DATAFIED:

A CRITICAL EXPLORATION OF THE PRODUCTION OF KNOWLEDGE IN THE AGE OF DATAFICATION

HELENE LIU

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School of Design

DATAFIED:

A Critical Exploration of The Production of Knowledge in The Age of Datafication

Hélène Liu

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CERTIFICATE OF ORIGINALITY

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_____ (Signed)

Helene Liu

DEDICATION

To Elvire and Maurice, my parents, who instilled in me a love of knowledge. In gratitude for their love, support and wisdom.

To Alistair and Aurelie, my source of joy, pride and inspiration.

To Raymond, in gratitude for your kind support over the years.

ABSTRACT

As qualitative aspects of life become increasingly subjected to the extractive processes of datafication, this theoretical research offers an in-depth analysis on how these technologies skew the relationship between tacit and datafied ways of knowing. Given the role tacit knowledge plays in the design process, this research seeks to illuminate how technologies of datafication are impacting designerly ways of knowing and what design can do to recalibrate this imbalance. In particular, this thesis is predicated on 4 interrelated objectives: (1) To understand how the shift toward the technologies of datafication has created an overreliance on datafied (i.e., explicit) knowledge (2) To comprehend how tacit knowledge (i.e. designerly ways of knowing) is impacted by this increased reliance, (3) To critically explore technologies of datafication through the lens of Walter Benjamin's work on the phantasmagoria of modernity and (4) To discover what design can do to safeguard, protect and revive the production of tacit knowledge in a world increasingly dominated by datafication.

To bring greater awareness into what counts as valid knowledge today, this research begins by first identifying the principles that define tacit knowledge and datafied ways of knowing. By differentiating these two processes of knowledge creation, this thesis offers a foundation for understanding how datafication not only augments *how* we know things, but also actively directs and dominates *what* we know. This research goes on to also examine how this unchecked faith in datafication has led to a kind of 21st century phantasmagoria, reinforcing the wholesale belief that technology can be used to solve some of the most perplexing problems we face today. As a result, more tacit processes of knowledge creation are increasingly being overlooked and side-lined. To conclude this discussion, insights into how the discipline of design is uniquely situated to create a more regenerative relationship with technology, one that supports and honours the unique contributions of designerly ways of knowing, are offered.

Fundamental principles framing Grounded Theory are used as a methodological guide for structing this theoretical research. Given the unprecedented and rapid rate technology is being integrated into modern life, this methodological framework provided the flexibility needed to accommodate the evolving contours of this study while also providing the necessary systematic rigour to sustain the integrity of this PhD.

Keywords: datafication, tacit knowledge, phantasmagoria, regeneration, ecology of knowledge

PUBLICATIONS

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1 INTRODUCTION

As natural born designers, humans intrinsically share a collective desire to probe, experiment, test, fail and try again. This irresistible penchant to create has been driven by a need to understand and enhance life, even in disruptive ways. Since the beginning of time, this shared tendency for progress has sustained us through great periods of change – propelling us through the Stone, Bronze and Iron Ages right on through three modern Industrial Revolutions. When we consider the transformative advancements of digital technologies today, this inclination to create becomes even more striking. In the last two decades alone, we have witnessed a steady launch of digital innovations that has revolutionised nearly every level of human existence. Due to the mass adoption of mobile devices, coupled with 24/7 connectivity, how we engage in the world has been transformed in irreversible ways. With the vast array of technological options at our fingertips, we can now book a ride to the airport, monitor our heart rates and have nearly anything – including DNA sequencing - delivered to our doorstep.

The advances brought about by digital technology are real and hold many benefits. The insights emerging from big data can be used to yield vital yet previously untapped sources of knowledge. These improvements have been amply and duly celebrated. However, they have also led to an unequivocal faith in modern technology, and its vast and rapid integration into all aspects of life, including its most qualitative. Underlying this evolution is a widely held belief that these digital innovations hold the key to unlocking unprecedented improvements for humankind. The trust in big data has led to the widely-held belief that we can now safely outsource the "big thinking" to algorithms (O'Neil, 2013). This has both overlooked and facilitated a number of unintended consequences which are only starting to reveal themselves. A closer analysis of how these technologies are impacting how we think and engage in the world is required. In particular, a more critical and broader analysis is needed on how our (quantified) data-centric world is reconstructing how knowledge is created, shared and applied. More attention is required on how the over-reliance on big data is increasingly siloing *how* and *what* we know (boyd, 2015).

As a result of this positivist approach to technoscience, the knowledge arising from big data has been endowed with a sense of often unchecked legitimacy and objectivity. Embedded in this line of thinking is the belief that the process of harvesting data through algorithms affords us with a more scientific and therefore superior type of knowledge. As a result, technologies of datafication – defined as turning qualitative aspects of life into quantitative, discrete, computer-ready data[1] (Cukier & Mayer-Schoenberger, 2013; Van Dijck, 2014) - are not only reshaping what counts as valid knowledge, but also redefining and determining who - or what - decides what kind of data are useful and meaningful. While it is true that technology offers an impressive array of tools to help us navigate through vast amounts of information, there is a problematic trade off that undervalues the role humans play in the creation and application of knowledge (Cukier & Mayer-Schoenberger, 2013). This point of contention is particularly relevant to the discipline of design which operates at the intersection of human experience and the generating of new ways of knowing.

Research Aims

While it is true that digital data expands our shared human potential for decision-making, it also obscures it. We, as users of those technologies, are caught in an ever-expanding and consolidating nexus of data with our experience continuously being filtered, distilled and manipulated. As a result, technologies of datafication are reconfiguring both *how* we know and *what* we know. This shift is critical to the discipline of design, which remains heavily embedded in both the practice and experience of tacit knowledge – a unique form of knowing that is highly nuanced and socially placed. While tacit knowledge is not the only form of knowledge designers rely upon, it is nevertheless vital to the creative and innovative dimensions of design. As a highly contextualised process, it resides in the realm of the *unsayable* – that unique interplay of experiences (both conscious and unconscious), where the qualitative nuances and unspoken experiences of a larger

[1] This is the specific definition of datafication adopted throughout this thesis.

world are understood and embodied (Polanyi, 1966b). The acquisition of such inferred knowledge can only be obtained through direct engagement with the world, making it, at its essence, the personification of critical awareness. As such, tacit knowledge requires a willingness to be one with complexity - to hold a space for *learning to be* rather *than learning about* (Duguid, 2005, p. 113).

Datafied ways of knowing in contrast are far more explicit and quantified. Extracted from human experience and reconstituted into algorithmic certainty, technologies of datafication work to translate the complexity and subtleties of human experiences and behaviours into separate and stable "truths". Instead of viewing the world as an interrelated and constantly changing web of qualitative experiences, datafication is redefining knowledge in its own image (Hong, 2020). While it is true that technologies of datafication work best in situations involving specific and redundant tasks, they have proven to be far less effective in addressing the more complex and, at times, messy arenas of human experience (Cheney-Lippold, 2017). Thus, where datafied ways of knowing best apply to that which can be quantified, tacit ways of knowing offer a better grasp of the qualitative complexities of everyday life. While these are not the only ways of knowing, the scope of this research focuses on this particular dichotomy because it stands at the centre of the debate on technology vs. human understanding.

Given this growing divergence between the quantitative nature of datafication and the qualitative nature of tacit knowledge, this thesis aims to critically analyse how this disparity impacts the discipline of design. More specifically, the key objectives for this thesis are:

1. To illuminate how tacit ways of knowing differ from datafied ways of knowing.
2. To explore how the current faith in datafication generates an "illusion of indispensability" in creating and validating knowledge.
3. To understand what design can do to create new avenues to safeguard, protect and revive the production of tacit knowledge.

Research Gap

As I was considering how technological shifts have impacted the production of knowledge and therefore marked civilisations throughout human history, Walter Benjamin's research conducted in the early years of the 20th century offered a particularly stimulating impulse to my exploration. In his seminal work *The Arcades Project*, Benjamin sets out to qualify and make sense of the monumental changes that were taking place in Europe during this time. Using the Paris arcades - a newly constructed shopping promenade made possible by the advancements in architectural materials - as the symbol of technological innovation and the rise of consumerism, Benjamin mapped out how the emerging system of industrial capitalism was creating a radical and transformational impact on society at large. Realising that the "great men" approach to history would not fully uncover the real essence of this shift, Benjamin explored the meaning behind the motifs and the tacit imagery framing of this newly emerging civilisation.

Throughout his work, Benjamin looked at the manifestations of the phantasmagoria (i.e., a reality that seems real but is not) that arose from the effects of industrial capitalism seeping into the most intimate areas of life and work (see Chapter 5). He also examined how these new trends created a paradox whereby society had become more realist through capitalism and yet more idealist through the dream of consumerism. In particular, he writes about "the pomp and the splendour*"* that defines a "commodity-producing society*"* as well as the phantasmagoria these innovations carried (1999).

I saw strong similarities between his investigation at the dawn a new century and the questioning that motivated me to start this exploration at the dawn of the next one. Inspired by his enquiry into the "haze of the 19th century", I began to wonder if digital technology in general, and datafication in particular were also participating in the creation of a 21st century phantasmagoria. Benjamin examined how the manipulation of perceptions and desires were masking the conditions and labour involved in the production of the 20th century commodities. I had similar questioning about the architectures of social platforms, and what (or who) were the commodities of the 21st century.

Taking this exploration one step further, I began to see parallels emerge relating to how our current dependency on digital data reflects the same conditions of phantasmagoria he spoke about nearly a century ago. I began to consider how our faith and dependency on datafication are derived from a type of thinking that at best overlooks and at worst undermines the tacit-based processes of design.

Despite this however, much of the academic literature to date focuses on how technology can be applied to reveal and synthesise batches of algorithmic-based knowledge, with little research being conducted on how these trends are directly recalibrating and informing the conditions by which tacit knowledge is used and experienced. It is also important to note that while the processes of creative and practice-led disciplines indeed integrate different forms of knowledge - such as practical, experiential, personal, implicit or situational to name a few (Niedderer, 2006; Reber, 1989), tacit knowledge is a core element of human experience and awareness (Polanyi, 1958), and therefore of design practice. Consequently, the dichotomy between tacit and datafied knowledge stands at the heart of this research.

Thus, while technologies of datafication undeniably deliver a number of positive applications for design, this research contends that our current overreliance on these tools to distil *how* and *what* we are experiencing often yields highly problematic results. Given the nuanced complexity of life, human experience is not always fully or effectively captured through the filters of quantified variables. As this thesis contends, when we take an overly reductionist approach to translating human experience into datafied knowledge, we run the risk of obscuring, and in some cases erasing, the more nuanced and experiential processes of knowing that often defy the scientism of reduction but that are nonetheless crucial to human understanding.

Tacit Knowledge of Design vs Explicit Knowledge of Datafication

As this research sets out to illuminate, the limits of digital data-driven knowledge are not limited to technoscience, but rather, become apparent in the growing list of unintended repercussions

datafication brings[2]. Our current reliance on algorithms to determine what counts as valuable and important knowledge carries an air of unchecked "truth", with very little pushback on the ways in which we come to accept the legitimacy of this said truth (Gillespie, 2012; Gitelman, 2013; Iliadis & Russo, 2016). Thus, the question driving this research is not so much whether datafication produces reliable knowledge, but rather, how do these technologies transform the underlying conditions for creating, validating and accessing a full spectrum of knowledge today?

While modern societies rely on and benefit from the computational "crunching" of big data, there are qualitative domains of experience and social life that do not align with such filtering. Furthermore, those domains often suffer when the mainstream methods undervalue and overwhelm other more tacit ways of knowing; there are simply too many qualitative, tacit and intuitive layers of being human that cannot be expressed through computational data (O'Neil, 2017; Striphas, 2015; Van Dijck, 2014).

This is not to say, however, that the processes giving rise to knowledge arising from datafication and intuitive knowledge are wholly irreconcilable. They can and do co-exist and support each other. Like most things in life, it is a matter of balance. Today, algorithmic ways of knowing are becoming increasingly dominant to the point that these methods are overwhelming other tacit, more qualitative and experience-based ways of knowing. As a result, datafication as an epistemology begins to take on a circular nature: not only is knowledge an output of machines, but it is also fed back to us (humans in general, and designers in particular) to help orient ourselves in the world and guide our decision making and innovative thinking. In this sense, it affects the production of knowledge that designers rely on to handle the "wicked" problems of design.

[2] Datafication as understood in this thesis, i.e., as quantification of qualitative aspects of life and human experience.

Knowledge vs Information

Before going further, a brief explanation of how this thesis distinguishes between knowledge and information is needed. The extensive and cross-disciplinary literature on the topic reveals that there is some disagreement on how information and knowledge are defined and understood (Rowley, 2007). While it is outside the scope of this research to dwell on the debates surrounding this topic, it is important to make clear the relationship between these two constructs and how they relate to this research.

A widely accepted paradigm used throughout the literature on Information Science and Knowledge Management is known as the DIKW model (Data-Information-Knowledge-Wisdom). This framework establishes a pyramidal hierarchy as well as an ontological relationship among the various components within the pyramid (i.e., data turns into information, information turns into knowledge and knowledge turns into wisdom)[3].

Fig. 1. The DIKW Pyramid (from Ackoff, 1989)

In this model, as a subset of knowledge, information is the result of transforming raw data into something "useful" (Ackoff, 1989), allowing to go from "knowing nothing" (data) to "knowing what" (information) (Zeleny, 1987). Similarly, knowledge reflects the ability to bring understanding to information. Thus, from the vantage point of the DIKW model, data is the *symbol*, information is the *what*, and knowledge is the *how* (Ackoff, 1989; Zeleny, 1987).

[3] The DIKW pyramid is widely studied in the relatively recent domains of information philosophy and knowledge management. Those fields are closely related to the rise of digital technologies.

However, while there is general agreement on how these various levels relate within this pyramid, there is little consensus on how to define knowledge, with most authors agreeing that it is a highly elusive concept (Awad & Ghaziri, 2007; Jashapara, 2011; Laudon & Laudon, 2022).

While this thesis recognises the differences among data, information and knowledge, rapid advances in data technologies have dramatically altered how datafied information is used to create, manage and apply knowledge. Spurred on by the emergence of "smart" technologies, coupled with the increased use of sophisticated algorithms, the relationship between information and knowledge has become particularly nebulous, making the distinction between the two more tenuous and complex.

The difficulties sub-fields of digital technologies have in defining knowledge help to illustrate this point. The expansion of digital technologies and big data confers new qualities to data that carry an aura of truth, and in the process, flattens the differences (in both quality and meaning) in how data, information and knowledge are understood and differentiated (Reigeluth, 2014). Additionally, when algorithmic filters are used to inform policy and decision-making in the social realm, the resulting datafied output is often taken as valid knowledge. As Jashapara puts it, "there is still no consensus on the nature of knowledge except that it is based on perceptions that can provide rational justifications for it" (2011, p. 18). This is especially true today when we consider how the boundaries between knowledge (which has traditionally been associated with understanding) and information are becoming more porous. Thus, while both data and information have traditionally sat below knowledge in the DIKW pyramid, in today's tech-centric world, datafied information is becoming increasingly aligned with knowledge. In other words, it is important to recognise that the nature of "datafied knowledge" is problematic because of 1. the controversial character of datafication as an epistemology, and 2. its dynamic, worlding aspect, which is a core question of this research.

This is neatly, albeit unwittingly, illustrated in a Facebook corporate mantra that consistently appears in many of the company's PR communications - including a recent email updating users

about Facebook's privacy policies that reads: "we do not sell and will not sell your information" (Appendix A). Indeed, Facebook does not sell our information (understood as the content users share on the platform and throughout the web) but it has established a remarkably extractive and profitable business on selling knowledge-based products built upon our information. Thus, for the purposes of this research, information generated through technologies of datafication is viewed as being highly aligned with long-standing definitions of knowledge and sense-making.

Organisation of Thesis

Following this introductory chapter, a review of the literature framing this thesis is presented in Chapter 2. To guide this discussion on how tacit knowledge is impacted by technologies of datafication, this chapter is divided into two sections, each drawing from a cross section of relevant research and disciplines. Section I offers a chronological overview of design as a discipline with particular emphasis placed on how tacit knowledge features in the historical development of design thinking from the 1950's onward. This discussion also underscores how design emerged as a unique discipline - intersecting both the sciences and the arts to occupy a space that is highly reliant on tacit knowledge. Section II reviews and addresses the prevailing trends in datafication as they relate to how knowledge is produced, determined and defined. This discussion includes a review of research illustrating how technologies of datafication are rapidly expanding, creating a new reality for how knowledge is produced and disseminated.

Chapter 3 describes the methods used in collecting, analysing and presenting the research findings generated from this study. Included in this discussion is the rationale used for selecting constructivist Grounded Theory (GT) as the methodological framework for this study. Given its rigour as well as its long-standing reputation for illuminating the complexities of emerging phenomena, constructivist GT provided the flexibility needed to uncover key details of this newly evolving trend. Understanding that no methodological approach is without some limitations, this

chapter addresses some of the structural limitations of this PhD as well as the steps taken to safeguard the credibility and validity of this study.

Chapter 4 presents a contrasting critique of tacit designerly ways of knowing and datafied ways of knowing, with particular emphasis placed on how these two processes present opposing attributes. This chapter also includes two theoretical frameworks reflecting the patterns and principles framing both tacit and datafied ways of knowing. These frameworks are then integrated in the subsequent chapters.

Following this analysis, Chapter 5 revisits the work of Walter Benjamin, with a focus on how the rampant and unchecked implementation of technological innovations has allowed a kind of 21st century phantasmagoria to set in. As mentioned above, Benjamin's work provided the inspiration for this thesis, motivating me to understand how technologies of datafication are overriding tacit experiences - a fundamental seed of tacit designerly ways of knowing - thus creating phantasmagoria-like conditions that have led to accepting the presumed legitimacy of datafied ways of knowing. To illustrate this emerging phantasmagoria, the framework presented in Chapter 4 depicting the attributes of datafied ways of knowing is analysed against the backdrop of Benjamin's model defining the features of phantasmagoria.

Chapter 6 examines how the framework of living systems can inform the regenerative conditions needed to reset the epistemological imbalances brought on by technologies of datafication. To facilitate this discussion, this chapter draws upon the principles of tacit knowledge (presented in Chapter 4) as well as research on the organising principles of living systems, to show how the creative and practice-led disciplines (including design) are uniquely situated to create new pathways for countering the extractive and reductionist repercussions of datafication. In order to proactively address the unchecked integration of datafication in qualitative areas of living, Chapter 6 explores how designers can create a new, more balanced relationship with datafication - one that supports the regenerative and innovative power of tacit ways of knowing.

Chapter 7 concludes this thesis with a discussion on the significance of this study and its larger applications to the field of design. The chapter includes a recap of findings and their relevance in relation to current literature. Suggestions for future research are also considered in this final chapter.

Research Challenges and Limitations

While the methodological limitations related to this research are discussed in Chapter 3, there are a few theoretical issues inherent to this study that should be raised from the onset. One of the biggest challenges associated with this investigation was the sheer depth and breadth of the topic at hand. The study of both knowledge and technology stands at the intersection of many academic disciplines, creating a vast body of research. While undertaking this PhD, I quickly discovered that the academic studies framing knowledge are indeed many, comparable perhaps only to the equally extensive (and growing) body of research surrounding digital technology.

Thus, to make this research feasible, I focused my attention on knowledge as it pertains specifically to the processes of tacit knowledge, as understood in and defined by design. Similarly, I refined my discussion on technology to the technologies of datafication as they relate explicitly to tacit knowledge. In doing so, a number of adjacent topics (i.e., technology and social design; user experience and design; design of smart technology etc.) had to be put aside in order to maintain a manageable research scope. In order to remain on track, I had to be careful to circle back to the central discussion on tacit knowledge. In fact, when I tried to open up the scope of this investigation to include additional new threads of discussion, integrating these themes proved to be too cumbersome and ultimately unmanageable.

Understanding how the narrowing of the research scope can limit a comprehensive understanding of the issue at hand, I decided to mitigate this potential limitation by including a diverse array of academic literature associated with this specificity of my research question. Hence, while the focus of this investigation remained exclusively focused on how knowledge is created, I took steps

to weave-in diverse and multidisciplinary sources to ensure the analysis for this thesis did not become myopic. I used theoretical triangulation (which involves the use of different theoretical perspectives to analyse data) to consider the question from different angles, which helped me gain new insights and get a more comprehensive understanding of this emerging phenomenon, as well as the clarity to refine this discussion.

While conducting this research, I had to also had to remain mindful of the trap of reductionist thinking – especially when developing a matrix of principles to reflect a synthesis of ideas and theories connected to this research. As discussed in Chapter 4, this research proposes two frameworks that encapsulate the key patterns and principles of both tacit knowledge and datafication. When constructing these paradigms (using the methodological principles put forth by constructivist Grounded Theory) I carefully balanced the task of gathering key concepts that resonated throughout the literature with the task of sustaining an interdependent view of how these attributes operate in situ. To maintain validity, I went through a number of edits and reiterations to ensure my conclusions reflected an accurate composite of the attributes framing both tacit ways of knowing and datafied ways of knowing.

Also, most of the literature used for this research (to the exception of a few sources in French) was in the English language. While an increasing number of English-speaking authors are translating and publishing about non-mainstream epistemologies, I am aware that these linguistic limitations may have possibly led me to overlook some interesting insights.

Summary of Research Contributions

This thesis examines how technologies of datafication are recalibrating the processes by which knowledge is produced, validated and accessed and how this reconfiguration is, in turn, altering the tacit processes involved in tacit designerly ways of knowing. More than any other discipline, design deals with manifesting tacit experiences into lived realities. It is therefore imperative that

designers are cognisant of how datafication truncates tacit processes of knowing and how to safeguard against the potential hazards these technologies present.

Thus, the fundamental aim of this thesis is to critically explore how a new epistemology is emerging - one that is increasingly defined by digital data-driven systems – that, if allowed to go unchecked, is redefining: (1) what counts as valid knowledge and (2) who – or what - has the right and the capacities to construct it. With this fundamental objective in mind, this thesis contributes to the academic field of design by:

(1) Illuminating the risks an over-reliance on technologies of datafication presents to tacit designerly ways of knowing.
(2) Developing and applying Walter Benjamin's concept of phantasmagoria to shed light on how datafication is a 21st century phantasmagoria.
(3) Exploring how the regenerative principles of living systems theory can offer a solid basis to rebalance the complex relationships between datafication and tacit designerly ways of knowing.

Furthermore, this thesis contributes three theoretical frameworks to the academic field of design, namely:

(1) a framework synthesising the attributes of both tacit and datafied ways of knowing;
(2) a framework for Benjamin's concept of phantasmagoria;
(3) a framework for a regenerative ecology of knowledge.

2 LITERATURE REVIEW

Chapter Overview

As mentioned in Chapter 1, the fundamental aim of this research is to understand how 21st century datafication impacts designerly ways of knowing. In particular, this thesis focuses on how the "scientism" of datafication impacts tacit knowledge in design. In line with this objective, the following literature review is divided into two main sections. Section I provides a historical summary of theories framing tacit knowledge in the design literature, beginning from the 1950's. The focus of this overview is to underscore how tacit knowledge is uniquely situated within the field and to underscore its role in defining the evolution of design as a discipline.

Section I of this review also explores how design emerged as a unique discipline at the intersection of the sciences and the arts, and the place that tacit knowledge occupies in how knowledge is created, shared and applied. With this aim in mind, this discussion highlights the early period and failures of design as science, design as a third culture and the important defining themes of this culture, as well as a specific look at the role of tacit knowledge in the production of knowledge in design.

Section II of this chapter will review the current research on datafication. Firstly, a review of what is datafication, the different definitions of data as its building block, the role of metadata, the architectures of big data and the ideology behind datafication. Following this, a review of research showing that datafication is growing and how, the evolution from digitisation to datafication, what are algorithms and how they are creating a new reality, and finally, the architectures of datafication.

Section I - Design Ways of Knowing

2.1.1 Design and Tacit Knowledge

The increased academic interest in design as an epistemology in the past thirty years has posited a number of complex processes that designers go through when they design. While quantification does have a place in designers' work, the creative processes that are the hallmark of design are complex and do not readily lend themselves to step-by-step measurement. Below is a summary of the research framing this topic.

- ***What is Tacit Knowledge?***

Since Nigel Cross (1982) seminal article, the place of tacit knowledge in designerly ways of knowing has been increasingly recognised. Tacit knowledge became a major element of study with scientist-philosopher Michael Polanyi in the 1950s. In *The Tacit Dimension* (1966b), he defines tacit knowledge by saying "I shall reconsider human knowledge by starting from the fact that we can know more than we can tell" (p. 4). For Polanyi, tacit knowledge is private, uncodified, intuitive and embodied and it is not available for linear analysis. It is however, the foundation of a wide range of complex skills, from tool use to application of the scientific method (Cianciolo & Sternberg, 2018). Within this definition, examples of tacit knowledge include activities that require some knowledge that is not always explicit, and is difficult or impossible to explain or verbalise and thus difficult to directly transfer to others (i.e., speaking a language, driving, playing chess, cooking, playing a musical instrument, using complex equipment or designing). From this vantage point, tacit knowledge is identified as "knowing-how", acquired experientially by living in the world. It is often described as opposed to the "knowing that" of explicit knowledge (Ryle, 2009; Schrijver, 2021a, p. 10).

Polanyi aimed to demonstrate how tacit knowledge (i.e., all that we know but cannot tell) was an important part of scientific knowledge. Even if knowledge is expressed into words or mathematic formula, it must rely on tacit knowledge to be understood. In other words, knowing is not

detached from the knower who plays an active role in the process of knowing (1966a). Following a discussion with Russian theorist Bukharin in 1935, he realised that socialism seemed to have created a mechanical conception of man, which paradoxically did not leave space for a tacit dimension of knowing, triggering a deep interest in tacit knowledge in him (1966b, p. 3; Weizenbaum, 1976). In many ways, Polanyi's view of tacit knowledge could be compared to the intuitive, oblique knowledge of the Greeks, called mētis (Wears, 2004). Mētis is tacit, unaware, conjectural knowledge that arises from long experience, the "practical skills and acquired intelligence in responding to a constantly changing natural and human environment" (Scott, 2008, p. 313).

It is important to note that the main issue for Polanyi was a view of the world that was anchored in an objectivist conception of science separate from a human and moral foundation. His critique arose from the atrocities of WWII, and while he did not blame it on science and technology, he made it clear that he viewed it as a result of positivism and the mechanistic worldview. The target of Polanyi's critique was "the [modern] ideal of scientific detachment" viewing it as something that "falsifies our whole outlook far beyond the domain of science." In its place, he offers "an alternative ideal of knowledge", quite broad in scope and application (Polanyi, 1958, p. iv). He advocates for the re-establishment of emergence, the idea that the whole has properties that its parts do not have, and that reality is multidimensional.

- ***Design and Tacit Knowledge***

Willcocks and Whitley (2009) differentiate between tacit knowledge that *has not yet been* formalised and tacit knowledge that *cannot* be formalised because it is embodied. Early on in the history of computer research, Weizenbaum (1976) critiqued the mechanical view of man and society. According to him, the danger of a reductionist view of human cognition (man as machine) is that this view taints the research into computational developments. Research on skill mastery has shown that higher levels of mastery requires a degree of intuitive intelligence that machines have yet to fully replicate (Dreyfus et al., 2000). Learning is a situated activity, and tacit

knowledge is embedded in designers' personal understanding of the context in which design happens and is only transferable though social interaction in communities of practitioners (such as apprenticeship for example), not through computer knowledge management systems (Lave & Wenger, 1991).

In the 1980s, design research shifted from a scientific focus on design methods to understanding how designers design (Glynn, 1993) and what made design a unique discipline that belonged neither completely to science nor completely to the arts (Cross, 2012). Design research began to examine the processes occurring in the minds of designers when they are designing. Through this research, it became clear that the collective processes of experience, sketching and other elements of tacit knowledge were playing a critical role in the design process (Cross, 1999, 2011; Lawson, 2005; Schon, 1984).

Of particular interest for design theory was the theory of practical intelligence and tacit knowledge (Sternberg, 1996), which frames expertise in terms of the relationship between information processing and experience. It considers the development and application of tacit knowledge as an important aspect of success in daily human endeavours. As such, the development of tacit knowledge is performed through a series of steps beginning with (1) an engagement with the environment (enquiry), (2) knowledge acquisition and (3) application (Cianciolo & Sternberg, 2018). This three-step process has also been found to resonate with other studies on design expertise, which demonstrate how experience and intuition played a major role in the design process (Ahmed et al., 2003; Deken et al., 2012; Lawson, 1979).

Furthermore, as a discipline that sits at the intersection of science and the arts, design combines several ways of knowing. Some theories of knowledge about design emphasise that design's way of knowing is unique because designers use three ways of knowing (or as Aristotle called them in The Nicomachean Ethics, three "states"): *episteme*, *techne* and *phronesis* (Mahdjoubi, 2003; Wang, 2013). Designers manipulate concepts (*episteme*) but they also have a very close relationship with tools in their process of knowing (*techne*), for example, sketching (also defined

as “thinking in action”). Designers also make value-based decisions in the process of designing, thereby bringing practical wisdom to the process (*phronesis*) (Crisp, 2014). Hence, for many design researchers, turning design into a completely explicit way of knowing is neither possible nor desirable (Abel, 1981).

2.1.2 Increased Recognition of the Role of Tacit Knowledge in Design Research

To give a more in-depth review of how theories of tacit knowledge interface within the field of design, it is important to consider the early developments in the field of design thinking, and how designers’ way of knowing became a topic of research. These early developments paved the way for why and how design became a separate discipline, sitting at the intersection of, but separate from, science and the arts.

- ***The Design Methods Movement, Design as Science***

At the beginning of the 21st century, Nigel Cross (2001b) published a seminal paper entitled *Designerly Ways of Knowing: Design Discipline Versus Design Science* in which he reviewed the developments in the field of design thinking throughout the past century. The major evolution he observed was the shift from design as science to design as a stand-alone discipline, with its own philosophy, culture, values, processes and methodologies, and more importantly for the purpose of this thesis, its own ways of knowing.

The years following the end of WWII saw major changes in strategic thinking and how design, in particular industrial design, was practiced and understood. During this period, there was a shift toward using more scientific methodologies and processes, such as rational methods, systematic thinking and calculations[4]. In line with these developments, the 1960s were also marked by an effort to “scientise” design (Cross, 2001b), i.e., bring it within the field of the objective, rational

[4] The success of operational research (OR) during the war triggered the spread of those methods in most industries, government, management and educational institutions. Agar, J. (2003). *The government machine: a revolutionary history of the computer*. MIT press. , Kirby, M. W. (2003). *Operational research in war and peace: the British experience from the 1930s to 1970*. Imperial College Press.

sciences. Key thinkers such as Archer (1964), Jones (1963), Alexander (1964) and Rittel (1973) spearheaded the movement believing that adding rigour to how design is approached and implemented would help legitimise the field.

Efforts to "scientise" design were predicated on the belief that applying scientific methodology and processes to design would allow better design processes to emerge. Technologist Buckminster Fuller summed up the idea in his call for a "design science revolution", based on science, technology and rationalism (Cross, 2007)[5]. Today, many models of applied design thinking (such as the model made popular by IDEO and widely used in business settings) find their roots in the design methods movement (Rith & Dubberly, 2007).

The assumption driving this movement was the belief that by making design more scientific, it would render itself to better problem solving. Designers could follow a set of procedures that would allow them to systematically go from problem to solution. design activities would be communicative, comparable, reversible, and repeatable (Laseau, 2000). For many leading thinkers of this movement, design was ultimately about rationalising decision-making and solving problems to ensure that the best solutions were implemented (Ackoff, 1962).

Herbert A. Simon (1996) was the first to propose a framework for design as a science or a scientific way of way of thinking in his book *Sciences of the Artificial*. A large portion of his work was focused on the development of artificial intelligence and whether human forms of thinking could be synthesized. From there, two academic approaches emerged: one that supported a more quantitative approach (which has been kept alive in the fields of digital technologies and AI) and one that embraced a more qualitative and living systems approach emphasising tacit knowledge (design as a discipline, then social and ontological design).

[5] Archives of the World design Science Decade initiative spearheaded by Fuller can be found on the Buckminster Fuller Institute webpage at https://www.bfi.org/design-science/primer/world-design-science-decade.

During this time, studies on creativity turned toward psychology, with an emphasis on identifying, understanding and measuring personal creative gifts so that it could be eventually replicated and taught (Becker, 2011). J. Paul Guilford (1950), the president of the American Psychological Association is credited with spearheading this line of research and dovetailed a burgeoning movement in design thinking to also look into modelling expert designers' cognitive strategies and processes (Lawson, 1979).

Developments in computer systems research from the 1950s also contributed to the emergence of a more systemic method of design. The Design Method Movement (DMM) was an offshoot of the post-war optimism that placed a premium on science-based progress (Langrish, 2016). The aim was to make the design processes "public" - as opposed to a private process occurring in the designer's head – to support collaboration (Jones, 1963). Here the emphasis was on the problem-solving dimension of design (Jones, 1966; Jones & Thornley, 1963). Today, modelling design methods is still a live tradition in the field of design of computing systems and AI, with studies aiming at systematising design and creativity (Von Thienen et al., 2018) and automated decision making and data processing (Patnaik et al., 2019).

- ***From Design as Science to Design as Discipline***

This movement to make design a "pure science" did not, however fully resonate. It became clear that the design methods approach did not yield results in everyday life, as real-world problems are highly complex and did not always bend to the application of linear methods (Cross, 1993). In the early 1970s, some of the founders of the design method movement (DMM) turned against its mechanical and behaviourist approach (Jones, 1977). In the 1971 preface to *Notes on the Synthesis of Form* (1964), Christopher Alexander separated himself from the movement by publicly claiming that it was not possible to separate the study of design from the practice of design. Rittel (1984) was more nuanced in his judgement of the DMM and while he acknowledged the limitations of a purely scientific design method, he did not repudiate the movement outright, coming up with a revision which he called "second generation" design methods instead.

In his rebuttal of the early design methods, Jones (1977) shared that the attempts to systematise design led to a separation between reason and intuition and left aside a major element of the design process: experience. Victor Papanek (1988) summed up the situation in his paper *The Future Isn't What It Used to Be*:

> Their approach stands for reason, logic, and intellect, but such a method leads to reductionism and frequently results in sterility and the sort of high-tech functionalism that disregards human psychic needs at the expense of clarity. (p. 4)

Alexander (1964) said that scientists try to identify structures whereas designers try to shape them. Indeed, there is a fundamental distinction between the epistemology of science (where results have to be replicated) and that of design, where replication is not even desired (Cross, 2006, p. 97).

During the late 1970's and 80s, an emergence of thought took root, which recognised that design could not be viewed entirely as a science but as a unique field that deals with unique problems (Archer, 1979; Cross, 1982; Rowe, 1991). The newly launched journal *Design Studies* published a series of articles on 'Design as a Discipline' (Archer, 1979; Cross, 1982; Nadler, 1980), which aimed to study design as a specific culture with specific practices. Going beyond simplistic distinctions between science and design, Cross (1993) proposed that the science of design is in fact the study of design. He introduced the idea of design being a "third culture" (between science and the humanities), and a third area of education (Cross, 2006). Building on from this premise, Cross (2006) posits that as a culture, design has specific ways to transmit knowledge. For him, design has its unifying focus (man-made world), its method of enquiry (modelling, pattern formation, synthesis), as well as a set of beliefs system (practicality, ingenuity, empathy, and a concern for 'appropriateness'). The emphasis was then put on the work of designers, individually or as a group (De Vries, 1993).

During this time, there was a shift toward viewing the design process as multidirectional and thus, not reducible to a step-by-step linear process. There was a growing awareness of and appreciation

for how designers draw from multiple intangible resources when they design, i.e., they do things that machines cannot. It has its own logic and specific way of perceiving the world (March, 1976), that spurred unique forms of creativity and innovation (Glynn, 1985), and thus, could never be a scientific activity (Cross et al., 1981; Steadman, 1979).

At the same time however, design methods continued to develop a strong hold in specific branches such as engineering and industrial design (Beitz et al., 1996; Hubka, 2015; Pugh, 1991), and of course, artificial intelligence. Within these revisions and additions, the main idea remained constant: one of the underlying cultural assumptions of design is that it draws from experience-based tacit knowledge, and thus can only truly be performed by thinking humans.

2.1.3 Designerly Ways of Knowing: How Designers Know

- ***A Third Culture***

The concept of 'designerly ways of knowing' arose in the early 1980s in connection with questioning about design education. Cross (1982) first explained the concept in the journal design Studies, setting the stage for a line of research that would span the next decades and would have profound implications for design research, education and practice.

"Designerly ways of knowing" refers to a desire to understand and articulate the nature of cognition in design, and the specific way of knowing and thinking displayed by designers-at-large (architects, engineers, product designers, etc.) It started with the acknowledgment that while the sciences and the arts (or humanities) had been at the forefront of our educational systems, there was a third culture which had been neglected and insufficiently articulated, that which could be called design with a capital D. In this context, design is described as "the ability to understand, appreciate and value those ideas which are expressed through the medium of making and doing" (Archer, 1979).

As Cross (1982) puts it, design has specific "things to know, ways of knowing them and ways of finding out about them". This third culture studies the man-made world through pattern-formation

or synthesis, based on values such as “practicality, ingenuity, empathy, and a concern for ‘appropriateness’.” In 1982, Cross noted the lack of appropriate language to describe this culture of “technique” (i.e., Aristotle’s *techne*) other than “designerly”.

Insights into design processes were also gathered from looking at how scientists and architects were solving the same ambiguous problem (Buchanan, 1992; Lawson, 1979). Through these studies, Lawson found architects employed solution-focused cognitive strategies (synthesis), whereas scientists used problem-focused strategies (analysis). In studies, designers quickly disposed some colour blocks in different arrangements, then tested to check whether they could help with the problem at hand. The designers were problem-solving while focusing on the problem, by coming up with several different solutions and eliminating those which did not work (Lawson, 2005, p. 43).

A characteristic of designers’ process is their focus on finding a satisfactory instead of an optimal solution. In other words, designers aim to “satisfice” (Simon, 1996) instead of optimise. This is an important distinction from the more science-based algorithmic processes that aim to optimise for a certain outcome. Cross attributes this not to a fundamental defect in designers’ cognitive processes, but to the complex nature of design problems themselves (see below) and the need for designers to quickly generate practical results, utilising their own judgement to make subjective decisions. Objectivity and replicability are not necessary in the design process, nor are they even desirable (Abel, 1981; Biggs, 2000). Design is a process of pattern synthesis rather than pattern recognition, the solution is not pre-existent, but is actively constructed by the designer.

- ***Important Themes***

There are a number of common themes that emerge when experienced designers talk about design (Cross, 2011). As Jones (1992) has noted, the design brief is a partial map of an unknown territory. In that sense, a designer is an explorer (of the design space) (Goldschmidt, 2006; Schon, 1984), a person who sets out to discover something because the relationship between design

problem and design solution is vaguely defined. Problem and solution develop together, making the design process organic and non-linear (Buchanan, 1992; Lawson, 2004).

- *Intuition and The Qualitative*

This first theme has to do with intuition as a way of thinking and how these intuitive processes emphasise the natural, unconscious aspect of knowing (Agor, 1989; Kahneman et al., 1982). Scholarship has long studied intuition as an aspect of knowledge (Bunge, 1962). Intuition has been defined as "knowing without being able to explain how we know" (Vaughan, 1979), which is very close to Polanyi's definition of tacit knowledge. Neuroscientist Antonio Damasio (2006) equates intuition to a gut feeling, an embodied perception that is only describable in metaphorical terms, but which is essential to rational thinking.

Research recognised it as an important element of decision making (Kahneman & Tversky, 2013; Khatri & Ng, 2000; Simon, 1987), and gives it its full place in the domain of decision-making as "judgments that arise through rapid, nonconscious, and holistic associations" and important in learning as well (Dane & Pratt, 2007). Research suggests that intuition is best used in instances where decisions have to be made in unprecedented and unpredictable situations with limited factual knowledge and time (Agor, 1991). While these original studies did not focus specifically on design, those elements fit the design process. More recently, design-specific research has given more space to the study of intuition in the design process, recognising its central importance, especially in designers from practice (Günther & Ehrlenspiel, 1999), and recommending that it be given a place in the design process (Badke-Schaub & Eris, 2014; Cross, 1999).

