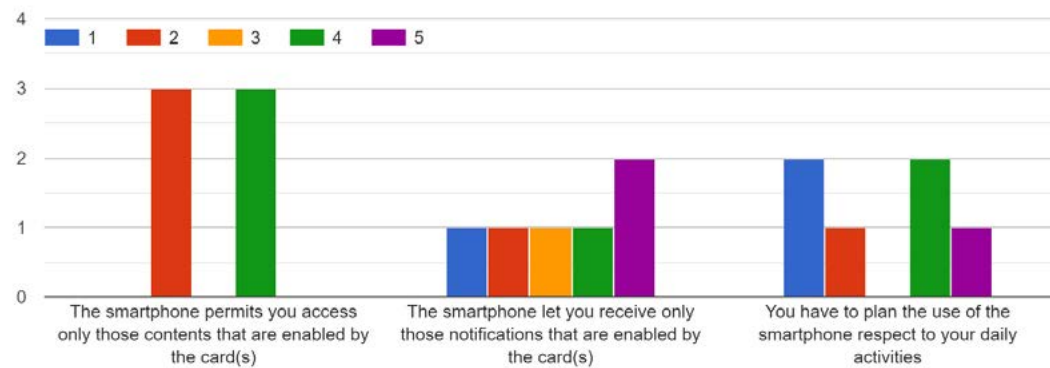
How efficient do you find these interaction modalities and rituals in helping you become more aware of how you are using your smartphone in terms of [1- not efficient, 5- very efficient]



How efficient do you find these interaction modalities in letting you [1- not efficient, 5-very efficient]

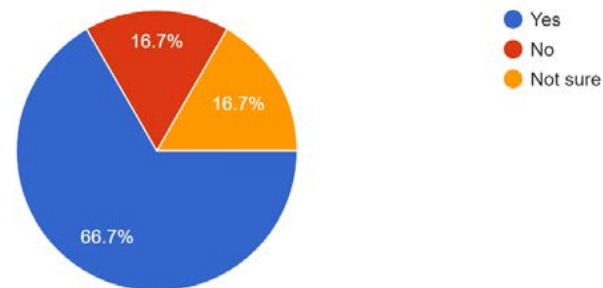


Do you find appropriate the way in which the artefact interacts with the user to prevent the problematic usage patterns with respect to [1-not at all, 5-very much]:



Do you think that this kind of artefact could allow you to become more aware of how your relation to the smartphone influences your social relations and everyday life?

6 responses



## Questionnaire E1: FOCUS GROUP 1\_Living Artefacts [September 10th, 2021]

### Sezione 01: Aspetti interattivi e formali

1. **Siete familiari con queste nuove modalità di interazione? (cioè interazioni gestuali, interfacce aumentate)**

- Si
- No
- Alcune (quali?) \_\_\_\_\_

2. **Quanto hai apprezzato le modalità di interazione in relazione a:**

A) Feedback in tempo reale attraverso il colore della sfera.

(1 - non apprezzo, 5 - apprezzo molto)



○ ○ ○ ○ ○  
1 2 3 4 5

B) Feedback reale e lungo nel tempo attraverso le interfacce aumentate [immagini olografiche] fornito dal mobiletto e dal powerbank. (1 - non apprezzo, 5 - apprezzo molto)

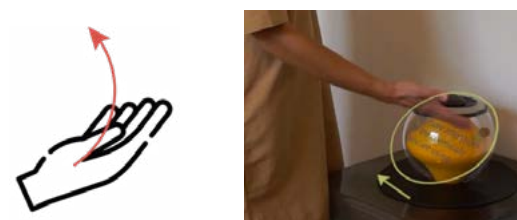


○ ○ ○ ○ ○  
1 2 3 4 5

C) Interazioni gestuali. (1 - non apprezzo, 5 - apprezzo molto) [valutare ciascuna delle opzioni]

|                            |                                |
|----------------------------|--------------------------------|
| <p>GESTO CIRCOLARE</p>     | <p>○ ○ ○ ○ ○<br/>1 2 3 4 5</p> |
| <p>"TOUCH" (tocco)</p>     | <p>○ ○ ○ ○ ○<br/>1 2 3 4 5</p> |
| <p>"DRAW" (trascinare)</p> | <p>○ ○ ○ ○ ○<br/>1 2 3 4 5</p> |

ALZARE L'INTERFACCIA



○ ○ ○ ○ ○  
1 2 3 4 5

SCORRERE CON DITO/MANO



○ ○ ○ ○ ○  
1 2 3 4 5

3. **Quanto hai trovato comprensibile quanto segue? (1 - non comprensivo), 5 - molto comprensivo)**

A) Modalità di attivazione: versare il liquido e gesto circolare?

○ ○ ○ ○ ○  
1 2 3 4 5

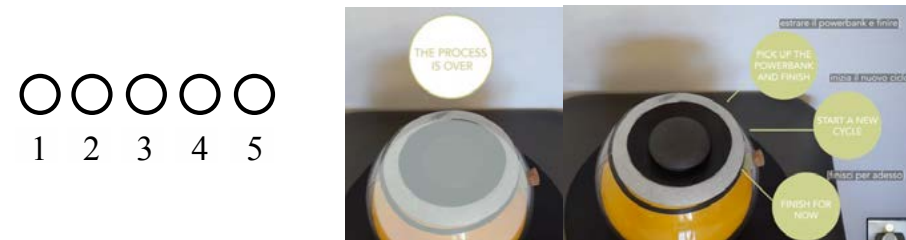


B) Sfera che cambia colore e diversa ripetizione del suono (1 squillo – verde, 2 squilli – giallo, 3 squilli - rosso) per comunicare la qualità dell'aria nel momento specifico.

○ ○ ○ ○ ○  
1 2 3 4 5



- C) Notifiche giornaliere sulla qualità dell'aria e suggerimenti su come migliorare la qualità dell'aria, e consultare i dati riguardo. [immagini e bottoni olografici]



- E) Posizionamento su *hub* e gestione della powerbank: interfacce sulla superficie di powerbank, manipolazione delle interfaccia sul muro (on-surface).