Early design research was oriented toward design as science (design methods) and the design of technology was influenced by this perspective. However, considering the important place of tacit knowledge in the designing process, Cross (1999) proposed that research in AI needs to "inform understanding of the natural intelligence of design ability" and be seen as a support to designers rather than replacing them.

Tacit knowledge, in the general sense of the term, includes aspects of the human dimension that have never been quantified until now. Today, we have digital tools with powerful capabilities to collect, process and analyse enormous amounts of data. Those tools make us believe that because we can, we successfully do quantify human experience. In other words, ability is equated with validity. This, however, has yet to be proven.

- *Abductive Thinking, Creativity and Sense-Making*

Within the context of the process of designing, abductive logic plays a major part in the process of designing (Kolko, 2009). Pragmatist philosopher Charles S. Peirce's work on types of formal logic has been studied in the context of design (Roozenburg & Eekels, 1995). Abductive thinking is a reasoning process used to explain something that is puzzling (Aliseda, 2006) and has become a hallmark of the type of the (creative) thinking that designers do (Serrat, 2017).

The difference between deductive, inductive, and abductive logic can be best explained in terms of the unknown elements in the equation: *What* (thing) and *how* (working principle) lead to *result* (observed). In deduction, the *what* and *how* are known but the *result* is unknown. In induction, we know the *what*, we know the observed *results*, but we do not know the *how*. This is the process behind discoveries in science, how hypotheses are formed (Douven, 2021). Both deduction and induction are analytical processes, which work together in science. The inductive process informs discoveries, and the deductive process justifies those discoveries - often by trying to falsify them, which is the foundation of the scientific method.

With abduction on another hand, the result is not a statement of facts, but the attainment of a certain value. The first way of abductive thinking is a conventional problem-solving process used in design and engineering where the *what* is unknown (i.e., object, service or system that will deliver the value), but the working principles and the *result* (value) are known. The second type of abductive thinking however is best used for the complex problems of design. Here, only the value

(the *result*) is known, but both the thing (the *what*) and the working principle (the *how*) must be created (Dorst, 2011).

Designers must come up with the what and the "how to reach a specific result. They work backward, starting with the value (the only known element of the equation) to discover a thing and a working principle. To do this, they find a frame to work from. Then, once they have found the what and how, they work forward to check if they perform well enough to create the value or result.

Pierce himself argued that abductive logic is not used to show that something is false or true, but to open new paths to new truths, which neither deductive nor inductive logic can achieve because they are positioned in the past (Martin, 2009). Abduction proposes the best explanation, the one that makes most sense in the current context, based on observation of the phenomenon, data, or previous experience. In other words, this type of reasoning has to do with insights and creative problem solving, and is at the heart of design synthesis (Kolko, 2009).

Abductive thinking is a powerful and tacit form of sense making. Sense-making has been defined in a general sense as "a motivated, continuous effort to understand connections (which can be among people, places, and events) in order to anticipate their trajectories and act effectively" (Klein et al., 2006). In other words, it involves turning circumstances into situations that are comprehended explicitly in words and then serve as a springboard into action. People undergo the automatic processes of sense-making, using their experiences to create an understanding of the world around them. Humans (as opposed to algorithms) bring the complexities of embodiment to this process of sense-making (Hummels & Van Dijk, 2015; Matthews, 2006, p. 75).

- *Emergence*

Another common theme discussed in design is emergence. Design uses aspects of emergence, which means that relevant features surface in the process of conceptualising solutions. "In the process of designing, the problem and solution emerge together" (Cross, 2011). The design

process exists in an area of “total uncertainty” and remains ambiguous until late in the process – making it both a source of frustration and joy for designers.

Emergence refers to implicit structures arising from other structures, usually explicit. It not only involves pattern recognition by the designer but also pattern definition (Jonas, 1996). As such, it is less about search and more about exploration. Search is simpler to programme, since it is concerned with identifying a particular solution. Exploration is more vague, because it seeks something that will only be recognised as interesting or of value once it has been found (Goldschmidt, 1997).

Goel (1995) critiques the computational theory of mind by comparing its precise, rigid, discrete, and unambiguous thought processes to the imprecise, inarticulate, non-discursive and ambiguous thought processes that characterise sketching activities and how they emerge in fluid and amorphous ways. Behind this is a critique of the assumptions of AI, that intelligence is a form of information processing and that computers can replicate human thought processes (Chandrasekaran, 1997).

- *Embodied Thinking, Embodied Language*

Design is an embodied epistemology that allows designers to learn and know by doing (Lawson, 2004). While much has been written on design thinking, the nature of the design process and what designers do when they design, there is no “one-size-fits-all” manual on how to design. In contrast to scientific knowledge, design does not have one common theoretical body of knowledge that is used to generate a solution (Lawson, 2004, p. 10). A lot depends on the unique experiences of the practitioner. Whereas the scientific approach draws from a common theoretical body of knowledge defined around universal principles, it is up to the designer to decide which body of knowledge (s)he will draw from. (Goel & Pirolli, 1992).

Thus design is highly situated and can only be learned and perfected by doing; it is not only a process but also a situation must be experienced (Dorst & Dijkhuis, 1995). Given that there is no

one way to approach design, most of the knowledge used in the design process "is on the one hand crucial and central and yet on the other implicit, poorly understood and seldom explained" (Lawson, 2004, p. 8).

Cross (1982) laments that design researchers "have been seduced by the lure of Wissenschaft, and turned away from the lore of Technik", i.e., have tried to study design as part of science or the arts without paying attention to the special language of design. The design process is not a purely internal mental process. Knowledge is generated and accumulated through action (Razzouk & Shute, 2012). Generating form is a creative activity whereby the designer sees in order to think (Liu, 1996). Designers are creative "makers", their knowledge is synthetic and real (Owen, 2007), they need to externalise thoughts (Lawson, 2004), and interact with an external representation (draw, sketch, models) to synthesise what they know.

However, sketching is not only a process of putting internal images on paper but also a tool to aid creative thinking (Goldschmidt, 1991). The relationship between designers and sketches is circular, sketches "speak back" to designers and help mediate between mode of visual representation (Fish & Scrivener, 1990). Sketching usually starts with simple representations which become more sophisticated and complex as the process moves forward (Do & Gross, 2001). Suwa and Tversky (1997) examined how architects interacted with their freehand sketches, concluding that sketching is an essential activity to crystallise design ideas in the early stages of the design process. Another experiment revealed that designing is a highly situated process, i.e., designers come up with ideas that arise from the environment in which they design. Innovation and unexpected discoveries emerge from alternating related activities, emphasising the opportunistic nature of design creativity (Suwa et al., 2000).

Artefacts are central to design's way of knowing, which is anchored in materiality. Even in the digital age, design is concerned with making the immaterial "material", turning the abstract into the concrete. Sketching, is a foundational language of design activity (Alexander, 1964; Archer, 1979); a language that enables the designer to express insights through 'constructive diagrams'

and 'pattern language' (Alexander, 1977). Designers think through sketching, by turning abstract patterns into something concrete, an actual object. In doing so, they translate "from individual, organizational and social needs to physical artefacts" (Hillier & Leaman, 1974). The problem-solving processes that they use remain mostly implicit - i.e., they know tacitly how to accomplish that skill.

- *Complexity*

A large part of the discourse on solving global issues involves applying technological innovations to resolve the complexities of modern life. This approach underlies the belief that technology can be applied to solve any problem (Postman, 1992). This has in turn led to an overarching trust in computational processes. David Deutsch (2011), a pioneer of quantum computing, argues that computers can replicate any complex process, including that of the human mind. The computational theory of mind assumes that the mind is a machine that "thinks" (Rescorla, 2020). The field of artificial intelligence has been developed along those lines, a search for "electronic super brains", with unlimited potential for "intelligence", that think better than humans because their thought is rational and "mathematically perfect" (Russell & Norvig, 2020).

However, it is also argued that the ability to compute does not equate with the ability to gain insights and understanding (Rees, 2018, p. 112), and that complex problems require the comprehension and discernment afforded by tacit knowledge. In fact, it is often forgotten that Polanyi's central aim in his exploration of tacit knowledge was to rehabilitate its place in science (Schrijver, 2021b). In *The Tacit Dimension* (1966b, p. 20) he argued that the trends in modern science toward the development of a body of objective knowledge was in fact damaging to knowledge in general.

It is beyond the scope of this thesis to advocate for one side or the other in the current debate about intelligence and whether AI will be (or already is) able to equate human intelligence. However, it is within the scope of this research to consider the issue of the capacity for creativity

and for complex thinking. Astro-physicist Martin Rees (2018) maintains that while technological artefacts are complex (see for example the micro-chip), they pale in comparison to living beings which not only display interlinked multidimensional structure from the scale of cells to that of limbs, but who are also influenced by their environment (p. 102). According to him, the most complex things known are held in the human brain.

Studies on creativity in science have put forward the importance of the "problem of the problem" (Getzels, 1979). Einstein and Infeld (1938) noted that "the formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advance in science" (p. 92). Computational systems and AI's decisive advantage over humans lies in their ability to rapidly sift through vast amounts of data and find patterns (Rees, 2018, p. 57).

Design studies tend to emphasise the importance of the "human element" in the process of designing, and indicate a gap between designers' and computers' ways of knowing. The question of whether machines could design is not new. Cross (2001a) argued that asking whether a machine can design is equivalent to asking whether a machine can think. Lawson (2004, p. 63) observed that computer-aided design had been limited to computer-aided drawing and there was no evidence that the results had made a positive difference across the board. Lawson (2004) went on to wonder whether this was due to a fundamental difference in how computer and humans manipulate knowledge.

- ***Tacit Knowledge, Complexity and the Unique Problems of Design***

One major area of focus of the research on design's knowledge production is the complex nature of design problems. Over the course of the past fifty years, it was recognised that the problems of design were essentially different from the problems confronting hard science.

- *The "Ill-Structured" Problems of design*

Herbert Simon (1973), who pioneered new disciplines such as artificial intelligence, information processing, decision-making, problem-solving, organization theory, and complex systems, was instrumental in bringing to light the specific nature of design's problems. He describes them as "ill-structured" (as opposed to the well-structured problems of science). While this was a first step in considering and honouring the more ambiguous components of design problems, the qualification hints at the negative attitude toward them: "ill" means not normal, unnatural, not in good health, placing it in a negative context. Simon proposes to turn the ill-structured problems into well-structured ones in order to solve them.

Simon observes that there is a fuzzy dividing line between ill-structured and well-structured problems and thus assumes that with enough knowledge, one can solve ill-structured problems (like those in design) like well-structured problems. Research on the topic of expertise has shown that it requires about ten years of experience to develop expert knowledge (Ericsson et al., 1993; Lawson & Dorst, 2009) and Simon fellow researchers estimated that it required to learn roughly 50,000 chunks of information (Simon & Chase, 1988). However, Simon's work is solidly anchored into the theorisation of decision-making, but as we shall see, design is more than a practice of decision-making (Huppatz, 2015).

- *The Wicked Problems of design*

> The search for scientific bases for confronting problems of social policy is bound to fail, because of the nature of these problems. They are "wicked" problems, whereas science has developed to deal with "tame" problems. […] and it makes no sense to talk about "optimal solutions" to social problems unless severe qualifications are imposed first. Even worse, there are no "solutions" in the sense of definitive and objective answers. (Rittel & Webber, 1973, p. 155)

Rittel (1973), who coined the term "wicked problems" (i.e., extremely complex and multi-dimensional problems), did considerable research on design as problem-solving. He focused on the use of second-generation design methodologies to solve “wicked problems” (i.e., problems that are ambiguously defined or too complex to lend itself to a linear problem-solution process). Rittel and Webber (1973) compared these to "tame" or "well-defined" problems which are clear and which solution is revealed by applying rules or technique.

Rittel’s work was instrumental in the evolution of design as a discipline, proposing several ideas that have remained at the foundation of how we understand design as a separate discipline from science (Rith & Dubberly, 2007). Notably, he introduced the idea that problem-solving depends on: (1) how problems are defined (or framed), (2) how solving “wicked” problems requires collaboration between stakeholders and argumentation (taking a stance about the nature of the problem) and (3) how the factual knowledge of science (“what-is”) is different from the instrumental knowledge of design (how “what-is” relates to what ought-to-be). He also emphasised how design is essentially a political process, setting it apart from a purely scientific discipline. In rejecting the purely rational-scientific, system-based theory of planning to frame design, he situated design and its wicked problems in the social realm (Crowley & Head, 2017).

- *Problems-Solution Co-Evolution*

The next step in understanding design’s problems is a radical revision of the relationship between problem and solution (Buchanan, 1992). The design problem is non-linear (Bazjanac, 1974), indeterminate (Rittel & Webber, 1973) and unlike problems in other disciplines, it requires considerable time for establishing a relationship between multiple factors (Dorst & Cross, 2001). This is similar to the creative work done by a therapist who helps her client reframe the presenting problem so that the underlying root of the issue can be revealed.

A shift in understanding design problems came with seeing the problem-solution as a co-evolving entity (Chivukula & Gray, 2020; Dorst, 2019; Dorst & Cross, 2001; Poon & Maher, 1997).

Designers do not take the problem as defined, but explore it and its context, often requiring re-interpretation or restructuring of the given problem to reach a suggested solution. This view rejects a linear problem-solution relationship and establishes a circular co-creative connection between the two. In doing so, this process leaves much more room for personal creativity and the use of tacit knowledge, especially when it comes to expert designers with a long experience (Cross, 2018).

The preliminary design phase relies most on intuitive tacit knowledge. It consists of generating and exploring alternative solutions. They emerge from a few seeds ideas that are in fact solutions to problems that the designer met previously or from her life experience (Goel, 1995, p. 260). In this sense, they are phenomenologically embedded. Akin (2001) also notes that “expert designers display a typical strategy of breadth first, depth next in solving problems”. This perspective also leads to the idea that one major step of the design process is the discovery of a frame of understanding for the design problem (Dorst, 2015c). Likewise, as Cross (1982) duly notes, when the problem itself is uncertain, designers work out possible solutions from the problem itself, their own experience, and other non-deductive thinking styles such as inferred analogies. For example, Peirce's abductive reasoning is called innovative abduction (as opposed to explanatory abduction) (Kroll & Koskela, 2015; Roozenburg, 1993).

When she designs, the designer typically moves her focus between her understanding of the context of the problem and notions about a possible solution, in a process where problem and solution co-evolve (Ball et al., 2004). Ideas for new solution can trigger a deeper or another understanding of the problematic context, which in turn offers more options and solutions (Dorst, 2015c). It is the designer’s skill in finding the right problem that separates good and mediocre design (Cross, 2011). This view abandons the traditional linear relationship between problem and solution to adopt a circular perspective of a dynamic and self-organising system of problem-solution (Jonas, 1993). This thinking process has also been applied to the design of strategy (Dew, 2007).

In 1992, Buchanan, published “Wicked Problems in Design Thinking” (1992), a seminal book about the origins of design thinking, where he discussed scientific development since the Renaissance, and how specialisations and processes became increasingly separate from each other. He elucidated that design thinking was a way to integrate highly specialised spheres of knowledge so they can be holistically applied to the new problems.

Lawson (2004) looked at the knowledge that designers rely upon and concluded that design knowledge is invisible, and thus we need to look at its manifestations. As a profession, design is often a social endeavour; involving teams of designers, specialist consultants, clients and other stakeholders. As a result, practicing designers come to understand the nature of this interdisciplinary knowledge implicitly. Thus, we need to look at conversations to reveal the nature of knowledge used as well as the nature of expertise in design (Lawson & Dorst, 2009) and ask ourselves: *What is it that marks out the really successful designers?* How we chose to investigate design knowledge (look at input and output, observe designers in controlled situations, in their natural environment, or simulate design process with design-like software), it is going to be incomplete and imperfect anyway because design is naturally a creative process (Lawson, 2005; Wiltschnig et al., 2013).

- *Frame Creation*

Dorst (2015c) introduced the concept of “frame creation” that further supported the role that tacit knowledge plays in design. Here, Dorst addresses what he sees as a central practice of design. He critiques Simon’s rational approach to problem-solving which ignores the subjectivity of the problem solver (Dorst, 2006). He argues that creative design is not about mending the problem to find a suitable solution, but allowing the problem and the solution to co-emerge (Dorst & Cross, 2001). Under this understanding, there is no such thing as a “design problem”. Designers do not solve problems but resolve paradoxes, which he defines as complex and conflicting statements (Dorst, 2006), by adopting a meta-view which allows to approach the situation from another

perspective. Frame creation is a way to move design from a solution-seeking exercise to thinking differently about wicked problems (Weedon, 2019).

Frame creation has to do with how designers solve problems, especially in complex situations that challenge us by their complexity and often large-scale impact (Dorst, 2015c; van Leeuwen et al., 2016). Dorst (2011) mentions designers dealing with problems that encompass a lot of moving parts that can only be handled by reframing them. Using the example of how an area in the city of Sydney, Australia, dealt with drunkenness, violence, theft and drug dealing, he cites how police saw this as a problem that would be solved with more control and stricter law enforcement. Designers however saw to correct these problems using the frame of music festivals: improve transportation, crowd control, safety and way-finding. Reframing the problem itself instead of jumping to solutions led to a successful revival of the urban area (Dorst, 2011).

Using frames to answer paradoxical problems is a central element of the problem-solving aspect of design, and is also applied outside the area of design for creative problem solving (Beckman & Barry, 2015; Beckman, 2020; Goto et al., 2020; Mitchell & Walinga, 2017; van Leeuwen et al., 2016). Frame creation is similar to reading complex situation through “themes” in the phenomenological method (Van Manen, 2016, p. 90). Themes are used to give meaning, a way to apprehend the phenomenon one tries to understand. One distils “themes” from a situation and these themes prompt the generation of new frames that give a new and interesting new perspective on the paradox at hand - i.e., to think outside of the box – making frame creation an important element of the design process, despite its organic and informal approach (van Leeuwen et al., 2016).

- ***The Reflective Practitioner***

Donald Schön (1984) recognises the importance of tacit knowledge in design in the preface to his book “Reflective Practitioner”: “I begin with the assumption that competent practitioners usually

know more than they can say. They exhibit a kind of knowing-in-practice, most of which is tacit" (p. viii).

For Schön, the positivist view of design as a linear problem-solving endeavour is reductionist. The underlying assumption is that we live in a linear world of cause and effect, the world of the hard sciences. He critiques the primacy of technical rationality in professional practice in general, and more specifically in design. "Technical rationality holds that practitioners are instrumental problem solvers who select technical means best suited to particular purposes" (p. 21). He rejects the positivist approach to design (i.e., design as a body of clearly delimited, scientific, specialised, and standardised knowledge), and proposes a constructivist epistemology to deal with the "uncertainty, uniqueness, instability, and value conflict" characterising phenomena in real-life (p. 39).

Schön aims to explore what type of knowledge informs good practice as well as the relationships between practice and research and thinking and doing. He critiques the tendency by many professionals to adopt "one-solution-fits-all" approach which emphasises a set of general and generic step-by-step instructions that can be applied across the board (Emslie & Watts, 2017). He argues technical rationality as a way of knowing does not equate with good practice (1984; 1987), but practitioners who employ other ways of knowing cannot speak about the knowledge they use because it characterised by "complexity, uncertainty, instability, uniqueness, and value conflict" (p. 39).

Schön argues that professionals live and work in situated environments and communities and need to make complex contextual judgments involving non-technical and non-rational abilities, which falls into what he calls "reflective practice". As an epistemological frame, reflection-in-action is a kind of knowing that involves "an art of problem framing, an art of implementation, and an art of improvisation—all necessary to mediate the use in practice of applied science and technique" (1987, p. 13). He advocates for "reflection-in-action" where designers actively engage in a

conversation with the situation, using their abilities and their competencies rather than following a set of external rules.

The concept of reflective practice has become influential in many professional fields outside of design (Thompson & Pascal, 2012). The interest generated by the concept has generated much new research, especially of a critical nature on the basis that Schön's original work does not provide a rigorous interrogation of the central notion of reflection itself (Clandinin & Connelly, 1986). Subsequent research set to unpack the concept of reflective practice (Bleakley, 1999; Van Manen, 1995), clarify its lineage (Hébert, 2015) and strengthen its theoretical foundation (Newman, 1999; Thompson & Pascal, 2012) especially in the field of professional education.

2.1.4 Tacit knowledge: Designing in and for the Future

Klaus Krippendorff (2005) suggests that design was in crisis because designers had lost their sense of direction in a sea of technological change. He suggested that designers had to shift gears to focus on creating physical and social artefacts that had meaning for users, and supported communities and society. Concerns have also grown inside and outside of the field of design about the necessity to transition to more sustainable ways of being and therefore of doing (Irwin, 2015; Willis, 2006), and for design to be the agent of this change (Blevis, 2018; Fry, 2017a).

An important element of this new direction is dialogue, which suggests an emphasis on collaboration and on treating the social "as if it mattered" (Couldry & Van Dijck, 2015). Manzini (2015, p. 66) encourages designers to participate to the emergence of a new way of being together, and to use their design culture and creativity to facilitate and support (but not control) a co-design process that leads them toward designing in "a dialogic way". Designers can assist in the formulation of new scenarios, which become the ground for collaborative discussions and shared ideas about how we want to be together (Manzini & Jégou, 2003). Deep and meaningful conversations are a central pillar in this empathetic co-creative process, putting the focus again on the tacit dimension of designing. Standing in opposition to the Shannon linear model of

communication (which conceptually underpins much of the developments in data science), Dubberly and Pangaro (2009) propose that a conversation happens when the following are present: a channel is opened for the conversation to happen; there is a commitment to engage and each participant sees value in doing so; meaning is constructed, understanding of the other party emerges; the participants evolve and change as a result of the interaction; and there is a convergence on agreement.

But the tacit conversation goes further than between two people. While human-centred design was regarded as an improvement over user-centred design (Buchanan, 2001), human-centred design is viewed by some as contributing to the destruction of the planet because it does often presumes non-human entities as resources to be plundered (Norman, 2005b; Schmeer, 2019). Some researchers propose a new view of knowledge which takes into consideration the agency of non-human actors (Bennett et al., 2010; Latour, 2005; Schrijver, 2021b), and even the creation of "a rich multispecies assemblage" which Donna Haraway calls the Chthulucene (2015).

Since its inception in the 1970's, human-centred design has its roots in computer science, AI and ergonomics (Giacomin, 2014) and is viewed by some as a means to scientise design (and thus focused on a mechanistic view of the production of knowledge) (Cooley, 1987; Gasson, 2003; Gill, 2012, p. 2; Krippendorff, 2004). However, pushed to its extreme, the consequences of an anthropocentric approach can be quite destructive because it destroys the commons (Bowers, 2006) and creates ecology-breaking hierarchies by elevating humans over everything else (Escobar, 2012).

This critique of a human centric focus seeks to reconsider the assumed hierarchies underlying the act of design by including non-human actors, while at the same time emphasising "care for the fragile condition of the human estate in its multiple entanglements" (Connolly, 2013). The idea here, as scholar Haraway (2016) puts it, is to "make kin", not only within the bounds of our human family, but with other living species as well. In line with 20th century radical evolutionary theorist Lynn Margulis' idea of symbiogenesis - the idea that evolution happens primarily through the

long-lasting “intimacy of strangers” – she proposes that sympoiesis, making-with, is at the heart of the act of Designing (with a capital D), which she reframes and expands as “worlding” (p. 60). She proposes the concept of “natureculture” to evoke the intimate interconnectedness of multispecies history (Haraway & Goodeve, 2000).

This critique expands beyond the boundaries of the natural world to examine the paradigm of objective knowledge as a way to legitimise dominant power structures. According to Haraway (1988), the idea of universal knowledge that is detached from context ignores the reality of the embodiment of the individual in complex webs of social, cultural, political, economic and historical relationships. Instead, she proposes the concept of situated knowledge, which honours the knowers’ qualitative aspects of being in the world and their “worlding” capacity, i.e., the individuals’ agency to actively create their world. This relational view recognises that we live in a “pluriverse” (Escobar, 2018a) and advocates for a collaborative, trans-disciplinary approach to the creation of knowledge (Stengers, 1997).

These approaches adopt a systemic standpoint, i.e., a view that sees relationships and interconnections rather than discrete isolated things (Capra & Luisi, 2014). As such, systems theory serves as a theoretical foundation for proposals to rethink the nature and the role of design in the complex world of the 21st century (Irwin, 2015; Thackara, 2022). One of the aspects of this new definition is the role design can (and needs to) play in ecology, which is understood not only from the position of life sciences, as the study of organisms within their environments, but more generally as a relational and regenerative (or autopoietic) stance (Fry, 2020).

The basis of this is the theoretical background set by the Santiago school (Maturana & Varela, 1992), rooted in living systems theory, which suggests to model design theories and practices on living systems. This requires seeing the world as a complex network of intricate relationships between everything, rather than a total sum of isolated parts (Capra & Luisi, 2014), or as Bateson (1970) puts it, seeing the “organism-in-its-environment”. This call for a shift toward focusing on relationships in the living world rather than on isolated and clearly defined organisms is the

underlying foundation of the ecological movement. But the term ecology, and its attendant concept of ecosystems (an ecological community considered together with the non-living factors of its environment as a unit[6]), have also come to describe more generally any relational system.

From this vantage point, we see how design, over the course of half a century, took a 180-degree turn from the view of design as science ("design methods") with its linear, logical, step-by-step approach to a living system approach based on interdependence and holism. From the living systems perspective, design, like life itself, is too complex to be distilled to testable variables. Thus, in this new framework, tacit knowledge is something that must be nourished and celebrated for its role in helping designers avoid the pitfalls of creating pre-packaged experiences (Maturana, 1997).

This new paradigm, which rejects the basic assumptions of design as a purely scientific discipline and underscores the importance of the tacit dimension of design knowledge, goes one step further than Cross et al. For them, design as a discipline as viewed by Cross (2006), Dorst (2015c) and others (Lawson, 2005; Pangaro, 2011; Schon, 1984) does not go far enough; it is still within the realm of the mechanistic paradigm which is at the crux of the many complex dilemmas we are facing today. Living systems-based design aims to create a new ontology, a new way of being in the world that emphasizes embodied "relationality" (Macy, 2007), and radical interdependence (Escobar, 2018b). Similar to the Buddhist notion of interdependence, ontological design's main tenet is the deep interconnection between human and non-human actors in living eco-systems, and the assumption that design needs to be modelled on life and its constant process of regeneration.

2.1.5 Summary

Both as a discipline and as a way of knowing, design has an intricate relationship with tacit knowledge. From the early developments in the field in the 1950s, there has been a clear move

[6] Ecosystem." Merriam-Webster's Unabridged Dictionary, Merriam-Webster, https://unabridged-merriam-webster-com.ezproxy.lb.polyu.edu.hk/unabridged/ecosystem. Accessed 26 May 2023.

toward the recognition of this relationship. Experience and research have shown that, contrary to the earlier view of design (1950s-1960s), the scientific paradigm does not fully encapsulate the complexity of design nor does it adequately convey how designers draw from and produce a specific type of "designerly knowledge" (Cross, 1982). This emphasis on tacit ways of knowing is even more crucial today as design is called to look into new ways of being and new ways of engaging the social and the whole of life to build a regenerative future.

To sum up the above literature review, the role of tacit knowledge as a designerly way of knowing illuminates 5 key attributes of design as an epistemology:

> **Design is qualitative and tacit**. Many aspects of the design process can be known but cannot be told (Polanyi, 1966b). It is the "know how" dimension of design as opposed to the "know what" (Schrijver, 2021a) which cannot be formalised because it is embodied (Willcocks & Whitley, 2009). Those aspects are therefore difficult (or impossible) to transfer to other verbally (Ryle, 2009), but can be transferred through experience such as apprenticeship for example (Gasson, 2005). The tacit knowledge of design relies on a non-mechanical conception of humans (Polanyi, 1966b; Weizenbaum, 1976); objectivity and neutrality are not desirable, and design does not rely on one theoretical body of knowledge like science (Abel, 1981; Biggs, 2000; Cross, 2006; Lawson, 2004). The knowledge of design is intuitive, i.e., "gut feelings" play an important role (Damasio, 2006), and broad in its scope and application. It cannot be reduced to problem-solving or decision-making, and is about knowing and understanding (as opposed to recognising and predicting)(Rees, 2018). Empathy is a fundamental value at the core of the production of design knowledge (Cross, 1982; Kelley & Kelley, 2012; Schmeer, 2019) and qualitative dialogue is a core phenomenon of designing (Dubberly & Pangaro, 2009). Design is attuned to human psychic needs (Pangaro, 2008; Papanek, 1988), the capacity to emote is an asset, not a liability (Norman, 2005a).

Design is embodied. Design is fundamentally anchored in materiality, artefacts, the artificial (Alexander, 1964; Archer, 1979; Hillier & Leaman, 1974; Simon, 1996) and is therefore contextual and situated. The tacit knowledge of design is embedded in designers' personal understanding of the context in which design happens and is only transferable though social interaction in communities of practitioners (Cianciolo & Sternberg, 2018; Lave & Wenger, 1991; Sternberg, 1996), so they produce highly unique responses to the design problems in a process of embodied cognition (Rescorla, 2020). Design is a medium of making, and designers learn by doing (Dorst & Dijkhuis, 1995; Razzouk & Shute, 2012). Sketching, as a specific language of design is also an embodied way to externalise thought (Goldschmidt, 1991; Lawson, 2004) and reveals an imprecise, inarticulate, non-discursive, and ambiguous thought process (Cross, 1982). As an embodied activity, design has sensitivity for the local, the contextual, and respect of underlying human networks and cultures (Manzini, 2010; Manzini & Jégou, 2003).

Design is emergent. Design's way of knowing is organic and explorative by nature (Goldschmidt, 2006; Schon, 1984). The complex problems of design are not set, but co-evolve organically with the solution in a process of pattern-creation (as opposed to pattern-recognition) (Cross, 2006, 2011; Dorst & Cross, 2001). The "solution" emerges not from data analysis but from the learning along the way (Buchanan, 1992). The abductive process of knowledge production is a reasoning process well-suited to situations that are complex or puzzling (Aliseda, 2006; Peirce, 1974), and has become a hallmark of the type of (creative) thinking that designers do (Serrat, 2017). It starts from a value to find the what and how in an emergent process of frame (or theme) creation (Dorst, 2011, 2015c; Jonas, 1996).

Design is experiential. Design is a medium of making and doing, emphasising the know-how rather than the know-what (Archer, 1979; Cross, 1982). Experience plays an important role in the acquisition and production of design's knowledge (Ryle, 2009;

Schrijver, 2021a). Experienced designers recall frames from their experience. Hence the importance of experience and expertise (Dorst, 2015b). Expertise in design sits at the intersection of information processing and experience (Lawson, 1979; Lawson & Dorst, 2009), and design as a culture has its own ways to transmit knowledge experientially (Cross, 2006). Design's knowledge is non-repeatable, and repeatability is not even desirable (Abel, 1981; Biggs, 2000; Cross, 2006). The collaborative and dialogic nature of design also reflects this experiential dimension, where participants to the dialogue change as a result of the interaction (Dubberly & Pangaro, 2009; Manzini & Coad, 2015). The tacit knowledge of design could be compared to mētis, the conjectural knowledge that arises from a long experience "in responding to a constantly changing natural and human environment" (Scott, 2008; Wears, 2004).

Design is complex. Design's way of knowing is non-linear and reflective (Schon, 1984). As a discipline that sits at the intersection of science and the arts, design combines several ways of knowing, episteme's concepts, techne's tools and phronesis' practical wisdom (Mahdjoubi, 2003; Wang, 2013). It is collaborative and interdisciplinary by nature, so integrates the complexity of social interactions (Lawson, 2004). It is complex because it relies on natural intelligence, using a limited number of data but complex multidimensional processes, meta-cognition, the ability to reflect on cognition itself (Cross, 1999; Evans, 2012; Maturana, 1997). There is no limit to the kind of knowledge that is used during the design process (Goel & Pirolli, 1992).

Section II - Datafication as Way of Knowing

Recent technological evolution in machine learning and the proliferation of big data have changed traditional assumptions about how knowledge is produced. The rise of the digital algorithm emphasises an encounter between two ways of knowing: firstly, the human, tacit, intuitive and abductive way of knowing (Cross, 2006, p. 130), and secondly, knowledge based on machine cognition. While the former is central to design activities, the latter is based on digital data and

interpreted by digital algorithms. Insights arising from computational processes are increasingly considered most valuable and have become widespread sources of knowledge for decision-making. Such knowledge is derived from two main elements. Firstly, the collection of an enormous amount of computer-ready data. Secondly, the processing of this data which requires complex computational systems involving coding as well as an expensive infrastructure to support such systems (boyd & Crawford, 2012b).

Once set up, those technological structures and processes function autonomously from the intervention of humans. The belief underlying this view is that machines are more reliable, and more "trustworthy" than humans (Postman, 1992; Van Dijck, 2014). Increased reliance on machine cognition brings important changes in our understanding of the world, or more specifically, *how* we know about *what* we know. Such fundamental changes are not always revealed by the general narrative of the day on technology, which tends to focus on the immediate benefits to individual users, rather than the long-term effects on individuals, societies and the political order. Benjamin (1999) refers to this type of illusory blindness as a "phantasmagoria".

Walter Benjamin's critical analysis of the shifts that accompanied the industrial revolution and the attendant rise of modern consumer culture is expressed through his concept of phantasmagoria. This concept is central to his broader work, and refers to the illusionary spectacle created by early 20th century capitalist societies, in which commodities take on a magical dimension detached from the labour and material conditions that produced them. Through this lens, Benjamin (1999) critically explores a number of epiphenomena of industrial capitalism such as for example the department store, proposing a dazzling array of mass-produced goods from across the world, but also the new Hausmannian urban architecture in Paris or the world's exhibitions providing entertainment for the masses to name a few. Together, those artefacts created a societal 'dream world'. This phantasmagoric spectacle served to entice consumers while at the same time obfuscating the harsh realities of capitalist production. Benjamin's work has been instrumental in shedding light on how capitalism veils its underlying mechanisms. Today, his concept of

phantasmagoria remains a valid filter to understand and critique the dynamics of how cultural changes triggered by technological shifts affect perception and knowledge.

As mentioned in the introduction, this research does not concern itself with understanding digital life, but rather, how the production, use and control of knowledge are impacted by datafication. With this in mind, this portion of the literature review lays the foundation for understanding how our current and expanding dependency of datafication impacts knowledge in general and the tacit knowledge of design in particular. The following discussion will first define what datafication is by providing the underlying assumptions and ideology supporting it. Following this, a survey of how the encroachment of datafication is coding a new reality that is shaping how knowledge is created, exchanged and "valued" today will be presented.

2.1.6 What is Datafication?

> Never before could our unconscious subjectivities be analysed and manipulated like today. (Latour, 2007)

The word datafication was first proposed in a paper about the relationships between "big data" and the social sciences. It was defined as the "transformation of social action into quantified data for tracking and predictive purposes" (Mayer-Schonberger & Cukier, 2013). There are two important elements in the definition of datafication. Firstly, it is the process by which qualitative aspects of human experience are turned into quantified, computer-ready data bits (Van Dijck, 2014). Secondly, datafication makes data searchable and indexable, as opposed to digitisation which is simply the process of turning symbolic knowledge (text, photo, audio or video) into digital form (Mejias & Couldry, 2019).

Datafication is also accompanied by a process of standardisation, i.e., all data bits must fit the computational analytical structures of "big data". This is important because the resulting data can be computationally tabulated, analysed and used in the production of knowledge, turning human behaviour "into an analysable form" (Mayer-Schonberger & Cukier, 2013, pp. 93-94).

Datafication turns human life and subjective experience into a computational field that can be turned into standardised discrete bits and analysed by automated means on a large scale (Mejias & Couldry, 2019).

While the processes of big data undeniably bring valuable insights, an increasing number of scholars from diverse disciplines argue that, generally, datafication of human life is at best problematic, and at worse dangerous (boyd & Crawford, 2012b; Cukier & Mayer-Schoenberger, 2013; d'Alessandro et al., 2017; Kappler et al., 2018; Van Dijck, 2014). In other words, datafication best applies to a group of phenomena that lend themselves to be quantified. It is arguable that human experience is one of them.

For example, turning human life into computational bits requires a process of abstraction (Kitchin, 2014b), therefore, a selection and transformation of what is harvested from real life, as Gitelman (2013) reminds us in her introduction of *Raw Data is an Oxymoron*. Van Dijck (2014, p. 198) likewise critiques the use of datafication as an accepted method to understand human behaviour, emphasising its reductionist approach to the social. Political economist Zuboff (2019) also argues that datafication has turned human experience into a raw commodity used for profit and to predict and influence our behaviours. Some voices from the field of data science also emphasise that datafication can create or increase social inequalities (d'Alessandro et al., 2017; O'Neil, 2017).

Datafication is intricate. Data production, collection and analysis involve many actors and stakeholders with divergent and often opposing agendas (Mejias & Couldry, 2019). It is also important to remember that datafication happens through a range of specifically designed architectures, such as social platforms, search engines, apps, eCommerce and other services, smart objects and smart cities etc. which are not neutral. For example, sociality is at the heart of social media (Facebook, Instagram or Tik Tok to name a few), but the term covers a very different reality in the age of datafication when invisible algorithms regulate visibility and relationships according to concealed corporate agendas (Bucher, 2013; Haidt & Twenge, 2021).

- *The Medium of Datafication*

Datafication is reliant upon the production, collection and analysis of an immense amount of computer-ready data, so it needs a medium to perform those functions (Alaimo & Kallinikos, 2017). Every medium has its own logic, a frame of reference guiding the interpretation of social affairs and the format used to present them (Van Dijck, 2013, p. 5). By affecting shared knowledge, the dominant medium of an age presents and transforms social institutions (Winston, 2002; Zielinski, 1999) but also other less dominant media, as television did in its time (Altheide, 1979). Today, it is fair to say that social media have become the dominant medium. It is therefore useful to explore its logic in order to understand the mechanisms supporting datafication.

Social media platforms are also a functional infrastructure designed and programmed to serve a certain agenda (Van Dijck, 2013), and should be seen as a transforming force for the process of datafication to emerge as a way of knowing. Social media logic consists of the norms, strategies, mechanisms and economies that guide the framing of public and social life today. The four features that define today's social media logic (i.e. programmability, popularity, connectivity and datafication) help us understand how they frame the reality that underlies social practices (van Dijck & Poell, 2013). It is to be also noted that all four of these elements comprise code at their root in one way or another, making the question of what values are encoded in the proprietary algorithms even more pressing. Programmability allows platforms to steer user-generated content; popularity allows platforms to steer attention toward certain content; connectivity allows platforms to steer connections. Datafication is the critical feature of the new medium. All the other three elements serve the agenda of datafication (van Dijck & Poell, 2013).

- ***Defining Data***

Data is originally the plural form of the word "datum". Etymologically, the word datum comes from the Latin meaning "something given"[7]. This hints at the property of something that is offered or presented, but with leeway as to how to use it. It is often loosely defined as "a unit of information, often numeric, collected through observation[8]". In the hard sciences, a datum (*plural* datums) is a point of reference, a benchmark ("a point, line, or surface with reference to which positions are measured or indicated"[9]). Datum as benchmark gives it a cloak of neutrality (i.e., this is how things really are), or at least, introduces a sense of righteousness (i.e., how things ought to be). Another definition emphasises the ultimate purpose of the datum, "something used as the basis for calculating, measuring, inferring, or reasoning[9]" This definition presupposes that the datum is the most trusted element of cognition and decision-making. In and of itself, the concept of a datum, i.e., a piece of something, separate from the rest and that constitutes the building block of reality, fits a mechanistic view of the world that values the individual parts of the whole.

In actual practice, the word data has a life of its own and is quite independent of datum. Data are not necessarily digital. One general definition of data is "recording of states or events" (Banasiewicz, 2021c). However, in the digital age, "information in numerical form that can be digitally transmitted or processed[10]" is often added to the understanding of the concept. This view emphasises that data in and of themself do not carry intrinsic meaning and need to be organised to produce knowledge. Some authors critique this view, arguing instead that data are contextually created and culturally situated and therefore, they hold certain assumptions about the world (Gitelman, 2013).

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[7] "Datum." Merriam-Webster's Unabridged Dictionary, https://unabridged-merriam-webster-com.ezproxy.lb.polyu.edu.hk/unabridged/datum. Accessed 7 Nov. 2021.
[8] OECD Glossary of Statistical Terms. OECD. 2008. p. 119.
[9] https://www.merriam-webster.com/dictionary/datum#usage-1
[10] "Data." Merriam-Webster's Unabridged Dictionary, https://unabridged-merriam-webster-com.ezproxy.lb.polyu.edu.hk/unabridged/data. Accessed 7 Nov. 2021.

Today, it becomes clear that “computer-ready” data are increasingly viewed as dependable and reliable, while other forms of information being tagged as “discordant” and relegated to invisibility (Boyd, 2018). As it relates to datafication, the word data has been defined as “material produced by abstracting the world into categories, measures and other representational forms [...] that constitute the building blocks from which information and knowledge are created” (Kitchin, 2014b, p. 1). This definition emphasises the crucial role that data play in the production of knowledge in the age of datafication. It also hints at the problematic ways the world is abstracted into categories and measurements.

- *“Raw Data is an Oxymoron”*

Since the advent of the web and the subsequent development of the computational capacities to analyse massive amounts of data (big data), this analysis has served to assist in a number of human decision-making processes. The main assumption underlying this growth has been led by the positivist perspective that the datum from which decisions are made is neutral, and therefore more “scientific” than human cognition which is dangerously prejudiced by its irrational and emotional nature (Cheney-Lippold, 2017).

This assumption has been critiqued by a growing body of research. In the introduction to *Raw Data is an Oxymoron*, Gitelman (2013) argues that we have been functioning on the wrong assumption that data (which she considers as plural) were merely a neutral representation of the objective world. She contends that “data are always imagined and created in particular historical, social, cultural and economic circumstances” and that they do not simply exist in and of themselves.

There is also a widely held assumption that data are subject to us, when we are in fact they are embedded in a circular relationship whereby we create data which is then collected, analysed and organised into patterns that present perspectives that affect our individual and social realities (2013). For example, O’Neil (2017) elucidates how the algorithmic systems used by U.S. police

departments for decision-making are fed with data gathered from past human decisions, thereby reinforcing the biases embedded in these social systems. In other words, "if data are somehow subject to us, we are also subject to data". Data are cultural, situated, and contextual. They are a product of human biases and are therefore shaped by human agenda, and by the acts of collecting, storing and transmitting (Gitelman et al., 2013). They are plural in that they are assumed as such by different disciplines and cultures, making them cultural objects (Cheney-Lippold, 2017). It is useful to consider data as situated socio-technical phenomena to understand and critique the underlying assumptions on data that characterise the social technologies under focus for this research (boyd & Crawford, 2012b).

- *Data Only Exists in a Web of Relationships*

As cultural entities, data do not exist in isolation but in a complex ecosystem of relationships with other entities. The first level of relationship is between data and data sets, which is done primarily through aggregation. The second level is the relationship between data and the processing systems that organise them. Thirdly, data are also in relationship with people (one of their most important relationship), and in that aspect, they shape and frame new understandings of the world we live in, but also of ourselves as revealed by studies of the Quantified Self movement for example (Sharon & Zandbergen, 2017). We live in a circular relationship with data whereby the behavioural data we produce is packaged and mirrored back to us through, for example, friends' suggestions on social media. Studies have described how users draw conclusions about the state of their relationships based on how often they appeared in their news feed (Eslami et al., 2015). In this sense, by subtly shaping our social environments, data actively participate to shaping our sense of self and how we relate to the world (Cheney-Lippold, 2011).

Data are also intertwined with the narratives we give them. Dourish and Gomez (2018) explored how data and narratives are closely embedded into each other using an example from the 2000s when the California Department of Corrections and Rehabilitation developed a system to constantly monitor the movements of paroled sex offenders. They described how attaching GPS

devices to the body of offenders changed the narratives about themselves. They also pointed to how the extreme granularity of the data impacted their lives in different ways. For example, crossing the street too close to a school threshold would trigger an investigation (when it may only mean walking on the wrong sidewalk or taking a bus through an unfamiliar neighbourhood). Their study clearly showed the epistemological impact of data on human narratives. The use of digital data opened a whole new world that was fed back to the people living in it. In this sense, data exist not in isolation, but relationally - i.e., it is not the discreet data, but the relation between data that produces the insights that are sold at such high price by companies in the data economy (Dourish, 2017).

- ***Central but Invisible: Metadata***

The concept of metadata jumped on the public scene in 2014 after the Snowden revelation that the NSA (National Security Agency) of the US government had collected troves of phone data about American citizens. As it turned out, the bulk of the data collected was not content, but "metadata". At the time, the defenders of the NSA programme used this as an argument to justify that the programme was in fact benign and posed much less danger to privacy. The collection of data about who people called, who called them, when they talked, and for how long did not seem to invade into the privacy of personal conversations. However, as Professor David Cole (2014) from Georgetown University Law Centre recalls in his testimony to Congress, the NSA counsel admitted that the sharpness of the insights culled from metadata rendered the need for content irrelevant. In the digital age, metadata has become a crucially important concept. It is generally defined as the data about data (Pomerantz, 2015, p. 19). While this is not an entirely new concept, its importance has become central in the process of datafication.

Metadata refers to the pieces of information about something that provides relevant details, providing information about other data[11]. In other words, metadata is the simplified map of a complex territory (Pomerantz, 2015, p. 11). There are several types of metadata. Descriptive metadata describes the object so it can be searched and found; administrative metadata provides background information about the object so it can be stored and accessed; structural metadata outlines the organisation of an object; preservation metadata enables the management of files or objects and use metadata relates how an object has been used; technical metadata allows digital systems to serve data in a usable form; rights metadata permits the enforcement of intellectual copyrights (Gartner & Gartner, 2016; Riley, 2017). While the word itself does not necessarily describe computational pieces of information, today, it relates mostly to digitalised metadata.

However, not all metadata is created deliberately. The quantification of human life and sociality predates the digital, but until big data it was limited by a lack of relevant tools. In the digital age, information that had previously been discarded as a side effect of online activity has become central to the data economy (Bhimani & Willcocks, 2014). A push toward the quantification of human experience was initiated by Google's shift in the early 2000 from serving ads based on search keywords to serving ads to the person who is searching (Zuboff, 2019).

Pushed by economic pressure to become profitable, Google engineers discovered that the side-data left behind unintentionally by users when doing a search could yield important information about those users and their behaviours. Google started packaging what it called "breadcrumbs", or "data exhaust" into behavioural products that could be sold to advertisers, and created a new ultra-profitable business model, targeted advertising, based on metadata (Zuboff, 2019). Data exhaust is produced in very large quantities, and manifests in a wide range of different forms: location data, purchases, contacts, identifiers, user content, usage data etc. (O'Leary & Storey, 2022). It is worth

[11] "Metadata." Merriam-Webster's Unabridged Dictionary, https://unabridged-merriam-webster-com.ezproxy.lb.polyu.edu.hk/unabridged/metadata. Accessed 6 Nov. 2021.

noting here that the explosion of metadata is closely connected to the development of web 2.0 from the mid-2000s onward. Datafication is an intimate companion of social platforms and their attendant phenomenon, the platformisation of the web (Helmond, 2015). In an era of ultra-personalisation, metadata helps the companies in the data economy track who we are, not what we search. Furthermore, it would be a mistake to think that metadata is anonymous data. It can be re-identified, and such methods are on the increase (Galdon Clavell, 2018, p. 102).

- *Structured Data, Enriched Evidence*

When users think of data, they tend to think of the content they produce while online; the content of the messages they exchange, of their posts on social media, or the representations shown on the photos they take. As "auxiliary information about empirical results", metadata is always associated with data (Boyd, 2018). But metadata is more than that. It is the structuring element that allows the system holding the content to function, allows users to find topics, collect essential information and share it with others (Riley, 2017). For example, in 2012, Google launched *The Google Knowledge Graph*, a knowledge platform gathering metadata about 500 million people, places, and things from varied sources that helps enhance the search engine's results (Singhal, 2014).

From the computational systems point of view, the difference between data and metadata is one of semantics (Riley, 2017). A major problem for datafication is unstructured data (Feldman & Sanger, 2007), which requires much efforts to structure and validate (Buneman et al., 1997). The advantages of metadata for computer systems is that it is structured, i.e., it follows a fixed record-variable format that is easy to store analyse (Banasiewicz, 2021b). It can easily be collected and sorted into categories, turning it into "actionable" data.

"Actionable" data are a crucial concept in computers' way of knowing, because the purpose of knowledge is predictive (Dhar, 2013), and the cleaner the data, the higher the certainty of predictions. Metadata acts as an added evidence about the insights culled from data - which boyd

calls the “empirical results” (2018), or in other words, the enriching evidence provided by data. This is particularly interesting in the context of a critical study on datafication, as it shown the essentially quantitative aspect of the language of datafication.

The specific implications of the uses of metadata have been lost in the more general debate about data. However, considering it as a separate element would help clarify this debate. Users often conflate the data they willingly submit to social platforms (e.g. age, gender etc.) and the myriad of other data that is collected from them as they go about their life online (i.e., location, time of the day etc.) most of the time, unknowingly (Riley, 2017). Just changing the collection of all those metadata from opt-out to opt-in would create a pervasive change in the ease by which it is to access this data for apps or social platforms. The IOS 14 update Apple implemented in 2021 goes in this direction, and reports after just a few months of the switch seem to indicate that they are having an impact, i.e., users overwhelmingly prefer not to give access, and this affects the business results of social platforms (Perez, 2021).

- ***Big data: Shift in Nature of Knowledge***

With the advent of networked technologies and social media, there has been an explosion in the depth and scope of person-specific data. The shift is not only about size and scope though, it is also about the nature of the data that is being aggregated into the large computational systems of big data, and the emergence of new computational methods and modelling to treat it (Tufekci, 2014). Their design is not about making artefacts (computers or programmes) (Mahoney, 2005). The term big data therefore, refers to a number of elements, size of course, but also the storage medium and more importantly the new attendant techniques of sense-making (Andrejevic & Gates, 2014).

Big data is also different in that it has a fundamentally networked architecture, i.e., data are only meaningful in relation to other data. It is from those relationships that patterns are derived, by establishing connections between data about individuals, but also data about the relationships

between individuals and between groups of individuals (boyd & Crawford, 2012b). Lessig pointed out that the four forces shaping systems are the market, the law, social norms, and architecture – or, in the case of digital technology, code (1999). Code is the knowledge-shaping architecture of datafication. As boyd and Crawford (2011) remind us, just as Ford transformed how we think about work through his assembly line, big data has become the technology that changes what we consider valid knowledge, and how we understand the world around us. In the words of Latour (2010), "change the instruments, and you will change the entire social theory that goes with them" (p. 9).

- *A Knowledge Designed for Predictive Power*

The main purpose of scientific knowledge is to find the principles, i.e., the theories, that underlie and explain how the world operates. Theories aiming at explaining a phenomenon are not considered as robust as theories making predictions that stand the test of time and attempts at falsification (Popper, 2014, pp. 43-78). This works well for the hard sciences, but has never been fully successfully applicable to the social sciences (Mahoney, 2005; Postman, 1992). Similarly, data science is based on general theories as the "study of the generalisable extraction of knowledge from data" (Dhar, 2013).

Considerable time and effort are spent by data scientists trying to find out how to perfect the algorithmic models and mitigate the sources of possible errors, cleaning, excluding (censoring), exploring or rounding data and generally, tweaking algorithmic processes to attain a higher level of accuracy (Dhar, 2013; Porter et al., 2018). Data science does not ask whether the mathematical models that have become so ingrained in our lives are actually truly representative of human reality, and whether the insights they provide are objective or truthful. Insights are deemed "actionable" based on the precision of their predictive power (2013). The type of knowledge that algorithms produce are "models", which are essentially statistical probabilities. Furthermore, datafication relies solely on measurements, and data science is preoccupied with correcting measurement errors (Eid & Kutscher, 2014). The focus on mitigating errors and perfecting the

algorithms of big data shows a central concern with reducing uncertainty (Dhar, 2013). Rather than embracing uncertainty and ambiguity to open a space of emergence (which is the way of knowing of design), datafication aims to fit reality into pre-established theories.

According to Davenport and Patil (2012) , data scientists have the "sexiest job of the 21st century". Some of their important skills are the ability to find order, meaning, and value in unstructured data, to predict outcomes and automate processes. They create knowledge out of programming code coupled with statistical knowledge. Data science derives knowledge from patterns that come out of the treatment of vast amounts of data. While these patterns have predictive power, they do not necessarily provide explanations nor do they indicate how the correlations were obtained (Andrejevic & Gates, 2014). The ability to predict based on computational data is central to the processes of datafication. Predictive models have become crucial for the internet-based data-driven businesses of the data economy (Dhar, 2013; O'Reilly, 2017; Siegel, 2013), as they essentially correlate patterns of communication with patterns of purchasing behaviour (2014).

- *Big Data, Not Only Bigger, Different*

The order that arises from big data activity is not a mere transposition of the "human way" into a computational form (Rieder, 2020). As Edsger Dijkstra (1974) reflected over 40 years ago:

> The amount of information they can store and the amount of processing that they can perform, in a reasonably short time, are both large and beyond imagination. And as a result, what the computer can do for us has outgrown its basic triviality by several orders of magnitude. (p. 608)

One of the elements that define big data is the capacity to compute a prodigious amount of data points through an extraordinary number of iterations. Computers "think" by running a vast amount of data points through an incalculable number of little steps (Burrell, 2016). The different techniques of datafication (such as for example machine learning or social networks' algorithms) not only produce knowledge according to certain values and certain practices, but also actually

define what valid knowledge is. They perform this in two ways. Firstly, by using certain types of conceptual resources (i.e., the way they conceive of knowledge), and secondly by generating certain levels of interpretation and order (Rieder, 2020).

The term "big data" puts the emphasis on size. It suggests something that does not really reflect the full reality of the phenomenon. As boyd and Crawford (2012b) state, big data is really about a "capacity to search, aggregate, and cross-reference large data sets". In this context, big data is a cultural, technological, and scholarly phenomenon that blends three elements. Firstly, the computational power to gather, analyse, link, and contrast large data sets. Secondly, the identification of patterns that enable to make economic, social, technical, and legal claims. And thirdly, the myth that the above two elements provide a higher form of intelligence that is more reliable, truer and more accurate than human judgement.

Early computer languages (such as HTML) were designed to display information in a humanly readable format. Today, while data are (mostly) produced both by humans and computers, they are only readable by computers. This means that computational systems operate background work and make decisions automatically. It is possible because the nature and the scale of big data is different from that of earlier information systems and big data has become the main source for the production and the shaping of knowledge in the 21st century (Dhar, 2013). In this sense, big data is much more than a technical hardware or a practice; as a technology, it is an epistemological phenomenon that has wide ranging social, environmental and human consequences (Kranzberg, 1986, p. 545).

- ***Dataism, an Ideology of Quantification***

The scientism of datafication relies on three core ideas: (1) the scientific method can be applied to human behaviour, (2) the principles produced by social science can be the basis to organize society rationally and humanely, so human behaviour can be engineered through technical means (i.e. "invisible technologies" supervised by experts), and (3) faith in science gives a meaning to

life, a sense of well-being, morality, and even immortality (Postman, 1992, p. 161). For Van Dijck (2014, p. 198), dataism is the illustration of a problematic belief in quantification's objectivity and refers to the conviction that a direct relationship exists between quantified data and people. Blind faith in the neutrality of datafication leads to an erroneous trust in the results of big data treatment of qualitative aspects of the social. Dataism finds its source in what media theorist and cultural critic Postman calls scientism – the belief that social phenomena can be quantified, that the quantification of the unquantifiable produces reliable knowledge, and solely identifies the realm of human experience with the physical sphere (1992, p. 161). Similarly, Polanyi (2012, p. 18) writes: "the avowed purpose of the exact sciences is to establish complete intellectual control over experience in terms of precise rules which can be formally set out and empirically tested".

Both the scale and the scope of today's enterprise of datafication is unrivalled (Mejias & Couldry, 2019). Under the umbrella of dataism, datafication becomes accepted as the new paradigm to understand the social (Van Dijck, 2014). This leads to the quantification of a multiplicity of purely qualitative human domains, from friendship to personal interests, conversations, searches, emotions, and even the self. The latter is illustrated by the Quantified Self movement, a concept that emerged in 2007 and which promotes a dataistic paradigm (Ruckenstein & Pantzar, 2017) through tracking biological, physical, behavioural, or environmental information about oneself (Swan, 2013). The purpose of those "lifelogs" was to turn the individual's life into a searchable database for the purpose of efficiency without taking into account the consequences of turning every slice of life into a piece of information that could never be forgotten (Kitchin, 2021, p. 129). Today, the rise of "wearables" helps to spread and further legitimise this approach.

Dataism has roots in the positivist conception of knowledge, an idea that emerged in the early 19th century, which only regards measurable knowledge as true knowledge (Postman, 1992). French sociologist August Comte was the first to both coin the term and apply the scientific experimental method to the social sciences. His doctrine advocated that empirical science is the only source of knowledge, and that scientific knowledge should be extended to the control of human society to

find political and moral answers in technology (Schon, 1984). Positivist knowledge is a techno-rational understanding of knowledge, which relies on the idea that truth is derived from the application of theory supported by rigorous scientific research. Under this ideology, the social behaves in predictable ways and its ills can be solved by technology, practice manuals, assessments tools, and today data analyses (Emslie & Watts, 2017).

It is to be noted that "statistical thinking" has been prominent not only in science but in the government and commercial fields since the industrial revolution of the 19th century (Bowker & Star, 2000), and that the attendant rise of bureaucracy has contributed to shaping the social and our understanding of it (Porter, 2020). This phenomenon has also been accompanied by the idea that artificial intelligence is superior to human intelligence in that it is unencumbered by emotions (Broussard, 2018; Cross, 1993). This idea has been repeatedly dispelled by a number of studies in different fields, with notably research demonstrating that the adoption and mastery of skills and knowledge require a high degree of intuitive intelligence (Dreyfus et al., 2000).

Within this context, there is an associated belief in the neutrality and objectivity of data generated through algorithms. Objectivity has been a major topic in the philosophy of science for the past two centuries, as shown for example by the debate between Durkheim's social facts and Weber's conception of the social as actively constructed (Hughes et al., 2003). From the positivist viewpoint, subjectivity is to be shunned as it does not produce valid reliable knowledge. This is accompanied by a belief that qualitative research produces interpreted narratives and quantitative research produces hard facts (boyd & Crawford, 2011). Since the early research in AI, a leading aim has been for AI to "detect and reduce human bias and prejudice" (Crawford & Calo, 2016).

2.1.7 Datafication is Growing

- ***From Digitisation to Datafication***
    - *The Semantic Web, Turning Knowledge into Data*

In the early 2000s, the web was a fragmented network of resources which were essentially transferred from person to person and were lacking standardisation, searchability and interoperability. It did not provide the facilities to search and extract information and maintain a global knowledge base (Hardin, 2005). The infrastructures for eCommerce and eBusiness were also lacking and needed new structures and standards to enable the automated (or "intelligent") management of a global digital knowledge base.

Tim Berners-Lee, the lead inventor of the world wide web, published an article titled *The Semantic Web* (2001) in which he described his vision of a shift from the web as "medium of documents for people" to a medium where information could be manipulated automatically by computers. He called this the "semantic web". The semantic web was to be decentralised, distributed and fully connected and use a common denominator approach so that the information was universally "understandable" by any computer (Kim, 2003).

While this sounds technical and outside of the realm of average users, the emergence of the semantic web was one of the most important shifts towards the datafication in online environments, and eventually of our lives. Berners-Lee, Hendler and Lassila (2001) summarise its implications as follows:

> In the near future, these developments will usher in significant new functionality as machines become much better able to process and 'understand' the data that they merely display at present. (p. 37)

In other words, the semantic web ushered the translation of human speech and writing into computational semantic documents and data. The semantic web effectively turned the web into a searchable and indexable computational standardised boundary-free environment. At the time, the

purpose of the semantic web was to "assist the evolution of human knowledge as a whole" (Berners-Lee et al., 2001)[12].

- *The Data, Information, Knowledge (and Wisdom) Model*

The past fifteen years have been characterised by the rise of the data economy. This trend has been accompanied not only by increased amounts of data, but also the concurrent ability to collect, manage, analyse and interpret this data using new technologies of datafication. As we saw above, some important questions are being raised about the nature of data and the nature of the crucial role they play in the connective economy. In order to examine the phenomenon of datafication which quantifies qualitative aspects of life, we need to understand the relationships and the logic underlying the articulation between data, information and knowledge (Van Dijck, 2014).

The Data-Information-Knowledge-Wisdom (DIKW) model was originally articulated by Ackoff (1989), and has become a central concept in the information and knowledge management fields, and one that it "taken for granted" (Rowley, 2007). In this hierarchy, each level is defined in terms of the level below. Ackoff defined data as the product of observation that only becomes meaningful when given form; information as the product of observation that also organises the data; knowledge as know-how either acquired from others or through personal experience, and wisdom (not always included in the model) as the ability to judge based on certain values (Rowley & Hartley, 2008). The literature on knowledge management commonly acknowledges that those elements incrementally build upon each other in a linear fashion to create the basis for human action (Alavi & Leidner, 2001).

[12] Some 17 years later in 2018, Tim Berners-Lee launched a "Contract for the Web" campaign to stop "misuse" by governments, companies and individuals (https://contractfortheweb.org). He also developed a platform called "Solid" to give users control over their data.

Fig. 2. The DIKW Hierarchy

While the model appears straight forward, in practice, the transition from one level to the other is not always direct. Firstly, a review of the information & knowledge management literature on the topic reveals that there is no real consensus on what exactly is meant by data, information and knowledge (we shall leave wisdom aside for the purpose of this discussion) (Rowley, 2007). For example, information can be understood in different forms, "information-as-process", "information-as-knowledge" and "information-as-thing" (Buckland, 1991). The meaning changes depending on whether one considers its attributes, properties, elements, techniques, functions, dimensions, or connections (Rieder, 2020). Knowledge is generally divided into explicit and tacit knowledge (Nonaka & Takeuchi, 1995), but some authors have argued that explicit knowledge is in fact what is called information (Wilson, 2002). Secondly, it does not illuminate *how* data are converted into information and information into knowledge. Studies of digital information systems in organisations have shown that critical aspects of an organisation's life rely on tacit knowledge that either has not or cannot be formalised (Willcocks & Whitley, 2009) and therefore go missing if the pyramid is understood too literally. In practice, it is necessary to consider the larger context within which the DIKW model resides to mitigate the negative impact on knowledge, strategy, decision-making and generally organisational effectiveness (Bhimani & Willcocks, 2014). Some voices from the field have even argued that the pyramid should be abandoned altogether as it does not represent a true reality (Frické, 2008).

- *Data, Information, Knowledge and Agency*

The DIKW model was developed to serve a technological and managerial agenda. Thus, a major critique of the model pertains to the role agency plays in this model. As a theory of knowledge construction, the model exists within a technological context that enables data mining and analytics at a very large scale. However, it obfuscates the impact of the decisions involved in preparing the data and managing the analytic process on the resulting outcome and the implications on the type of knowledge that is derived (Couldry, 2014; Diesner, 2015). The pyramid also conceals the circular relationship between data, information, knowledge and the social. We, as users, produce the data that feeds the lower level of the pyramid, but knowledge is fed back to us, and helps us orient ourselves in the world, deeply embedding itself into the social fabric (Kennedy et al., 2015). Critical social media theorists have questioned how this process affects human capacity for informed action. In the digital age, they have argued that we cannot ignore that technological systems have been engineered as "scientific instruments" (Shaw, 2015), well suited for probabilistic and anticipatory knowledge (Lyon, 2014) but otherwise limiting to human agency in choice-making (Couldry & Van Dijck, 2015) and sense-making (Gillespie, 2015). In other words, "knowledge" requires a process of interpretation that those instruments cannot perform. Additionally, some argue that the opacity surrounding the tools and processes that turn social media data into knowledge – an opacity that the DIKW model does not dissipate - create an interpretative monopoly that diminishes individual and public agency (Andrejevic, 2013). Some authors propose to reframe the relationship between data power and agency by opening up to a more systemic view on knowledge production, one that integrates the real world (Couldry & Mejias, 2018; Cukier & Mayer-Schoenberger, 2013; van Dijck & Poell, 2013).

- ***Algorithms, Coding New Realities***

Data are the building blocks of the emerging connective economy. However, data in and of themselves are not enough. Just like dancers need a choreographer to shape their moves and bring the dancing together, data need an organising force. They need to be treated and organised in order

to be interpreted. Therefore, digital data (and metadata) need and feed the mathematical programmes that process and organise them, the algorithms. In simple terms, algorithms switch bits of data on and off and in relation to each other. Claude Shannon, the founder of information theory saw this as a process of logical reasoning performing three operations in relation to each other: “and”, “or” and “not” (Domingos, 2015).

As such, these computational models claim to quantify important human attributes based on data trails left behind when living life in the digital age. In this sense, algorithms act as categorising and indexing agents, giving “concrete meaning” to the digital data that is fed to them. Categorising and indexing are not neutral processes. They are highly designed procedures that reflect certain intentions and purposes (Bowker & Star, 2000). Therefore, far from being neutral, those models are intentionally optimised for certain outcomes (Introna & Nissenbaum, 2000), and require extensive work on modelling to contain and reduce the potential discriminatory results that they produce (d'Alessandro et al., 2017). To illustrate this, a popular model called LSI–R, or Level of Service Inventory–Revised is used in the US justice system to create recidivism scores that, in some states, guide sentencing (O'Neil, 2017). Amongst others, it includes questions relating to prior convictions, but also birth, upbringing, neighbourhood, family and friends. The algorithm is “trained” to give more weight to answers more highly correlated with recidivism. Minorities coming from poor neighbourhoods tend to score higher, get longer sentences, thereby creating harmful feedback loops. In actual facts, the choices behind categorisation and indexing create portraits of the ideal criminal, rather than judge people on their actions. This example also illustrates the relationship between data, information, knowledge and agency in the digital age.

Despite their relatively recent history, the awareness of the potential pitfalls of the rise of programmable web-based social technologies is not new. In *The Human Use of Human Beings*, Norbert Wiener (1954) mentions a number of potential issues arising from machines’ capacity to learn: escaping human control if careful supervision is not put in place, human increased dependence on them and possibly being controlled by them, and finally the dangers of

surrendering decision-making to something that does not comprehend non-utilitarian human values.

A general and widely accepted definition of an algorithm views it as a "finite sequence of well-defined instructions that describe in great detail how to solve a problem" (Kraemer et al., 2011). In broad terms, both humans and computers use algorithms to solve problems. For the purpose of this research however, we will only concern ourselves with computational algorithms which rely on coding. A simple definition is "a sequence of instructions telling a computer what to do" (Domingos, 2015). This is a more political definition that hints at the social and epistemological impact of algorithms. Gillespie's (2014, p. 167) definition "encoded processes for transforming input data into a desired output, based on specified calculations", puts even more emphasis on algorithms' active participation in shaping what we know and how we know it. However simple they may seem, when we look closely at these definitions, we realise that they raise a number of questions. Notably, what do we mean by "what to do", and more importantly who decides and who benefits from these decisions?

- *Algorithms, Vectors of Information Ordering*

The architecture of datafication is purely computational. Computational systems, like all systems, organise and shape information according to a particular logic and are supported by an underlying ideology (Bowker & Star, 2000). As Chadwick (2017, p. 100) argues, computer data-based systems "encourage disaggregation and disassembly, but also reaggregation and reassembly". By turning human experience into a series of discrete flows of data that can be reassembled into "data doubles" (Cheney-Lippold, 2017) or disembodied digital selves, algorithms abstract the reality of human lives in their environment (Andrejevic & Gates, 2014). They create a type of knowledge that is essentially fluid, a disembodied "surveillant assemblage" that can be observed and targeted for intervention (Haggerty & Ericson, 2006). In other words, contrary to the human world, there is no truth other than that designed into the algorithm.

The faith in algorithms has led some to declare that the era of big data heralds the end of theory and science (Anderson, 2008) because the patterns emerging from the analysis of large data sets will suffice to produce insights into individual and collective (Ruckenstein & Schüll, 2017). This view, however, forgets that algorithms themselves need to be hypothesised, modelled and tested. One of the issues with the algorithms being used to make decisions in the social realm is that many assumptions are camouflaged by math, making them opaque, untested and unquestioned (O'Neil, 2017). The value leading to the design of algorithms is not enquiry but optimisation, and its purpose is not understanding but prediction (O'Reilly, 2017). One issue here is that the design of algorithms is left to coders and statisticians; their technicity makes them utterly incomprehensible to untrained human cognition and their complexity makes them unintelligible even to trained data scientists (O'Neil, 2017).

Furthermore, algorithms do not share a universal grammar. Domingos (2015) brings our attention to the five main groups of algorithmic grammar, which he calls the 'five tribes'. Each of them possesses its own master algorithm that can be used to extract certain specific meanings but not others, thereby producing different knowledge outputs. As Seaver (2012) also comments, algorithms are a form of social theory: they establish latent connections between things and people, or in other words, the cultural order, but according to imperatives either of commerce, or other agendas that are built into the algorithm; they do not mirror an existing order but create a new one through the choices made in how they classify.

- *We Shape our Algorithms and our Algorithms Shape Us*

Since McLuhan (1994) memorably observed that the "medium is the message", research on the circular relationship between our media and our ways of thinking has increased dramatically. The ubiquity of mobile technologies and the social web has made our experience of the "medium as the extension of man" even more absolute. How we shape algorithms and how in turn algorithms shape us is an important question as it informs how datafication shapes the knowledge that is reflected back to help us. As Turkle's (2005) notes in her seminal work *The Second Self*,

computers have become an inescapable part of our social and psychological lives. As she puts it, “technology, catalyses change not only in what we do but in how we think” (p. 18). She uses Piaget's psychology concepts to discuss how children learn about computers and how this affects their minds as they grow up in a personal computer culture.

Digital design has become more dynamic and the barriers between design and engineering (coding) are unravelling. Going back to the maxim “we shape our tools and in turn our tools shape us”, it may be more accurate today to say that we shape our algorithms and in turn our algorithms shape us. The problem with this lies in the nature of the algorithm. Unlike a physical tool, digital artefacts are mediated and dynamic. Many of the algorithmic systems that have been put in place to organise the digital environments we inhabit have been designed to disregard the humans and reward the machines (O'Reilly, 2017). Furthermore, the algorithmic architectures are invisible, making this shaping process more difficult to discern.

In *Who Owns the Future?*, Jaron Lanier (2014) proposes the idea that online economies are increasingly hostile to the existence of the middle class. Users give away information about themselves in exchange for free services, allowing the “Siren Servers” (the corporations who control the servers and benefit from this free data) to concentrate wealth in the hands of the few. He posits that middle classes need to be nurtured but the nurturing mechanisms do not exist in the online networked economies that are coming to dominate our lives and that tend to organise people in winner-take-all configurations. He compares the online networked economies to robber baron economies, warning that “if we go on as we are, we will probably enter into a period of hyper-unemployment, and the attendant political and social chaos” (p. 4).

At the other end of techno-determinism there lies the idea that our technologies merely mirror our societies and societal values are embedded in the technologies we design and that design us back (Bijker & Law, 1992). If this is the case, we need to critically examine not the technologies, but the values upon which they are built.

- *Humans and Machines Do Not Speak the Same Language*

As media studies scholar Tarleton Gillespie (2012) argues, “a human linguistic framework is not appropriate to understand computational logic”. The failures of social platforms to find purely technological solutions to adequately remove inappropriate content from their platforms is an indication that the reverse may be true as well. It is beyond the scope of this research to go into the details of the long-standing debate about whether AI can (or will) equal human cognition. The point here is to note that from the early stages of the science of probabilities and the development of statistical inference (in the 1700s) to deep learning and cognitive computing (in the 2010s), datafication had its own linguistic way to describe and conceptualise the world (Banasiewicz, 2021b). Because they rely on processes of quantification, algorithmic languages follow a fundamental logic of fragmentation (Amaro, 2019).

Abstraction is essential to computational knowledge (Rieder, 2020), which is based on mathematical concepts which model real life and translate it into a purely digital universe (Colburn, 2015). Kleinberg et al. (2018) have shown the effects of this abstraction process by showing how algorithms used in judicial decision-making miss elements at different stages of the justice process, i.e., pre-trial, sentencing and parole. This is because algorithms will consider that the outcome re-arrest or recidivism is equally important in decision-making at all stages, when in fact, experience has shown that it is not the case. Furthermore, algorithms can only process digital data, but digital data do not capture the whole meaning of a situation. A human judge, even if she can make mistakes, still has access to information not captured by the algorithm.

- ***Platformed and Networked Infrastructure***
  - *Early History*

The early internet structure was defined by its open-source ideology. Information was free to flow and proprietary control impossible by design. A number of applications built on this idea in different domains. For example, when Napster and other file sharing services stored information

not on their own servers but on millions of computers hard drives, they created an architecture that directly stood against the traditional proprietary business model where competitive advantage came from centralised ownership. The paradigm shift of the early 21st century was the switch from the software model to the web delivery model. In other words, Microsoft was made obsolete by Google (O'Reilly, 2017).

In essence, social networking sites were developed as native web applications. Up to the late 2000s, the web-based services known as social networking sites (SNS) provided a space for their members to create a profile on a bounded website, connect with others and get access to a network of friends (and friends of friends). Although open to everyone, the space was bounded, i.e. limited to the confines of the site, and required to create an account and a profile (Helmond, 2015). The registration process was (and to some extent still is) as easy as entering a name, email address and password into a form. SNSs made it very easy to become part of the "family" but it was nonetheless necessary to join. In fact, for several years, Facebook restricted its membership to certain people; first students of Harvard university[13] and other Ivy League institutions in 2004, then universities around the world and high schools in 2005, followed by employees of some large companies. It finally opened to anyone over age 13 with an email address in 2006 (Van Dijck, 2013).

It is worth highlighting that in the early to mid 2000s, a wave of new SNSs hit the mainstream as many sites appeared, organising communities socially (e.g., Friendster, MySpace, LinkedIn) or by personal interests (e.g., Dogster, CouchSurfing, MyChurch). Some media sharing sites became SNSs in their own right (Flickr, YouTube), while others became wildly popular in some countries but not others (e.g., Google's Orkut in Brazil). "Connection" has been one of SNSs keywords

[13] A predecessor to Facebook, Facemash, created by Harvard sophomore Mark Zuckerberg, placed students' photos (hacked from the Harvard database) next to each other and asked users to choose the "hotter" person. The site was forced to close down after accusation of breaching security, violating copyrights and violating individual privacy were directed at it, and Zuckerberg apologised profusely (a script uncannily reminiscent of the life of his later creation).
https://www.thecrimson.com/article/2003/11/19/facemash-creator-survives-ad-board-the

from the start, either connecting to friends (such as SixDegrees.com in 1997) or to a professional network (such as Ryze.com in 2001) (boyd & Ellison, 2007). However, the reality is a restricted interpretation of the term. While in theory SNSs allowed members to connect with strangers, in reality, their most important feature was (and still is) to make visible the "latent ties" of users - i.e. their extended social personal or professional networks (Haythornthwaite, 2005).

- *The Platformisation of The Web and of Society*

Since the early days of the SNSs, the logic of the free-for-data model of the networked social media has contributed to the phenomenon of platformisation of social media (Helmond, 2015). It is important to note here that the process of platformisation follows the logic and the needs of datafication. Platformisation is actually a necessary architecture to datafication which requires large networked environments to harvest vast amounts of data. In the pre-social web, scholars had warned against a trend toward a commercial centralisation coupled with a decentralisation of publics, warning that the prospects of the internet relied rather precariously on political, economic and technical factors (Introna & Nissenbaum, 2000).

Helmond (2015) refers to the platformisation of Facebook, defined as "the rise of the platform as the dominant infrastructural and economic model of the social web and its consequences", as a critique of the consequences of the programmability of the social web. Just as the 19th century gold rushes brought an onrush of miners seeking their fortune in a new land, the social networking sites of the early 21st century, seeking increasing amounts of the invaluable "online precious metal" (data), embarked on a race to disseminate their features into the world wide web in pursuit of harvesting and re-importing data. In 2006, Facebook, did not allow users to make their full profile visible but gave third-party developers full access to their data to create "applications" to "improve their experience" while on site (boyd & Ellison, 2007). Essentially, as energy companies went into fracking to reach new resources in search of growth, social networking sites looked for valuable commodities in the previously unreachable web. Platformisation involved decentralising

SNS's features into the web in order to recentralise the most valuable commodity of the web, "platform ready" data.

The phenomenon of platformisation is larger than networking platforms; it has spread to the whole of society and has infiltrated all sectors of the economy today including education, healthcare and many others, confronting different value systems and social actors and affecting the balance between private and public interests in the "platform society" (Van Dijck, 2016). In this context, it is fair to ask who is responsible and accountable for defending the common good in the platform society.

2.1.8 Summary

As the above discussion highlights, datafication relies on a positivist paradigm which believes that the social is predictable and can be explained using the tools and ways of knowing of science (Emslie & Watts, 2017; Postman, 1992). In this context, the objective of datafication is to translate human experience into computer-ready data that can be processed through algorithms and analysed by the computational infrastructures of big data. While valuable insights can be derived from the processes of datafication, such synthesis can also be quite problematic when applied to the qualitative realms of human experience. This is even truer today when datafication has become overwhelmingly present as a trusted agent of decision-making in all areas of life, from sociality to learning, from education to justice and more.

To sum up the literature review above, datafication positions itself along the following lines when it comes into interaction with the attributes of tacit design knowledge.

> **Datafication is quantitative**. This is a defining characteristic of datafication, which is defined as the quantification of non-quantifiable, qualitative aspects of human experience (Mayer-Schonberger & Cukier, 2013). It is based on "computer-ready data" (Van Dijck, 2014) as its building blocks, designed to fit computational analytical structures. The term big data denotes a shift in size, scope but also in the nature of data, the nature of the

analysis (Tufekci, 2014) and the nature of knowledge (Rieder, 2020). The logic of the medium, programmability, popularity, and connectivity all serve datafication (van Dijck & Poell, 2013). By selecting sources and interpreting them, big data is defining what is valid knowledge (boyd & Crawford, 2012b), essentially a quantified, computational, analysable form of knowledge (Mejias & Couldry, 2019).

Datafication is disembodied. Under datafication, the source of knowledge is understandable by computers but not by humans (Mahoney, 2005). It is a phenomenon of reverse reification, as the language of datafication is only readable by computers. Knowledge is essentially decontextualised and "fluid". Computational architectures encourage the disaggregation and re-aggregation of discrete data points (Chadwick, 2017). Unstructured data must be shaped, validated, proxied or abandoned (Buneman et al., 1997). It has been described as a "truthless knowledge", and the end of theories and science (Anderson, 2008).

With big data, knowledge comes from the analysis of patterns of relationships and the ability to sort, aggregate and cross-reference data sets. Big data requires computational power, patterns identification, and the belief that the other two create a more reliable, truer form of intelligence than human intelligence (boyd & Crawford, 2012b).

The knowledge of datafication is an abstraction of the reality of human life (Andrejevic & Gates, 2014), and abstracted knowledge (Kitchin, 2014b; Rieder, 2020) obtained by modelling real life around mathematical concepts (Colburn, 2015). In this context, knowledge becomes searchable and indexable - as exemplified by the Quantified Self movement (Kitchin, 2014a; Swan, 2013), and information is automatically manipulated and universally understandable by computers (Berners-Lee et al., 2001).

Datafication is linear. Datafication holds mechanistic assumptions that data are the building blocks of reality (Van Dijck, 2014). It is part of statistical thinking, a thinking

style which is the product of the industrial revolution (Benjamin, 1999; Bowker & Star, 2000), and relies on the belief dominant in data science that emotions are a liability in the production of reliable knowledge (Dreyfus, 1976). Under this paradigm, knowledge is a model of statistical probabilities (Dhar, 2013). Correct knowledge therefore becomes correct measurement (Eid & Kutscher, 2014). It is the belief that quantitative research produces reliable hard facts, whereas qualitative research produces untrustworthy narratives (boyd & Crawford, 2011).