4. **Trovrebbe impegnativo l'uso del prodotto nel suo complesso in termini di gestione e utilizzo?**

- Sì  
 Leggermente impegnativo  
 No

5. **Se la risposta è sì, puoi spiegare cosa ti ha lasciato questa impressione?**

6. **Guardando il artefatto in termini di apparenza estetica in quale periodo lo collocheresti?**

- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto  
 L'artefatto sembra appartenere al presente  
 L'artefatto sembra appartenere al periodo tra 10 anni [2030]  
 L'artefatto sembra appartenere al periodo tra 20 anni [2040]  
 L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]  
 L'artefatto sembra impossibile - non esisterà mai

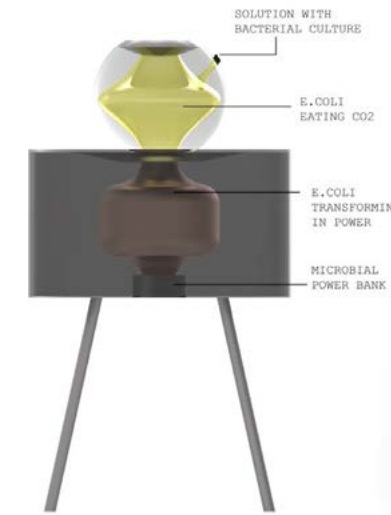
7. **Perché ti lascia questa impressione?**

## Sezione 2: Valutazione della tecnologia applicata

8. **Rispetto alle tecnologie che abbiamo oggi, quanto ti sembra avanzata questa tecnologia in relazione a:**

- A) Processi metabolici come tecnologia per catturare e trasformare co2 in energia, e immagazzinarla in un Powerbank (e.coli > trasformazione in energia) [selezionare una delle opzioni]

- Non avanzata  
 Avanzata  
 Media  
 Molto avanzata  
 È fantascienza (SCI-FI)



- B) Interfacce aumentate: Immagini olografiche.



- Non avanzata  
 Avanzata  
 Media  
 Molto avanzata  
 È fantascienza (SCI-FI)

- C) Possibilità di usare l'energia che si produce partendo dalla raccolta di CO<sub>2</sub> e decidere come usarla (immagazzinare, condividere, usare immediatamente per attivare i prodotti elettrici).



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

9. Cosa ti lascia questa impressione?

10. Dove collocheresti questi artefatti in termini di sviluppo tecnologico? [selezionare una delle opzioni].

- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto
- L'artefatto sembra appartenere al presente
- L'artefatto sembra appartenere al periodo tra 10 anni [2030]
- L'artefatto sembra appartenere al periodo tra 20 anni [2040]
- L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]
- L'artefatto sembra impossibile - non esisterà mai

11. Cosa ti lascia questa impressione?

12. In alcuni casi abbiamo difficoltà a fidarci della tecnologia. Questo può accadere per diversi motivi, come non essere sicuri che funzioni correttamente, che fornisca dati corretti e utili, non essere sicuri di come funziona, sentire di non avere un controllo su di essa, e tanti altri. Per quanto riguarda gli artefatti che stiamo analizzando, li trovi affidabili?

13. Riconosci dei benefici nell'uso di un tale artefatto a livello personale? Che tipo di benefici?

14. Riconosci dei benefici dell'uso di questi manufatti per la società? Che tipo di benefici?

15. Riconosci qualche considerazione o implicazione sociale o etica nell'uso di un tale artefatto a livello personale? Che tipo di preoccupazione, a cosa sono legate?

16. Pensi che ci siano considerazioni o implicazioni sociali o etiche su scala più ampia (come a livello di comunità)? Che tipo di considerazione, a cosa sono collegate?

### Sezione 03: Riassunto

17. Pensi che questo tipo di artefatto potrebbe aiutarti ad adottare comportamenti e abitudini più consapevoli riguardo alla qualità dell'aria nell'ambiente della tua casa e a capire meglio il tuo impatto sul mondo esterno?

18. Trovi appropriato ed efficiente il modo in cui l'artefatto cerca di influenzare il tuo comportamento in relazione a: (1 - per niente, 5- molto)

A) Feedback in tempo reale attraverso il colore e il suono della sfera.

○ ○ ○ ○ ○  
1 2 3 4 5

B) Informazioni quotidiane che ti suggeriscono come migliorare la qualità dell'aria [quantità e qualità delle informazioni]

○ ○ ○ ○ ○  
1 2 3 4 5

C) Dati per mostrare i tuoi progressi [quantità e qualità delle informazioni]

○ ○ ○ ○ ○  
1 2 3 4 5

D) Avere la possibilità di usare l'energia che si autoproduce, e decidere come usarla (immagazzinare, condividere, usare immediatamente)

○ ○ ○ ○ ○  
1 2 3 4 5

19. Per favore, spiega perché la pensi così?



20. *A volte gli artefatti tecnologici tendono a persuadere l'utente in modo invasivo o addirittura non etico. Per esempio, notifiche invasive che attirano l'attenzione su un contenuto o un prodotto specifico, raccogliendo i dati dell'utente e usandoli per adattare le informazioni per influenzare le sue scelte, anche influenzare le decisioni di voto, e altri. Questo tipo di influenza sul comportamento umano può essere dannoso in diversi modi, per la salute, le relazioni sociali e altro. Nel caso degli artefatti che abbiamo analizzato, riconoscete qualche implicazione etica o sociale?*

- Si
- No
- Non ne sono sicura/o

21. *Pensi che questo tipo di artefatto ti permetterebbe di stabilire meglio un dialogo con il tuo ambiente? Capire meglio l'impatto che hai sul pianeta?*

- Si
- No
- Non ne sono sicura/o

22. *Puoi immaginarti di usare questi artefatti tra 30 anni?*

- Si
- No
- Non ne sono sicuro

## Valutazione Artefatto 2

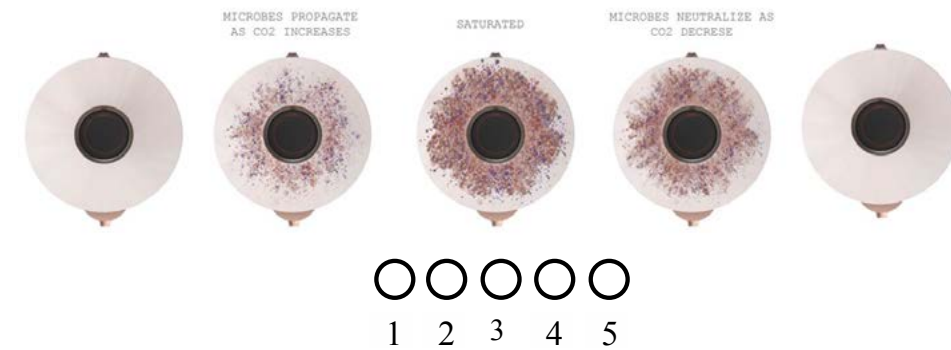
### Sezione 01: Aspetti interattivi e formali

1. *Sei familiare con queste nuove modalità di interazione? (cioè interazioni gestuali, interfacce aumentate)*

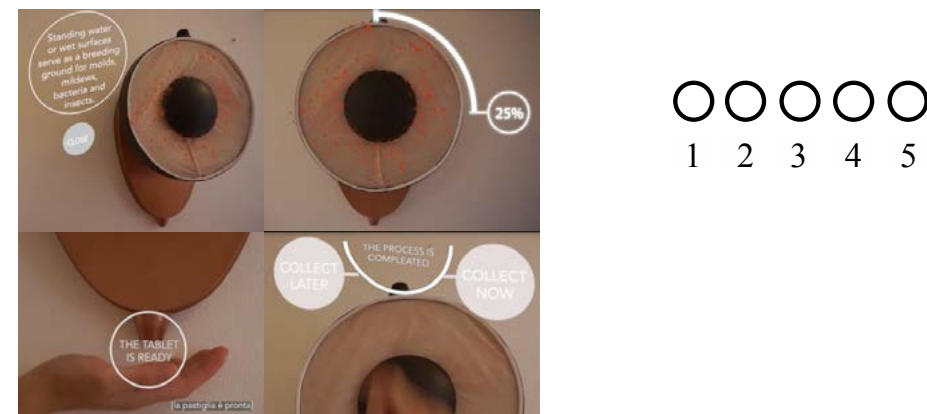
- Si
- No
- Alcune sì (quali?) \_\_\_\_\_

2. *Quanto hai apprezzato le modalità di interazione in relazione a:*


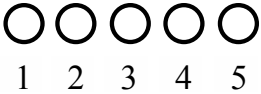

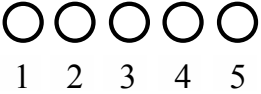

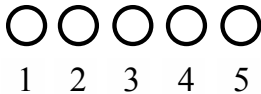
A) *Feedback in tempo reale attraverso la propagazione microbica reversibile. (1 - non apprezzo, 5 - apprezzo molto)*



B) *Feedback reale e lungo nel tempo attraverso le interfacce sulla parete intorno all'oggetto. (1 - non apprezzo, 5 - apprezzo molto)*



C) Interazioni gestuali. (1 - non apprezzo, 5 - apprezzo molto) [valutare ciascuna delle opzioni]

|                                                                                                                |                                                                                       |
|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <p>CIRCOLARE</p>              |    |
| <p>TOUCH</p>                  |    |
| <p>SCROLL (UP AND DOWN)</p>  |  |

**3. Quanto hai trovato comprensibile quanto segue?**

A) Modalità di attivazione: versare il liquido e salutare l'artefatto con la mano? (1- non comprensibile, 5 - molto comprensibile)

○ ○ ○ ○ ○  
1 2 3 4 5



B) Indicatore del processo: interfaccia sulla superficie come striscia progressiva per indicare la durata del processo? (1- non comprensibile, 5 - molto comprensibile)

○ ○ ○ ○ ○  
1 2 3 4 5



C) La propagazione/riduzione microbica presente sulla superficie del artefatto che indica il livello di nocività dell'aria? (1- non comprensibile, 5 - molto comprensibile)

○ ○ ○ ○ ○  
1 2 3 4 5



D) Le notifiche appaiono e rilasciano il suono per attivare la tua attenzione. (1- non comprensibile, 5 - molto comprensibile)

○ ○ ○ ○ ○  
1 2 3 4 5

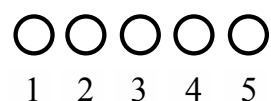


E) Interfacce olografiche e sulla superficie che mostrano notifiche quotidiane sulla qualità dell'aria e suggerimenti su come migliorare la qualità dell'aria. (1- non comprensibile, 5 - molto comprensibile)

○ ○ ○ ○ ○  
1 2 3 4 5



F) Chiusura del processo: suono, linea di progresso, interfaccia sulla superficie e raccolta delle pastiglia.



4. Troveresti impegnativo l'uso del artefatto nel suo complesso in termini di gestione e utilizzo?

- Si
- Leggermente impegnativo
- No

5. Se hai risposto si, spiega perché pensi così?

6. Guardando il artefatto in termini di apparenza estetica in quale periodo lo collocheresti?

- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto
- L'artefatto sembra appartenere al presente
- L'artefatto sembra appartenere al periodo tra 10 anni [2030]
- L'artefatto sembra appartenere al periodo tra 20 anni [2040]
- L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]
- L'artefatto sembra impossibile - non esisterà mai

7. Perché ti lascia questa impressione?

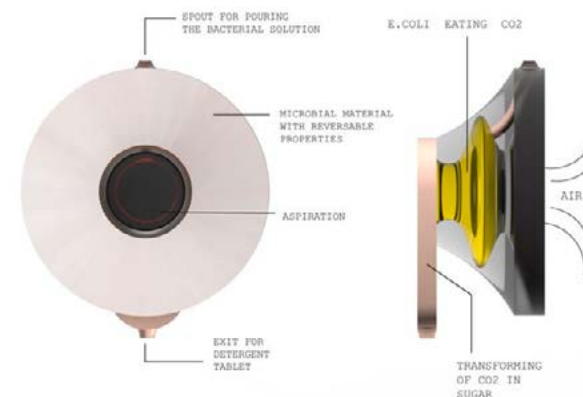
## Sezione 2: Valutazione delle tecnologie applicate

8. Rispetto alle tecnologie che abbiamo oggi, quanto ti sembra avanzata questa tecnologia in relazione a:

A) Processi metabolici come tecnologia per catturare e trasformare la CO<sub>2</sub> (e.coli > trasformazione in pastiglie chimiche solubili) [selezionare una delle opzioni]

- Non avanzata
- Avanzata
- Media
- Molto avanzata

È fantascienza (SCI-FI)



B) Materiali microbici in grado di cambiare le loro proprietà in modo reversibile e appaiono come interfacce. (la quantità del modello sulla superficie indica la qualità dell'aria) [selezionare una delle opzioni]



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

C) Produrre i prodotti chimici (pastiglie) dalla CO<sub>2</sub> per la pulizia e l'igiene personale.