The cognitive model of datafication is based on the DIKW (data – information – knowledge – wisdom) model (Ackoff, 1989), a pyramidal, linear model, which elements incrementally build upon each other in a linear fashion to create the basis for human action (Alavi & Leidner, 2001). This model is widely used in the data science today. It is based on the Shannon linear model of communication, a type of logical reasoning at the heart of algorithmic processes (Domingos, 2015). This model leaves out two important considerations. Firstly, it obfuscates that knowledge emerges from a process of interpretation. Secondly, it brushes aside the circular relationship we have with knowledge, and how data, information and knowledge relate to human agency.

Linearity assumes neutrality and objectivity, but it has been critiqued as illusory when applied to non-quantifiable domains such as human experience (Gitelman, 2013). Datafication aims to reduce human bias (Crawford & Calo, 2016), but it is a reductionist approach to understanding the social (Couldry & Van Dijck, 2015). Metadata is a simplified map of a complex territory, a standardising language (Feldman & Sanger, 2007) that aims to create perfect algorithmic models (Dhar, 2013; Porter et al., 2018) to fit social realities into over-simplified categories (Banasiewicz, 2021a; Pomerantz, 2015).

Datafication is optimised. The platform is the medium of datafication. It is intentionally planned and constructed according to a pre-defined agenda. Despite a diversity of manifestations (platforms, search engines, apps, eCommerce, smart objects or cities etc.), it

is optimised for a certain economic logic (van Dijck & Poell, 2013) . The platform is not only a spatial and social phenomenon, it also carries a political and an economic logic, and has infiltrated all sectors of the economy (Van Dijck, 2013). It is optimised for a specific agenda (economic or otherwise), with the potential (often actualised) to turn human experience into a commodity (Zuboff, 2019).

Algorithms are not neutral; they are pieces of code that crunch data to optimise the outcomes chosen by programmers (Tufekci et al., 2015). The purpose of this knowledge production is prediction (Dhar, 2013), not enquiry or understanding (O'Reilly, 2017). It participates to the logic of a decision-making process aimed at reducing uncertainty and are based on statistics which have fundamental discomfort with ambiguity and uncertainty and emergence (Dhar, 2013).

Datafication is complicated. Datafication relies on large scale connective, purely computational architectures, which are entirely automated (Bowker & Star, 2000). These architectures are complicated in that the production, collection and analysis of data involve many actors and agendas (Mejias & Couldry, 2019). They decentralise features outside of their own boundaries to centralise data gleaned all over the web (Helmond, 2015). In that sense, they are complicated because of the amount of information that is processed. Knowledge production consists of pattern finding by sifting through enormous amounts of data (Davenport & Patil, 2012). However, they do not have the ability to create patterns. They are complicated because they are unintelligible for human cognition. Algorithms technicity makes them utterly incomprehensible to untrained human cognition and the prodigious amount of code makes them impenetrable even to trained data scientists (O'Neil, 2017). Datafication has its own way to conceptualise and describe the world (Banasiewicz, 2021a). However, it does not have the capacity for multidimensional cognition like humans.

3 METHODOLOGY

Purpose of Research

To reiterate briefly, the focus of this research is to examine how the spread of datafication increasingly impacts designerly ways of knowing. Due to a number of complex and rapidly changing forces driving this increase, the field of design must be aware of this evolving landscape if it is to remain at the forefront of innovation. As both gatekeepers and producers of knowledge, designers need to be aware of the multiple shifts that affect the production of knowledge. To gain a more critical understanding, this thesis aims to illuminate how current datafication trends change how knowledge is created, what is considered valid knowledge and what this means for design as a discipline and for designers as practitioners.

Chapter Overview

To begin this discussion, the inspiration for this research is presented. Following this, the rationale for selecting a critical constructivist approach to Grounded Theory (GT) as the methodological guide is offered, with an emphasis on how the principles of GT provide the necessary rigour to sustain this study. To conclude this chapter, the challenges associated with this research are explored and analysed, with attention given to the steps taken to help mitigate these limitations.

Research Inspiration

As mentioned in the Introduction chapter of this thesis, the work of Walter Benjamin sparked a curiosity to understand how early 21st century technological shifts were creating a new way of thinking and being. In his seminal work *The Arcades Project* (1999), Benjamin critically examines the profound shifts that took place at the onset of the 20th century, during what is now known as the inception period of the industrial revolution. He set out to clarify the meaning behind these shifts and discover how these changes informed, shaped and influenced the key characteristics of the emerging civilisation. In particular, Benjamin observed how the early years of 20th century

society were reorienting towards capitalistic production, and in turn, creating a dreamscape of unrestrained consumerism. Using the Parisian "arcade" (in French "passage") as the symbol of the rise of the age of "the mass" (i.e., mass entertainment, mass market, mass production, mass consumption, mass communication etc.), Benjamin observed a number of epiphenomena such as the flâneur, the interior, urban architecture, the World Exhibitions, which he viewed not only as the phantasmagoria of the marketplace, but also as the phantasmagoria of civilisation itself.

Both the subject of his study and approach interested me as I could see some striking parallels between his pursuit to clarify what he called the "haze of the 19th century" and my own questions surrounding the emerging "haze of the 21st century". We were both standing at the dawn of a new technological era, a stance that did not afford much hindsight. What Benjamin called "commodification of things" during the industrial revolution echoed my own questioning about the commodification of knowledge that is taking hold today. In particular, Benjamin's insight on the paradoxical movement of a society, which had become simultaneously more realist and more idealist, resonated with my own enquiry about how our digital society was turning more quantified and more utopian, and how this might in turn, shape and inform our experiences.

I was also inspired in that, while Benjamin is part of a situated critical theory lineage, in The Arcades Project, he was adopting a very personal attitude and methodology. In fact, this was the subject of heavy criticism on the part of his friend and mentor Theodor Adorno (1977) who scolded him for departing from the tenets of classical Marxist theory too liberally and too poetically. One area of particular rebuke was his use of the concept of phantasmagoria to illuminate the profound shifts he was living through. As my research was progressing, and the "data"[14] gleaned from the ground started to coalesce into themes, it became clear that a critical approach was necessary to achieve an understanding of what was happening. A critique is an act

[14] Here, I understand "data" in the Grounded Theory sense (not in the sense of discrete, digital data), as the result of the original harvest done during the research.

of illumination by shedding a new light on a phenomenon. For me, Benjamin's phantasmagoria was the instrument of this act of illumination.

As mentioned above, Benjamin's approach in The Arcades Project (looking at the emerging epiphenomena of the epoch) was both designerly and grounded in nature. Similar to Benjamin's approach, the impetus for this research initially took root with a "hunch" - fed by personal observations - that something momentous was happening in the ways in which digital technologies are shaping us, our societies and the world(s) we live in - something far larger than what the public discourse was accounting for at the time. Inspired by Benjamin's grounded approach to his enquiry – i.e., by investigating the new artefacts emerging from the Industrial Revolution from the ground up, I turned my focus to the new artefacts emerging from the Digital Revolution at the time, social media. Since the mid-2000s, the World Wide Web had taken a new direction with the adoption of the social network model ("the social web[15]"). The platformisation of the medium had resulted in the rise of so-called social platforms, characterised by the concurrent decentralisation of platforms features and centralisation of data gleaned all over the web (Helmond, 2015).

As the number of users on social platforms increased exponentially in a short period of time, user behaviour had been the focus of a number of studies. However, more than what was happening "at the surface" of those new online environments, I was intrigued by what was hiding both behind and under the social media interface. My enquiry centred on the lack of transparency surrounding those platforms. I wanted to get a clearer understanding of the main features of those environments and how they were defining human experiences. I began reflecting on the long-term

[15] Also referred to as "web 2.0" to reflect the second stage in the evolution of the World Wide Web (or simply the web). The first generation was defined by Tim Berners-Lee in 1989 and consisted of connectivity through hyperlinks and static pages emphasising information but with little interactivity. Web 2.0 refers to the second generation which started to emerge after 2004. It marked the birth of a new medium featuring the network as its core component.

implications of our growing reliance on those new technologies and the problems associated with this dependency. I saw this as a Design (with a capital D) question par excellence.

While it was obvious that advances in technology have pushed us into unchartered waters, I wondered if we were starting on a new trajectory (as the term "digital revolution" seemed to suggest) or if were we simply on the same track but at a higher speed. Public and academic discourse have long understood that technologies of digitisation[16] (and subsequently of datafication) constitute a major shift in our societies. However, it was, and to a large extent still is, not clear how technology was influencing how knowledge was being created, shared and applied, and in what way this defined and shaped the emerging digital civilisation.

As I began to take a closer look, a number of "connection points" began to emerge. In the Digital Age of Information, knowledge was certainly being shaped by datafication processes (i.e., turning qualitative aspects of life into quantitative, measurable, computer-ready data (Van Dijck, 2014)), leaving me to wonder how tacit knowledge – a fundamental feature in human experience in general and in the design process in particular– was likewise being impacted.
Thus, my aim for this research is predicated on four interconnected objectives:

1. To explore the emergence of a new digital, data-driven epistemology and understand how it impacts tacit ways of knowing and therefore, the discipline and practices of design.
2. To illuminate how tacit knowledge as a major feature of designerly way of knowing differ from datafied ways of knowing (Chapter 4).
3. To situate the essence of the shift toward datafied knowledge and the current faith in datafication in relation to Benjamin's concept of phantasmagoria (Chapter 5).
4. To discover how design as a discipline and a practice can ensure that tacit knowledge is nurtured and sustained in a world increasingly dominated by datafication (Chapter 6).

[16] The difference between digitisation, digitalisation and datafication is elucidated in the glossary.

Methodology Rationale

In order to examine the emerging and fluctuating impact imposed by technologies of datafication, I needed to find a way to go with the natural flow of my research. Given the unprecedented nature of this technological shift and its meteoric rate of integration into modern life, I needed a methodology that was flexible enough to accommodate the evolving contours of my study. In essence I needed go from the ground up to understand what was happening.

Given the singular and dynamic context of this study, Grounded Theory (GT) provides a useful framework to help guide this investigation. Since its introduction in the 1960s, GT has provided researchers with the tools to generate and elaborate newly emerging theories (Charmaz & Belgrave, 2007). Due to its inherent flexibility, it remains one of the most practical and effective qualitative methodologies available to date (Haig, 1995). GT has been referred to as "grounded theorising" to reflect an underlying dynamic process (Bryant, 2017) well-suited for a fast-changing topic of research. With its theoretical underpinnings derived from a bottom-up approach, the application of GT fits with my research in a number of ways. For example, since GT research is not tied to any preconceived theoretical constructs, it is often regarded as one of the best methodologies for research treading into unfamiliar waters (Dey, 2004). Given that the scholarly research on how datafication impacts the field of design offers scant theoretical starting points, this study is particularly well-suited for GT. Additionally since this study seeks to examine how datafication impacts tacit knowledge in the design process, the findings here do not lend themselves to be quantified and/or statistically represented. By aligning itself to a more dynamic perspective on the emergence of theory, GT offers the space to understand complex and multifaceted phenomena.

GT is a widely used qualitative research method. However, it encompasses a number of different versions and approaches. It is therefore necessary to give more details about how it is used in this research. The earlier iteration of the methodology, developed at a time when quantitative methodologies prevailed in social research, aimed to validate qualitative research and therefore

emphasised objectivity and rigour (Tavory & Timmermans, 2019). Later developments, based on the work of Charmaz (2008), shifted toward a constructivist approach, recognising and celebrating the researcher's subjectivity, emphasising the importance of self-reflexivity and opening a space for a tacit knowledge friendly research methodology (Mey & Mruck, 2019). Constructivist GT still aims at finding an emerging theory or idea from the ground up, but it also emancipates the researcher from the positivist constraints limiting their reliance on tacit knowledge (Cutcliffe, 2000).

Constructivist GT is data agnostic in the sense that that any source is acceptable as long as it is aligned with the research aims and objectives (Charmaz, 2008; Glaser, 2007). Because it embraces subjectivity, it allows the researcher to work simultaneously with all kinds of qualitative, and even elusive, data[17]. These include oral, visual or textual sources. As Charmaz (2008) recalls, GT helped Anselm Strauss, one of the founders of the methodology, gather insights from data collected from narratives of daydreaming. Therefore, GT enables the treatment of subtle and even "evasive" data. It is therefore not a process of datafication as defined in this thesis (turning qualitative aspects of life into quantitative, measurable, computer-ready data). As an open-ended and exploratory methodology (Charmaz, 2008), constructivist GT opens a space for hermeneutics and heuristics processes (Suddaby, 2006). In other words, I saw constructivist GT as the methodology to help me produce "unbiased but situated accounts of the world" (Haraway, 2004, p. 5). Those qualities made constructivist GT particularly well-suited for the type of exploratory research I was embarking on.

As mentioned above, during the different iterations of my research, I had lingering questions about the design politics behind the mediated environments of the social web. Designing is a political act. Designing social media (the early manifestations of the nascent digital age) is not an exception. The interface of these social platforms (and more importantly, what was hiding behind

[17] As previously mentioned, here, the term "data" is understood quite differently from the digital data bits which are the main subject of enquiry of this research. In the context of GT, it refers to the qualitative information gathered during the grounded enquiry process.

it) piqued my curiosity. What agenda was embedded in this design? Were these invisible architectures changing the configurations of knowledge-power, and if so, how? The questions arising as I was standing in front of this emerging civilisation included questions relating to social justice, power imbalances, and the role of ideology in shaping social experiences. In the age of datafication, knowledge is the ultimate power. Google (the search arm of Alphabet Inc.) controls the result of most online searches on the planet (except in a few countries like China), and therefore holds enormous power on the organisation of knowledge. In other words, being true to my enquiry necessitated a critical dimension to my approach. Recent developments in GT have incorporated this dimension (Levitt, 2021; Timonen et al., 2018), making critical constructivist GT a good fit for my research.

This is a theoretical, exploratory research into the nascent phenomenon of datafication. As mentioned previously, the aims of this enquiry into the haze of the 21st century (to paraphrase Benjamin) made it impossible to utilise qualitative methodologies that required interviewing people (or participatory methods). Insights had to come from a much wider field, i.e., the extensive literature on tacit and datafied ways of knowing. The use of critical constructivist GT to interrogate the literature is justified based on the following elements.

Firstly, revealing and addressing gaps and limitations. Exploring a wide range of existing literature helped to identify gaps, limitations, but also contradictions between the different fields of knowledge. Critical constructivist GT allows for a systematic examination of the literature (Levitt et al., 2021), enabling researchers to uncover underlying assumptions, biases, and power dynamics that may have influenced previous studies. By critically engaging with a wide range of bodies of literature, I could identify areas that require further investigation and contribute to filling those gaps.

A second aspect was to uncover alternative perspectives. Critical constructivist GT emphasises the inclusion of multiple perspectives and the deconstruction of dominant narratives (Levitt, 2021). Interrogating the literature allowed me to identify alternative viewpoints or overlooked theories

and frameworks. This in turn, allowed me to get a better understanding of the topic under investigation by challenging and expanding upon existing knowledge.

Thirdly, because engaging in theoretical exploratory research involves critically examining one's own assumptions, biases, and positionality as a researcher, critical constructivist GT provided a framework for reflexivity (Cutcliffe, 2000; Timonen et al., 2018). During this process, I was allowed to acknowledge and address my own positionality and how it could potentially influence the interpretation of the literature. GT allowed me to actively engage in critical self-reflection, to raise my awareness of how my own perspectives could shape my analysis and conclusions. I could observe my own fluctuations as I was observing a fluctuating phenomenon. A noticeable example of this was the shift that operated inside me in how I viewed technology after Cambridge Analytica in 2017.

One of the main aims of theoretical exploratory research is to develop new theoretical frameworks or refine existing ones. GT offers a systematic approach to developing new theories or ideas by systematically analysing and synthesizing the literature (Bryant & Charmaz, 2007). Engaging with the literature through a critical constructivist lens allowed me to identify emergent themes, concepts, or theoretical frameworks that had the potential to contribute to the theoretical development in the field.

An important aspect of this research was to engage with the social and the political dimensions. Critical constructivist GT recognises the social and political dimensions that shape knowledge production (Hadley, 2019). By interrogating the literature, I could identify the underlying power dynamics, ideologies, and social structures that influence the theoretical perspectives present in the literature. This also allowed for a critical examination of how the literature has been shaped by these forces. This enabled me to reflect upon and propose alternative frameworks that challenge and subvert existing power dynamics. Ultimately, by engaging with my topic through the approach of critical constructivist GT I hoped to be able to contribute to the advancement and critical understanding of the field.

In light of the theoretical objectives and the theoretical triangulation approach of my research, the methodology I selected needed to be flexible yet robust enough to help reveal important insights. In order to study the many emerging phenomena of technology, I recognised very early on that both my research "subject and laboratory" were in constant flux, often changing shape and direction in unpredictable ways. I also acknowledged that I was not an objective observer of the flow, but involved in this movement. As a result, I needed a methodological framework that allowed me to accommodate the dynamics of my investigation.

More specifically, the elements of the methodology that make GT an ideal fit for this PhD can be summarized as follows:

- The qualitative nature of this research requires a qualitative methodology that also provides the flexibility needed to allow patterns to emerge.
- Due to the exploratory nature of this research, the methodology used needed to generate new concepts and ideas, rather than preconceived theories.
- The nature of this investigation required a very broad view, one that allowed the bridging of several different fields of enquiry.

I realised that the nature of this theoretical PhD made it challenging to arrive at convincing conclusions through some of the traditional modes of qualitative data collection in the social sciences (i.e., interviewing people). While the essential features of GT were a perfect fit for my research, I could not directly interview individuals as the overall impact of datafication was not experienced or readily understood on an individual level. Given the fundamental impetus of this research (i.e., to understand how tacit knowledge is being impacted by datafication) it did not seem plausible or feasible to interview people on something that they may not necessarily be aware of. Thus, I decided to structure my research as a theoretical PhD and apply constructivist GT to investigate bodies of literature – all whilst adhering to the fundamental principles of GT. In doing so, I was keeping with the principles of constructivist GT, which allows for all types of data to be interrogated and analysed, including online or offline textual sources (Bryant, 2017; Corbin

& Strauss, 2015), archival analysis (Denzin, 2019) or "data available from previous research for secondary consideration and re-analysis" (Mey & Mruck, 2019).

3.1.1 Grounded Theory: Steps and Principles

As reiterated by Bernard (2013), applying a GT approach to research can appear to be a "deceptively simple" process. The methods of GT require a reflexive and iterative process to collect, code and analyse data, which aim is to develop themes anchored in the researcher's interpretation of the data. Those are then synthesised into an idea or theory. Despite its seemingly simple approach, GT is nonetheless an organised research tool that can be utilised to reveal substantial insights as well as new ideas or theories (Bernard, 2013). While the terms used to describe each step have an aura of positivist truth (probably due to the necessity for GT to prove itself in the early days), in the constructivist approach, the methods honour the subjectivity of the researcher, are interpretative and tacit knowledge-friendly.

To summarize here, the GT process includes the following 5 steps:

1. Identify a research focus (i.e., contextualising the research enquiry and scope).
2. Data collection[18] (i.e., developing a list of queries to be posed to various segments pertinent to the study).
3. Data analysis (i.e., creating notes based on the above to be eventually compared and coded).
4. Conceptualisation of data (i.e., sense-making by comparing the various themes to emerge, while also checking the emerging concepts against "outlier" themes).
5. Presentation of the emerging theory (i.e., establishing the framework to support the new theoretical narrative).

[18] It is important to restate that the term "data" here is not understood as the computer-ready, measurable data of datafication.

As the reminder of this chapter will show, the above five steps were systematically applied although not in a linear process. Due to the iterative nature of steps above, data collection, analysis, and writing are interwoven (Charmaz, 2014; Mey & Mruck, 2019) and inform each other. In other words, those steps do not happen linearly, but in a loop, and it is through this process of looping back and forth that larger themes are developed and frameworks emerge.

It is perhaps also worthy to note here that, when applying these above steps, I began to see how Benjamin's Arcades Project was structured along a similar framework. He too was looking at something that had not clearly taken form yet; he too wanted to understand unprecedented change that defined a new century. One could argue that his forward-thinking methodology was also based in the principles of GT: instead of examining historical facts, he interrogated artefacts of the emerging 20th century. This gave me the impetus to forge ahead, confident that in my investigation had a solid methodological anchor and precedent.

- ***Step 1: Identifying a Research Focus***

Following the principles of GT, I did not begin my research with a fixed hypothesis, but rather a question about how the increased expansion of digital technology was changing how information is shared and created on a fundamental level. Thus, I began by first focusing on identifying a variety of data sources that would most likely yield the diversity of insights I needed to begin my research. These early steps included conducting some observational research, noting how, with increased regularity, people were spending a considerable amount of time online, and more precisely on social media. I observed people in public transports, at their desks at work, in their social interactions and at school continuously checking their Facebook profile and Instagram updates.

I wondered what was behind this life online and to what extend these behaviours were the result of intentionally designed digital architecture. I began wondering about the "Master Architect" of this online world. Given that online life is essentially mediated, I needed to consider the structures behind this mediation and the agenda driving the design of those environments. Through this

process a number of preliminary questions began to emerge: What are these mediated environments aiming to achieve? Who is designing these mediated experiences? Who is benefiting more from these spaces? How successful are those architectures of control in shaping tacit experiences?

Despite my sense that there was something else lurking behind all the digital hype, the public discourse at the time (mid-2010s) seemed to hold a favourable view on tech. To gain a clearer picture of what was behind these observations, I began to investigate the literature on digital media. Guided by the principles of GT, I maintained an open mind as I traversed through numerous and diverse disciplines studying the underlying structures framing this new world of tech and their related repercussions. Topics such as privacy, user experience, information economy, knowledge exchange, social control, digital addiction etc., were at the forefront of the vast research I was exploring. Through this process, I noticed that very little attention was given to how this new metric-based approach to information was directing and influencing not only *what* and *how* information was being "experienced" on a personal level, but also, *who* was deciding what that information and experience should be.

I reviewed the research centred on social media, with the suspicion that these platforms were designed to be "sticky" – i.e., keep users in these digital spaces. As I investigated this idea further, I was struck by how this stickiness caused a systemic shift in the way users gained, created and shared information and knowledge. This led me to look into the echo chambers of social media, (also called "filter bubbles") because studies conducted around that time showed that the algorithms optimised for maximum engagement tend to create bubbles of "think-alike" populations. During this initially investigation, I began to note that while the public discourse often mentioned the "technological revolution" mostly in positive terms, very little critical assessment was given to how the mechanisms of this revolution worked to manipulate and distil information outside of a few academic domains.

From here a clear research focus began to emerge, namely:

How is knowledge being redesigned in the Digital Age?

How does this shift influence how designers integrate experiential knowledge – i.e., tacit knowledge?

What are the long-term epistemological implications emerging from this increased dependency on datafication?

- ***Step 2: Data collection***

With conventional methodologies, identifying theoretical bodies of literature to be interrogated typically comes before data collection. In GT however, researchers reverse the process by collecting data first before making decisions on who or what to interrogate (Glaser & Strauss, 1967). According to Glaser and Strauss, sampling choices must be theoretically-informed and, therefore, must await the emergence of a guiding theory (Dey, 2004). Hence, I focused on identifying a variety of literature sources that would likely yield rich insights in the form of qualitative data.

Given that design is a vast field at the intersection of several other disciplines, so too is the related literature. Therefore, my literature review needed to be likewise exhaustive, covering a range of fields (UX, HCI, interaction design), media studies, psychology, sociology and political economy among others (see Appendix B for full list). Relying on what GT refers to as my "own theoretical sensitivity" (Glaser, 1978), I set out to identify bodies of literature to investigate. Thus, I began by first conducting a broad review of a number of books and articles on design. This helped me to not only become intimately familiar with the design literature but also to understand more clearly how the field of design intersects with other disciplines, particularly in relationship to tacit knowledge. Additionally, given that one of the main objectives of this research was to understand how trends in technology were impacting knowledge production, I needed to also consider the seminal research conducted in the field of digital innovations as well.

  - *Identifying the Key Bodies of Literature*

The entry point for this research was the design literature centred around social media. An important theme that arose was the political play between visible and invisible, leading to a questioning about the configurations on how knowledge is created, i.e., the structures of knowledge creation.

A review of the literature around those two themes led me to engage with the literature of (social) media studies. Following Marshal McLuhan's famous maxim "the medium is the message", i.e., how "the form of knowledge on offer is tied to the infrastructure that generates it" (Andrejevic & Gates, 2014), I wondered what was the essence of this new medium, and how it fundamentally differed from the previous ones. It became clear that datafication was the major feature of the algorithmic medium of the 21st century.

Guided by the main emerging themes of knowledge, knowledge-power (or power-knowledge), and the logic of the algorithmic medium, I wanted to better understand how design operates in an online universe that is fully mediated (i.e., without any physical affordances other than a screen and a mouse). This led me to the fields of interaction design, UX and HCI but also psychology (social psychology and the principles of behavioural economics).

It also became clear that technology is shaped by the underlying ideology of the age. As the centre of power of those social platforms was highly situated both in terms of geography (the US) and economic paradigm (neoliberalism), I went into the field of political economy to look at how the context had contributed to shape them, and what was the underlying model that drove their development. I also looked into the critical theories of industrial capitalism (covering topics such as commodification, consumerism etc.) to understand whether these trends were indicative of a continuation or a break altogether from 20th century capitalism. This exploration also led me back to the work of Walter Benjamin, inspiring me to undertake an in-depth exploration into how 20th century capitalism had emerged from the Industrial Revolution. I began to investigate the framework driving his work and began to see how his methodology reflected - in spirit, if not in name - key principles of GT.

Finally, as social media is also a “dwelling space” (i.e., an environment), I looked into theories of spatialisation. As my research progressed, I also noticed that a new phenomenon was emerging, where the penetration of technology was spilling into the physical realm (the emergence of smart cities, smart buildings, smart objects and the use of sensors and wearables), which led me to look into the urban field of territory, and more specifically the critical process of territorialisation. From this wide and diverse survey of literature, the following themes emerged surrounding tacit designerly ways of knowing:

1. First-hand experiences directly contribute to the creation of tacit knowledge.
2. The field of design is heavily dependent on the tacit knowledge that emerges from first hand experiences.
3. Technologies of datafication are inherently structured to influence human experiences.
4. The explicit knowledge generated through datafication is viewed as objective and therefore carries the authority of scientific truth.

- *Designing the Questions*

To obtain insights, I constructed a set of core questions to determine if datafication was influencing tacit designerly ways of knowing (Appendix C). When framing these questions, I was careful to keep my questionnaire flexible enough to apply to the different bodies of literature I had selected to investigate (Appendix B). This proved to be very helpful in extracting more detailed information from my interrogation process. Despite this flexibility, careful attention was nonetheless given to ensure that the set of core questions remained consistent throughout the data collection process. With this in mind, core questions were structured to extract information that was most relevant to the purpose of this investigation, i.e., understanding the repercussions of datafication on tacit designerly ways of knowing (e.g., what does datafication want me to see (and not see)? Is there a hidden agenda? How does datafication impact tacit knowledge in design?) From here additional questions were developed to clarify this intersection between designerly ways of knowing (i.e., tacit knowledge) and the production of explicit knowledge through

datafication. With this aim in mind, questions such as “what is knowledge in this context?” or “what are the main architectures of control shaping knowledge?” were included in the questionnaire.

- ***Step 3: Data Analysis***

Throughout the GT process, hypotheses emerge through the continuous comparing of data on a number of different levels - hence requiring data collection and analyses to be conducted simultaneously. In order to collate a concise summary of the patterns that were emerging, data was coded into themes and categories. This process also included note taking, memo writing and map-making. This proved to be instrumental in allowing me to track the emerging patterns and insights as well as conceptualise themes. I adopted the same methodological steps to reveal the characteristics of a Phantasmagoria as defined by Benjamin (see Chapter 5) (Appendix D).

  - *Coding and Note Taking*

For each question, I created a transcript in the form of detailed notes, organised in a way to facilitate the coding process[19]. Notes and memos relating to the content of the literature under review were identified using a normal font/colour (Times New Roman, size 12, black), while my own comments appeared in Georgia font in black, italics and bold in the body text. New questions arising from the responses gathered were then colour coded into groups. Important quotes were recorded verbatim and underlined in order to recognise them easily.

I also created a separate file titled “keywords” (Appendix E) to define important terms to which I added to regularly. The list was organised by colour-coded themes, with the keyword for each theme being underlined. Later, the list was transferred to a mind map to get a better sense of the how these terms could be best operationalised. As discussed in more detail in Chapter 4, these re-occurring terms and concepts proved to be instrumental in the objective comparison of tacit

[19] The term “coding” here does not refer to a process equivalent to digital coding, but to an emergent process of sense making.

knowledge (i.e., designerly ways of knowing) with explicit knowledge (i.e., datafied ways of knowing).

- ***Step 4: Conceptualization of Data***

Notes were then reviewed and themes were highlighted particularly as they emerged repeatedly from several sources across disciplines related in this research. Each body of literature was then summarised into a mind map to clearly separate the themes, draw connections and prioritise them. This format allowed me to play with different possible understandings. All mind maps were then brought into one main document to get a big picture of key findings and to better ascertain the larger meaning of emerging themes.

I then compared and contrasted the emerging themes to understand the intricate relationship with designerly and datafied ways of knowing. While this process revealed how datafication takes a primarily reductionist view of tacit knowledge, the similarities and differences that emerged from this process required that I go deeper and map out these trends to gain better clarity. Similarly, I gathered, compared and contrasted the themes emerging from the literature on phantasmagoria to discover its key characteristics.

- ***Step 5: Presenting the Emerging Theory***

As summarised above, I started with designerly ways of knowing at the centre, then spread out from there (continuously going back and forth among the different data sets) until I reached a satisfying answer. Through this process, it also became clear that what I was studying was a systemic issue, something that was impacting both the present and the future. It also became clear how datafication was reconfiguring how knowledge is created and shared on a grand scale. I wondered whether we were not facing a phenomenon on the same scale and complexity that Walter Benjamin confronted in his study of how 19th century consumerism was creating a crucial and defining sea change that continues to reverberate today. Upon closer examination, I also began to see how designerly ways of knowing were being reshaped and redefined through this process of datafication – allowing the core essence of my research question to step into clear view.

Guided by Marshall McLuhan's "The medium is the message" I looked into what exactly was the difference that made a difference, i.e., what was the core essence of the new medium of datafication and more importantly, how it was turning human experience into computer-ready data. I also wondered whether a parallel could be drawn between what Walter Benjamin saw emerging from the industrial revolution and what I saw emerging from the digital revolution. With this in mind, the theoretical contributions emerging from this research can be summarised in the following way:

1. Expand the current body of research on design ways of knowing by contrasting the attributes of tacit designerly ways of knowing with the ways of knowing of datafication.
2. Illustrate how datafication creates a false sense of objectivity that has been largely overlooked in the design literature.
3. Indicate how datafication is not well suited to building "personal reservoirs" of tacit knowledge.
4. Reveal how datafication is the phantasmagoria of the 21st century, a revolution of medium, but not of paradigm.
5. Propose a new paradigm, a relational framework based on the principles of living systems, to integrate designerly ways of knowing within a world that has grown heavily-dependent on datafication.

Research Summary and Limitations

Constructivist GT was well suited for this critical exploration and I found the process to move along smoothly and efficiently. As mentioned above, GT is a widely used research methodology for qualitative research into emerging and fast evolving phenomena. The focus of this thesis is to understand the new civilisation emerging from a major technological shift through a critical study of the knowledge it produces. Due to the unprecedented nature of this topic, there were no human experts or users to interview.

GT was developed at a time when quantitative research was dominant in the social sciences. Since

its founding, GT has evolved into several branches, and retains a terminology that evokes positivism (data collection, coding). However, it has proven to be a suitable methodology for constructivist and critical approaches for phenomena "in the making" (Levitt, 2021). Constructivist GT provides a framework to conduct qualitative research, but it is friendly to a wide range of data sources (Corbin & Strauss, 2015; Timonen et al., 2018). In the context of this research, since there were no experts to interview, the sources with the best potential for insights were literary, both of an academic, and more immediate (i.e., journalistic) nature. To build an understanding, I interrogated a wide range of different bodies of literature (see Appendix B). This approach led to the development of the attribute-based frameworks proposed in this thesis (for tacit knowledge and datafication in Chapter 4; for phantasmagoria in Chapter 5 and for a regenerative ecology of knowledge in Chapter 6).

However, despite constructive GT's "natural fit", there were some limitations.

As with any research methodology, the issue of validity is a central concern. To uphold the integrity of this research, I was particularly attentive when constructing my core list of questions used to interrogate the literature. Understanding that the validity of the data generated would likewise be dependent on the validity of the questions I posed, several revisions were made before completing the final questionnaire.

Finally, given how design stands at the intersection of many academic fields the number of possible directions this research could take are endless. Thus, to make this research project feasible, I decided to focus on design-related fields most impacted by datafication. However, to ensure that the academic literature I selected to investigate was defensible and reliable, I was mindful to do an exhaustive search before paring down my final research scope. This strategy not only afforded me a macro view of the overarching landscape, but also the clarity needed to pinpoint more specifically how designerly ways of knowing were being affected by datafication.

4 A FRAMEWORK TO UNDERSTAND TACIT KNOWLEDGE & DATAFICATION

Chapter Overview

As mentioned in the methodology chapter, a constructivist approach to Grounded Theory (GT) was used as the methodological guide to understand how datafication impacts designerly ways of knowing. To obtain a clearer picture of how these two ways of knowing processes intersect, I traversed through hundreds of sources in multiple disciplines to excavate commonalities and stress points between the ways of knowing of tacit knowledge and datafication. Implementing the five steps of GT mentioned in Chapter 3, I first developed a list of questions I posed to each body of literature used in this thesis (Appendices B & C). After extensively interrogating the literature from multiple disciplines, five key attributes framing tacit designerly ways of knowing began to emerge. Applying the same process to the extensive body of research on datafication, a list of five salient attributes likewise emerged (see chart below).

The aim of this chapter is to compare these two sets of attributes and illuminate the essential commonalities and differences embedded in these two systems of knowing. To help bring this discussion into clearer focus, this analysis also includes a number of sub-descriptors that illuminate how these the key attributes operate. With this in mind, this chapter is divided in two main parts. First, a brief overview of the rationale used to operationalise key terms is presented. Following this, a critical comparison of tacit-designerly and datafication ways of knowing is offered[20]. This analysis is presented to underscore and illuminate the repercussions datafication has on tacit designerly ways of knowing that have been largely overlooked in the literature. It is to be noted that section 4.3 is constructed as a contrasting critique in order to shine a light on some fundamental attributes of those two ways of knowing. This is not to say that they are to be seen as

[20] Since the focus of this chapter is a comparison between the attributes of tacit designerly knowledge and datafied knowledge, and in order to keep the reading fluid, I will refer to the tacit aspect of designerly knowledge as “design knowledge”.

separate, or as an either/or choice. They ultimately need to be considered inter-relatedly and in balance with each other (this idea is central to Chapter 6).

Preliminaries: Principles

4.1.1 Operationalising Key Terms

When conducting the literature review for this thesis, I took copious notes and memos (as per the GT methodology) on the reoccurring themes and concepts used to describe tacit knowledge and datafication. Through this multi-disciplinary process, five attributes of tacit knowledge (i.e., qualitative, embodied, emergent, experiential, complex) as well as five attributes of datafication (i.e., quantitative, disembodied, linear, optimised, and complicated) (see figure 1 below) began to take hold. Before going further, it is important to briefly lay out how these terms are used and defined in this research.

Designerly Ways of Knowing	Datafication Ways of Knowing
Qualitative	Quantitative
Embodied	Disembodied
Emergent	Linear
Experiential	Pre-Optimised
Complex	Complicated

Fig. 3. Comparative Chart: Design vs Datafication Ways of Knowing

- ***Qualitative & Quantitative***

The etymology of qualitative refers to the quality as opposed to quantity and as such, equates diversity and plurality. For example, the field of qualitative research is a diverse field without clearly defined boundaries, which resists the inclination toward establishing a "single umbrella-like paradigm" (Denzin & Lincoln, 2018, p. 19). The qualitative also embraces interpretative approaches to understanding the world and ourselves. The qualitative accepts that rigorous approaches can encompass nuances and shades of grey because it gives space to the local and the situated (Denzin & Lincoln, 2018). It is at the core of the concept of situated knowledge as defined by Haraway (1988), a knowledge is neither objective nor universal but dependent on the context and the point of view of the knower. For those reasons, the qualitive requires a human mind.

When qualitative refers to know-how, quantitative refers to "know what", a type of knowledge based on countable quantities which is easier to measure and break down into parts (Polanyi, 1966b). The quantitative feature aligns with a statistical mindset and an underlying ideology of a mechanical world that is external from one's inner world. Because of this, it can be paired with explicit knowledge. This way of knowing relies on dividing the whole into parts as well as analytical processes accompanied by linear logic. An important value behind it is efficiency.

- ***Embodied & Disembodied***

Linked to the qualitative aspect of tacit knowledge, another concept which kept emerging from the literature is the idea of embodiment – literally meaning knowledge as embedded in form. Because of its relationship with what Simon (1996) called "the artificial", embodiment is an important feature of design. Here, this idea is understood at several levels. Firstly, the output of design as a process, i.e., as a discipline of making and doing, is embodied. In other words, design gives form. But there is another, maybe more subtle level of embodiment. Because it is private, uncodified and unavailable for conscious analysis (Polanyi, 1966b), tacit knowledge literally needs the contours, boundaries and perceptual intelligence of a living body to be generated. A third level refers to tacit knowledge as also being embodied in time and space, i.e., it is created not "apart from" but "in

relation to". Tacit knowledge exists not as a separate, isolated epistemological entity, but as embedded in a living eco-system of relationships.

In contrast, disembodiment - another construct that consistently resonated in the literature framing datafication's way of knowing - refers to that which lies outside of a living body. This feature can be seen as a great advantage, because freedom from embodiment is equated with freedom from the biases and false perceptions that afflict human perceptions, and therefore grants neutrality and universality status to the production of (datafied) knowledge (Boyd, 2018). Because the knowledge of datafication is not embedded into an individual body with a history, an experience and a sense of identity, it is inherently fluid, meaning that it can take any shape depending on how data are aggregated. (O'Neil, 2013; O'Reilly, 2017; van Dijck & Poell, 2013; Zuboff, 2019).

- ***Emergent & Linear***

A third theme which was consistently surfaced throughout the literature was the idea of emergence. In philosophy and in the science of life, emergence is defined as the properties of an organised whole that are not present in its parts (Capra & Luisi, 2014). Thus, for the purpose of this research, the term 'emergent' refers to the essentially open-ended quality of tacit knowledge, its close relationship with ambiguity and paradox, as well as its abductive nature (i.e., an inference from an observation that cannot be proven positively). Emergent also relate to the creative aspect of tacit knowledge, i.e., the aspect of pattern creation rather than pattern finding (Cross, 2006), and the process of co-creation, which is intrinsically collaborative and relational in nature (Couldry & Van Dijck, 2015; Manzini & Coad, 2015).

The multi-disciplinary literature on how knowledge is produced under datafication shows that this process utilises a more linear pattern. Thus, the term linear in this research is used to convey the deductive and statistical logic used to find patterns in the data sets algorithms filter through. Each medium shapes its knowledge production, and the medium of datafication is one that relies on measurability and therefore standardisation.

- ***Experiential & Optimised***

The analysis of the literature revealed the nature of tacit knowledge as experiential. It is connected to time (past, present and future) because experience arises as time passes and with time, experience is shaped into expertise (Dorst, 2015b; Lawson & Dorst, 2009). Importantly, the type of sense-making of tacit knowledge is anchored in "being in the world" and being in dialogue with the world. The sciences of life offer an analogy in the cell, which membrane is a boundary of identity but not a boundary of separation (Capra & Luisi, 2014, p. 138). This means that the cell keeps exchanging with its environment in a very dynamic manner, based on direct experience, not according to pre-determined sequences of behaviour. The dialogue with the environment (which is another way to describe experience) is the main mean to knowledge production.

A corresponding theme in the literature on datafication reveals that the knowledge of datafication is optimised to fit a predictive purpose (Mayer-Schonberger & Cukier, 2013). Unlike experiential knowledge, datafication creates knowledge through computational power and code to help decrease uncertainty, through abstract analysis that produces predictions.