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

**9. Cosa ti lascia questa impressione?**

**10. Dove collocheresti questi artefatti in termini di sviluppo tecnologico? [selezionare una delle opzioni].**

- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto
- L'artefatto sembra appartenere al presente
- L'artefatto sembra appartenere al periodo tra 10 anni [2030]
- L'artefatto sembra appartenere al periodo tra 20 anni [2040]
- L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]
- L'artefatto sembra impossibile - non esisterà mai

**11. Cosa ti lascia questa impressione?**

**12. In alcuni casi abbiamo difficoltà a fidarci della tecnologia. Questo può accadere per diversi motivi, come non essere sicuri che funzioni correttamente, che fornisca dati corretti e utili, non essere sicuri di come funziona, sentire di non avere un controllo su di essa, e tanti altri. Per quanto riguarda gli artefatti che stiamo analizzando, li trovi affidabili?**

**13. Riconosci dei benefici nell'uso di un tale artefatto a livello personale? Che tipo di benefici?**

**14. Riconosci dei benefici dell'uso di questi manufatti per la società? Che tipo di benefici?**

**15. Riconosci qualche considerazione o implicazione sociale o etica nell'uso di un tale artefatto a livello personale? Che tipo di preoccupazione, a cosa sono legate?**

**16. Pensi che ci siano considerazioni o implicazioni sociali o etiche su scala più ampia (come a livello di comunità)? Che tipo di considerazione, a cosa sono collegate?**

### Sezione 03: Riassunto

**17. Pensi che questo tipo di artefatto potrebbe aiutarti ad adottare comportamenti e abitudini più consapevoli riguardo alla qualità dell'aria nell'ambiente della tua casa e a capire meglio il tuo impatto sul mondo esterno?**

**18. Trovi appropriato ed efficiente il modo in cui l'artefatto cerca di influenzare il tuo comportamento in relazione a: (1 - per niente, 5 - molto)**

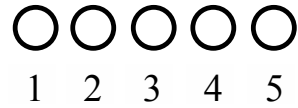
A) Feedback in tempo reale attraverso la propagazione microbica [più si usano prodotti chimici "buoni" e si applicano altre pratiche per migliorare la qualità dell'aria, la superficie è sempre meno contaminata] (1 - per niente, 5 - molto)

○ ○ ○ ○ ○  
1 2 3 4 5

B) Informazioni quotidiane che ti suggeriscono come migliorare la qualità dell'aria. [considerando sia la quantità che la qualità delle informazioni]

○ ○ ○ ○ ○  
1 2 3 4 5

C) Avere la possibilità di produrre e utilizzare le sostanze chimiche (comprese) a partire dalla CO<sub>2</sub>.



19. Perché pensi così?

20. A volte gli artefatti tecnologici tendono a persuadere l'utente in modo invasivo o addirittura non etico. Per esempio, notifiche invasive che attirano l'attenzione su un contenuto o un prodotto specifico, raccogliendo i dati dell'utente e usandoli per adattare le informazioni per influenzare le sue scelte, anche influenzare le decisioni di voto, e altri. Questo tipo di influenza sul comportamento umano può essere dannoso in diversi modi, per la salute, le relazioni sociali e altro. Nel caso degli artefatti che abbiamo analizzato, riconoscete qualche implicazione etica o sociale?

21. Pensi che questo tipo di artefatto ti permetterebbe di stabilire meglio un dialogo con il tuo ambiente? Capire meglio l'impatto che hai sul pianeta?

- Sì
- No
- Non ne sono sicura/o

22. Puoi immaginarti di usare questi artefatti tra 30 anni?

- Sì
- No
- Non ne sono sicura/o

**Per chiudere**

**Gli artefatti viventi (Living Artefacts) che abbiamo analizzato oggi, colonizzano il nostro spazio, coabitano attivamente con noi. Possono essere usati separatamente o insieme. Qui l'autore propone due possibili soluzioni, ma ce ne possono essere diverse presenti nel nostro ambiente. Vi piace l'idea di vivere in un tale ambiente? Scegliereste di usare solo un artefatto o vorreste averli entrambi, o anche più artefatti su questo argomento?**

## Questionnaire E2: FOCUS GROUP 2\_Water Doughnut [September 17th, 2021]

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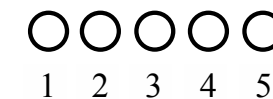
### Sezione 01: Aspetti interattivi e formali

23. Siete familiari con queste nuove modalità di interazione? (cioè interfacce olografiche interattive, autoparlanti)

- Sì
- No
- Alcune (quali) \_\_\_\_\_

24. Quanto hai apprezzato le modalità di interazione in relazione a (1 - non apprezzato, 5 - apprezzato molto):

D) Feedback in tempo reale attraverso l'avatar olografico (visivo e audio).



E) Intensità dell'interazione con avatar: se microplastiche solo in aumento si fa vedere e sentire spesso, se diminuiscono si fa notare meno.



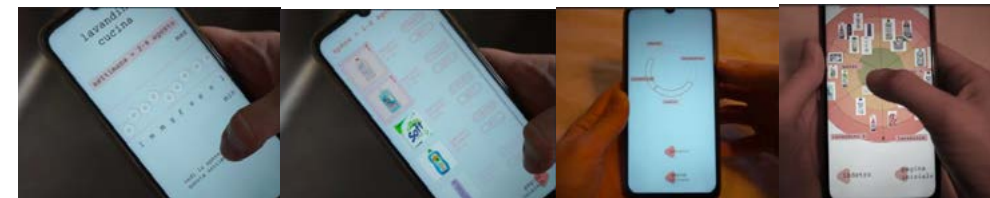
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1 2 3 4 5

F) Informazioni che avatar dà all'utente (storie, consigli, feedback).



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1 2 3 4 5

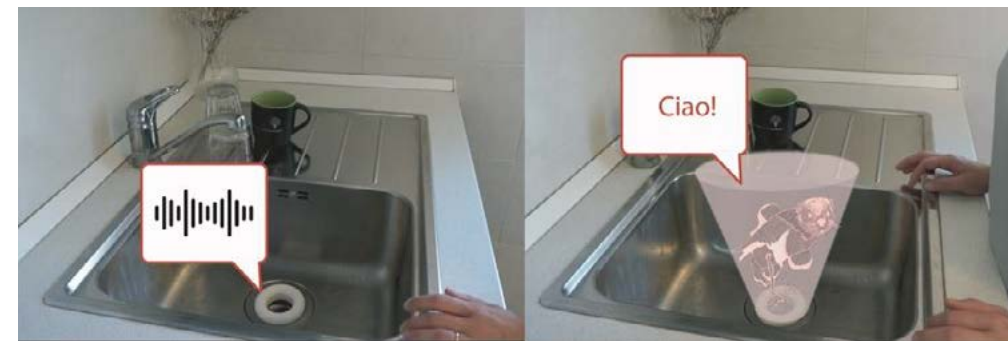
G) Interazione tramite mobile app (possibilità di seguire il monitoraggio del dispositivo Water Doughnut, indagare i prodotti che consumo, fare un piano per la prossima spesa, ecc.)