- ***Complex & Complicated***

When I interrogated the bodies of literature pertinent to this thesis, the dichotomy between complex vs complicated consistently emerged. It became clear to me that tacit knowledge fell under the rubric complexity while the knowledge of datafication can best be categorised as complicated. Throughout the literature, tacit knowledge is often linked to holism as it is attuned to the subtleties of social nuances, and it is multidimensional[21] (Cross, 2006; Kahneman & Tversky, 2013; Polanyi, 1966b). The problems design tries to solve often involve many unknowns and interrelated factors. Given this web of complexity, it is necessary to employ tacit ways of knowing

[21] What I mean by multidimensional is best illustrated by the following: AlphaGo is an AI developed by Google's DeepMind Technologies that beat Lee Sedol, one of the top Go players in 2016. This was hailed as a major milestone as Go is a game that requires cunning strategic thinking. However, while Alpha Go could beat the best Go player in the world, AI is only good as what it is trained on. On the other hand, a human can play Go, recognise emotions on a face, ride a bicycle, create enduring relationships or cry at a concert.

as there is often no algorithm that can be applied to tell a designer how to respond. Datafication is large-scaled and multi-nodal (as opposed to multidimensional), uses social maps, and relies on ability rather than skill. As indicated throughout the literature, problems best suited for datafication tend to be complicated rather than complex in nature in that they can be approach by applying a set of linear steps and/or processes (i.e., algorithms).

4.1.2 Framework for Comparing design and Datafication as Ways of Knowing

Characteristics of Designerly Ways of Knowing	Descriptors	Characteristics of Datafication Ways of Knowing	Descriptors
Qualitative	• Know-How • Non-mechanical • Subjective • Intuitive • Empathetic (value: being-with)	Quantitative	• Know-What • Mechanical • Objective (but it's illusory) • Logical • Efficient (value: reduce human bias)
Embodied	• Making and doing • Concern for the living • Artefact (reification) • Representational language (sketching) • Situated	Disembodied	• Liquid • Concern for optimisation • Abstract (reverse reification) • Computational language • Universal (but it's illusory)
Emergent	• Ambiguous • Adaptive • Co-creative • Abductive • Pattern Creating	Linear	• Statistical • Standardised • Measurable • Deductive • Pattern Finding
Experiential	• Anchored in time (past, present, future) • Expertise-based • Physical, emotional, mental power • Understanding • Dialogic	Optimised	• Ever-changing present • Code-based • Computational power • Predicting • Sequential
Complex	• Holistic • Social nuances • Interconnection • Multidimensional • Skill	Complicated	• Large-scaled • Social maps • Centralisation • Multi-nodal • Ability

Fig. 4. Comparative Chart of the Five Attributes of Design and Datafication

Comparative Critique of the Attributes of Tacit Knowledge & Datafication

4.1.3 Qualitative – Quantitative

- ***Science or Scientism?***

As noted in Chapter 2, design as a scientific discipline in the 20th century began in earnest during the 1960s, with the design methods movement. What the early researchers in design were trying to achieve was to identify a methodological template that all designers could follow to "do" design. The design method movement was based on rationalisation and deductive logic. It was the "design as science" view of design. To be more precise, it was a view of design based not on science as

such, but more specifically on scientism. Media and culture critic Neil Postman (1992) defines scientism as composed of three main elements, firstly that the methods of the hard sciences can be transposed to human behaviour; secondly that society can be engineered according to the principles uncovered by those methods and thirdly, that faith in science is a belief system that provides meaning to life. In *The Tacit Dimension*, Polanyi (1966b) argues that science does in fact rely on tacit knowledge, and that there is a qualitative aspect to science. As I went through the literature, I realised that what we saw happening in the late 19th century and 20th century was actually a more specific phenomenon: the rise of engineering and administrative thought (Bowker & Star, 2000). Those come from engineering and management thinking that became preeminent during the industrial revolution with the need for systematic administrative structure and statistical thinking to organise the production and manage the business of mass consumerism (Agar, 2003; Benjamin, 1999). The most striking example of this is Taylorism. Number-based metrics have their place in economic life, but they are fundamentally abstractions and suppose predictable and rational situations. This is the type of thinking that underlies the design methods and the enterprise of rationalisation of design in the 1960s.

- ***The Great Split of the 1970s-1980s***

The history of design in the second half of the 20th century shows the failure of trying to reduce design to this type of thinking. In the 1970s and 1980s, the realisation emerged that design deals with unique complex problems that the methods of the natural sciences are not equipped to handle (Archer, 1979; Cross, 1982; Rowe, 1991) and that design has a specific way to produce and transmit knowledge (Cross, 2006). The design method movement is of particular interest for this thesis because two branches came out of it. One school of thought focused on "designerly ways of knowing "and tacit knowledge, placing an emphasis on the human aspect of design epistemology while the other delved into the exploration of what can be described in generic terms as "artificial intelligence". Artificial intelligence as an idea fits the conception and the ideology behind the design method movement, namely that human intelligence and cognition can be quantified,

reduced to a series of mechanical processes that can be modelled and replicated by machines. Throughout my interrogation of the literature, these two branches kept growing in parallel, and as it became clear that design's ways of knowing relied on a humanistic ideology and the subtlety of tacit knowledge, it also became clear that the "engineering branch" was developing another way of knowing, based on an ideology of man as machine which found its greatest expression in datafication, i.e., reducing human life to discrete data bits. On one hand, we had the qualitative expression of human cognition, the importance of the "je ne sais quoi" of human tacit knowing, i.e., a "know-how", and on the other, the quantitative and mechanistic view of the world that was embodied in the research to develop intelligent machines (a "know-what"). While design established itself at the intersection of the arts and science, datafication was a clear result of the second.

- ***Objectivity at The Heart of The Matter***

While combing through the different bodies of literature, another consistent theme that kept coming back centred on the question of objectivity. The concept of objectivity has been a major question in the philosophy and the practice of modern science. The scientific method relies on objectivity, the world of objects and facts, which holds tightly to the idea that there is a world outside of the observer. It is suspicious of subjectivity which it sees as unreliable because it is conditioned and biased (boyd & Crawford, 2011). The aim of the natural sciences is to detach from the subjective realm, and apply a process whereby hypotheses are created, tested and verified through replication, leading to "true" knowledge. A marker of the domain of the hard sciences, the principles of the scientific method have nevertheless been applied to the social sciences since the 19th century to discover general truths about human behaviour (Durkheim, 2014; Postman, 1992).

- ***Tainted Intuition***

Another theme to consistently emerged dealt with how datafication relies on the assumption that humans' tacit, intuitive way of knowing cannot be trusted because it is tainted by emotions that sway judgement (Mau, 2019, p. 62). Dataism, the underlying ideology supporting this assumption,

reveals a fundamental belief in the objectivity of quantification (Van Dijck, 2014), and the trust that scientific methods apply to the study of human behaviour (Postman, 1992, p. 146). In contrast, tacit designerly ways of knowing, offer a space for the subjective. Today, the tacit knowledge of design and datafication way of knowing are forced to co-exist, but as the related literature clearly shows, there is a deep-seated distrust of the data science in the subjective and this belief is often antagonistic to design's tacit ways of knowing (Chandrasekaran, 1997; Goel, 1995).

This trust in the objectivity of data partly reflects the underlying dominant positivist ideology that proposes that the social can fully submit to the principles of the hard sciences (Bourdeau, 2022; Postman, 1992), but it also betrays some more mundane concerns related to purely economic interests. The idea that datafication produces reliable "facts" about human behaviour drives the success of the targeted advertising model and the profitability of the companies relying on it. The business model of the targeted advertising platforms relies on the confidence advertisers put in those datafied platforms that they are able to deliver results. In other words, if advertisers did not have confidence in the platforms' methods to bring results, they would not pay for those methods[22]. While a number of factors coalesce to give datafication an undisputable halo of truth, this veil of objectivity is illusory.

- ***Who Decides for Whom?***

Today, many of the decisions made in the human and social realms are made by computers relying on digital data and algorithms. For example, social media platforms have turned making friends into an algorithmic process of friending (Couldry & Van Dijck, 2015). I had a hunch that this was problematic despite the claims of objectivity and neutrality, and analysis from the literature confirmed that data are a situated and contextual socio-technical phenomenon (boyd & Crawford,

[22] As it happens, metrics do not automatically equate with truth. A 2018 class action lawsuit filed in California by some small advertisers argued that Facebook executives ignored employees' request to fix a grossly inflated ad metric to avoid a "significant" drop in sales. In 2019, Facebook admitted it overstated video-viewing metrics and settled a lawsuit for US$40 millions. The company (which changed its name to "Meta" in October 2021) derived a US$119.93 billion revenue from targeted advertising in 2021 based on proprietary and opaque metrics.

2012b), operating much like a cultural object (Cheney-Lippold, 2017) that reflects human bias (Bowker & Star, 2000). Data are part of a narrative, they are neither neutral nor objective but need to be interpreted to give meaning (Dourish & Gómez Cruz, 2018). Additionally, it emerged that they can also create or exacerbate inequalities because they do not come out of nothing but are created from the computational rendering of existing human relationships and assumptions (d'Alessandro et al., 2017). They also need to be organised and processed by algorithms that follow a logic of quantification and fragmentation (Amaro, 2019).

- ***Too Much of a Good Thing***

As mentioned from the onset of this research, it is not the aim of this thesis to show that datafication is harmful in and of itself. Modern societies do rely on and benefit from knowledge production arising from machines. They are useful and bring many benefits such as early detection of life-threatening diseases, development of new drugs, natural disasters prediction just to name a few. What I aim to examine is how datafication is applied and how much we rely on it. Firstly, as mentioned earlier, datafication is defined specifically as the quantification into computer-ready data of qualitative aspects of life. There are qualitative, tacit and intuitive aspects of being human that do not readily lend themselves to being turned into computer data. Secondly, there is also the matter of how much we rely on knowledge arising from computer-data. Datafied and intuitive ways of knowing can co-exist and reinforce each other when they operate in a balanced relationship. Today however, the algorithmic way of knowing is spreading to every qualitative aspect of life, overwhelming other tacit, more human-friendly ways of knowing.

- ***Mechanical Objectivity vs Empathy***

One of the ideas triggering this research was a concern about where the trust in “objectivity” is leading us and how it affects design knowledge. In *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (2020), Porter argues that there is a distinction to be made between disciplinary objectivity and mechanical objectivity in the context decision-making. Whereas the first one is based on the expertise of selected professional elites coming from professional

standards and practice, the second one only requires the standardisation of rules and procedures. Datafication fits the requirements of mechanical objectivity as it aims to take human subjectivity out of the process of knowledge production. In this context, what is often presented as the "digital revolution" may turn out to be the pinnacle of modernity's mechanical type of thinking.

Furthermore, what became clear when I compared data gleaned from the various literature sources was that the values underlying design and datafication are at odds with each other. Design relies on a fundamentally empathetic value of "being-with" whereas datafication relies on values relating to efficiency (administrative knowledge), and the reduction of human biases (positivism). This is particularly acute in algorithms, which have come to represent a presumed neutrality and scientific truth about human and social behaviours. As we saw above, data are not objective. If data are the wheat, algorithm is the machine that turns the wheat into flour. Algorithms are vehicles to sort things out in order to produce a desired output. The intention and the value behind their blueprint is predictive efficiency (O'Neil, 2017). For example, while social platforms play a social role in "bringing people together", their algorithmic architectures fundamentally serve the purpose of systematically collecting behavioural data and creating an efficient market place (Zuboff, 2019). Datafication is a reductionist logic of knowledge based on impoverishing assumptions about human nature. It assumes that sets of computer data encompass the totality of human behaviours, and that by entering a set of quantifiable behavioural data, we can predict and even modify human behaviours (2019).

4.1.4 The Embodiment of Knowledge

> I would like to insist on the embodied nature of all vision. (Haraway, 1991, p. 188)

When gathering insights from the literature from various disciples, I realised that there was a fundamental dichotomy between embodiment and disembodiment emerging. Tacit knowledge of design is embodied whereas datafication is disembodied, which means that because it does not exist within a living body, it is not embedded in any perception of time and space, of identity or

any lived experience. While it is an issue that is seldom addressed in the literature on datafication, the quality of embodiment is a major element in the nature of the knowledge that is produced. One issue which is not often addressed in the literature as of now is that a medium produces knowledge at its image, so the question can be asked of how does the knowledge that is produced by a medium and a language that are disconnected from lived and perceptive experience relates to embodied beings? The media of oral (oral traditions), written (the book), auditory (radio) and visual (TV) communication all appeal to the senses, i.e., perception. But algorithms are truly disembodied and their language is utterly incomprehensible for human cognition.

Tacit designerly knowledge has a natural connection to embodiment. Firstly, because design as a discipline has a concern for embodiment in general, the embodiment of ideas, values and sense-making into artefacts. Herbert Simon (1996) emphasised this early on by defining design as the "science of the artificial". It is clear from the insights from different strands of literature that another aspect of this deep relation to embodiment has to do with embodied cognition. This understanding has been deepened by Haraway's work on situated knowledge. She argues that knowing is always located within the specific contexts and the specific perspective of the knowers and shaped by their experience (1991). In this sense, knowledge is at the image of the knower: positioned, affective, embedded and relational; therefore, all knowledge claims - even scientific - are partial and can't be completely known. In other words, tacit is an intrinsic quality of knowledge (1988). As knowledge that can be known but not told, tacit knowledge cannot be produced outside of the living physical envelope of a living being.

The field of artificial intelligence has been working for decades on trying to create a form of tacit intelligence comparable to that of humans, but has failed to fully replicate the basic natural capacities of embodied cognition. In other words, design is not "all in the head"; it is deeply embedded into the artefact, the human, the social, or more generally, the living. This dimension is characterised by a number of qualities that were revealed during the analysis and conceptualisation phases of the research, namely an emphasis on making and doing, a concern for the relationship of

human or non-human actors to the world, a tradition of artefacts (reification), the use of specific representational language (sketching is a specific language of design and is situated and contextualised). The same methodological process revealed that datafication on the other hand is a disembodied epistemology. It is essentially fluid, i.e., disconnected from people's perceived and experienced reality – with emphasis placed on optimisation that is purely abstract. It also uses computational abstract linguistic forms and claims to be neutral and universal. An illustration of this is found in the design of social media. Physical architectural artefacts often reflect and incorporate the diversity of contexts where they occur, in other words, they are situated, but the architecture of social platforms, and the values that underlie it, transcends geographies and cultures.

The analysis of sources reveals that computational theories of mind leave aside the lived, embodied aspect of experience. For example, in *The Embodied Mind* (2016), Varela, Thompson and Rosch illustrate this by arguing that there is a fundamental circularity between our experience of the world ("that is not made but found") and our body, or the structure "that enables us to reflect upon this world" (p. 3). With datafication, we see the (re)-emergence of a genuine problem, that of a ubiquitous science of mind that fails to inform the nature of lived human existence.

- ***A Liquid Epistemology***

The nature of datafication is liquid, i.e., detached from the embodied reality of being human in a physical world and anchored in the timeline of past, present and future. Discrete bits of data do not surrender to the constraints of time or space. Like atomic particles, they aggregate and disaggregate at will (the will of whoever controls the algorithms). Because they are disembodied, they cannot encompass a memory of previous experience, a beingness in the present or a hope for the future. As all data from the literature made clear, designers deal with realities that are embedded in lived contexts. Datafication erases the memories, the embodied perceptions, the experiences, the lived relationships that shape our awareness of who we are. It cancels context and the understanding of situations that come from it. For example, under datafication, users' ability to

perform effortlessly in the datafied universe becomes a piece of knowledge. Some vulnerable groups are unable to fill online forms for a multitude of reasons (language, unfamiliarity with computers, disabilities etc.), but when "data not filled" is considered a proxy for unreliability, it also becomes a proxy for systemic discrimination. This is but one example of how datafication can lead to misguided discrimination.

Under datafication, digital "metrics" become the filters that give shape to reality. With the datafication of previously unquantified knowledge, new categories appear and new social hierarchies emerge (Mau, 2020). For example, digital infrastructures transform identities into fluid algorithmic "measurable types", or as Deleuze (1992) puts it "dividuals" partitioned into various informational units. This is illustrated by Google's response to the "right to be forgotten" regulation in the EU, with the development of an algorithmic metric that could set apart non-celebrities and celebrities (Cheney-Lippold, 2017). Measurable types are essentially different from individuals in that they constantly change with the aggregation or disaggregation of digital data, whereas the perception of one's individuality is a compound process of adding tacit information from experience.

- ***Proxied Meaning***

While this is an often overlooked and under-discussed issue in the public arena, there is an important amount of unusable, unstructured data collected from social interactions. This is largely due to the fact that they cannot be turned into metrics, i.e., into measurable, quantified pieces of information. To extract meaning, data that cannot be measured is "proxied", i.e., the meaning is sourced from other data sets under a logic of equivalence. This is not to say that other measurements systems do not use such logic. In fact, even before the advent of datafication, administrative systems used postal or ZIP codes as a stand-in for revenue levels. The human mind also uses heuristics when faced with the unknown. However, under datafication, this approach has become more central and opaque. An example of this is measuring the interest from a website user through the number of pages visited and the amount of time spent on the site, or inferring a user's

intent, interest and engagement from a click (O'Neil, 2013). Social platforms constantly use proxying to infer qualitative knowledge about users from measurable behaviour (clicks, friending etc).

As it became clear from the analysis of the literature, the politics behind the decisions to include or exclude, to aggregate or disaggregate are concealed by the scale of big data and its utter incomprehensibility for the human mind. However, the decisions about what counts as relevant data, and what proxies are adopted are not neutral and can (and often do) confer immense power. Anything that is deemed irrelevant (i.e., cannot be quantified or proxied) is abandoned from the models and disappears into the void. However, this provides a truncated interpretation, as what is not there is often just as important (sometimes more) as what is. While that power is shrouded in the secrecy of algorithmic processes, it impacts the production of knowledge and the social nevertheless. Furthermore, proxying qualitative data creates real issues with the reliability of the knowledge that is produced. It decreases the reliability of the evidence, increases the risk for errors and causes problems with establishing relationships between variables (Steven, 2007).

In education for example, teachers' performance is often proxied on students standardised test scores, obfuscating other non-measurable factors and the important qualitative aspects of a teacher-student relationship. Data scientist Cathy O'Neil (2013) sheds light on the politics of modelling and the choices made to rate junk mortgage derivatives using historical default rates data resulting in junk investments being sold to people with fallaciously high ratings. While these decisions led to the most severe financial crisis of the 21st century, they were also optimised for increased sales and larger bonuses. This example once again illustrates how data-dependent models focusing on optimisation can be highly detrimental.

- ***Concern for Optimisation***

In 2017, a ProPublica investigations into Facebook's secret censorship rules revealed that white men were protected from hate speech but not black children. This is because in the model, both

race and sex are protected categories, but age is not, and the protection only applies when all traits fall in protected categories. Facebook defended the policy to protect all races and genders equally, an approach known to disadvantage younger and more vulnerable users (Citron, 2014), by saying its goal is to apply consistent standards worldwide. Facebook's response reveals an emphasis on the blanket application of universal principles rather than a more nuanced sensitivity to context. It indicates an underlying concern for disembodied efficiency and optimisation rather than for honouring situated human experience that is embedded in a context and in complex qualitative relationships. This is problematic in that Facebook's opaque and unaccountable algorithms operate at a global scale, sorting, targeting and optimising billions of people (O'Neil, 2017).

Optimisation does not happen in a void; it is supported by the intention of the actor who controls the design of the algorithms. However, this agenda is obfuscated behind the technicity and the opacity of the algorithm. Furthermore, because of the circularity of knowledge production, i.e., knowledge produced by algorithms is fed back to us to orient ourselves in the world, the problematic result of these processes of optimisation becomes a proxy for what comes to be considered as the truth. This is illustrated by the algorithmic newsfeed on social platforms. Many users do not know that what and who they see in their newsfeed is orchestrated by an algorithm, leading to the making or breaking of "real world" friendships.

- ***Abstract Knowledge***

A basic definition of reification is to turn an abstraction into something material or concrete[23]. In its simplest definition, reification means to create things (Pitkin, 1987). While it is outside the scope of this thesis to go into the debates surrounding the process of reification in design and the critique of the different paradigms that support this process (human-centred, user-centred etc.), suffices it to say it carries a long tradition within the field of design, especially in designing

[23] Etymologically the word derives from the Latin res, which is translated as "thing" or "object".

complex relationships between the world and its inhabitants (humans or non-humans). More specifically, it is a process by which the world is "re-presented" to help us orient ourselves in it and derive meaning from our experience (Berry, 2015).

Datafication shifts the meaning of the term, whereby reification consists of turning abstract ideas into programming language. In this context, the "res" of reification is not something that offers affordances in the physical world, but a computer code which is inherently incomprehensible to human cognition. For this reason, I call this process "reverse reification" to emphasise datafication's alternative focus. We can find numerous examples of this in the digital world, amongst which turning a qualitative human activities such as making friends into an algorithmic relationship called "friending" (van Dijck & Poell, 2013). One of the most obvious examples of the differences between the epistemologies of design and datafication can be found in the treatment of images. Under datafication, the visual, a fundamental element of design epistemology (see the discussion on sketching above), is turned into an aggregation of pixels.

The analysis of the literature quickly revealed that statistical models are highly abstract technical models written in programming languages which offer specific affordances. They are optimised for specific agendas, such as getting users to click on ads, or purchase products, or return to a platform. There was a clear consensus, even in the literature on data science, that these highly theoretical models based on mathematical equations are not perfect when they apply to the real-world experiences, and can create a profound disconnect between the knowledge emerging from the model and the actual lived reality. This is highly problematic as it leads to overconfidence in their ability to deliver true knowledge results in self-fulfilling definitions of success and increasingly tight feedback loops.

- ***Abstract Language***

Differences in language is another theme that came back repeatedly in multiple ways throughout the literature. In his seminal article on designerly ways of knowing, Nigel Cross (1982) argues that

designers should not turn away from “Technik”, and embrace the special language of design, which is not purely intellectual, but also embodied, and anchored in making and doing. A common theme that comes back throughout the literature is that sketching is a critical tool for the designer not only to externalise thoughts (Lawson, 2004), but also creatively interact with the image (Goldschmidt, 1991). The designer enters into a dialogue with the sketch which is mediated through the body and the senses (the hand, the eye, feelings and thoughts etc.). The language of design is multi-dimensionally rich and draws on the intuitive and creative side of the human mind that enables and provokes flashes of insights. It is equipped for and aims at turning the abstract into the concrete realm of human life and experience.

On the other hand, while digital language carries potentials, it is clearly inadequate to understand the subtleties of human communication. One of the most disturbing illustrations of the deficiencies of computational language in understanding and feeding the social is the necessity for social platforms to recruit human content checkers to police their content. For years, social platforms have praised the automation capacities which enabled them to scale up at speed and “connect the world” while paying lip service to the regulation of violent material, gore, hate speech, or conspiracy theories being circulated in their space. In May 2017, after it was publicly confirmed that harmful content was being disseminated on Facebook in the aftermath of the US presidential elections, Facebook announced that it would hire 3,000 human moderators to police content on the platform[24]. This proved to be problematic in several ways. Firstly, because one can wonder how 3,000 people can effectively moderate content produced by 1.3 billion users (the number of Facebook users at the time[25]), and secondly, because it illustrates the profound helplessness of algorithms in the face of human-produced content, and the gap of understanding between human cognition and digital technologies. Human checkers are tasked with reviewing material posted on

[24] Marc Zuckerberg made the announcement in a Facebook post: https://www.facebook.com/zuck/posts/10103695315624661
[25] https://www.statista.com/statistics/417295/facebook-messenger-monthly-active-users/

the platform that ranges from disturbing to horrific and decide whether or not it violates Facebook's community guidelines, a decision that algorithms do not have the capacity to make.

In May 2020, Facebook paid US$52 million to settle with thousands of US "moderators" who developed PTSD[26] as a result of the material they were exposed to in the course of their work. A spokesperson issued a statement thanking the moderators for making "Facebook a safe environment for everyone", implicitly recognising that the company's algorithms do not have the capacities to do so. In 2020, the Financial Times revealed that people hired by companies providing "moderation" services for platforms (such as Accenture) are routinely asked to sign forms acknowledging that they may develop PTSD from their work (Murgia, 2020). It is clear that there is no digital solution to human-produced content moderation. It also clearly means that there is a discrepancy between the scale of social platforms which are run purely by computational processes and the needs arising from content moderation on those platforms.

Everywhere in the world today, human moderators of datafied universes are in increasing demand and companies compete by offering better benefits (Criddle, 2022), offering a bleak image of the potential of datafication to understand human experience. We can also wonder what kind of culture requires thousands of human workers to develop PTSD on the job simply to scrub material that its technology is unable to decode. It is a stark proof that datafication cannot handle the subtleties of human symbolic language in the same way designerly ways of knowing can. It is also a poignant reminder that in a universe where datafication rules (as on social platforms), technology does not serve people, but people serve technology.

- ***Illusory Claims for Universality***

Disembodied datafication claims universality and neutrality but the truth of the matter is that it is far more complicated than that. The disembodied nature of data makes sense-making a particularly

[26] https://www.theverge.com/2020/5/12/21255870/facebook-content-moderator-settlement-scola-ptsd-mental-health

fluid endeavour and there is nothing neutral about it. Data scientists "work" data extensively before they can be processed through algorithms. They are also filtered, organised, summarised, and grouped into sets to be cleaned (or in data science terms, "structured") so they fit the standardised computational systems that treat them.

Furthermore, data need to be interpreted, and questions need to be asked about how they are considered. It has been clearly established by several fields of research that data do not speak for themselves, they "must be narrated" (Dourish & Gómez Cruz, p. 45). In contrast to quantitative data, qualitative evidence must be inferred and requires a number of coding restrictions (Steven, 2007). They do not carry with them an innate ability to provide meaning, but must be aggregated into larger narratives and passed through processes of interpretation to make sense. If data are the building blocks of knowledge, sense-making is more than just a process of putting them together. Data are not meaningful in and of themselves, they are made to be so. They do not organise themselves organically but according to certain agendas and certain interests (Rieder, 2020, p. 32).

Getting data to "speak" requires a complicated process of sense-making which first requires to put discrete data into data sets. The fundamental nature of datafication is its fluidity, or its openness to interpretation. Like atoms, data can be disaggregated and reaggregated according to specific agendas, desires and interests. As Weinberger (2008) puts it, "*how* we slice it up depends on *why* we slice it up" (p. 82) (emphasis mine). The methodological processes that give meaning to data are not neutral (boyd & Crawford, 2011). The decisions that shape those sets are political acts often driven by hidden expectations and ideological or cultural assumptions. Then, in a chunking down process, the data sets are given meaning by allocating them to certain situations, which is also a political act.

Despite an assumption by some in the field of data science, and a belief by the general public about the neutrality of digital data, there is no such things as raw data. Firstly, there is a choice to include some data and leave others aside - and this choice to include or exclude is not neutral. Data are then interpreted, and the interpretation is not neutral either. This is even unwittingly

hinted at by the DIKW pyramid (i.e., data, information knowledge wisdom) a preferred model of communication in data science: data needs to be interpreted to become information. Data are situated; they are a result and an outcome of a certain cultural, political, economic, social context. Not only are data contextual and situated, included, omitted or proxied, they also require interpretation to provide an argument. Data need translation to become information, as making sense of patterns necessitates a critical interrogation. Data interpretation therefore requires a pre-set framework, and data analysis requires a pre-set purpose.

- ***The Materiality of Immaterial Models***

It became clear to me that - despite being presented as such - datafication is not purely immaterial. This is problematic at different levels. For one, it relies on a vast and expensive physical infrastructure. Undersea cables for example, are a critical element of datafication and carry ninety nine percent of global data (Burnett & Carter, 2017). As such, they often involve (and contribute to transforming) international law, but also reinforce global inequalities by following already established telegraphic paths (Vatanparast, 2020). They are also the objects of fierce geopolitical competition between countries or corporations to establish and control strategic undersea routes. Furthermore, large servers occupy space and consume significant amounts of energy. By some estimates, communication technology could use as much as 51% of global electricity, and contribute up to 23% of greenhouse gas emissions by 2030 (Andrae & Edler, 2015). But materiality is also found in virtual spaces and affect the production of knowledge in more subtle ways. Algorithmic constraints shape and enable human capacities and practices. What is included or not included in the code has a direct result on the real-life outputs as well as the protocols used to determine what can be expressed in the networks that they support. Datafication directly impact the ways of knowing and the ways of communicating, what can or cannot be expressed in the lived world.

One critical area where it becomes obvious that datafication has an impact in the real world is when the interactions between automated systems and humans produce “moral crumple zones”

(Elish, 2016) where moral and legal responsibility for a (possibly serious) mistake is attributed to a human who, in fact, has little control over the computational system that created the situation to begin with. A recent example of this in the domain of automated transportation: a safety driver is held legally responsible for an accident perpetrated by an autonomous vehicle. Elish and Hwang (2015) have argued that in some cases, a human presence is retained for the sole purpose of answering to regimes of liability.

4.1.5 Emergence

The third dimension of the tacit knowledge of design is its emergent nature. It is ambiguous (meaning that ambiguity is not only welcomed, it is valued), adaptive (meaning that it adapts to multiple elements such as the context, the aims, the design brief etc., but also that it adapts over time to the evolving situation, understanding etc.). It is also essentially co-creative (meaning that it arises from collaborative interactions of all sorts) and follows a process of abductive logic to create patterns. Even though datafication deals with and sifts through enormous amounts of data, the algorithmic process is essentially linear. It is a statistical, explicit and binary type of epistemology, measurable and standardised (what cannot be measured is abandoned), deductive and its essence is to find (rather than create) patterns in the vast amounts of data it has the ability to treat.

- ***Comfort with Ambiguity***

A common refrain in the literature centres on how design problems are ambiguous, which is not particularly surprising when considering how most problems having to do with living systems are in fact ambiguously defined. It is the way that design approaches those ambiguous problems that is distinctive. As we saw earlier, during the period when design was becoming a discipline in the later decades of the 20th century, studies comparing how designers and scientists approached the same ambiguous problems showed that designers employed solution-focus strategies (synthesis), rather than problem-focused strategies (analysis) (Buchanan, 1992; Lawson, 1979). Designers find satisfactory solutions rather than optimal and optimised solutions. We also saw that one of the

very unique elements of the design process of knowledge production is the co-evolution of problems and solutions – i.e., there is no pre-set outcome. The outcome is emergent, meaning that it is unknown from the start because it is created during the design process. It relies on the vague boundary between problem and solution. In fact, there is no design outcome if the boundary between the problem and the solution is tightly defined. Design knowledge is produced organically, it grows according to a process that has more to do with fungi growth than with arithmetic. Thus, ambiguity is not only welcome, it is necessary[27].

Optimisation on the other hand adapts solutions to a pre-set outcome. This is exactly what optimisation refers to. It means to set an outcome and build a set of procedures (an algorithm) that will deliver this outcome. Under datafication, ambiguity is shunned, as it is a major problem in the production of knowledge in the age of datafication. Ambiguous means unquantifiable, and unquantifiable means messy. Unstructured data are ambiguous data, and ambiguous data are unusable. They either have to be modified to become measurable, proxied (i.e., replaced by something else that is quantifiable), or abandoned altogether. Under datafication, ambiguity is rendered invisible and pushed under the carpet, like a mad uncle hidden in an asylum. In fact, datafication as a way of knowing claims to erase uncertainty and ambiguity. Measured precision is highly valued and a necessary element of a type of knowledge that finds its foundation in the discrete data bits (Dhar, 2013; Porter et al., 2018). To use an analogy from the ecological literature, if design knowledge is wholeness, datafication knowledge is parts. This is problematic because a large aspect of relational living is implicit and situational, relying on unsaid and vague rules that actors interpret differently. Datafication's claim to erase ambiguity also means that nuance is erased (van Dijck & Poell, 2013) .

[27] Not all design knowledge is produced this way, but the processes described form an important body of methods that designers can and do draw from when they design.

Data type	State	Treatment
Structured	Quantifiable	Quantified (1,0)
Unstructured	Qualitative	Proxied
Unstructured	Tacit	Abandoned

Fig. 5. Treatment of structured and unstructured data

- ***Being Adaptive***

As mentioned in the literature review, adaptability is embedded into design's DNA. Adaptable means versatile, alterable, modifiable, adjustable, changeable but also resilient, multiskilled and collaborative. One of the unique features here is the co-evolution of problem and solution as a *sine qua non* condition of design's way of knowing. During the evolution of design as a third discipline, with its own epistemology, there came the realisation that unlike disciplines from the hard sciences, designers spend a significant amount of time exploring the relationship between the design problem and the solution.

This exploration is not limited to the beginning but continues throughout the design process. Designers do not take the problem at face value, but explore different frames to understand the problem and open avenues for solutions (Dorst, 2015a; Weedon, 2019). Personal interpretation and inference are prime aspects of this process, and subjectivity is valued and even necessary as a component of adaptability. This approach establishes a circular relationship between problem and solution, and is needed to allow for the expression of personal creativity through the use of designer's tacit knowledge. In fact, it could not happen without the use of tacit knowledge.

In a way, it can be argued that datafication is adaptive as well, because the output evolves with the data. However, it is adaptive in a fundamentally different way than the emergent way of design knowledge in that the nature of datafication requires standardisation. Datafication adapts to the data included in the sets, but it also erases differences and renders a whole dimension of life invisible by proxying and abandoning unstructured data.

There is also another aspect of the standardisation nature of datafication, which has to do with the purpose of knowledge. While tacit knowledge assists understanding, datafication aims to predict. A white paper published by IBM in 2019 titled *A business guide to modern predictive analytics*[28] illuminates an aspect of datafication by laying the ground for how AI can assist business. The first page of the guide summarises the fundamental purpose of datafication in the following statement:

> In business, foresight is everything. If you can predict what will happen next, you can do the following tasks: make smarter decisions, get to market faster, disrupt your competitors.

The white paper then goes on by saying that data scientists "need to find repeatable, automated ways to provide real-time insights for day-to-day decision-making". It is interesting to read those words in 2019 as they echo what was written in the 1960s about design methods.

- ***Valuing Co-Creativity***

The problems of design are "wicked" (Rittel & Webber, 1973), which means that they are of a level of complexity that requires more than linear applications to solve. Design knowledge welcomes and even requires uncertainty. Schon illustrated this by saying that the production of design knowledge involves risk taking and improvising (1984). One very striking feature that emerged from interrogating different fields of research through the GT methodology used in this thesis is that different disciplines are like pieces of a puzzle. They are not parts of the whole, but represent different aspects of the whole, like a hologram. Designers, and the creative and practice-led disciplines in general, know first-hand that the world does not lend itself to reductionist epistemological silos. On the contrary, co-creation is a distinctive feature of the production of knowledge in design. This is seen for example in the co-evolution of problem and solution, where the end problem is often very different from that of the original brief. The prefix "co" is very important and emphasises that creation happens not linearly and abstracted from context but in

[28] https://www.ibm.com/downloads/cas/0RMBW34B

situ, and in dialogue. The dialogue is multidimensional and happens during the design process between internal and external representations, between designer and situation (Schon, 1984), but also between human actors, as well as between human and non-human actors.

One major element of datafication is measurability. It is a major theme that underlies the literature in data science. This theme is supported by an ideology that makes objective classification a fundamental requirement. A primary assumption of the quantified view of the world is that everything is measurable in one way or another. Once we accept this underlying assumption, then the logic of datafication becomes unquestionable. However, this assumption is problematic when it comes to human life; can objective measurements of such aspects of being human as emotions and relationships truly render their complexity and richness? One example is the standardised assessment of teaching and learning on a large scale. O'Neil (2017) relates the issues relating to the algorithmic scoring of teachers' effectiveness through the tests results of their students (a compelling example of the process of proxying unstructured data that was mentioned in the sections above). Firstly, effective teaching and learning encompass many factors that are very difficult to measure. The most important ones may not be measurable at all. Secondly, students' test results are not a reliable proxy for overall teaching effectiveness as too many other elements come into the equation. Then, in many instances, the statistical sampling is too small to be sound (twenty-five to thirty students). Finally, algorithmic systems require feedback to tell them how they perform. Most of the time, the result of algorithmic assessments is taken at face value (i.e., in this case, teachers are fired) but the algorithms remain unquestioned. Human experience and performance are evaluated by a measure for which there is no explanation, as the analysis is left to code and the statisticians behind it. Apart from the potentially harmful personal and social consequences, it also has pernicious consequences on the production of knowledge.

Analysis from wide-ranging sources shows that another harmful consequence of the overarching proliferation of a quantified epistemology is due to the circularity of knowledge. Namely, the knowledge produced by algorithms shapes the world as we see it because it is fed back to us to

orient ourselves in the world and becomes the language to explain that world to ourselves. Simon (1973) was one of the first in a long lineage to data scientists to propose to solve the "ill-structured" problems of design by turning them into (or treating them as) well-structured problems in order to solve them.

- ***Abductive Logic***

A consistent theme in design literature is that designers employ abductive modes of thinking to engage with uncertainty and to create new knowledge to "design a radical unknown" (Gentes, 2017, p. 7). There is a back-and-forth alternating dynamic between problem and solution. The problem becomes a springboard to generate and explore solutions and in turn, the newly minted solutions illuminate unseen aspects of the problem, which then bounce back toward the solution in a non-linear process. As mentioned earlier, the abductive process is creative in that the process is led neither by a known *what* (problem at hand) nor a known *how* (working principle), but by an end *value*. It is clear that this abductive back and forth cannot be translated into computer language as it is an utterly fuzzy and unstructured process. Both the design problem and the working principles have to be created. The designer has to adopt a line of action while at the same time, remain open to change (Schon, 1989). This creative process arises in design when the designer is faced with a paradoxical situation consisting of incompatible statements that are all valid but cannot be integrated (Dorst, 2011). The wicked problems of design are inherently contradictory thus placing the production of design knowledge in these paradoxical and abductive spaces.

Datafication on the other hand relies on a language that is essentially deductive whereby the result is unknown, but the data and the way to get the result (algorithmic process) are known and predetermined (Douven, 2021). In datafication, there are no paradox as defined above (conflicting statements that are all valid but irreconcilable), because conflicting data does not remain as such but is swallowed and aggregated into a whole (like ingredients added to a soup, they lose their individuality, and becomes part of the soup). The boundaries of discrete data disappear when

aggregated, just as the boundaries of our identities disappear, this is the essential fluid nature of big data. Creativity and innovation emerge from a tension between incompatible but valid statements. Big data however, neither integrates nor abandons paradoxical statements, causing the tension to disappear.

- ***Pattern Creation***

One of the aspects of datafication that is often put forward as a proof that algorithmic ways of knowing are superior to that of humans' is that algorithms can find patterns in vast amount of information that reside outside of human cognition (McClure, 2020). While it is true that algorithms can process huge data groups and that this ability serves an important purpose, I propose that it is unfair to consider this as a proof of superiority. It is at best a proof of difference. The development of digital networked technologies has been accompanied by a parallel explosion in the amount of data on all types about people. As indicated in the literature review, big data is more than an increase in the size and scope, it is also a shift in the nature of how knowledge is created (Tufekci, 2014). Algorithms rely on new assumptions about what is valid knowledge, and propose new models of the world that are comprehensible to computers but not to human actors. As Latour (2010) argues, a change in instruments is followed by a shift in the attendant social theory. There is ample proof in the literature that big data is not only a process or a technology, it is a completely new type of sense-making, one that relies on pattern recognition.

Pattern recognition is often associated with big data, but I have asked myself the question: what reality does it refer to? It is useful to unpack what hides behind the term. Because of the networked architecture of datafication, data, as its atomic building block, only acquires meaning in relation to other data. Pattern finding depends on the connections that are recognised between data about individuals, between data about the relationship between individuals, and between data about groups of people (boyd & Crawford, 2012b). As previously mentioned, research indicates that these data are already existing and already organised in data sets. This means that the substrate for the pattern recognition process is a selected number of bits of information from the

past. It is clear that because the process of pattern finding occurs in a sea of past data, datafication does not allow to lean into a new imagined future, but instead solidifies past patterns. They consolidate the existing biases inherent in society that have been embedded into the digital data that feed the algorithms which recognise those patterns. In some instances, the pattern recognition ability is beneficial (predictions relating to weather or health for example). However, in domains that relate to human social life or issues relating to all living systems in general, it is problematic because it solidifies the existing disequilibrium. This is clearly illustrated by the phenomenon of filter bubbles on social media, which locks users in an echo chamber by giving them more of what they have been asking instead of opening new avenues and new possibilities, or in other words, by favouring the past (and the known) to the detriment of the future (and the emerging).