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1 2 3 4 5

25. Quanto hai trovato comprensibile quanto segue? (1 - non comprensivo, 5 - molto comprensivo)

F) L'avatar appare dopo lo squillo.



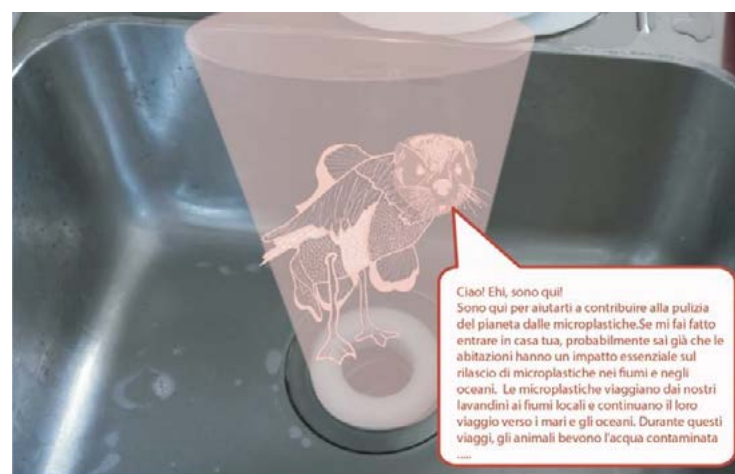
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1 2 3 4 5

G) Intensità della presenza dell'avatar dipende da rilascio di microplastiche: più inquinano più si fa notare.



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1 2 3 4 5

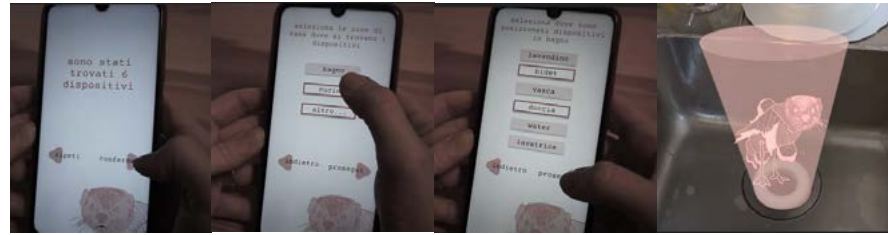
H) Storie, consigli e il feedback tramite avatar.



○ ○ ○ ○ ○  
1 2 3 4 5

I) Feedback in tempo reale e lungo nel tempo attraverso la mobile app [valutare ciascuna delle opzioni]

Attivazione dei dispositivi



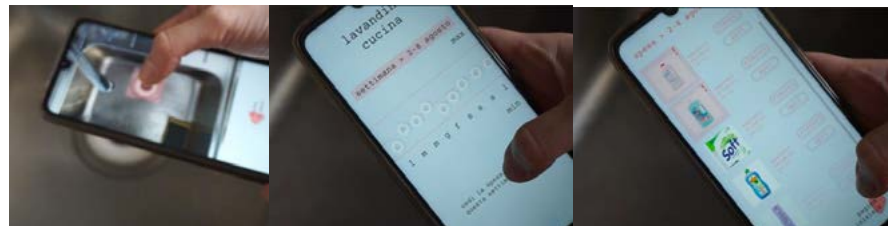
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1 2 3 4 5

Scannerizzare i prodotti (inserire i prodotti nella libreria)



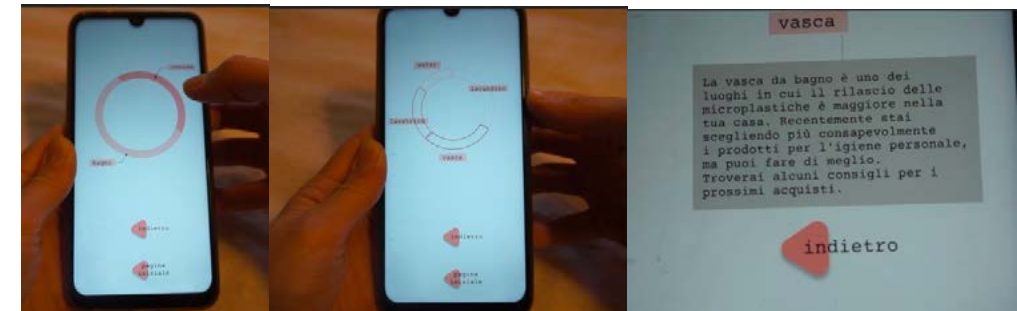
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1 2 3 4 5

Consultare la zona specifica dello scarico nel tempo reale



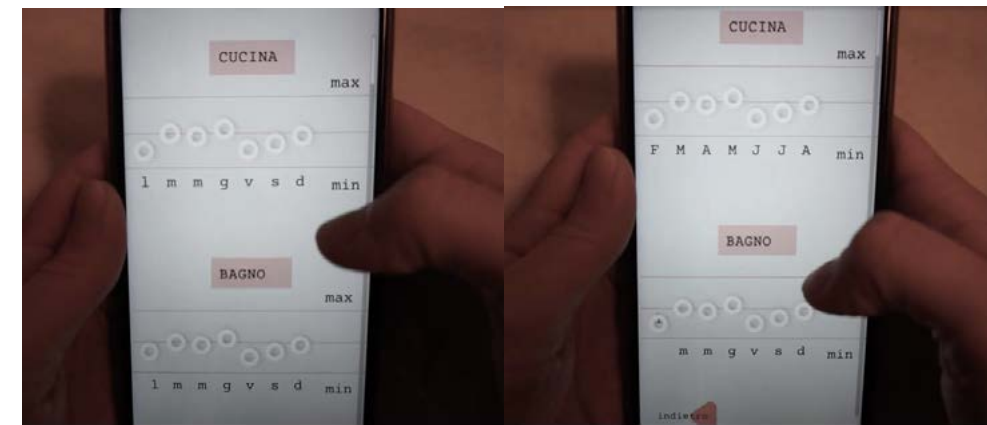
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1 2 3 4 5

Consultazione di data riguardo la zona e/o luogo specifico al livello giornaliero



○ ○ ○ ○ ○  
1 2 3 4 5

Consultazione di data riguardo la zone e/o luogo di casa e zone al livello settimanale/mensile



○ ○ ○ ○ ○  
1 2 3 4 5

Consultazioni per organizzazione della spesa





26. Troveresti impegnativo l'uso del prodotto nel suo complesso in termini di gestione e utilizzo?

- Sì
- Leggermente impegnativo
- No

27. Se la risposta è Sì o leggermente impegnativo, puoi spiegare cosa ti ha lasciato questa impressione? [discutiamo]

28. Guardando il artefatto (nel suo complesso dispositivo + app) in termini di apparenza estetica in quale periodo lo collocheresti?

- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto
- L'artefatto sembra appartenere al presente
- L'artefatto sembra appartenere al periodo tra 10 anni [2030]
- L'artefatto sembra appartenere al periodo tra 20 anni [2040]
- L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]
- L'artefatto sembra impossibile - non esisterà mai

29. Perché ti lascia questa impressione? [discutiamo]

## Sezione 2: Valutazione della tecnologia applicata

30. Rispetto alle tecnologie che abbiamo oggi, quanto ti sembra avanzata questa tecnologia in relazione a:

D) Sensore per le microplastiche integrato nel dispositivo per utilizzo casalingo.

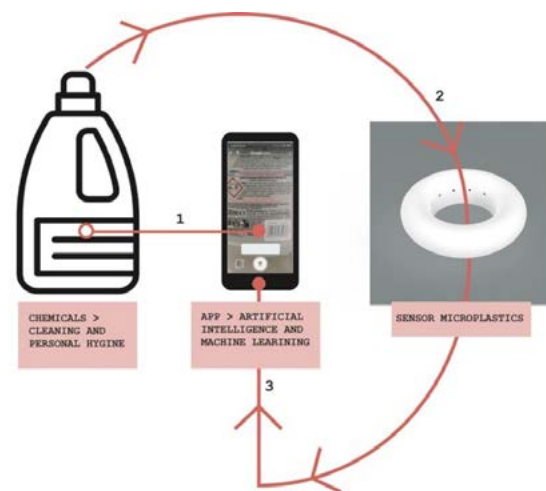
- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

E) Interfacce aumentate: Immagini olografiche.



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

F) Possibilità di avere una mobile app che osserva e elabora i dati relativi alle tue abitudini da consumatore e suggerirti come scegliere i prodotti che rilasciano meno microplastica negli scarichi. (tecnologia di base Intelligenza Artificiale e Machine Learning + sensore per le microplastiche)



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

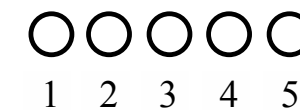
31. Cosa ti lascia questa impressione? [discutiamo]

32. Dove collocheresti questi artefatti in termini di sviluppo tecnologico (dispositivo + l'app)? [selezionare una delle opzioni].

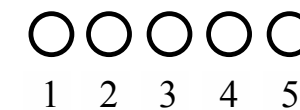
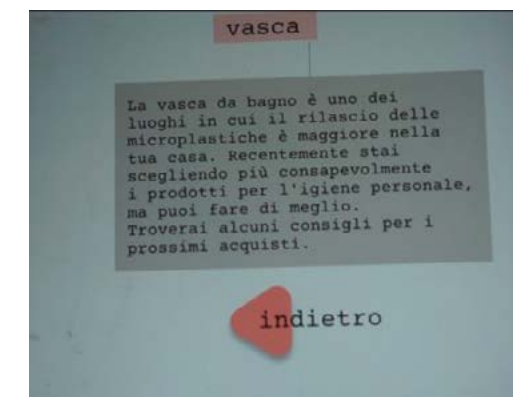
- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto
- L'artefatto sembra appartenere al presente
- L'artefatto sembra appartenere al periodo tra 10 anni [2030]
- L'artefatto sembra appartenere al periodo tra 20 anni [2040]
- L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]
- L'artefatto sembra impossibile - non esisterà mai

33. Cosa ti lascia questa impressione? [discutiamo]

34. In alcuni casi abbiamo difficoltà a fidarci della tecnologia. Questo può accadere per diversi motivi, come non essere sicuri che funzioni correttamente, che fornisca dati corretti e utili, non essere sicuri di come funziona, sentire di non avere un controllo su di essa, e tanti altri. Per



F) Informazioni e dati giornalieri che ti suggeriscono dove e come ridurre il rilascio delle microplastiche.



G) Dati (grafici) per mostrare come cambiano le tue abitudini da consumatore lungo nel tempo (al livello settimanale, mensile).

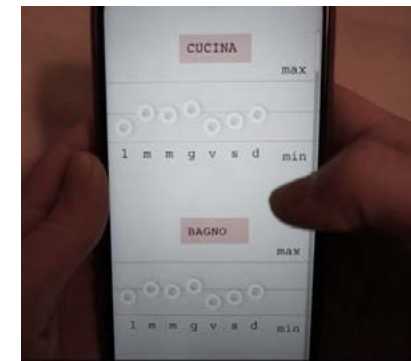
quanto riguarda gli artefatti che stiamo analizzando, li trovi affidabili?  
[discutiamo]

35. **Riconosci dei benefici nell'uso di un tale artefatto a livello personale? Che tipo di benefici? [discutiamo]**
36. **Riconosci dei benefici dell'uso di questi artefatti per la società? Che tipo di benefici? [discutiamo]**
37. **Riconosci qualche considerazione o implicazione sociale o etica nell'uso di un tale artefatto (Water Doughnut con l'avatar e mobile app) a livello personale? Che tipo di preoccupazione, a cosa sono legate? [discutiamo]**
38. **Pensi che ci siano considerazioni o implicazioni sociali o etiche su scala più ampia (come a livello di comunità)? Che tipo di considerazione, a cosa sono collegate? [discutiamo]**

### Sezione 03: Riassunto

39. **Pensi che questo tipo di artefatto (Water Doughnut con l'avatar e mobile app) potrebbe aiutarti ad adottare comportamenti e abitudini più consapevoli riguardo all'ambiente e abitudini da consumatore e a capire meglio il tuo impatto sul mondo esterno? [discutiamo]**
40. **Trovi appropriato ed efficiente il modo in cui l'artefatto cerca di influenzare il tuo comportamento in relazione a: (1 - per niente, 5- molto)**

E) Feedback in tempo reale attraverso l'avatar.



○ ○ ○ ○ ○  
1 2 3 4 5

H) Avere i prodotti mappati per programmare meglio la prossima spesa.



○ ○ ○ ○ ○  
1 2 3 4 5

41. **Per favore, spiega perché la pensi così? [discutiamo]**
42. **A volte gli artefatti tecnologici tendono a persuadere l'utente in modo invasivo o addirittura non etico. Per esempio, notifiche invasive che attirano l'attenzione su un contenuto o un prodotto specifico, raccogliendo i dati dell'utente e usandoli per adattare le informazioni per influenzare le sue scelte, anche influenzare le decisioni di voto, e altri. Questo tipo di influenza sul comportamento umano può essere dannoso in diversi modi, per la salute, le relazioni sociali e altro. Nel caso degli artefatti che abbiamo analizzato, riconoscete qualche implicazione etica o sociale?**

- Si
- No
- Non ne sono sicura/o

43. **Pensi che questo tipo di artefatto ti permetterebbe di stabilire meglio un dialogo con il tuo ambiente? Capire meglio l'impatto che hai sul pianeta?**

- Si
- No
- Non ne sono sicura/o

44. **Puoi immaginarti di usare questi artefatti tra 10 anni?**

- Si
- No
- Non ne sono sicuro

## Questionnaire E3: FOCUS GROUP 3\_The Animal [September 24th, 2021]

### Sezione 01: Aspetti interattivi e formali

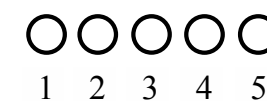
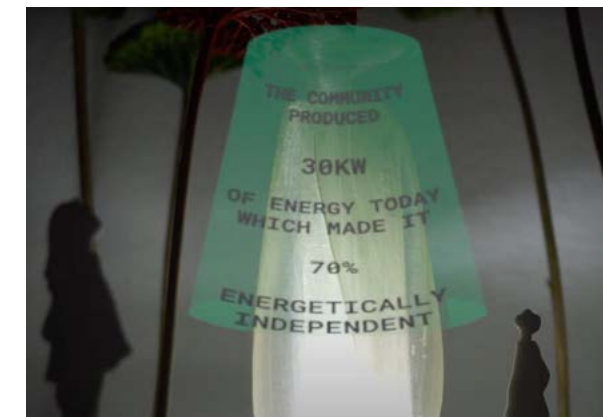
45. **Siete familiari con queste nuove modalità di interazione? (cioè interfacce proiettate come quella intorno il totem o in casa)**

- Si
- No
- Alcune \_\_\_\_\_

46. **Quanto hai apprezzato le modalità di interazione in relazione a:**

H) Feedback in tempo reale attraverso il totem in piazza (visivo e audio).

(1 - non apprezco, 5 - apprezco molto)



- I) Feedback in tempo reale attraverso la proiezione in casa (visivo e audio).  
(1 - non apprezzo, 5 - apprezzo molto)



○ ○ ○ ○ ○  
1 2 3 4 5

- J) Totem che si illumina alla fine della giornata per mostrare che il ciclo è finito.



○ ○ ○ ○ ○  
1 2 3 4 5

47. Quanto hai trovato comprensibile quanto segue? (1 - non comprensivo), 5 - molto comprensivo)

- J) Gli animali (The Animal) si svegliano con il suono della campana al mattino.



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1 2 3 4 5

- K) Gli animali (The Animal) svuotano i rifiuti introno al totem.



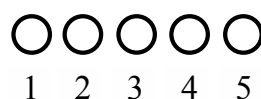
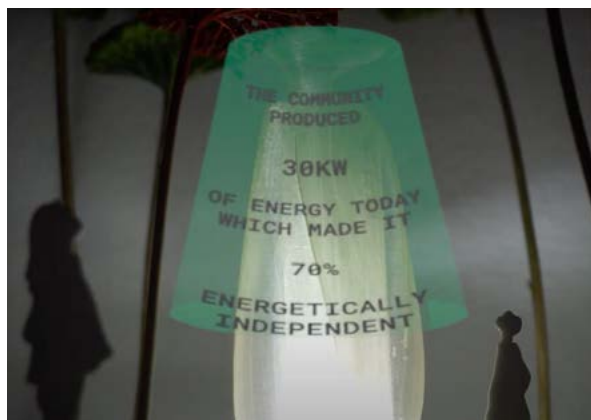
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1 2 3 4 5

- L) Il totem si illumina per comunicare che la raccolta e trasformazione si è conclusa per questa giornata.

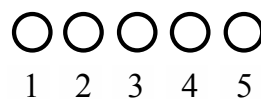


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1 2 3 4 5

M) Feedback sul **contributo energetico di intera comunità** tramite totem in piazza.



G) Feedback (contemporaneamente a quello del totem) sul **contributo energetico personale e il tuo impatto alla comunità** tramite la proiezione in casa.



48. **Trovrebbe impegnativo l'uso del sistema/servizio nel suo complesso in termini di gestione e utilizzo?**

- Si
- Leggermente impegnativo
- No

49. **Se la risposta è Si o leggermente impegnativo, puoi spiegare cosa ti ha lasciato questa impressione? [discutiamo]**

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50. **Guardando il artefatto (nel suo complesso totem-the animal-interfacce proiettate) in termini di apparenza estetica in quale periodo lo collocheresti?**

- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto
- L'artefatto sembra appartenere al presente
- L'artefatto sembra appartenere al periodo tra 10 anni [2030]
- L'artefatto sembra appartenere al periodo tra 20 anni [2040]
- L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]
- L'artefatto sembra impossibile - non esisterà mai

51. **Perché ti lascia questa impressione? [discutiamo]**

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## Sezione 2: Valutazione della tecnologia applicata

52. **Rispetto alle tecnologie che abbiamo oggi, quanto ti sembra avanzata questa tecnologia in relazione a:**

A) Un robot che riconosce e raccoglie i rifiuti organici e opera indipendentemente.



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

B) Un totem pubblico che raccoglie i rifiuti organici, li trasforma in energia, distribuisce energia alla comunità, lasciando un feedback agli cittadini alla fine della giornata.



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

C) Possibilità di avere una interfaccia proiettata in casa quando non vuoi uscire fuori e su quale puoi vedere i dati relativi ai consumi personali e l'energia prodotta.