The point here is not to say that the human mind is not biased, but rather to highlight the many ways algorithms replicate these biases. It is telling that Davenport and Patil (2012) list some of the important skills that data scientists must have, which have to do with bringing "structure to large quantities of formless data", "identify rich data sources, join them with other, potentially incomplete data sources, and clean the resulting set" (p. 73). It is quite clear from this that there is human intervention at all stages of the data preparation (not to mention the design of code), meaning that the data are highly "massaged". Furthermore, an important theme coming from the literature is that while the patterns have predictive powers, they do not propose explanations that further understanding. Algorithms operate like black boxes in how they establish the correlations in pattern finding (Andrejevic & Gates, 2014). As boyd and Crawford (2012b) remind us, it is a mistake to equate the ability of big data to identify patterns with higher intelligence. It is at best another form of intelligence. And like all forms of intelligence, it may apply better in one context but not another and it may reveal certain aspects of the world that do not represent a universal or unquestionable truth.

In the modern field of life science, the term emergence points out to the surfacing of new properties in an organised living structure that are not present in its parts (Capra & Luisi, 2014, p.

144). In other words, emergence refers to the appearance of something new that could not have been deduced by analysing the parts and putting them together. The concept is closely related to that of self-organisation, whereby a living system organises itself according to rules internal to the system itself. A system organised by external "imposing" forces (such as algorithms for example) is not self-organising. Emergence is therefore related not to pattern recognition but to pattern creation, the result of the co-evolution of problems and solutions in design. Similarly, while digital search (defined as sifting through oceans of data) can be programmed, exploration cannot; exploration involves searching for something that can only be recognised once it is found (Goldschmidt, 1997).

4.1.6 Experience at the Centre

Design knowledge is experiential, i.e., the designer's personal experience as a designer and as an individual holds a critical place. In doing so, it is: (1) anchored in time (2) expertise-based (3) requiring of physical, emotional and mental power (4) dialogic in nature, i.e., based on multidimensional interaction and collaboration between the designer and the design problem and subsequent solution. Datafication on the other hand is: (1) optimised (2) created in an ever-changing present (3) dependent on the liquid aggregation of data into datasets (4) code-based and sequential and (5) aimed at prediction rather than understanding.

- ***Being Anchored in Time***

Tacit knowledge is anchored in time, and datafication lives in an ever-changing present. Polanyi's reference to knowing more than we can tell (1966b, p. 4) refers to a knowledge that is essentially unconscious, uncodified, embodied and that is refined by direct experience over time. Polanyi's assertion is that, for all the emphasis put on objectivity, deduction, falsification and reproducibility, science also relies to a great extent on tacit knowledge. In this sense, science is distinct from the administrative, engineering or scientific management mindsets which tend to favour sets of standards and procedures to follow (see: Taylorism, the assembly line of the industrial revolution, or more recently, the Six Sigma mindset).

Haraway (1988) develops this idea with the concept of situated knowledge which recognises that all knowledge is positioned in specific social, historical, and cultural contexts and therefore always implies some degree of tacitness. Stengers (1997) echoes this with a call to rethink the neutrality and objectivity of scientific knowledge and honour the place that power, politics, and social values play in its production. She emphasises the need to acknowledge and embrace other, more intuitive ways of knowing.

As alluded to throughout the different bodies of literature, datafication is liquid, i.e., detached from the embodied reality of being human in a physical world, anchored in the timeline of a past, a present and a future. Discrete bits of data do not surrender to the constraints of time or space. Like atomic particles, they aggregate (into datasets) and disaggregate at will (the will of whoever controls the algorithms). Because they are disembodied, they do not carry a memory of previous experience, a present beingness or a hope for the future. It is clear from the research that designers deal with realities that are embedded in lived contexts, even when they are intangible. Datafication erases the memories, the experiences, the lived relationships that shape our perceptions of who we are. It renders context and the understanding of situations that comes from it irrelevant. For example, under datafication, the mere ability to perform effortlessly in the datafied universe becomes a piece of information. As mentioned previously, this is starkly illustrated among vulnerable groups who are unable to fill online forms for a multitude of reasons (language, unfamiliarity with computers, disabilities etc.) and get downgraded, because “data not filled” is considered a proxy for unreliability. More often than not, these built-in mechanisms of discrimination impact the poorest and most vulnerable populations most. Through this fluctuating process of data assembly and disassembly, datafication finds patterns invisible to the human eye, and this can be extremely beneficial in certain contexts. This is a well-known benefit that has been put forward. However, this research reveals that because of this very process, datafication also creates a knowledge that is disconnected from the lived reality of human social actors.

It is not to say that algorithms cannot improve with time; they can. In fact, AI is predicated on the idea of learning by repetition. But they only do so when they get the necessary feedback, which is far from always the case as described by data scientist turned big data critic Cathy O'Neil (2017). There are several reasons why algorithms do not get the required feedback necessary for them to improve. Firstly, for a circumstantial matter of convenience. The algorithms that decide on educators' performance, recidivism, socialisation and other human activities are designed by coders and statisticians, not by the people who will use the algorithms (educational institutions management, judges, social media users etc.). While in theory, there is a smooth flow of communication between software creators and end users (such as for example when coders design algorithms for a police department), in actual facts, there is often a gap of expertise between the two (i.e., users know their business and coders know coding with a gap in-between), which would require extensive amounts of time and funding to fill. The reality is that in many instances, the manufacturing of the algorithm itself is outsourced to expert companies which, following the concepts of scientific management, are optimised for maximum profit in minimum time. Their clients' IT budgets and time are also limited and choices for cuts are more likely to affect side elements such as lengthy assessments of results. Plus, as mentioned above, the data fed to algorithms are also situated and not neutral. Furthermore, it became clear that there is another more surreptitious and more problematic aspect of feedback as it relates to lived experience; even when feedback is present, it must be given in a way and through a language that can be understood by computational systems, which is often not possible when assessments are composed of purely qualitative information. So, we fall back into the main issue which is at the centre of this thesis, namely, how to turn qualitative elements of human life into quantified data to feed back to the computational systems.

The architecture of computational systems itself encourages the aggregation and disaggregation of data, creating constantly changing "data doubles" and abstracting the reality of lived experience. The resulting knowledge has been described as a moving "surveillant assemblage" (Haggerty &

Ericson, 2006). While the truth of the human world is anchored into time and space, the truth of datafication lies solely in the ever-changing present of the agendas and assumptions designed into algorithms.

- ***Expertise***

Tacit knowledge is not separable from the idea of expertise. The study of how expert designers produce knowledge took off in the 1980s (Glynn, 1993). Before that, the emphasis had been put on design methods, or the scientific approach to design. Insights from the literature show that over the years, the critical role of expertise arising from tacit knowledge has become increasingly obvious, and studies have shown that experience and intuition play a large part in the design process (Ahmed et al., 2003; Deken et al., 2012; Lawson, 1979). The result from those studies has been confirmed by parallel research in the fields of psychology of creativity and the quest to understand expert designers' cognitive strategies (Lawson, 1979). Research has shown that expertise is built over time, requiring about ten years of experience (Ericsson et al., 1993; Lawson & Dorst, 2009). An important theme in design is the "generation of alternative solutions" which is central to the design process and relies on ideas that expert designers have embedded in their life experience.

Datafication on the other hand does not rely on expertise but on code. One could argue that coding takes expertise, but this is not the point. The point here is that the tacit knowledge of design arises out of experiential ways of knowing, i.e., embodied expertise, whereas the knowledge of datafication arises from "flat", detached and abstract code. Coding does take expertise indeed, and comparatively few people have the ability to handle this type of activity. This is problematic, because while it has been argued that everyone designs (Manzini & Coad, 2015), not very many people can code. Coding is not a natural human skill; it is a learned abstraction. It is outside the scope of this research to enter into the rich debate about computer languages vs natural languages. Suffice it to say here that abstract mathematical language-based datafication lacks the experiential dimension of the tacit knowledge of design.

- ***Physical, Emotional, and Mental Power***

While combing through the literature, it became clear to me that while the tacit knowledge of design requires physical (embodied), emotional (empathetic) and mental (reasoning) power to come into existence, the knowledge of datafication primarily requires computational power. By transforming qualitative aspects of life into computer languages, a process called formalisation which has been critiqued as reductionist (Rieder, 2020), datafication obstructs and limits our ability to make sense of the world around us.

To follow Korzybski's well-known saying, "the map is not the territory" (1933, p. 58), humans do not have direct access to reality because of the limitation of their nervous system and the limitations of language. What we know of reality is what is filtered through the brain and turned into abstractions. Korzybski (1933) aimed to bring awareness to this process of reality constructing and to help illustrate this point, he once offered premium biscuits from a tin box to his students who enjoyed the treat until they learned that they were in fact premium dog biscuits. Through this experiment, Korzybski aimed to show that language is not just an abstraction but a potent tool that influences our perception and experience. While what we perceive may exist imperfectly, it also underscores that there is something intrinsically real and true underlying the perceived reality. In *Form, Substance and Difference*, Bateson (1970) asserts that there is in fact nothing really true underlying the act of perception. Perceiving gives life to a certain reality, and there is no intrinsic reality underlying that action. However, Bateson also argues about the critical usefulness of the map as a certain representation of reality, both to orient ourselves individually in the world but also to create coherence around the common understandings of the world we live in. In other words, even though the maps of tacit knowledge may not be perfect, they nonetheless are necessary. Because they are created through physical, emotional and mental power, they are uniquely understandable to humans.

Computational power on the other hand collects data which is then treated in a number of ways. Typically, treatment involves cleaning, cutting, reducing, and calibrating to turn them into

standardised data sets (boyd & Crawford, 2012a). When the domain of application is human experience, we are using a process from the hard sciences and applying it to a soft discipline target. Behind the veil of scientific truthfulness described above, most data collected are in fact unstructured, so they need to be selected and reworked to be used in the computational systems that try to make sense of them. The data culled from networked social interactions is a blend of miscellaneous, unstructured pieces of information collected in highly diversified formats from a multiplicity of proprietary and non-proprietary sources and contain a massive amount of informational noise. The potential insights resulting from the computational treatment of the oceans of information released by users is mitigated by the operational and analytical difficulties in treating extremely disparate raw material (Banasiewicz, 2021b).

Talking about data in the digital age means talking about data errors and processes of data cleaning. Large data sets need to be cleaned as they are often unreliable. Errors and gaps are amplified when they are combined. The decision to include, ignore or leave aside elements and variables is not neutral and has far-reaching impacts in the epistemological output. Williams (2013) reminds us that "a data set is already interpreted by the fact that it is a set: some elements are privileged by inclusion, while others are denied relevance through exclusion" (p. 41). Therefore, data-related choices are highly political. Taken together, this shows that the political treatment of data creates a highly curated map. I argue that this map is incomprehensible to humans, so by taking over the process of reality-making, datafication steals our ability for sense-making.

- ***Designing is Understanding***

Another them to emerge from the literature is that design is a field and a practice of sense-making. A lot has been said in the literature about sense-making which has been defined as an "effort to understand connections (which can be among people, places, and events) in order to anticipate their trajectories and act effectively" (Klein et al., 2006). While sense-making is not unique to design and while datafication also proposes a model of sense-making aimed at decision and action,

sense-making in design incorporates the tacit and complex embodied experience of living in the physical world. Designers alternate between their understanding of the design problem and their hunches for a solution, each movement bringing depth of understanding or alternative ways of seeing (Ball et al., 2004; Dorst, 2015b). Designers do not look for the right solution. One of their most valued skills is to look for the right problem. The subtle skill of reframing is design's super power.

While design is anchored in making and doing, datafication is essentially abstract and removed from lived experience. In much of the literature on data science, datafication is often celebrated as a superior way of knowing because of its so-called neutrality. However, it is necessary to critically evaluate this statement and tease out the underlying assumptions behind it. This research shows that datafication is a predictive tool, and the overarching value which presides to the making of algorithms is not understanding or explication but prediction. While absolutely essential to the functioning of our societies, predictive analysis is a decision-making aid, it is not equivalent to understanding. Thus, while tacit knowledge focuses on meaning and comprehension, datafication is a "result-oriented epistemic attitude" which aims to find the right answer (Rieder, 2020, p. 29).

Prediction by nature aims at reducing or even banning uncertainty, thereby ignoring the rich insights that arise from uncertainty and paradox. While important, it would be reductionist to consider that this is the only purpose of knowing. This attitude also lies on the assumption that there is an objective reality out there to be discovered, one that ignores the possibility that algorithms are actually a form of social theory that create a cultural order. Some have argued that technology is neutral, however, I would argue with Marshall McLuhan (1963) and Neil Postman (1992) that it is not always the case. Technology affects and is affected by the social. When technology tries to encapsulate life in digital code, what results is an impoverished and incomplete view of the world. Datafication reassures because it provides certainty (which is illusory) giving its decision-making power an aura of scientific truth. Again, I am not claiming that there is no

merit to the assertion, but I doubt that the merits are applicable to all aspects of life, and I call into question the overwhelming reliance on this type of epistemology.

- ***A Dialogic Endeavour***

Increasingly, voices within the design field encourage designers to find new ways of being-together, to become facilitators and supporters of a process of co-design between all social actors and even non-human actors, to design in a "dialogic way" Manzini (2015, p. 66). The idea is to put the prefix "co" back into the process of designing. This is a co-creative process based on empathy and dialogue where participants engage deeply with each other to collaborate and construct meaning, advance shared understanding, as well as change themselves in the process and create the conditions for convergence toward consensus (Dubberly & Pangaro, 2009). As mentioned above, this dialogic process includes human and non-human actors (Bennett et al., 2010; Schrijver, 2021b). In this sense, designing is a dynamic activity which accounts for systems nested within systems.

Datafication on the other hand is sequential. The early work on artificial intelligence by John McCarthy, Marvin L. Minsky, Nathaniel Rochester, and Claude E. Shannon (2006) was based upon establishing a parallel between computer programmes and the human mind. As the founder of Information Theory, Claude E. Shannon (1948) had done work using probabilities applied to communication and developed the Shannon & Weaver linear model of communication. This idea that machines can mimic a human mind that functions in linear processes endures today. This is especially true when looking into the narrative presented by technology companies. IBM's *What is Artificial Intelligence* dedicated website presents AI as follows:

> Artificial intelligence leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind[29].

[29] https://www.ibm.com/cloud/learn/what-is-artificial-intelligence

Many academic and non-academic articles about artificial intelligence reduce human intelligence to some performative sequential processes. The following excerpt from a data science publication proposes the following description of the essence of human intelligence and the corresponding simulations performed by AI:

> AI is the simulation of human intelligence processes by machines. These processes include learning from constantly changing data, reasoning to make sense of data and self-correction mechanisms to make decisions. Human intelligence is rooted in sensing the environment, learning from the environment and processing the information from the environment. Therefore, AI includes: simulation of human senses: sight, hearing, smell, taste, and touch; simulation of learning and processing: deep learning, machine learning; simulations of human responses: robotics. (Wu, 2019)

The point Wu (2019) raises is highly pertinent because it exposes the presuppositions underlying the development of digital technology today, as a mirror of the assumptions, beliefs and judgements held by technologists. It also shows how the reductionist approach has been adopted by "technologists" to understand the holism of human cognition. The basis of the understanding is the idea of mind as a machine. Human intelligence is reduced to a sequence of sensing, learning, processing. In a way, this understanding of the human is to design's understanding of the human what a stickman is to a Rembrandt.

4.1.7 Irreducible Complexity

As Bateson (2016) duly notes, "the opposite of complexity is not simplicity, it is reductionism". Datafication systems involve many actors and function in networked systems, therefore they seem very complex. They are not however, complex in the sense that the "cognitive" processes they use are quite basic and mainly involve the capacity to sift through and organise vast amount of discrete, digital, quantitative data. Therefore, I wish to establish a difference between "complex" and "complicated" on the basis that human cognition is complex because it is multi-layered, multi-

dimensional, ambiguity-friendly and performs well in conditions of unclear boundaries whereas datafication is complicated because, despite its networked infrastructure, it only performs in conditions of clarity when dealing with discrete, tightly bounded data bits. Furthermore, because they are optimised (see above), the systems of datafication are designed to perform unidimensionally. In other words, an AI can beat the (human) chess world champion or gather all that has been published about a topic, but it can't fry an egg.

The fifth dimension of the tacit knowledge of design is its complexity. Understanding it through this lens, I see designerly ways of knowing as (1) holistic and reflexive, (2) encompassing of social complexity, (3) modelled on the interconnection of living systems and (4) highly reliant on nuanced cognitive skills. Despite characterisations of big data as "complex" in the literature, I would argue that datafication is more complicated than complex. Big data may seem complex because of its scale, but not in terms of its "cognitive" processes. Datafication depends on a complicated network of multiple actors and agendas to produce, collect and analyse data. In doing so, datafied ways of knowing: (1) are modelled on a decentralised infrastructure of data collection (2) are incomprehensible for humans because of its scale, and their computational power, (3) use mono-level sequential "cognitive" processes to treat the vast amount of data collected and (4) possess ability (to manipulate vast amounts of data), but not skills (in interpreting the social or linguistic ambiguities that form a major part of human existence).

- ***Large Scale Does Not Mean Holistic***

The 1956 Dartmouth College Conference, (where the term "artificial intelligence" was coined), included a two-month workshop gathering ten white male computer scientists and mathematicians, to try to understand how to simulate human intelligence. The study was built on the premise that "every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it" (McCarthy et al., 2006). Members of this conference were confident that they could ultimately automate or simulate intelligence. While my research is not precisely on artificial intelligence (a field that is much wider than the scope of this

thesis), the Dartmouth conference reveals the assumption underlying the research developments in artificial intelligence and some misunderstandings about the scope of the knowledge produced by those systems.

August 1956. From left to right: Oliver Selfridge, Nathaniel Rochester, Ray Solomonoff, Marvin Minsky, Trenchard More, John McCarthy, Claude Shannon.

Fig. 6. 1956 Dartmouth College Conference Participants

AI in education scholar Rosemary Luckin (2018) reminds us that computer data systems are essentially pattern matching systems. The term “matching” is important here because it reveals the underlying functioning of those systems. In the early days, they functioned by encoding certain rules that allowed them to make certain deductions such as medical diagnoses for example. The only way to learn was to modify the code. Over the years, algorithms learned to learn, and in 2016, Google’s AlphaGo made the news by beating Go champion Lee Sedol. Leaving the media hype aside, the literature reveals that even insiders accept that they are far from equalling human intelligence. Sophisticated machine learning algorithms still function on the same pattern matching as early systems. AlphaGo may be able to beat a world champion, but it cannot make medical diagnoses or analyse an image. Machine learning is also dependent on the amount and the quality of data available, glaringly illustrated by the difficulties of facial recognition systems to recognise faces that are not white, adult and male.

More importantly, the most sophisticated algorithms do not have meta-cognitive abilities. They are unable to self-reflect, understand themselves, and do not have the common sense that humans rely on so often. An average person can comfortably express how they feel and also say that they do not know anything about how combustion engines work. Designers can use frames to help them reflect upon design problem. Algorithms on the other hand cannot (Luckin, 2018). Human intelligence is complex because it is holistic, multidimensional and has a natural affinity with meta-cognition; the type of intelligence that datafication displays is to find patterns in very large-scale environments.

- ***Social Maps are Not Social Nuances***

The tacit knowledge of design is attuned to and feeds on social complexity. A theme that emerged regularly in the literature is that social nuance and ambiguity are not shunned but welcome. They are the elements that gives substance to the design process by not only adding shades of grey but all the other colours on palette. Tacit knowledge is attuned to the unsaid and the non-verbalised aspect of social currents and relationships.

Knowledge produced by datafication focuses on a central agenda: assist in the process of decision-making. Instead of decrypting the subtilities of social nuances, datafication hinges on mapping the social. Social graphs are maps that represent the complicated relationships between users in a system, not the complexity of real-life social relationships. Van Dijck and Couldry (2015) argue that applying the term “social” to algorithmic online formations is a smart but fallacious semantic choice. As mentioned above, technology impacts the social and algorithmic sociality does not reflect but to a great extent shapes social interaction.

An illustration of this is the reductionist way we “like” or “friend” on social platforms that leaves aside all the nuances of being in a relationship with another living being and the subtleties arising from this relationship taking place in a larger social context. Because qualitative aspects of the social world are either abandoned or proxied, it also reflects an impoverished concept of human

relationships. This is not to say that the insights brought about by the social graphs carry no value, but rather to point out that by putting aside fundamental aspects of relating, they just do not faithfully represent “the social”.

- ***Distributed Does Not Mean Interconnected***

The tacit knowledge of design naturally inclines towards living systems. It means that the ecological concept of interconnection stands at its core with interconnection remaining a dynamic concept. The wicked problems we face today require design to give serious attention to the complex interdependence of all systems. The essence of design knowledge is trans-disciplinary; it acknowledges that the world is too complex to be contained in one perspective.

At the height of the industrial revolution, urbanist and polymath Patrick Geddes thought man as part of nature and articulated a perception of the deep interconnection between social and ecological systems (Meller, 1994). He laid down a non-deterministic view of our relationship with nature and called to reassess to what extent humans could control the environment through science and technology (Crowe & Foley, 2016). Some years later, Bateson (1970) reiterated the idea and proposed that the need to shift epistemology from the unit-of-survival inherited from Darwin to the unit-in-its-environment was very real because “nobody knows how long we have before the old paradigm of the survival of the unit strengthened during the Industrial Revolution creates some disaster” (p. 102). In other words, a knowledge based on an isolated “discrete data” separated from its environment was not only incorrect, it was dangerous. He goes on to say that the attempt to separate the internal from the external mind was perilous, an idea echoed by Chilean biologists Maturana and Varela (1992) who showed that cognition is embedded in living systems.

With the rise of digital technology, new vocabulary and concepts came into existence. An important one is the idea of distributed knowledge. This model proposes that knowledge is distributed throughout the system through a network of interconnected nodes. While it is obviously true that the digital is mapped as a network (see for example the structure of social

platforms), I would argue that one point that is often forgotten is that the knowledge of datafication revolves around the algorithm at the centre. Centralisation is inscribed into datafication both in terms of the tools and the politics of knowledge production.

Firstly, under datafication, the algorithm is the centralised channel of knowledge production. It is a linear and centralised model of knowledge production, as opposed to the tacit model of knowledge production, which is multidimensional, multisensorial and holistic. Data is collected in the environment, sanitised and treated before being brought back to pass through algorithmic filter. It is a centripetal movement (from the world to the algorithm) as opposed to the centrifugal movement of tacit knowledge production (which, as we saw above, is dialogic and trans-disciplinary).

Secondly, while data collection is highly decentralised and spans the entire web (and even physical space through sensors and smart objects), the treatment and ownership of data are highly centralised. This centralised structure contributes to a major reconfiguration of the power that knowledge bestows in the Informational Age. Platformisation is the strategy employed by the data economy to expand its enterprise of data collection (Helmond, 2015). It consists of moving from a bounded social networking site model of organisation (under web 1.0) to a platform type of organisation (with web 2.0, the social web), whereby social media companies decentralised their API throughout the whole web (e.g., putting the Facebook Like button on other websites) in order to harvest and then repatriate data (2015). Paradoxically, this was made possible by the earlier switch from the software model to the web delivery model - in other words, Microsoft was made obsolete by Google (O'Reilly, 2017). Parallel to this, Google realised in the early 2000s that the data exhausts resulting from search had enormous commercial potential, thereby laying the foundation for the rise of a data economy that relied on the commodification of user generated data (Zuboff, 2019). For all the insights that big data allows, it also tends to require enormous investments in large scale physical infrastructures such as servers, as well as a skilled workforce able to design intangible digital infrastructures and related code.

- ***Multi-Nodal Does Not Mean Multidimensional***

Design knowledge performs in breadth (it can know about many subjects) and depth (it can acquire expertise in one subject) and relies on both common sense and heuristics that are very hard to translate into code. One of the more unique aspects of tacit knowledge is meta-cognition, defined as the ability to think about thinking. Datafication is unable to code the "meta" aspects of human intelligence such as social intelligence (working collaboratively), metacognitive intelligence (understand what we know and do not know), meta-subjective intelligence (understanding of emotional self and others), meta-contextual intelligence (sensitivity to context) and perceived self-efficacy (understanding of goals and how to achieve them) (Luckin, 2018). Thus, datafication as a way of knowing can only be called intelligent in a very limited way. While it has the ability to manipulate large amounts of discrete data across multi-nodal networks (like for example social platforms handling of users' data), algorithmic processes are often incomprehensible for untrained users - and in some instances to the well-trained data scientists as well (O'Neil, 2017).

Designerly way of knowing is multidimensional in that it gathers under the same umbrella a full orchestra of different disciplines from different fields, working together toward the production of design knowledge (Gentes, 2017). Design knowledge emerges from the coming together and the collaboration between different components of an array of disciplines in a co-creative process. Thus, I would argue that while design knowledge has skill in nuances, datafication has organisational power.

One illustration of this difference and how datafication lacks in comparison to human cognition is facial recognition. The often-cited example is that a new born baby can recognise subtle emotions on a human face, but it takes sifting through millions of images for facial recognition before a computer can recognise the features of a cat (Bollier & Firestone, 2010; LaBarbera et al., 1976). Furthermore, the facial recognition systems are notoriously unreliable and tend to misidentify people, especially people of colour, women and young people. The facial recognition systems

used by some US police departments to identify suspects for example, essentially compare the image of a suspect to those in a large database. Furthermore, they have to be vetted by a human analyst who reviews the results and chooses possible matches (Simonite, 2022). This clearly indicates the deficiencies of systems that have been called "intelligent" but do not match human cognition in ambiguous conditions. Proponents of facial recognition argue that it takes time to train the systems, but as of now, it has not been proven that such systems will equal human intelligence in the future (Angra & Ahuja, 2017; Dhall et al., 2020).

Another illustration of this lack is language. In her study of YouTube automated captions inserting explicit language in children's videos, Tatman (2017) showed the gap between the complexity of cognition and the abilities of computational statistical logic when it comes to policing language on social platforms. The systems underpinning datafication rely on pattern finding and the coding of rules to perform. While it is possible to statistically steer the algorithm away from adult language or set words blocklists, it is impossible to code systems for context sensitivity. Tatman (2017) argues that this is because "language models are not precision tools", and the logic and capacities of datafication are predicated on precision and unambiguity.

- ***Ability is Not Skill***

Another aspect of complex vs complicated can be found in the dichotomy between what I call designers' skill in handling complex nuances against datafication ability to handle and standardise large amounts of data. Skill is not ability; it is learned through an embodied process of trial and error, commitment of time and experience building. In contrast, ability is constructed and dependent on the affordances of the infrastructure[30].

[30] Etymologically, skill comes from the old Norse "skil" (n.) which means power of discernment, and "skiljia" (v.) meaning to separate, discern, understand. In French, skill contains an idea of "habileté" as in the capacity to ruse and elaborate stratagems, whereas ability refers to the aptitude to perform a task.

A major element of datafication is its ability to treat vast amount of data. In *Datafication and Data Fiction: Narrating Data and Narrating with Data*, Dourish and Gómez Cruz (2018) propose that big data operates along a single continuum that moves from small to large and back to small again. A move toward massification (i.e., from small to large) by gathering data into vast datasets depends on what the authors call "a logic of equivalence" - or the arbitration about the likeness of data that allows them to be treated as relating to the same circumstances. This is then followed by a move from large to small through a "logic of correspondence", when data are given meaning as evidence about something about the world. The authors remind us that both moves depend on the construction of a subjective narrative.

4.1.8 Summary

As highlighted in this chapter, there are unique qualities that define both tacit knowledge and datafication and these attributes are often at odd with one another. The knowledge of design, for example, is largely tacit, and qualitatively oriented, and therefore difficult to formalise in its entirety. As noted throughout this chapter, the tacit designerly way of knowing is heavily embodied, fundamentally anchored in materiality but also contextualised by the designer's personal understanding of his/her environment. In contrast, datafication is quantitatively oriented and disembodied, often detached from tacit experiences. Rather than taking a holistic approach, datafication distils the whole into measurable and linear units. Unlike the tacit way of knowing which is complex, non-linear, multi-dimensional and reflexive, datafied way of knowing is designed to be flexible enough to accommodate and process vast amounts of data which are treated by pre-optimised algorithms.

Despite these striking disparities, very little research has been done on how datafication impacts tacit knowledge, especially in the field of design. While it is quite clear that designers do not solely rely on intuitive and tacit knowledge, it is also clear that datafication impacts all ways of knowing.

This chapter established a critical contrasting of the attributes of tacit and datafied ways of knowing. These two specific types of knowledge were selected because of the ubiquitous presence of the technologies of datafication, and because the design literature shows that tacit knowledge stands at the centre of the design practice. During the data collecting, memoing and coding phases of this research, the question arose as to what attributes could help understand datafied knowing, and how they compared to the attributes of tacit knowledge. It appeared that this clarification was the first necessary step for a critical exploration of their relationship. This is what this chapter has investigated and the two proposed frameworks above are a result of this process.

However, this is not to say that datafied and tacit ways of knowing are disconnected. They interact in complex ways. As mentioned above, the motivation for this research was partially triggered by a concern about how our faith in the objectivity of datafication affects tacit ways of knowing. My intention was to adopt a critical stance to look at an emergent phenomenon that is not well understood, mainly unchecked but spreading very fast and that holds potentials for both the best and the worst consequences at a planetary scale. Critique is at the centre of this research into the "haze" of the 21st century.

I was inspired by Walter Benjamin's exploratory work into the haze of the 19th century, especially his concept of phantasmagoria, which illustrates how the technological shift toward a culture of consumption creates a kind of "dream world". There, perceptions and desires are manipulated to mask the material conditions and labour involved in the production of commodities which acquire a magical and autonomous existence. In this chapter, I wondered about the knowledge-producing logic of datafication with an aim to excavate the logic of knowledge creation behind datafication and contrast it to the logic of tacit ways of knowing. Once it emerged from the literature that the attributes of tacit knowledge and those of datafication are largely antinomic, the question arose as to whether our faith in datafication is justified. This launched an enquiry into the underlying ontological and epistemological assumptions of this logic, through the filter of Benjaminian phantasmagoria. In chapter 5, I use the benjaminian concept of phantasmagoria to critique, by

illuminating datafication from another angle. While Benjamin's concept of phantasmagoria is situated, it is also a relevant metaphor that has been revisited and dissected at a time when the internet was in its infancy, in the 1980s and 1990s. As such, it is an intriguing and valid filter to critique datafication and illuminate other aspects of its relationship with tacit ways of knowing. In a context where datafication has been hailed as a revolution (the digital revolution), it is also fair to wonder whether the digital is in fact a revolution, and if so, in which ways. Employing a concept from the previous (industrial) revolution may shed a light on whether this term is justified or not, and if so how.

5 DATAFICATION: THE PHANTASMAGORIA OF THE 21ST CENTURY

Chapter Overview

To expand further on the relationship between digital technology and tacit knowledge proposed in Chapter 4, this chapter examines how datafication is not only a challenge for design but a phantasmagoria of modern life. As stated in the introduction of this thesis, the concept of phantasmagoria (as initially proposed by Walter Benjamin in his seminal work, *The Arcades Project*) is used to critically denote an underlying ideological trend that characterises a particular era. Given the transient nature of phantasmagoria - i.e. it changes according to external forces typifying each epoch in history – it is not, in and of itself, real (Cohen, 1989). According to Benjamin, it is because of this illusionary nature that phantasmagoria offers critical insights into an overarching ideology that defines and shapes human history (1989).[31] Even though it is a situated concept in terms of ideology (the Frankfurt School), time (the Industrial Revolution) and geography (Europe), the staying power of phantasmagoria as a metaphor has been made manifest through time (as demonstrated for example in Baudrillard's (1981) concept of simulacrum and its challenge to reality).

In line with Benjamin's work, this chapter will first explore the concept of phantasmagoria by illuminating the different facets of its meaning. Following this discussion, this chapter will

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[31] From an etymological perspective, the term phantasm comes from the Greek phantasma, which means ghost or visual hallucination. The Greek word phantasia means "apparition", vision (from phainein, to appear). Hoad, T. F. (1996). *The concise Oxford dictionary of English etymology*. Oxford University Press. Plato refers to the term as a reflection in a mirror. Aristotle associates it with "a residue of the actual [sense] impression". Nanay, B. (2021). Mental Imagery. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2021 ed.). Stanford, Calif.: Metaphysics Research Lab, Stanford University. From those, we get a general idea of a mental image or apparition, a belief that arises through the senses, that could be false. The concept also plays an important role in psychology. In the 19th century, with the development of Freudian psychoanalysis, phantasma took on the meaning of an opposition between imagination and real perception. In German, « die Phantasie » refers to an imaginary production of the psyche that supports the realisation of a desire. Isaacs, S. (1948). The nature and function of phantasy. *International Journal of Psycho-Analysis, 29*, 73-97. In the analytical psychology of Carl Jung, phantasma takes on a more positive meaning and refers to the product of a creative psychic activity. Jung, C. G. (2012). *Psychology of the Unconscious*. Dover Publications. (New York: Moffat, Yard and Co. 1916). Another general meaning of the concept refers to a type of medium that became extremely popular in the nineteenth century. Etienne-Gaspard Robertson's Magic Lantern (1790's) was a form of theatre that used a hidden apparatus, lights, mirrors, music and smoke to project ghost-like images onto walls or screen. Barber, X. T. (1989). Phantasmagorical wonders: the magic lantern ghost show in nineteenth-century America. *Film History*, 73-86. In the 19th century, with the development of photo and film technology, the word phantasm also came to mean figment of imagination or illusion. Merriam-Webster. (n.d.). Phantasm. In *Merriam-Webster's Collegiate Dictionary*. Retrieved 31 January 2022, from https://unabridged-merriam-webster-com.ezproxy.lb.polyu.edu.hk/collegiate/phantasm, ibid.

summarise four key themes emerging from Benjamin's *Arcades Project* and show how these attributes can be used to demonstrate how datafication can be understood as a modern-day phantasmagoria. In doing so, this chapter offers the critical insights needed to not only reveal the "pseudo truths" surrounding datafication but also how they impact the field of design today.

5.1.1 Walter Benjamin's Phantasmagoria & the Arcades Project

Benjamin spent the last thirteen years of his life working on *The Arcades Project* (1927-1940). Focusing on the arcades of nineteenth-century Paris (the glass-covered streets lined with shops) as the first temples of consumerism, Benjamin's work consists of a constellation of quotes and reflections organised around thirty-six main topics and forms the basis for his critique of modernity.

As Benjamin pointed out, humanity is wired to be in a dream-state (Martel, 2011). Thus, it is not really possible to abandon it, but it is important to awaken to its existence. To do so, and with the aim to "liberate" history from the ideological mask and the phantasmagoria that covers it, Benjamin uses a radically different approach to time. Instead of adopting a traditional linear view of events (which often imbues history with an atmosphere of assumed progress), he focuses on a kaleidoscopic approach, using the markers of history and ephemeral phenomena to demonstrate the phantasmagoria of modernity.

The notion of phantasmagoria appears as a seed in the first exposé of the *Livre des Passages* of 1935 (Benjamin, 1999). Four years later, in 1939, at the request of Max Horkheimer, Benjamin wrote a second version where he makes clear that his aim in this work is to expose the phantasmagoria of the emerging civilisation (1999).

Benjamin uses the dialectical image as a central feature of his critique. For him, history is not a long uninterrupted flow but a constellation of images (Benjamin, 1978a). Thus, one must look at the remnants left behind by history to understand it. Each image has to be considered in its duality.

Dialectical images are a tool for the critic; they are the means by which we can unmask the hidden attributes and meaning of the artefacts we seek to explore (Kang, 2011).

The notion of phantasmagoria plays a crucial role in this process. By considering artefacts as phantasmagorias, Benjamin explores hidden aspects of key artefacts of the late 19th century (the arcades, exhibitions, interior, flâneur, streets of Paris etc.). In doing so, he gives them another dimension. They are what they are as artefacts (i.e., the reality of the artefact), but they are also something else, a phantasmagoria of dialectical images.

5.1.2 The 1935 Exposé

As mentioned above, key elements of Benjamin's work were presented in two exposés, published in 1935 and 1939 respectively. His 1935 exposé presents a cultural shift that becomes apparent through six symbols, each associated with a personality. They are (in the order presented): (1) Fourier or the Arcades, (2) Daguerre or the Panoramas, (3) Granville or the World of Exhibitions, (4) Louis Philippe or the Interior, (5) Baudelaire or the Streets of Paris, and (6) Haussmann or the Barricades. It is with these last four of these six symbolic representations that Benjamin presents the notion of phantasmagoria as a dream image that eventually becomes a central feature of his work:

1. In the "Granville, or the World of Exhibitions", phantasmagoria is referred to as a distraction, a type of entertainment that becomes embedded in a capitalist culture. ("[The World Exhibitions] open a phantasmagoria which a person enters in order to be distracted.")
2. In "Louis Philippe or the Interior", the place of dwelling becomes an extension of individuality, a safe haven where the private individual can sustain his illusions about himself (as opposed to the place of work where he has to deal with reality). Here, we see the phantasmagoria of the individuality as a social persona, a theatrical stage where

individuality can be expressed. ("From this arise the phantasmagorias of the interior- which, for the private man, represents the universe.")

3. In "Baudelaire, or the Streets of Paris", phantasmagoria appears as an allegoric veil. Here, space itself becomes the active actor of the dream. As the flâneur gazes at the crowd, this veil entices the soon-to-be alienated man to enter the space of the capitalist temple. For Benjamin, the greatest symbol of the capitalist temple is the department store and he observes how the crowd[32] envelops the individual, allowing a person to disappear into anonymity. In this sense, the crowd is both landscape (sociality embedded in the physical space) and interior (a type of womb into which individualities can merge and disappear).
4. In "Haussmann, or the Barricades", phantasmagoria becomes the dream of civilisation itself. The visible (the architectural beauty of "long perspectives through straight thoroughfares") hides the true agenda, i.e., "to secure the city against civil war." Behind the beautification of Paris, hides the reality of modernity's class distinction. This play between lights and shadows reveals the phantasmagoria as myth, cultural alibi or presumed truth of the age.[33]

The 1935 exposé was critiqued by Adorno, particularly the dialectical image as a "dream image" (i.e., a manifestation of a collective consciousness). In a letter dated August 1935, Adorno emphasises the importance of honouring the theological aspect of the dialectical image (the basis of Benjamin's critique), while at the same time avoid reducing it to mere mythical or allegorical thinking (Adorno, 1977).

In the early version of the 1935 exposé, the arcades are viewed as a dream image, a dynamic representation of collective consciousness. Adorno takes issue with the psychologising of the dialectical image. He argues that Jung's psychological notion of the collective unconscious was

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[32] "The crowd is the veil through which the familiar city beckons to the flâneur as phantasmagoria-now a landscape, now a room."
[33] The Commune brings to a close the phantasmagoria that the 1789 revolution was a joint initiative bringing together the bourgeoisie and the proletariat.

invented to "divert attention from objectivity and alienated subjectivity" (1977). According to him, using the notion of a collective dream highlights the gap between individual and society, which should be dissolved instead of emphasised.

Adorno also warns Benjamin against a tendency to become overly allegorical and to give an over-emphasised place to the senses (on the model of Baudelaire). He encourages a more materialistically centred approach. For him, it is necessary to dissolve the dream, whereas for Benjamin, we merely need to awaken from it. In other words, he criticises Benjamin's approach to engage with and subvert rather than annihilate or deny.

Benjamin's long correspondence (and friendship) with Adorno over the years was an obvious source of influence over his thinking. In 1937 however, two years before writing the 1939 exposé, he came across a largely forgotten work by French revolutionary Auguste Blanqui. In his last short book written in jail in 1872 (*L'éternité par les astres*, Eternity According to the Stars), Blanqui presents an atypical cosmology, which re-introduced Benjamin to the idea of the eternal return, the idea of infinite repetition of time in an indefinite series of cycles (Miller, 2008).

It should be noted that the notion of the eternal return was not foreign to Benjamin. It was also a central theme of Nietzsche's "Thus Spoke Zarathustra". The cyclical nature of time was also a reference to Baudelaire, an inspiration dear to Benjamin, as he wrote to his friend Max Horkheimer on January 6, 1938:

> The piece has as its theme, the eternal recurrence, the most remarkable relation to Nietzsche; and a more hidden and deeper one to Baudelaire, with whom in a few of its magnificent points it resonates almost word-for-word. (Benjamin, 2019, p. 548)

Blanqui's piece triggered great insights for Benjamin and produced a major impact on the larger framework of *Das Passagen-Werk*. It crystallised the motifs of the 1935 exposé around a conceptual pivot at the intersection of modernity and myth, the phantasmagoria which he knew intuitively defined the civilisation of the 19th century (Miller, 2008, p. 280).

5.1.3 The 1939 Exposé

> Our investigation proposes to show how, as a consequence of this reifying representation of civilisation, the new forms of behaviour and the new economically and technologically based creations that we owe to the nineteenth century enter the universe of a phantasmagoria. (Benjamin, 1999, p. 14)

The idea of phantasmagoria is the main difference between the exposé of 1935 and that of 1939. In the former, Benjamin focuses mostly on the notion of the dream. In the latter, he fully develops the concept of phantasmagoria (Cohen, 1989) and defines modernity as "the world dominated by its phantasmagoria" (Benjamin, 1999, p. 26). Unlike the piece of 1935, the exposé of 1939 includes a short introduction which contains no less than seven references to this theme. In his conclusion, Benjamin describes the *Passages* work as the "century's constellation of phantasmagorias" (1999, p. 25), putting the idea at the centre of his critique of the technological civilisation (Eiland & Jennings, 2014).

For Benjamin, the utopia of the dream image is anchored in the collective unconscious and manifests in inner and outer spaces, including works of architecture, fashions, interior etc. This is the basis of his methodology; he looks at the "refuse" of history, the manifestations of this collective utopia embedded in the collective unconscious (Cohen, 1989). Throughout his work, Benjamin likens the world to an apparatus, an optical device which creates an illusion (Eiland & Jennings, 2014). In this case, the illusion is created not through the play of lights and shadows reflected on a screen similar to that of 18th century illusionistic theatre, but through the play created by urban commodity capitalism. This environment seems real, when in fact, it is a mental construct embedded in the social messages of the age (2014).

The idea of the montage is an important one to illustrate Benjamin's idea. The montage is a construct in which images are constellated to convey meaning. In this sense, film is the phantasmagoria par excellence. It presents reality as continuous, but is in fact highly constructed.

It appears linear and real, but is merely a “montage” of separate images (the “takes”). Benjamin uses the concept of the dialectical image, a method to understand civilisation that requires looking at two opposing point of views. For Benjamin, phantasmagoria is at the heart of the dialectical image as a construct created by a constellation of images situated in time and space.

The 1939 exposé explores several artefacts of the 19th century civilisation and connects them to the notion of phantasmagoria. As a major technological innovation of the age, the arcades are a central theme of this work. For the very first time, the use of cast-iron in construction stands for the rise of the engineer over the artist, symbolising the emergence of a new civilisation. The arcades are ambiguous in essence, part interior and part public space, part urban environments for flânerie and part marketplace. They ultimately form the basis of Benjamin’s phantasmagoria.

The world exhibitions, temples of mass entertainment are the symbols of this civilisation of the spectacle and the phantasmagoria of distraction. Fashion, caricatures and the bourgeois interior are constructions, a constellation of “remote locales and memories of the past” (Benjamin, 1999, p. 19) which participate to creating a false universe appearing as real. Contrary to the more classical Marxist thinkers of this time, Benjamin was very interested in the allegorical, the irrationality of sensory impressions, exemplified by the gaze of the flâneur on the crowd (Miller, 2008). It is from here that new classifications such as human “types” (again, mental constructs) emerge from the gaze of the flâneur on the crowd.

Finally, for Benjamin, progress, a central idea of modernity, represents the ultimate phantasmagoria. In the conclusion, he quotes Blanqui: “Men of the nineteenth century, the hour of our apparitions is fixed forever, and always brings us back the very same ones” (Blanqui, 1872, pp. 74-75). This refers to the eternal return of the same phantasmagorias. He says: “Blanqui's book presents the idea of eternal return ten years before Zarathustra – in a manner scarcely less moving than that of Nietzsche, and with an extreme hallucinatory power” (1999, p. 25). A century later, Debaise & Stengers (2022) will echo this concern and expose the ecological ravages brought about by an unchecked faith in infinite progress on a finite planet.

Benjamin's approach is relevant to a discussion on the production of knowledge. Phantasmagoria as a form of social critique is anchored within the larger context of the technological shift that was happening at the beginning of the 20th century. In The Arcades Project, Benjamin describes in great details (including through the use of a montage of quotes and images) the epiphenomena of the Industrial Revolution. His distinctive approach, putting a great emphasis on the metaphorical, experience and the senses (a choice which was heavily criticised by Adorno and more traditional critical thinkers), is a subtle way to critically explore the relationship between technological, cultural and epistemological shifts.

Guiding Principles of Phantasmagoria Under Datafication

Benjamin is largely regarded as the author who has taken the concept of phantasmagoria to another level. It would not be exaggerated to say that, today, his name is closely connected with the concept when taken in the context of cultural critique (Kang, 2011), and that it has arguably inspired generations of thinkers, especially in the late 20th century, with ideas such as the simulacrum (Baudrillard, 1981), the spectacle (Debord, 1983) or the notion of assemblage (Barad, 2007; Deleuze & Guattari, 1979; Srnicek, 2007). He draws from multiple original definitions and marries them to present a rich and multifaceted understanding of the term. He spent years maturing a unique understanding of phantasmagoria, which is demonstrated throughout *The Arcades Project*.

One of the unique features of Benjamin's work is to use phantasmagoria as a method of illumination by rendering the commodity-objects as phantasmagorias as a way to reveal their hidden meaning. Benjamin explores the phantasmagorical nature of some 19th century artefacts in order to reveal their "other" nature. In doing so, he deliberately searches for the other side of the coin (the dialectical image), which gives substance to his critique.

In the following section, a model based on four principles inspired by Benjamin's work is offered. As described above, Benjamin takes important new artefacts of the age and looks at them through

a more critical lens. This thesis aims to do the same with the datafication of 21st century life. By looking at technologies of datafication as a major novelty artefact of the 21st century, the following discussion explores how data can be viewed as a dialectical image to uncover a modern-day phantasmagoria.

5.1.4 A Framework for Benjamin's Phantasmagoria

As mentioned previously, the aim of this critical explorative research is to frame and guide the study of datafication as it relates to the production of knowledge and its corresponding relationship with tacit designerly knowledge. As a field, design readily lends itself to an exploration into the phantasmagorical universe, emphasising such elements as the play between visible and invisible, or the architectures of social and psychological control, to name only a few.

Following common themes found in the Benjaminian literature (Berdet, 2013; Buck-Morss, 1991; Cohen, 1989; Stephens, 2007) these attributes are synthesized in the following four ways:

(1) Phantasmagoria as Imagery

(2) Phantasmagoria as Myth

(3) Phantasmagoria as Experience

(4) Phantasmagoria as Commodification.

5.1.5 Phantasmagoria as Imagery

- ***Dream Image as a Movie Screen***

Phantasmagoria represents a play between what is represented and the apparatus hidden in the background. It is a dance between representation and invisibility, between the image and the image-producing apparatus. Benjamin's apparatus metaphor is applied to his reflections on the work of art in the age of commodification, and especially film.

One of the original meanings of Phantasma, or Phantasie in German, relates to an illusory image, a visual dream spectacle, inspired by Robertson's 18th century Magic Lantern Theatre (Laterna Magica). Its aim was to entertain, but more importantly, to lay bare the rational mind's vulnerability to delusion (Blaettler, 2012). In the same vein, Emile Cohl invents the animation cartoon "Phantasmagorie" in 1908. The idea of the dream image as an artistic medium was thereafter developed in a wide range of directions (see for example the "Nocturnorama", a show combining music and painted transparencies to capture the audience's attention).

In the words of Benjamin, phantasmagorias are the "century's magic images". He gives a central importance to the apparatus creating the illusory representations, and the implication of the senses. Here, the apparatus is the underlying ideology that gives rise to the dream manifestations. The aim of his work is also a fundamental play of critical design, to reveal the unseen, to shed light on the invisible, so people (or in the digital age, users) will look at it differently. He points at the invisible apparatus to show the unreality of the ghost images in order to change perspectives.

- ***A Reified Dream Image Containing Traces of Reality***

Benjamin combines Marxist and Freudian concepts into the notion of a reified dream image, an illusion turned into something concrete (Khatib, 2013). He takes from the Marxist notion of the commodity fetish. In a commodity-producing society, things, people, phenomena become tradable objects (Blaettler, 2012). The phantasmagoria is the screen-image society creates of itself when it refuses to acknowledge its real nature (i.e., to create commodities) (Berdet, 2013). With Freud, all dreams become images to be deciphered and given meaning. The images are conjured up by a hidden psychic mechanism which is repressed from consciousness (the equivalent of the apparatus of the Laterna Magica) (Nikolinakos, 1992).

In the commodity-producing society, the reality of the productive forces at work and the reality of the exchange value are both repressed from consciousness. However, the dream emerges from the realm of the unconscious carrying meaning by reifying itself in the architecture and the artefacts of

the age. For Benjamin, they are reified in the arcades, the Haussmannian avenues, the bourgeois interior, the world exhibitions etc. In Lacanian psychoanalysis, the dream phantasma is the manifestation of a desire of the other (Lacan, 2006). The phantasmagoria betrays an underlying desire destined to remain incomplete by design.

It should be noted that, despite the dream-like nature of phantasmagoria, it also contains traces of reality. It is not complete imagination, nor is it metaphysical. It is anchored in the sociocultural, the political and epistemological systems of the society that creates it. As such, it arises from an ideology, but this apparatus is hidden and repressed from consciousness. From this vantage point, the image is an illumination that is perceived as true, real and pure. The purity of the aesthetic hides the political agenda. Hausmann's radical urbanism is an example of this. Behind the beautification of Paris and the long perspectives lies a political will to discourage manifestations of civil discontent.

- ***Datafication: A Phantasmagoria of Imagery***

Like the machinery behind the ghostly shapes of the Laterna Magica, the invisible apparatus behind the dream image of the digital age is the algorithm. The dream is reified in the environment of the digital platform. The space seems "real" because the algorithmic structures holding and shaping it are invisible. The illumination is seen as true and pure. In other words, the digital social space looks, tastes and feel like a social space.

The design of social platforms and the euphemistic language ("smart", "targeted", "connecting the world" etc.) cloaks the underlying ideology. The architectural choices are purposeful. They illuminate certain aspects relating to entertainment and sociality and hide corporate agendas, in a play of lights and shadows. They also hide the essential quantitative, disembodied, linear, optimised and complicated aspects of datafication behind a veil of connection and entertainment. Under datafication, the phantasmagoria is alive as a manifestation of a desire that constantly

remains unsatisfied by design. The out-of-sight quantitative algorithmic apparatus is designed for a type of “never enough” engagement.

Here, repression from consciousness refers to ignoring the reality of the productive forces. The phantasmagoria represses from consciousness the fact that the platform is a productive force. The dimension of the social platform as a place of sociality, entertainment and learning - a space of self-exhibition made visible and emphasised. The social platform is the factory of the 21st century, and this dimension remains largely hidden. Its structures are also factory-like: designed for efficiency and measurement that are optimised for a certain result.

The digital social platform also ignores the reality of the exchange value. The exchange value of commodified users is repressed from consciousness. In *Amusing Ourselves to Death*, Postman (2006) emphasises how entertainment hides the exchange value of people more effectively than open control - making it more like Aldous Huxley's *Brave New World* rather than George Orwell’s *1984*. The equivalent of the bourgeois interior is the social profile. The quantified exchange value of the user’s data is hidden and the aesthetic value of the “social media profile” is emphasised.

Phantasmagoria under datafication contains traces of reality in that it attempts to recreate social reality in an algorithmic universe. To be more precise, the traditional process of creating social ties become the lattice of algorithmic sociality. But sociality under datafication is a compromised reality. Simply put, “friending” contains traces of the reality of making friends, and “liking” contains traces of reality of showing support, but they are not the same. Whereas genuine friendship and emotional support are human endeavours that carry an important qualitative and tacit dimension, an inexplicable “je-ne-sais-quoi”, friending and liking are optimised activities (even though they are not presented as such).

The phantasmagoria containing traces of reality is also reflected in the blurring between the undeniable usefulness of certain aspects of datafication and its underlying economic logic. This

blurring is purposefully designed into the technology of datafication. By doing so, it also blurs users' choices. If one wants the benefits of the technology, one has to accept the economic logic that underlies it.

5.1.6 Phantasmagoria as Myth

Being image-dependent leads to the next characteristic of phantasmagoria, myth making. Phantasmagoria is multifaceted. It is not only a dream. It is also a method to illuminate how a particular epoch in time brings the dream alive, or in other words, how the ideology of the age comes into being. The ideology of the age refers to how the age choses to represent the world and convey that representation back to people. There is a strong connection between ideology (or the central myth of the age) and representation (i.e., how we view, perceive and sense).

This is what is hinted at by the idea of the Laterna Magica. The technology refers to a hidden apparatus projecting the ghost-images. The phantasmagoria refers to the images projected, but also illuminate the existence of the hidden apparatus. In this sense, Benjamin's phantasmagoria refers to the artefacts (cast-iron constructions, long avenues etc.), but it is also a medium; a medium that can uncover the ideological container that shapes knowledge and how it is represented, the relationship between reality and perceptions.

- ***Myth***

In *Theorising Myth*, Lincoln (1999) investigates the relationship between the rise and fall of myth as a preferred category of narrative and the underlying sociocultural, historic and political processes. He shows how Mythos (i.e., stories), a form of narrative of the privileged classes during the Golden Age of Greece, lost to Logos (i.e., reasoning) as part of the political, linguistic and epistemological battles of that time. Relegated to the lower ranks of "fabulae" from the Roman empire onwards, myth only regained its lustre with the political and cultural fever of the 18th and 19th centuries. Lincoln attributes the renewed enthusiasm to a combination of Romanticism,

nationalism and Aryan pride, with myth providing the language and stories to support the idea of the nation-state (1999).

The functional approach to myth emphasises the close connection between myth and sociocultural, political and economic conditions. Eliade for example argued that one of the main functions of myth is to establish acceptable models of behaviours (Eliade, 1963; Lincoln, 1999, p. 141). For Joseph Campbell, myth has a sociological function, i.e., to validate and support the existing social order (Campbell & Moyers, 2011). In other words, phantasmagoria as myth has the power to create the boundaries that bind society. In this sense, the phantasmagoria acts as a prison for utopian forces. This also relates to the Marxist concept of false consciousness, when the myth encourages people to think and act against their own interests (Benjamin, 1978b). Here, phantasmagoria has the repetitive structure and the form of the mythical story, resolving all social contradictions.

In his conclusion, Benjamin quotes Blanqui: "Men of the nineteenth century, the hour of our apparitions is fixed forever, and always brings us back the very same ones[34]". This refers to a central theme: the hallucinatory power of the eternal return. The discovery of Blanqui's last piece of writing had a profound effect on Benjamin's work. The eternal return of events and phenomena in a series of infinite cycles provides a theoretical pivot to link modernity and myth. Indeed, the eternal recurrence of history establishes historical continuity and enables the "narrative transmission of culture" and therefore of the myth (Miller, 2008, p. 282).

- ***Ideology, Cultural Alibi and False Synthesis***

> The world dominated by its phantasmagorias - this, to make use of Baudelaire's term, is "modernity". (Benjamin, 1999, p. 26)

[34] Auguste Blanqui, *L'Éternité par les Astres* pp. 74-75.

In *Theorising Myth: Narrative, Ideology and Scholarship*, Lincoln presents a theory of myth as ideology, defined as a "privileged narrative encoded in narrative form" (1999, p. 35). It is outside the scope of this thesis to explore in detail the multiple debates around the relationship between myth and ideology. Let's just say that as the rich scholarship in several disciplines (philosophy, history, cultural studies, anthropology, sociology etc.) on this topic attests, a close relationship exists. Whatever the arguments are about how they relate, they are inescapable concepts to a critical approach to the history of culture (Halpern, 1961).

To define them, Halpern distinguishes between myth and ideology from the point of view of origin and function. Myth represents the origin of beliefs outside of historic experience, whereas ideology originates in the shaping of beliefs by social situations (1961). Myth's function is to also bind societies together, while ideology segregates and serves special interests within that society (1961). In both cases, myth comes as a larger umbrella which defines the wider narrative of the civilisation within which ideologies arises. In that sense, ideology allows a more granular approach to the phantasmagoria of the age.

Despite Adorno's critique (discussed above), Benjamin decidedly places the object of his study within the profane order of the political (ideology), not only the theological (myth) as in the previous age. He uses the metaphor of the movie to describe the relationship between ideology and phantasmagoria with the distinction between the hidden camera (or apparatus) and the dream image projected on a screen. Here, the apparatus is the ideology that gives shape to the phantasmagoria and turns it into "the truth".

Phantasmagoria also acts as a cultural alibi (Berdet, 2013), the definer of "our" identity, the "this is who we are" ethos of a particular culture. As such, it is linked to myth and ideology, between the cultural glue established by myth and the cultural divide of ideology. Phantasmagoria is a spectacle (the movie metaphor) but in a commodity producing society, it becomes more than that. It becomes the essence of an epoch, beaming through different elements that manifest this epoch: construction of urban systems, fashion, self-image etc. The objects-turned-commodities reflect the

hidden and the absent (Teerds, 2015). As a cultural alibi, phantasmagoria becomes a trace of a civilisation, the essence of an epoch. Benjamin's monumental work, contained in the convolutes from letters A to Z (Arcades to Knowledge, to Puppet shadows etc.), represents those traces of a civilisation.

Along this line of reasoning, phantasmagoria is also a false synthesis (Berdet, 2013). As in myths, real and fictional worlds (i.e., spaces) are brought together, one informing the other and inspiring thought and action. Similarly, time is also synthesised into a past-present-future(s) continuum. The clearest illustration of this (as Benjamin remarked in his last exposé) is the notion of progress, the theme of the "eternal return" which underlies the understanding of the history of great men and events. As mentioned above, the origin and function of myth and ideology also have to do with synthesising social contradictions and hierarchies that are flattened in myth, and reawakened at a smaller scale in ideology.

- ***Datafication: A Phantasmagoria of Myth***

Under datafication, both the content and the narrative form of myth take on a new importance. The early Internet is the myth of origin, the glue that binds the digital society together. Like the hidden apparatus, the narrative of the early internet, based on values of equality, friendship, humanity, fairness, freedom and democratic ideals[35] hides a reductionist and quantified view of humanity, a faith in the application of engineering principles to the social, and a utilitarian and disembodied ideology[36] expanded to all areas of qualitative life. In fact, by reducing all particulars of life to computer data, and abandoning aspects that cannot be subjugated to their binary logic, datafication razes qualitative specificities and intuitive ways of knowing to the ground.

[35] John Perry Barlow's "Declaration of Independence of Cyberspace" in 1996 at Davos remains the manifesto of those early ideals.
[36] This can be summed up in the sentence: "if it can be done, it should be done" Postman, N. (1992). *Technopoly: the surrender of culture to technology*. Knopf.

In a Technopoly, the technology of the age is the alibi that gives us our cultural identity (Postman, 1992). When technocracy becomes Technopoly, the tool (or technology) goes from being a helpful servant to a philosophy to live by. In other words, in a Technopoly, technology justifies its own existence. In the digital age, data carry this role. Oftentimes, the value and benefits of datafication - efficiency, objectivity, expertise, efficiency, standardisation, measurement, optimisation and progress – are unquestioningly assumed. Datafication justifies itself, redefines what we mean by art (NTFs), truth (fake news, deepfakes), privacy, friends (friending), community (algorithmically defined) etc. The alternatives are not outlawed, they merely become invisible and therefore irrelevant. In this sense, there is a totalitarian aspect to datafication.

On social platforms, the distinctions between real and fictional worlds, space and time dissolve. For example, filter bubbles, the enclosed algorithmically-created microcosms, create artificial universes of like-mindedness. The platformisation of digital life throughout a multiplicity of digital devices blurs the distinction between the physical and the mediated (Van Dijck, 2013). Similarly, the following boundaries are obscured: past and present combine into a continuous flow of "always happening" (Brandtzaeg & Lüders, 2018). The distinction between here and there, the embodied experience of place and time becomes irrelevant on social platforms where physically distant places become immediately present. Social contradictions and hierarchies are also concealed by the algorithmically produced echo chambers that creates a false sense of synchronicity and uniformity.

5.1.7 Phantasmagoria as Experience

Benjamin thought of phantasmagoria as a multifaceted phenomenon. Not only did he consider its aesthetic aspect but also how we relate to it as a social, political and economic experience (Blaettler, 2012). He sets himself apart from the Frankfurt School by adopting a phenomenological approach to his social critique[37]. In doing so, he uniquely embraced a designerly attitude to his

[37] This was the theme of one of Adorno's comments on his exposé in his August 1935 letter.

work. For him, material objects and cultural products existed not only in their aesthetic dimension, but also in their physical interactions with subjects. Thus, there is a sensory, experiential and a relational dimension to phantasmagoria, and therefore, an epistemological relation as well. When objects become commodities, they enter into a relationship with the subject. They are tradable commodities, but they also charm, talk to the senses and affect what and how we know in profound ways. Here, Benjamin points to the subtle relationship between culture, technology and knowledge and shows how the experience of technological change triggers epistemological shifts.

- ***A Spectacle***

  The true Paris is full of freak shows, repositories at three centimes a night for unheard-of beings and human phantasmagorias.

It is not by chance that Benjamin chose the word phantasmagoria as a central theme of its critique of 20th century modernity. The term, reminiscent of Robertson's 18th century Magic Lantern Theatre, encapsulates the idea of a bizarre and freakish visual spectacle. In this sense, the phantasmagoria speaks to our senses and our emotions, thus reducing the attitude of the spectator to one of pure reaction.

The spectacle turns objects and relations into products, commodities which thereby gain a material reality in the world. They become objects of desire, and acquire a symbolic status. As such, they also acquire a power (Appadurai, 2012). They exert an effect on perception by affecting, transforming and manipulating the senses. By doing so, they create experiences that challenge reason (Blaettler, 2012).

As a spectacle, phantasmagoria provides a space for immediate (as opposed to delayed) enjoyment (Berdet, 2013). The immediacy of the entertainment value is a defining theme of Benjamin's phantasmagoria. Its function is to encourage (as opposed to repress) instantaneous pleasure. Here, entertainment takes centre-stage. For Benjamin, it is the world of exhibitions, the amusement park,

but decades later, it is also the “showbusiness” of the electronic age. As such, it is closely linked to experience, with a special emphasis on social experience.

- ***A Social Experience.***

For Benjamin, cultural phantasmagorias express "the ambiguity peculiar to the social relations and products of this epoch" (1999, p. 10). He examines those through historical objects, artefacts. In this sense, he takes a designer-like approach to his work. He considers the relationship between the artefacts of the age and our perceptions of them. He does not use objects to illustrate a theory, but to understand the social realm. By considering phenomena as phantasmagoria, Benjamin considers both their epistemological dimension and their social impact (Blaettler, 2012).

Phantasmagoria combines immediate experience, interaction with objects (i.e., affordances, phenomenology) and interaction with one another (i.e., the social). Here, in this process of relational experiencing, we “buy” much more than “things”. Individuals become discrete and unique individuals in social networks. The bourgeois interior, where the object is idealised and turns into a symbol of each originality, becomes the “étui”, the showcase of the individuality displaying itself to the world. The stuff-turned-commodity enables what the social can provide: a persona, prestige, recognition or celebrity status.

- ***Commodification of Social Relations & Social Shadow***

Like Marx, who emphasised the obfuscation of the social reality of the capitalistic economy, Benjamin is also sensitive to the aesthetic dynamics of the relationship between commodity and people, the social experience and how things enchant people and interact with their senses (Blaettler, 2012). For him, social experience cannot be separated from the aesthetic function of the entertainment (Cohen, 1989).[38] They both contribute to the commodification of social relations.

[38] According to Cohen, Breton’s modern materialism influenced Benjamin and focused him on forms of sensual phenomenology and perception.

Thus, Benjamin not only examines the atmosphere of social relations but also how the atmosphere encourages consumption (the arcades, the department store) and entices the senses.

When it enters the realm of the social, phantasmagoria also becomes a method of critical illumination (Cohen, 1989). This is metaphorically described in Lewis Carroll's poem by the same name, a narrative dialogue between a ghost (Phantom) and a man named Tibbets. The ghost's society mirrors ours, only in reverse. Through seven cantos, Carroll proceeds to expose the shadow side of the society of his time (Carroll, 1869, p. 5):

> Allow me to remark
>
> That ghosts [*sic*] has just as good a right,
>
> In every way to fear the light,
>
> As men to fear the dark.

- ***Datafication: Phantasmagoria as Experience***

It is important to note that datafication has arisen not out of the first wave of internet development, but out of what has been dubbed the "social web" or "web 2.0" starting in the mid 2000s (O'Reilly, 2017). Prior to this, in the beginning phase of the world wide web, data was not the central element and the driving force of technological development. It is only when the web became "social", i.e., with the platformisation of media when social mapping and relationships took front stage, that data became the "internet gold" (Helmond, 2015).

As social experience, phantasmagoria is a frame for the supremacy of immediate enjoyment. The temples of commerce of the late nineteenth century (i.e., the arcades, the department store) required an atmosphere that talked to the senses, awakened desire and stirred aspirations. But while the arcades provide physical affordances, digital space is mediated and disembodied. In the digital environment, experience becomes "user's experience" (UX), and ease of use becomes a

central concept. Here, the phantasmagoria of datafication is to believe that the social graphs and the sociality of social media truly reflect the embodied social.

While design improves digital interfaces to enhance experience, it also can be used for manipulative ends. Designing ease into the digital interfaces can make users overly dependent or impatient. It trains users to focus on convenience and overlook other important aspects of their lives in digital environments. Over the years, ease has become a central value for users of technology, but it can also come at the detriment of a critical approach to using technology. We expect ease because we have been habituated to expect it (Zuboff, 2019). Immediate enjoyment is a double edge sword, it works to users' benefit but also to their detriment, providing the conditions for media users to become habituated and uncritical (Postman, 2006).

UX becomes a prominent element in the phantasmagorical game of illumination and obfuscation and also actively participates to the process of habituation. As such, the design of users' experience, the capacity to illuminate or obfuscate and provide immediate enjoyment participates to creating the phantasmagoria. This is the basis of a new discipline which emerged from the digital age, captology (Fogg, 1999), the design of persuasive technologies. Behind the design of persuasive technologies lies datafication's inherent need to collect data. The very logic of datafication spells the design agenda, and leads to the emergence of the phantasmagoria through new media structures.

Social relations themselves becomes commodified through the mediation of the algorithm. In Benjamin's phantasmagoria, we buy more than goods. In the quantified and optimised connected world of the twenty-first century phantasmagoria, we get more than friends, we get tribes, we get algorithmically designed universes based on personal data collected about our presumed preferences and beliefs. It is the phantasmagoria of the filter bubble, algorithmic filters are used to create a utopian universe where we all agree, share the same interests, similar longings and concerns. To the user, it looks like a real universe, but seen from a larger scale, it is a tribalisation

of the social fabric by design. The online social fabric is an impoverished dream-image of real sociality (Couldry & Van Dijck, 2015) brought to us by the levers of datafication.

Furthermore, under datafication, social experience also becomes commodified. The new social contract is a Faustian bargain that entails giving data away to an intermediary in order to plug into the vast network that the social web affords users (Van Dijck, 2013). While the barter is presented as inevitable, it takes the shape of a phantasmagoria as it is not real. In other words, we do not really have to give up privacy in order to benefit from digital technology (Zuboff, 2015).

In the digital age, Benjamin's interior becomes the user's profile. There, the individual is afforded a public face to establish its place in the social network. The social profile is a repository of a multiplicity of phantasmagorias, the dream-images of the online personae. One can become whomever they wish. But this mediated universe is measured and quantified. The phantasmagoria is not exclusively of the user's making. In the purely mediated multiverses of the online cosmos, physicality gives way to the disembodied intangible, our personality gives way to "measurable types", images become pixels and our perceived individuality vanishes, replaced by computer-ready data. Under datafication, our identities become fluid sets of computer data, which can be aggregated and recombined at will (Cheney-Lippold, 2011).

5.1.8 Phantasmagoria as Commodification

For Benjamin, phantasmagoria is closely associated with the commodity culture and the processes of commodification and reification. As Margaret Cohen notes, Walter Benjamin was fascinated by the phantasmagoria and used it as a term to describe the experience of the Arcades in Paris. In his essays, he associated phantasmagoria with commodity culture and its experience of material and intellectual products. In this way, Benjamin expanded upon Marx's statement on the phantasmagorical powers of the commodity (1989).

The bourgeoisie is the social class central to this process of phantasmagoria generation. In this way, phantasmagoria becomes the specific illustration of a certain type of society. Some examples

of phantasmagoria production by the bourgeoisie are the phantasmagorias of the interior, of the market, of civilisation itself (as made plain by Haussmann's Paris for example). Each corresponds to different classes within the bourgeoisie: the trade bourgeoisie; the industrial bourgeoisie; the financial bourgeoisie (supporting Napoleon III). Phantasmagoria also becomes a neutralising weapon when the dominant class spreads its own phantasmagoria to other classes. One instance is the phantasmagoria of the market for the workers.

- ***Commodity Fetish***

Benjamin critiqued Marx's theory of commodity fetishism using a religious analogy. In *Das Kapital*, Marx defined it as a relationship between two person assuming the form of a relationship between two things (Ellen, 1988). Commodity fetishism also assumes that value is inherent to things, and does not arise from the social aspect contained in the production of the commodity (McNeill, 2021). Benjamin expands the Marxist notion of the dream-like nature of the commodity, and investigates the concept through the production of the work of art (Benjamin, 1978b). The concept becomes a keystone of his work in *The Arcades Project.*

While his approach has been critiqued as religious and even mystical, especially by Adorno (Adorno & Benjamin, 1999; Derrida, 2002), his interest in the work of art, and especially film is in fact highly political (Buck-Morss, 1991). He exposes the unhealthy effect commodity fetishism has on our sense of reality. He sees art as the only way to tear through the phantasmagoria, which also explains his methodical choice in *The Arcades Project*, using a constellation method to help his audience see differently. In his view, when we engage in artistic pursuits, we engage with representations, and in doing so, we reveal and disrupt the fetishism attached to all types of representations (Martel, 2011).

The obsession with mechanical reproduction negatively impacts the uniqueness of the work of art, because "even the most perfect reproduction of a work of art is lacking in one element: its presence in time and space, its unique existence at the place where it happens to be" (Benjamin,

1978b, p. 3). Once the work of art is reproduced, it becomes an artefact designed for reproducibility and it loses its original function (ritualistic) to become a political device. The work of art can be valued in two ways: firstly, by being hidden, what Benjamin calls the "cult value", and therefore becomes precious, and secondly by being exhibited. With mechanical reproduction, the second way is emphasised. In the process, it becomes "a creation with entirely new functions" (1978b, p. 7), the artistic function only being one of them, and becoming a commodity in a mass-culture society, autonomy gets lost forever.

- ***Datafication: A Phantasmagoria of Commodification***

Benjamin emphasises the important role of art in the critique of the fetishism intrinsic in all forms of representation. Under the light of fetishism, datafication takes on a double meaning. First, it evidently refers to data as fetish in the Marxist sense. But it also has relevance in terms of the ideology behind datafication. One of the ways to understand datafication is as an enterprise of eradicating uncertainty (Dhar, 2013), by giving a prominent place to disembodied, linear, optimised quantities. As such, it fundamentally becomes hostile to the artistic project in general, which relies on uncertainty, paradoxes and tacit ways of knowing.

It is not that datafication is detrimental in and of itself; it has a place and an important role to play in human affairs. But it is an ecological matter of balance. The phantasmagoria is the false "either-or" dream that datafication itself will bring solutions to the greatest issues of our age by eradicating human biases, or by revealing truths that the human mind is not otherwise privy to (Crawford & Calo, 2016). These conclusions, however, forget that big data patterns are based on data that had to be "cleaned" and turned into a computer-ready form, which means that it's missing subtle but important pieces pertaining to experience that could not be subjugated (Colburn, 2015; Rieder, 2020).

For Benjamin, phantasmagoria only exists in a commodity-producing society. At the dawn of the 20th century, in the age of the industrial revolution, objects and artefacts were the commodities of

choice. In the digital age, individuals have become the basic commodity from which valuable behavioural products are manufactured and sold (Zuboff, 2019). The phantasmagoria also lies in the idealisation of the phenomena of datafication. For example, the algorithmisation of human activities is presented as real ("friending" is equated to making friends). The idealising language of the datafied universe also participates to creating the misrepresentation by emphasising certain aspects and obfuscating others; claims such as "we connect the world" or "Don't Be Evil"[39] hide the underlying enterprise of datafication.

Summary

Benjamin's work is relevant to this thesis as it combines the analytical and the aesthetic, very much like what design does. Benjamin's aim was to unveil the mystery behind a particular marker of the 20th century - industrial capitalism - to explore how traces of the past merge into the present, producing a phantasmagorical image of civilisation. In many ways, his work should not only be read, but also, (and perhaps primarily) experienced. In this sense, it could be argued, it is an ode to the importance of tacit knowledge.

Benjamin was aware that a capitalist society can never be free from the attraction of fetishism or from its consequences. His engagement was not to deny or destroy a particular phantasmagoria that defines an epoch in history, but to spotlight its extenuating effects. Similarly, the emerging civilisation of the 21st century cannot be free from datafication, but we can however, identify its influences and biases. And as Benjamin has illuminated, design has a central role to play in this engagement.

Throughout his work, McLuhan argued that looking in the rearview mirror can't tell us much about what is coming ahead. However, a main aspect of critique is to shed a new light on the

[39] Google caused a stir when they deleted their famous motto from their code of conduct in 2018, tacitly acknowledging that it may have to be evil after all.

phenomenon under study. To do this, it is often instructive to look into the past in order to illuminate aspects of the present (Postman, 2011). This chapter described how Benjamin's concept of phantasmagoria illuminates some features of the technologies of datafication. The attributes of the phantasmagoria proposed in this thesis, namely, as imagery, as myth, as experience and as commodification, stand the test of time. They help us to understand the world from the perspective of a dreamlike type of projection. They reveal that datafication is indeed a technological revolution in terms of the medium, but not in terms of the ideology behind it. The dream of objective, measurable, optimised and disembodied knowledge is alive and well, and solidified by the computational power of the architectures of datafication.

Benjamin's cultural critique is anchored in the technological shift of the nascent industrial civilisation, and the attendant phantasmagoria of objective knowledge. Although it was not explicitly communicated in his work, both his methodology (from the ground up) and his conclusions in The Arcades Project resonates with Haraway's argument that knowledge is in fact situated. His reference to the flâneur, lost in the newly emerged urban crowd, illustrates the subjective standpoint of the situated knower embedded in a web of social, cultural, political, economic and technological relationships. His critique of a civilisation founded on the dream of unlimited progress (a central value of modernity) is especially relevant today as we witness the damaging effects of an unimpeded pursuit of economic development, as reflected in the work of authors such as philosopher of science Isabelle Stengers (2022).

Chapter 4 proposed two frameworks revealing the antinomic attributes of tacit and datafied ways of knowing. This chapter asked how the Benjaminian concept of phantasmagoria can inform our understanding of datafication and its underlying epistemological assumptions, and argued that datafication is only a revolution in terms of medium, but not in terms of paradigm. However, this research also aims to inform the present in order to build insights into the future. Therefore, while a critique of datafication through the lens of phantasmagoria brings valuable insights into the phenomenon and helps dispel the faith in its objectivity and reliability, it cannot ignore the fact

that Benjamin was a product of his epoch, and that the knowledge he produced is situated. Today, datafied and tacit ways of knowing are antinomic but not separate. The complexity of their interrelationship should neither be ignored, nor underscored, and can best be illuminated by a shift in epistemological paradigm.

The web of relationships, the systemic perspective, is maybe what is more crucially missing from Benjamin's oeuvre as we walk into the complexity of a 21st century networked present. Design as a lived practice, but also as an ethos that guides the materialisation of all sorts of environments, needs to constantly take stock, reframe and evolve. While tacit knowledge stands at the heart of the creative and practice-led disciplines of which design is a part, and while its importance needs to be acknowledged, it is also true that these disciplines need to find ways to contend with antinomic forms of knowing and knowledge production. To this effect, in the next chapter, I will present a relational framework that shifts the focus to a regenerative and ecological (i.e., deeply interconnected) paradigm.

6 TOWARD A REGENERATIVE ECOLOGY OF KNOWLEDGE IN AND FOR THE 21ST CENTURY

Chapter Overview

> To invent something new, and to bring it into being, is to change not only one's surroundings but to change oneself and the way one perceives, to change reality a little perhaps? (Jones, 1979)

To recap, Chapter 4 examined the attributes of tacit and datafied ways of knowing and proposed a comparative framework to understand how they relate. In light of the dramatic increase in the use of datafication in every area of life, Chapter 5 proposed a critical enquiry into whether our faith in datafication was justified and informed our understanding of its epistemological assumptions using the benjaminian concept of phantasmagoria. Having concluded that datafication fits the framework of a phantasmagoria, but acknowledging that design and creative & practice-led disciplines must find ways to reconcile antinomic forms of knowledge production, this chapter adopts the new paradigm of a systemic framework to consider the epistemological issues brought about by the exponential spread of datafication from an ecological, i.e., interconnection standpoint. Ecology (from the Greek (oîkos) 'household' or home, and (-logía) 'study of') is the study of the interactions between individual organisms and their environment (Sarkar, 2016). Bringing the concept of ecology into the discussion on knowledge production, new avenues for exploring an epistemological rebalance can better address our current systemic crisis of knowing is offered. To help contextualise this discussion, the ecology framework used here takes a holistic and interdependent perspective of datafication, viewing it as part of a larger living system. From this vantagepoint, this chapter examines how to move forward and find an epistemological rebalancing that utilises regenerative principles as the basis for designerly knowledge production in the 21st century.

An Ecological Crisis of Knowledge

To a great extent, we still live in a world entrenched in epistemological premises dating back to the 17th century, which sees the natural world as a machine comprised of many independent parts, and thus, best understood by isolating and analysing each cogwheel and gear. This type of reductionist thinking became particularly prevalent in the early 20th century with the industrial revolution and the development of mass production and mass-consumerism which Benjamin's Arcades work elucidates. As hinted by the work of Walter Benjamin in The Arcades Project, the Industrial Revolution was also the time when managerial disciplines appeared and the factory line type of thinking became pervasive, leading to a major enterprise of recategorisation of the world to fit the assumptions of the mechanistic paradigm (Bowker & Star, 2000). The faith in this phantasmagoric worldview greatly contributed to overconsumption, overuse of natural resources, the commodification of nature and living beings, and the associated complex global emergencies that plague much of the world today.[40]

The machine metaphor is convenient because it provides certainty and therefore facilitates decision-making. The clock, a prime example of the machine, represents systems that are regular, ordered and highly predictable. Such systems carry an inherent certainty on how they behave, allowing for order, planning and control. With the clockwork, we measure and are certain about how to divide time objectively. This type of thinking applies not only to the production of machines, but also to all living organisms as well as schools, organisations, the economy,

[40] To put things in perspective, it is useful to recall the narrative ("The Sermon") imagined by environmentalist David Brower which compresses the history of the Earth into the six days of creation. Brower, D., & Chappel, S. (1995). Let the mountains talk, let the rivers run. *New York*. In that narrative, Earth is formed on Sunday at midnight. On Saturday, the last day of creation, all visible forms of life appear, first marine animals then plants, followed by amphibians and insects in the morning, and by dinosaurs (who are only around for five hours or so), mammals and birds in the late afternoon. At 11pm, some tree climbing mammals evolve into monkeys. Homo Habilis appears at 11:56pm, and Homo Sapiens thirty seconds before midnight. Modern human species appear from 11 seconds (Africa and Asia) to 5 seconds (Europe) before midnight. Written human history begins around two-thirds of a second before midnight. The Industrial Revolution—with its attendant linear thinking, happens at about a 40th of a second before midnight (McPhee, 1977). In that fraction of a second, Brower argued, humans depleted soils and fisheries, destroyed many species and affected the climate.

relationships, health etc. What is designed as a machine however is subject to the laws of entropy and destined to degenerate.