- Non avanzata
- Avanzata
- Media
- Molto avanzata
- È fantascienza (SCI-FI)

53. **Cosa ti lascia questa impressione? [discutiamo]**

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54. **Dove collocheresti questi artefatti in termini di sviluppo tecnologico (totem-the animal-interfaccie proiettate)? [selezionare una delle opzioni].**

- L'artefatto sembra appartenere al passato - qualcosa che è già stato visto
- L'artefatto sembra appartenere al presente
- L'artefatto sembra appartenere al periodo tra 10 anni [2030]
- L'artefatto sembra appartenere al periodo tra 20 anni [2040]
- L'artefatto sembra appartenere al periodo tra più di 20 anni [2050]
- L'artefatto sembra impossibile - non esisterà mai

55. **Cosa ti lascia questa impressione? [discutiamo]**

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56. **In alcuni casi abbiamo difficoltà a fidarci della tecnologia. Questo può accadere per diversi motivi, come non essere sicuri che funzioni correttamente, che fornisca dati corretti e utili, non essere sicuri di come funziona, sentire di non avere un controllo su di essa, e tanti altri. Per quanto riguarda gli artefatti che stiamo analizzando, li trovi affidabili? [discutiamo]**

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57. **Riconosci dei benefici nell'uso di un tale artefatto a livello personale? Che tipo di benefici? [discutiamo]**

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58. **Riconosci dei benefici dell'uso di questi manufatti per la società? Che tipo di benefici? [discutiamo]**

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59. **Riconosci qualche considerazione o implicazione sociale o etica nell'uso di un tale artefatto a livello personale? Che tipo di preoccupazione, a cosa sono legate? [discutiamo]**

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60. **Pensi che ci siano considerazioni o implicazioni sociali o etiche su scala più ampia (come a livello di comunità)? Che tipo di considerazione, a cosa sono collegate? [discutiamo]**

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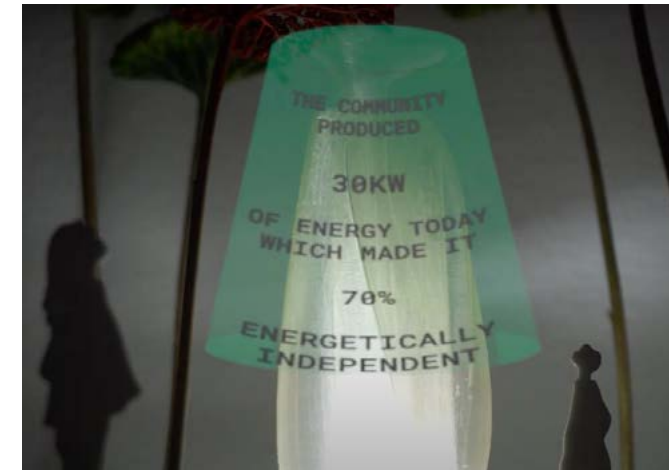
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### Sezione 03: Riassunto

61. **Pensi che questo tipo di artefatto potrebbe aiutarti ad adottare comportamenti e abitudini più consapevoli riguardo all'ambiente e abitudini da consumatore e a capire meglio il tuo impatto sul mondo esterno? [discutiamo]**

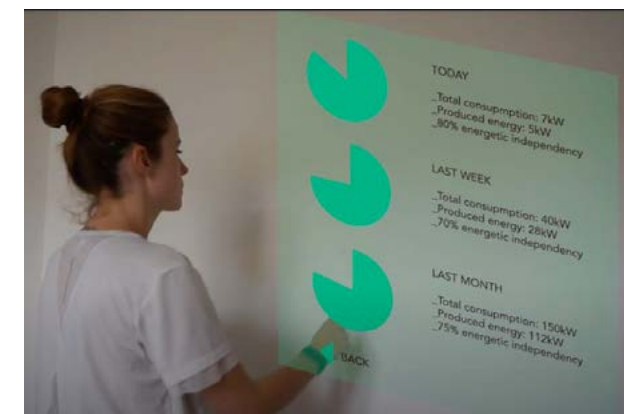
62. **Trovi appropriato ed efficiente il modo in cui l'artefatto cerca di influenzare il tuo comportamento in relazione a: (1 - per niente, 5- molto)**

I) Totem che dà il feedback quotidiano in piazza.



○ ○ ○ ○ ○  
1 2 3 4 5

J) Informazioni e dati giornalieri che ti mostrano la produttività della tua casa nel senso energetico (raccolta, consumi, quindi il livello di indipendenza energetica in corto e lungo termine).



○ ○ ○ ○ ○  
1 2 3 4 5



- K) Il concetto di avere un animale artificiale (robot) che vedi raccogliere i rifiuti organici che poi vengono trasformati in energia.



○ ○ ○ ○ ○  
1 2 3 4 5

63. **Per favore, spiega perché la pensi così? [discutiamo]**

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64. **A volte gli artefatti tecnologici tendono a persuadere l'utente in modo invasivo o addirittura non etico. Per esempio, notifiche invasive che attirano l'attenzione su un contenuto o un prodotto specifico, raccogliendo i dati dell'utente e usandoli per adattare le informazioni per influenzare le sue scelte, anche influenzare le decisioni di voto, e altri. Questo tipo di influenza sul comportamento umano può essere dannoso in diversi modi, per la salute, le relazioni sociali e altro. Nel caso degli artefatti che abbiamo analizzato, riconoscete qualche implicazione etica o sociale?**

- Sì
- No
- Non ne sono sicura/o

65. **Pensi che questo tipo di artefatto ti permetterebbe di stabilire meglio un dialogo con il tuo ambiente? Capire meglio l'impatto che hai sul pianeta?**

- Sì
- No
- Non ne sono sicura/o

66. **Puoi immaginarti di usare questi artefatti tra 10 anni?**

- Sì
- No
- Non ne sono sicuro

**ENVISIONING TOOL:  
TECHNOLOGY INSPIRATION  
CARDS AND SOCIETAL  
INSPIRATION CARDS**



*[Images contain links]*

# TRADEMARK





Benelux Office  
for Intellectual Property



## i-DEPOT evidence

Number

132761

Date

09-07-2021

Reference

36930CO/DG

Title

Protocollo per progettare artefatti tecnologici

In the name of

POLITECNICO DI MILANO  
Piazza Leonardo da Vinci 32  
20133 MILANO  
Italy

Representative

Brunacci & Partners S.r.l.  
Via Pietro Giardini 625  
41125 Modena  
Italy

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R. J. Gustafsson  
Director General BOIP

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POLITECNICO DI MILANO  
DESIGN DEPARTMENT  
DOCTORAL PROGRAMME IN DESIGN

PhD research:

**“DESIGN FICTION 4 CRITICAL THINKING: DESIGNING  
CONSCIOUSLY TECHNOLOGICAL ARTEFACTS TO  
TACKLE AWARE BEHAVIOURS”**

PhD Candidate: MILA STEPANOVIĆ

Supervisor: Prof. VENERE FERRARO

Discussant: Prof. TOM JENKINS

Coordinator of the Doctoral Programme: Prof. PAOLA BERTOLA

Cycle | 34° [2018/2021]

Date of discussion: 24/03/2022