The production of knowledge has also succumbed to this ideology, creating a machine-like ecology of ideas. This type of thinking has its advantages and areas of application and is not detrimental in and of itself. Essentially, datafication aims to resolve the issue of subjectivity and uncertainty (hence the difference between the attributes of datafication as "complicated" and of tacit knowledge as "complex" as presented in Chapter 4.) The 20th century is deeply anchored in the metaphor laid out by F.W. Taylor in 1909 in his then revolutionary book *Principles of Scientific Management.* This epistemology relies on values of productivity, efficiency, linear progress as well as a scientific approach to the social that guarantees certain outputs through the implementation of best practices. Throughout the ages, humanity has found ways to deal with the intrinsic uncertainty that accompanies life, from faith in an all-powerful God to faith in the all-powerful machine, a metaphor of control over the inherent unpredictability of life. Despite the claims about the paradigm shift that have accompanied the "digital revolution", we are, in many ways, epistemologically still anchored in the paradigm of the Industrial Revolution.

The age of datafication is clearly tied to the belief that everything can be reduced to the smallest common denominator and measured, aggregated and streamlined for more efficient planning and greater productivity (the optimisation mentioned in Chapter 4). An input followed by a series of steps leads to a predictable output. In *The Arcades Project* (1999), Benjamin chose Fourier's utopia as one of the characteristics of the phantasmagoria of the emerging industrial age. The advent of machines underlies the belief of Fourier's utopia in an efficient functioning society where everything works according to clockwork precision.

Postman (1992) argued that in a Technopoly, the deep-seated belief that everything has a clock nature reinforces the phantasmagoric idea that we can even leave ethical decision to technology. However, life is complex and cannot be domesticated so easily. Life is composed of dense interdependencies subject to non-linear change and is unpredictable. Therefore, there is a need for

a new framework to manage complexity to fill the gap, a framework that relies on values of abundance and emergence. Ecology views the world as a network of flowing communities and investigates their dynamic interplay. A living system maintains itself within a boundary of its own making where abundance and resilience are recurring outcomes of its underlying health. Thus, by creating the conditions for life, we can let the intelligence of the system do its work.

The motivation underlying this research rests in a deep concern for life, and the hope that the field of design can position itself to be a key steward in creating new ways of being in the world. Design stands at the core of a project of the Enlightenment to construct the world. How worlds are created is a fundamental question that underlies the discipline, its practices, methods and ethos. The "worlding" nature of design requires a constant review of the epistemological processes at play. Knowing, in this context, does not aim for predictive certainty, but for understanding. In this sense, designing requires interpretation to give form to knowledge, and is therefore a political act that posits agency.

While there is a growing movement toward the development of more sustainable ways of designing, most of the work on sustainability is still taking place within the technological paradigm that reflect the mechanistic-type thinking of the Industrial revolution (Reed, 2007). This approach is anchored in proposing incremental change to limit the damage when what is needed is to restore the living systems that we inhabit to health. Design, in all its dimensions, is central to human and non-human living, and as such, participates to the creation of the living, the social, the relational, in other words, the design of life. As such, it is well situated to participate in building a regenerative culture that is inherently holistic, interdependent and sustainable.

Rediscovering A Regenerative Ecology of Knowledge

6.1.1 Introductory comments

- ***A Regenerative Ecology of Knowledge: Why?***

Computational systems, which started off as a diversity of separate elements (smart grid, social platforms, cloud, apps, smart cities and IoT, automation of all sorts) have grown into a megastructure that is not only a set of gadgetry, but also acts as an overarching architecture within which we operate and "know things" (Bratton, 2016). Technologies of datafication are here to stay and it is important for design to consider what principles are needed to keep designing in complex milieux of forces framing 21st century life.

As a "science of the artificial" (Simon, 1996), design is in the business of tapping into the experiential, and in the early 21st century, datafication underlies the tools that frame a large part of our experience. Big data is incomprehensible to the human mind - not only because of its size but also and mainly because it uses a computational logic and language foreign to human cognition. While design has been critiqued as an active participant to the global challenges we are witnessing today (Fry, 1999; Papanek & Fuller, 1972), it is also well positioned to recreate a balance that has been significantly jeopardised by an over-reliance on datafication. While it is important for designers to be cognisant of the failings of datafication, it is imperative that we find a middle way of living with technology – one that adopts a more holistic, more systemic view of the world we live in, based on the regenerative principles of life itself. By understanding how life works, we can start designing for regeneration instead of degeneration.

Datafication is not inherently detrimental in and of itself. Rather, it is how we have become overly reliant on datafied processes that is most problematic. The unbridled spread of datafication in nearly all qualitative areas of life is creating an ecological crisis of knowledge - particularly to tacit way of knowing and being. What is needed is a rebalancing toward more regenerative ways

of knowing to rediscover what that modernity has forgotten, namely the importance of maintaining a regenerative ecology of knowledge.

- ***Succinct Historical Review of Regeneration as a Way of Thinking***

The issue of sustainability has been a central question of design for several decades. However, more recently, the concept has significantly evolved into the regenerative sustainability paradigm. While sustainable practices focused on limiting environmental harm, they do not fully address the real source of ecosystem degradation (Mang & Reed, 2020). The regenerative perspective on the other hand asks for a systemic approach that embeds human activity into self-sustaining living systems to maintain life-enhancing resilience for the benefit of all human and non-human actors in the planetary ecosystem. Lyle (1994) provided a framework to reverse the damages created by a one-way way of thinking that underlies the template design mindset. His main concern was to shift design toward a regenerative framework, one that moved from a technological perspective to an ecological one. This ecological and more integrated proposition has been put forward as strategy for more appropriately contextualising and addressing the complexity of today's world (Du Plessis, 2012). However, understanding what has been coined as "ecological sustainability" (Mang & Reed, 2020) requires to understand the science of living systems underlying it.

6.1.2 Introduction: Ecology & Systems View

> The more clearly we can focus our attention on the wonders and realities of the universe about us, the less taste we shall have for destruction. (Carson, 2011, p. 94)

- ***What's Ecology?***

Ecology is the study of the organism and its relationship with its environment. In a general sense, ecology is really the study of relationships. Relationships are not completely straight-forward, they are not easy to analyse and measure and often are messy and fuzzy. At their essence, they are qualitative, embodied, emergent and experiential and, most of all, complex. Ecology is a science of interconnectedness - defined as spontaneous emergence of new forms of order in nonlinear

systems at critical points of instability (Capra & Luisi, 2014). In sum, the ecological view is a systemic one. While some systemic views look at networks in purely mathematical ways, other perspectives honour and learn from the self-sustaining and regenerative capacity of life. For the purpose of this discussion ecology is understood as a "warm" systemic view (as opposed to a "cold" view), a terminology borrowed from Bateson's "warm" data (2017) which emphasises the transcontextual nature of complex living systems. The qualifiers "warm" and "cold" are not meant to diminish or disparage, but rather to describe the level of relational embodiment of the qualitative dynamics in a system[41].

- ***The Systems View of Life***

The epistemology of the 21st century needs to be based on ecological holism – one that places relationships at the centre and sees patterns rather than isolated organisms. This idea is not new; it is encapsulated in a system thinking approach which has been around for nearly a century. The idea was initially introduced in the 1920s and 1930s when biologists, psychologists and ecologists came together, interpreted the organism as an integrated whole, and developed the attributes of system thinking[42] (Capra & Luisi, 2014). Systems theory relies on a relational epistemology, i.e., thinking in terms connectedness, patterns, context, relationships, and concepts such as interdependence, adaptation, circular transactions, homeostasis, feedback loops. The 1940s saw the development of those theories during the Macy Conferences (Pias, 2016), with General System Theory (Bertalanffy, 1968) and Cybernetics (Wiener, 1948). In the 1970s, the field grew considerably with the development of complexity theory, or non-linear dynamics, with fields such as chaos theory or fractal geometry. A common feature of the theories under this umbrella - and

[41] Bateson defines "warm data" as follows: "Warm Data" is information about the interrelationships that integrate elements of a complex system. Such data elucidates qualitative dynamics and offers another dimension of understanding to what is learned through quantitative data (i.e., cold data) (https://batesoninstitute.org/announcement/warm-data).
[42] A process very similar to the development of design thinking.

the most pertinent feature for our discussion - is that their computations result not in formulas but in patterns (e.g., strange attractors and fractals patterns).

It is beyond the scope of this research to go into the technical details of the mathematics of complexity. What is interesting for us here is that the field of system thinking has branched out into a number of channels. One of them led to engineering developments in computational systems and another to developments in biology, social sciences, the humanities and psychology. Prompted by the work of Margaret Mead, second order cybernetics, (or the cybernetics of cybernetics) was developed between the late 1960s and mid 1970s by Heinz von Foerster (Glanville, 2004). While cybernetics was the study of observed systems, second order cybernetics is the study of observing systems, i.e., it takes a reflexive view on the process of observation, by observing oneself (the observer) doing the observing. This is important because in ways of knowing based on systems thinking and more specifically living systems, the knower is in active agent. Translated to design, the designer is being (re)designed by the process of designing. (This is related to the fifth characteristic of tacit knowledge, complexity, outlined in Chapter 4). This field is closely related to radical constructivism, autopoiesis (Maturana & Varela, 1980) and conversation theory (Pangaro, 2008).

6.1.3 Living Systems as a Framework

This section will explore living systems as a new epistemological metaphor, based on the premises put forward by the Santiago School and two of its founders, Humberto Maturana and Francisco Varela. As living systems, ecosystems of knowledge have to behave like other living systems to be sustainable. Given the current mainstream way of knowing however, living and designing are not self-sustaining. While living organisms and production of knowledge are not identical per se, at their heart, they are both about networked patterns of organisation. We need to find new metaphors for a new epistemology. This research is about recognising that the fundamental problem is of an epistemological nature, clarifying what’s the real problem with the current paradigm, and finding new metaphors as avenues to think differently.

As trained biologists, Maturana and Varela wanted to understand the organisational pattern of life. In the process, they developed a framework for self-sustainability[43] and regeneration. Indeed, life has been around for billions of years. It is inherently regenerative, meaning that it is organised to constantly renew itself. In the milieux of crises we are currently facing, there is a growing interest in learning from living systems to understand how regeneration operates and ultimately to translate those insights into a new way of being and knowing.

Living systems share four main characteristics: they organise themselves in networks of networks, they are inherently creative (or emergent), intelligent (or able to memorise, learn and respond), and regenerative (autopoietic and evolutionary) (F. Capra, Personal Communication, December 10, 2021). While it is not within the scope of this research to elaborate upon this, it is worth noting that while the emphasis on self-referentiality in Maturana's framework has been critiqued as radically constructivist, it has also been widely applied to domains other than biology (systems theory, sociology, business and legal studies, cybernetics, and computer systems).

- ***Of The Autopoietic Nature of Living Systems***

Maturana and Varela (1973) aimed to discover the patterns of organisation common to all living creatures that could sustain a grand theory of life. Their approach was anchored in experience. They used a phenomenological approach to defining life, and built their theory from the bottom up. They considered that living systems are essentially cellular - i.e., there is no life without cells. Based on this, the first important factor of life has to do with the cell structure, and the role the cell's membrane plays in sustaining cellular life. Here, the membrane acts as a boundary that determines the cell identity, meaning that within the membrane, the cell as a system is organised autonomously. It is in this way that the boundary is not one of separation but one of identity. If a system is organisationally circular, it is also organisationally closed, and thus autonomous

[43] Over the years, the word "sustainability" has come to refer to reductionist approaches to dealing with the global crises of our time. Here, "self-sustainability" refers to the capacity of living systems to re-generate themselves.

(Maturana & Varela, 1973; Varela, 1979). Within the boundaries of the membrane, the cell has its own structure, and it is this structure which decides the cell's behaviour. All living systems are determined by their structure. This means that it is the internal structure of the system - i.e., the components and their relationships - which determines how a system reacts to outside disturbances. In other words, the environment can impact the cell, but not control how it will react to the impact; only the changes that are aligned with the cell's inner structure will be accepted (this is called "structural determinism").

However, it doesn't mean that the cell's behaviour is linear and predictable; the cell structure is also impacted by disturbances from its environment in a circular relationship. The idea of structural determinism proposes a new view on the debate between freedom and determinism. According to Maturana and Varela (1992), the behaviour of a living organism is determined by its own structure rather than by its environment. This structure, however, is not static and evolves in a series of autonomous structural changes (the biological equivalent of learning), thus making the living organism both predetermined and free at the same time.

The second important feature of cellular life is metabolism, which is a dynamic process of ceaseless flow of energy and matter through a network of chemical reactions enabling the cell to constantly repair and regenerate itself. A cell is never in a static state; it engages in a constant balancing act (Capra & Luisi, 2014). This is a characteristic of dissipative structures that have the paradoxical quality of having stability far from equilibrium. Metabolism is the key dynamic factor for autopoiesis, i.e., the ability of the cell to constantly remake itself (i.e., to self-sustain). There are two aspects to metabolism, including the continuous flow as well as how the network is organised. What is important for our discussion is that living networks are not structural, but functional - i.e., they are a set of relationships between processes, not between "things".

The capacity to self-generate and self-maintain (i.e., autopoiesis) is the key dynamic of living systems. The autopoietic dynamic is at the centre of living systems. It combines the two essential elements of living systems: the membrane boundary - which as mentioned is not a boundary of

separation but of identity - and the networked metabolic processes. It signifies that living organisms have the capacity to continuously recreate themselves by transforming or replacing their components. Their structure changes continuously - the nature of this change is both cyclical and developmental which means that new structures are created, while at the same time, they retain their pattern of organisation. In doing so, they display both stability (of organisation) and change (of structure) at the same time.

The cell's membrane is porous, allowing the cell to interact with its environment in a way that is structurally determined. Thus, while the environment can disturb the cell, the cell's structure – i.e., the components and their relationships - will determine what disturbances it accepts and how it responds to them. According to Maturana and Varela (1980), the world (both living and non-living organisms) is structure-determined. The structure of an object determines its behaviour by defining all of its possible interactions. However, a living structure is not static but changes with every interaction. In other words, structure determines the behaviour of an organism, but structure continually changes in the process of living.

- ***To Live Is to Know: A Theory of Cognition***

In trying to understand and discover the patterns of organisation common to all living creatures, the Santiago School developed a theory of cognition that is linked to, but separate from, the concept of autopoiesis. As described above, living organisms have the ability to continually self-regenerate (autopoiesis), in a circular process of "structural coupling" with their environment. In this process, disturbances from the environment impact an organism but do not control how the organism responds and in turn, the organism changes itself (evolves) and impacts its environment. In this way, structural coupling becomes the organising activity that perpetuates life (autopoiesis). The Santiago School proposes a relational ontology whereby that which exists must do so in a

structural coupling to the world (in which it exists).[44] Likewise, for an organism to keep living (autopoiesis), it must be coupled in a circular relationship with its medium.

The important insight that the Santiago School draws from this observation is that the interaction between organism and environment - structural coupling - is "cognition" (Maturana, 1970). This relates to the idea that, in structurally coupling with its medium, a living organism behaves knowledgably and intelligently. Therefore, knowledge is not seen as an intrinsic property of an organism, but as the phenomenon that supports the autopoietic process (Maturana & Guiloff, 1980). In other words, life is a cognition process and to be structurally coupled (i.e., to be in this circular relationship of constant self-regeneration) is to be intelligent. In this view, cognition is a process and the process of life is a process of knowing. Thus, to live is to know how to exist (Maturana, 1970), and a system that is structurally plastic - i.e., able to change structurally as it interacts with itself, its medium or other systems, is a learning system (Dell, 1985).

This is of importance when we consider the epistemology of design because the Santiago School's theory of cognition provides a framework for knowledge production in the 21st century. As previously mentioned, reductionism is a key issue of datafication as this reductionist knowledge is fed back to us to orient ourselves in the world. Design actively produces knowledge about how to live in one's environment. This is one of design's essential activities. The Santiago School framework proposes a way of knowledge production that both helps us to orient ourselves in the world (i.e., know how to exist), and also at the same time, gives meaning to why we design (i.e., to sustain life). Following this logic, design can create the conditions for organisms to decide how they want to exist in their environments. Additional research based on Maturana's framework also

[44] The relational ontology of Maturana and Varela is closely linked to the Buddhist concept of dependent origination (Pratītyasamutpāda), whereby a phenomenon does not have any intrinsic existence, but comes into existence based on the presence of causes and conditions, and ceases when the causes and conditions disappear. In this light, there is no such thing as an independently existing intrinsic self. The self is a phenomenon coming into existence when the right causes and conditions come together. In this view, Pratītyasamutpāda explains the inherent impermanence of life.

accounts for the different levels of complexity involved in cognition. According to this research, lived embodiment is a feature and a requirement for knowledge acquisition (Luisi, 2016).

6.1.4 An "Ecology of Mind"

> On the whole, it was not the crudest, the simplest, the most animalistic and primitive aspects of the human species that were reflected in the natural phenomena. It was, rather, the more complex, the aesthetic, the intricate, and the elegant aspects of people that reflected nature. (Bateson, 1979, p. 5)

Bateson proposed a holistic framework and theory of mind which he called "ecology of ideas" and which bears similarities with the Santiago School's theory of cognition. He put forth the idea that the "mind" is in fact a process of knowing, i.e., a dynamic mental phenomenon which pervades living systems. Mind (the mental processes) reflects nature (the processes of living). The significance of the parts arises in the context of their relationship to the whole. Living systems are networks of relationships, not of things. Bateson's framework is both holistic and relational. He referred to "pathologies of epistemologies" (2021), which, just like pathologies of health, lead to disease.

The pathology of Western thought lies in fully accepting the concept of the objective outsider observing discrete units of survival within an objective environment. From this vantage point, the whole is merely the sum of its parts, and knowing is merely a process of putting them together in the right way. This is not to say that Western thought is inherently flawed. The way of thinking of datafication is valid, even required, in mechanistic contexts. The pathology becomes apparent with the belief that the mechanical way of thinking can apply to organic, living ecosystems. The essential source of the ecological unbalance of knowledge today is essentially forgetting that we are an integral part of the living systems that we seek to understand (Barad, 2007; Bateson, 1979).

Ecology studies "the interplay". Seeing things as separate from ourselves obfuscates the interaction; from there, the lived experience of interconnectedness fades in the background and the

environment becomes a commodity. “With” becomes “versus”, and the relationship of embeddedness turns into a relationship of separation and transaction. Just as nature is treated as a resource to exploit, so too is knowledge. The discrete data that have become the building blocks of the data economy have been commodified just like the resources of nature have been commodified. In both cases we see nature and knowledge as objective “things” outside of ourselves that we can control to serve an agenda. Datafication is a reductionist, objectivist way of knowing which treats nature and knowledge as “things”.

The way of knowing that sees “things” outside of oneself is one way to see, but when it becomes the only way to see, it leads to disrupting the fine balance between the ecology of knowledge and of the environment. Seeing ourselves as separate has led to the commodification of nature, and the overuse of resources, and this way of knowing is now threatening to destroy the planet. Ecological thinking focuses on how the intricate interactions in living systems sustain life, and on the tacit knowledge that underlies them. Breaking the intricacy of these ways of knowing disrupts the ecology of life and of ideas. The idea that machines can advantageously replace humans to produce unbiased knowledge is both wholly misguided - as it assumes we understand and control all the delicate variables of knowing - and destructive to living systems. While datafication is coveted for its convenience, as it allows us to offloads difficult decisions, the misplaced belief in its ability to replace human decision-making in complex contexts is highly detrimental as convenience is not a life-enhancing value.

Looking at ways of knowing through the lens of the ecology of ideas brings to mind the work of Benjamin (see Chapter 5), and the ecology of myths, beliefs and ideologies supporting an epoch. The phantasmagoria of the 20th century was mass consumerism supported by the attendant ecology of ideas of the industrial revolution. One century later, datafication has replaced mass consumerism, but the mainstream ideology supporting the system is the same. The digital revolution is a revolution in means, but not in thought.

6.1.5 Warm Ways of Knowing

- ***Non-Human Centric Ecology***

The term deep ecology came about in the 1980s as a reaction against more reformist, but less radical aspects of the ecological movement. A term coined by Norwegian philosopher and mountaineer Arne Naess in 1972, deep ecology has been an influential force in the ecological movement. Its critique of earlier forms of ecological thinking centres on the anthropocentrism that has characterised previous ecological movements. Deep ecology gives an equal weight to all entities, adopting a flat hierarchy of importance, a concept called "biocentric equality" (Devall & Sessions, 1985). Its foundational precept is to "live as if nature mattered" (1985), hence putting the focus on the deep interconnection between humans but also non-humans entities that collectively participate to life. It is more radical than the ecological reformist movement, which sees externalities as minor issues that can be handled by policy incentives. For deep ecology however, nothing less than a dramatic shift in thinking is required - from a paradigm centred on dominance (of humans over nature, masculine energy over feminine energy etc.), a belief in objective truth, a faith in technological progress, an industrial and commercial focus on growth at all cost and a rationalist mindset to one that values regeneration and self-sustaining of life above all (Luke, 2002). While deep ecology has been critiqued, especially when it comes to the difficulties in putting theory into practice, it remains an important guiding principle for restoring ecological balance. Deep ecology is anchored into a holistic tradition of knowing as well as indigenous way to see the universe we inhabit.

- ***Indigenous Ways of Knowing***

While systems thinking is a relatively new concept in the industrialised world, traditional cultures have a natural sensitivity to ecological perspectives. Yunkaporta (2020) proposes a four-axes framework to understand the indigenous generation of knowledge and compares it to the Western, "scientific" way of knowing. As the focus of this research centres on tacit ways of knowing as

opposed to datafied way of knowing, Yunkaporta four-fold approach sheds light on this dichotomy and illuminates this discussion.

Process	Metaphors for Process					
Ethical Process	Axiology	Law	Valuing	**Respecting**	Spirit	Root
Relational Process	Ontology	Existence (relations)	Being	**Connecting**	Heart	Stem
Intellectual Process	Epistemology	Knowledge	Knowing	**Reflecting**	Brain	Branch
Operational Process	Methodology	Practice	Doing	**Directing**	Feet/Hands	Leaf

Fig. 7. Indigenous Standpoint Theory (Yunkaporta)

This framework proposes four entry points to look at knowledge production: axiology (ethics), ontology (the main type of knowledge valued in the system), epistemology (ways of knowing), and methodology (the process leading to the production of knowledge). Yunkaporta argues that Western thinking (understood here as linear, scientific thinking) takes the first two for granted, implicitly considering that they simply are what they are. Thus, the paradigm from which knowledge production operates remains in the dark. Indigenous knowledge on the other hand is focused on interconnection and understanding the world as a network of relationships. In this context, knowing is a relational process aimed at increasing connectedness that is embedded in a system of ethics. The prime concern is fairness, truthfulness and sincerity, because if they are present, then the intellectual and operational processes will likewise have integrity. Following this framework, I argue that datafication takes the logic of traditional Western thought one step further by exclusively focusing on operational element, i.e., the methodology, the process of knowing, the "how", to the detriment of ethics, ontology and even epistemology. In other words, ethics, ontology and epistemology remain largely unquestioned in our current data-centric world and thus do not inform the processes of knowing.

- ***Warm Ways of Knowing***

Warm data[45] is information about connections, whereas cold data is statistical information. While useful and valuable, statistical knowledge does not include context, typically a tacit area of enquiry. As mentioned in Chapter 4, datafication ignores context and blends all data regardless of context to extract patterns. While those patterns can provide useful insights, the methodology also leaves aside essential elements of tacit knowledge (see Chapter 4), namely qualitative information, embodiment (anchoring in place and time), the emergent quality of interconnectedness, the experience of living, and the cognitive complexity required to navigate the relational.

By isolating the focus of enquiry from the larger context, cold data obliviates a critical aspect of lived experience and therefore, reduces the foundation of knowledge production to a set of hard facts, or cold data. Warm data on the other hand brings understanding about the context at hand and the multiplicity of contexts connected to it. Instead of a reductionist process that turns complexity into complicatedness, it increases and deepens the understanding of complexity because it retains the congruency of the interdependencies between contexts. In other words, warm data respects the complexity of real life (Bateson, 2017). We (humans) and all life exist in intricate networks of relationships and dependencies. Datafication (cold data) reduces the complexity of situations by deleting or proxying unstructured data. Therefore, datafication cannot inform the complexity of real-life situations, especially in the complex situations of globalisation. This impacts our decision-making ability as well as our capacity to attend to the global issues that plague today's world, leading to ever more destructive pattern of action that we desperately try to problem-solve.

[45] While I use "data" in the plural form throughout this thesis, I use "warm data" and "cold data" in the singular for the same reason "big data" and "metadata" is also used in the singular, as a specific concept.

- ***Pluriversal Ways of Knowing***

> Sooner or later, the time will have to come to draw attention to the manner in which the exclusion of other traditions of knowledge by reductionist science is itself part of the problem that has led to myriad failed development initiatives all around the world. (Hoppers, 2002, p. vii)

The ideology behind datafication arises directly from Western modern thought, based on the outside observer looking at an objective reality who understands the world by fragmenting the whole into parts and analysing them. Datafication is in the business of standardising, and therefore, it is not structured to honour the richly diverse experience of contextualised living. As mentioned previously, there certainly is a place for standardising information, presuming some guardrails are place. Modern datafication, however, is operating largely without restraint, leading to an imbalanced relationship. We need to recalibrate and rebalance our ways of knowing to give a larger place for tacit knowledge.

Any call to shift how we know what we know is a "worlding" project. One aspect of this project is to revisit the monothetic idea of a universe and replace the focus on the universal ontology with multiversality (Maturana, 1988) and pluriversality (Escobar, 2011). The multiverse recognises that while there may be an objective reality, the sensory experience of embodied living in this reality is multidimensional. The observer creates the world he/she observes, impacts it and is subsequently impacted back by it in a circular autopoietic relationship.

The idea of the pluriverse is not to change the world but to change the belief system and the cosmology to understand the world, from the totality of a universe to the radical interdependencies of pluriversity (Escobar, 2018b). In other words, to see many worlds in the world. The pluriverse brings forth the notion of a coexistence of epistemological diversities (a concept that is foreign to datafication) and the issue of epistemological hegemony of Western thought, of which datafication is the prime example (Reiter, 2018). In this framework, diversity is a keyword. The pluriverse

aims to critique the notion of knowledge centricity, reintroduce an understanding of diverse transcultural concepts and practices, as well as a multifaceted way of knowing.

The notion of the pluriverse also brings forth questions about border thinking (Mignolo, 2012). Fundamentally, pluriversality is an epistemological enterprise of sensing the world qualitatively to understand its diversity and complexity as opposed to reducing it to a solid totality. The fundamental shift is from a universe - which implies a totality - to a pluriverse, a world of interdependencies. To think pluriversally is to dwell in the borders, the in-between spaces, as opposed to studying them from an outsider's point of view. The pluriverse also means living an experience, as opposed to studying an object. Thus, to think pluriversally is to see, inhabit and feel the dynamic of relationships and to adopt the relational point of view. Bateson (1970) emphasised that we need to shift from seeing isolated units of survival to units-in-their-environment and to sense our way through these relationships. This is what border-sensing is also about. Being in the in-between spaces of the physical world but also in the in-between spaces of thought[46].

Inhabiting the borders also encourages a profound shift in sense-making, from a totality to a pluriversality of interconnected spaces. The structure of the medium shapes how knowledge is created and shared (McLuhan, 2012). Different media provide different affordances. For example, the written word encourages long, logical, linear argumentation, while a visual medium emphasises the immediacy of instinctual responses. Placing this in the context of datafication illuminates the totalitarian nature of the algorithm-controlled territory of datafication.

The pluriverse also allows us to look at datafication in terms of the geopolitics of knowledge (Reiter, 2018). In this context, datafication is fundamentally a philosophy of totalitarianism. First because of the standardisation of data - which dissolves the nuances of context into only one standard. It is also a totality because it applies indiscriminately to everything, especially to

[46] Interestingly, dwelling in the space between thoughts is a recognised meditational method endorsed by several schools of Eastern philosophies to train practitioners to see differently.

qualitative aspects of life that cannot be quantified. From the filter of the pluriverse, datafication becomes an enterprise of colonisation of thought, in the same way as Western cosmology colonised other cosmologies.

Furthermore, seeing through the lens of the pluriverse allows us to realise that datafication is both centralised and unilateral. Datafication is usually associated with networks of information and is thought about as highly decentralised into ecosystems of information. However, while data are gleaned throughout highly decentralised networks, they end up centralised into algorithms and physical infrastructures such as servers that are often proprietary, thereby reinforcing the centralisation of knowledge and power. This is known as the phenomenon of platformisation, which arose at the dawn of the 21st century with the rise of the social web. At first, social networking sites (such as MySpace or the early versions of Facebook) were enclosed spaces where users could meet and share, and what was happening on the site stayed on the site, i.e., did not overspill into other areas of the web. However, with the rise of the data economy and the datafication of knowledge, the priority shifted to data collection, and social networking sites turned into web-like sprawling platforms aimed at mining data (Helmond, 2015).

Given that platformisation involves decentralising platforms features (such as API) to centralise data, turning the connectivity of data networks into a type of platform society (Van Dijck, 2016), networks of datafication are not comparable to the networks of nature as they are essentially centralised[47]. The unilateral aspect of datafication is illustrated by code, a reductionist way to know, which obfuscate the rich patchwork of cultures and contexts underlying the data. Awareness of diversities & trans-cultural sensing are creative tools to expand understanding and

[47] More recently, Web3 succeeded Web2 and carries hopes for a truly decentralised internet. On the face of it, the blockchain technology that underlies web3 seems highly decentralised, all data being kept "on the blockchain", i.e., distributed in a network. However, a more technical look at it shows that while information is distributed, the infrastructures of the blockchain are not. Web3 is predicated on middlemen (or rather middle servers) mediating access to it, so access is reduced to a few entry points. Add to this the fact that 80% of the $41 billion market value of NFTs are owned by the top 9% accounts, 2% of accounts own 95% of the $800 billion supply of bitcoin and 0.1% miners of bitcoins are responsible for 50% of the mining output, and the concept of distribution suddenly doesn't seem so appropriate anymore. What is decentralised is the access to services, but underneath that, even blockchain is driven by a centralising centripetal force.

promote emergent knowing through what Escobar (2018a) calls radical interdependence. The pluriverse is also embedded in place, where place is viewed not as a location outside of ourselves but integrated into the whole of our being, our experience and our sense of identity.

6.1.6 Conversational Ways of Knowing

- ***Nature's Web-Like Conversations***

> They were conversing not only in the language of carbon but also nitrogen and phosphorus and water and defence signals and allele chemicals and hormones – information. (Simard, 2016)

Nature invented the world wide web millions of years before Silicon Valley did. There is an active, sophisticated, mutualist, symbiotic web below ground. Take for example the mycorrhiza, a fungus root of mushrooms that forms a mycelium that infects and colonises the roots of all trees as well as numerous species of plant life. The mycelium also forms a dense network connecting different species in the forest, enabling interspecies exchange. The network, like all networks, has nodes and links, and some particularly busy nodes are called "mother trees" because they nurture their young, thereby connecting and feeding hundreds of others trees. Scientists have found that these hub trees send their excess carbon to their seedlings through the mycelium web, increasing the smaller trees survival rate by four times. Through these invisible back and forth conversations, they reinforce the resilience of the whole community (Gorzelak et al., 2015). Nature's constant qualitative, embodied, emergent, experiential and complex ways of knowing creates a self-sustaining flourishing ecology of knowledge.

Furthermore, symbiogenesis, defined as the generation of evolutionary novelty through symbiosis (Rice, 2015), is one of the main processes underlying evolution. Biologist Lynn Margulis (1971) argued that inherited variation (important in evolution) does not come only from random mutations, but results from the acquisition of entire genomes through long term intimate conversations between species "strangers". This process involving bacteria and larger micro-

organisms as their hosts, have led and continue to lead to new forms of life. Margulis (2008) argued that symbiogenesis led to increasingly complex levels of individuality and was the main channel of evolution for higher organisms. This symbiotic collaboration between species is essentially the driving force behind evolution.

- ***Regeneration is Dialogical***

Global problems such as climate change, environmental pollution, the growing gap in economic wealth[48], the polarisation of public debate and the rise in conflicts and violence require a radical change in how we communicate, learn and know. Bohm (1991) proposed dialogue—a process of deep listening, as a more sustainable way to live and know together. As a theoretical physicist, he was also an unconventional thinker who contributed major developments in the fields of quantum theory but also neuropsychology and the understanding of mind. Bohm proposed the ontological idea of an "implicate order" to explain the peculiar behaviour of subatomic particles, an "enfolded", deeper level of unseen existence from which the surface phenomena we call reality emerge. While it is beyond the scope of this research to go deeper into the ontological premises of this worldview - which he shared in a series of dialogues with philosopher Jiddu Krishnamurti over a span of 25 years[49], it aptly illustrates how a leading scientist familiar with the paradoxes of quantum physics took a personal interest in the principles undergirding tacit (i.e., qualitative, embodied, emergent, experiential and complex) ways of knowing. His concept of dialogue carries the fundamental principles of participation and places tacit ways of knowing at the centre to understand the continuous unfolding of meaning (Bohm et al., 2004). For Bohm, dialogue not only informs the content of thoughts, feelings and actions, but also opens a door into the deeper

[48] According to Oxfam 2022 Inequality Report "Inequality Kills", "the wealth of the world's 10 richest men has doubled since the pandemic began. The incomes of 99% of humanity are worse off because of COVID-19". The report also mentions that "the 10 richest men in the world own more than the bottom 3.1 billion people".
[49] https://bohmkrishnamurti.com/the-dialogues/

motivations, assumptions and beliefs underlying them (Bohm et al., 1991). He believed that this way of knowing was an appropriate response to the crisis he saw unfolding in the world.

- ***Languaging As a Rebalancing Tool***

  By and large, language is a tool for concealing the truth. (Carlin, 2001)

  Objects arise in languaging. (Maturana, 2005)

As humourist and social critic George Carlin (2001) astutely remarked, language has a great capacity to obscure reality. How we "language" reality into existence is not neutral. Euphemisms play an important role in the larger design of digital boundaries. For example, "digital exhaust" - which refers to the side data users produce while searching, puts the emphasis on worthlessness when in fact, those bits of information are the core value of Google's business model. Similarly, "targeted advertising" emphasises precision and efficiency and hides the new power relationship in which rights have been taken off from users and transferred to the platforms. "Connection" has likewise been hijacked to obfuscate the computational nature of the online social environments. The term "platform" refers to a neutral environment (for example, a train platform), when in fact the environment is highly designed (invisibly) and driven by hidden algorithms. The emphasis on "networks" also highlights the intangible aspect of the technology and downplays its heavy infrastructure and energy-hungry aspects.

Similarly, much of the language used to describe the uses of datafication references intelligence or cognition. For example, data scientists trying to get algorithms to learn like humans developed an algorithmic learning technique called MAML: Model Agnostic Meta Learning[50]. The acronym spelling obviously recalls a living being (mammal). Metaphors serve an agenda, calling the attention to certain aspects and minimising others. The language surrounding datafication has

[50] https://towardsdatascience.com/learning-about-algorithms-that-learn-to-learn-9022f2fa3dd5?gi=9ee22c05f45a

taken life, cognition and intelligence as its core metaphorical themes, thereby establishing a de facto correlation and friendliness between us and the machines, while obscuring other aspects.

However, “languaging” can also be used in the design of a more regenerative world. While classic empiricists view language as a simple transmission of information conveyed from one individual to another (Dell, 1985), living systems view language as establishing a relationship between emotions and language in a conversational process (Maturana, 1997). This view honours the qualitative aspect of being alive and being human. We are not only a rational decontextualised homo economicus that maximises profit. We are also emotional beings living an embodied life in relation with other emotional beings, and languaging is a way to navigate and coordinate this interdependence - i.e., to live together, and to connect with others in a qualitative way that cannot be quantified. Fundamentally, we are “in conversation” with life.

As an epistemology and a way of being in the world, design has the capacity and the opportunity to experiment with languaging other realities into existence. For example, “Codefine”, a metadesign languaging tool (Lockheart, 2022), is a conversation-based three-stage process to develop a common understanding of a word that includes individual interpretation, group discussions and agreement on intended usage. It is a qualitative metadesign technique that includes elements such as storytelling, role play, silent reflection and deep listening, to bring forth tacit knowing and evoke a more empathic and common purpose.

We need to develop new vocabularies that emphasise the ecological perspective to develop an ecology of knowledge that is life-enhancing (Lockheart, 2022). Languaging is an important act of design as it allows to create new realities (Bateson, 1970; Korzybski, 1933). Regenerative languaging is even more important today, particularly when we consider how much of the knowledge produced is done by computer language (code) which uses reductionist grammar and logic in ways that human cognition cannot readily comprehend. Additionally, regenerative languaging is also made all the more necessary as the terminology associated with datafication obfuscates important aspects of technological developments - as the examples above demonstrate.

Regenerative languaging is fluid, interpretive and emergent, allowing communities to actively participate in learning and creating knowledge together.

Principles for a Regenerative Ecology of Knowledge in the Age of Datafication

As discussed above, regeneration is not an ultimate destination, but a continuous process of becoming and adapting. Designing for regeneration therefore necessitates the adoption of principles that foster new ways of knowing that honour the ecological limits that support life on the planet. This process is co-creative and emergent. Regeneration does not happen through top-down controlled processes that follow a universal blueprint, but as an emergent outcome of the co-creative tacit interactions between processes. While this type of epistemology breaks away from the traditional mechanistic way of knowing that is so prevalent in the age of datafication, it is not new by any means. It draws from epistemological principles that have been around for thousands of years. Thus, what is asked of us today is not to invent, but to remember.

We live and design in a world that is complex and uncertain. We have witnessed that top-down universal models designed outside of context can have highly challenging at best and at worst destructive results. We need compasses rather than prescriptive instructions to help us navigate the multifaced and complex systems we live in. While systematic instructions are helpful in understanding how machines operate, they are less useful in navigating the inherent complexity that sustains all life. With this in mind, the principles below are not prescriptive. Rather, they are maps to guide us through the regenerative ecology of knowledge that is needed to address the challenges facing designerly ways of knowing in in the age of datafication.

- ***Autopoietic***

Autopoiesis is the central feature of living systems. As mentioned earlier in this chapter, the autopoietic nature of living systems refers to their regenerative and self-sustaining nature. Living systems are organised in ways that allow them to constantly remake themselves. A feature of this arrangement is self-organisation; the cell or the organism has autonomy in how it responds to

environmental influences so it can choose how to react, but not be controlled. Living systems are complex adaptive systems. They adapt to movements based on their internal structure, but they also modify this structure through learning, making them inherently changeable and impermanent. While datafication is an enterprise that aims to increase a kind of fixed certainty, (and at times does so in ways that are helpful), the response of living organisms to environmental impacts is highly creative and unpredictable. The interactions of living organisms with their environment draw from the tacit intelligence that pervades life, in a more efficient and more resilient way than any mechanical system.

Living systems naturally know how to exist (as Maturana said, “to live is to know”) and naturally learn how to rebalance. They are the opposite of optimised systems in that they are inherently adaptive. As mentioned in Chapter 4, optimisation by design can create frictions and ultimately degrade the environment it is supposed to regulate. The ability to draw from the tacit intelligence of life to regenerate oneself is a central argument in favour of looking at living systems as a framework for a new ecology of knowledge. A natural principle of biological life is to find equilibrium. Instead of optimising for an outcome, living systems seek a balance between efficiency and resilience. Interestingly, they do so by leaning toward resilience (Ulanowicz et al., 2009).

The mechanistic focus on efficiency misses the important point that living systems cannot be improved by fixing the parts. As history has shown, a wholly mechanistic focus on efficiency is inherently problematic. It is important to design balance into the technologies of our age. In addition, because they are autopoietic, living systems are also naturally aligned with systems of ethics and governance. Yunkaporta (2020) emphasises that indigenous knowledge needs to give a primary importance of ethics and governance (axiology) because the main focus is to sustain relationality, making integrity a key consideration. Cast in this light, it is also crucial to give prime consideration to ethics and governance in the design of digital technologies.

- ***Holistic***

Holistic understanding starts with the whole, not with the parts. It is the whole, or the context, that informs the parts. Holistic knowing is a top-down approach embedded in reciprocity. Discrete, digital data-based ways of knowing are by definition oriented toward the past because data comes from pools of data sets, and therefore comes from the past. It is a logical truth that even data systems capable of processing immense amount of data bits cannot escape. Pattern-finding computational systems can only find the patterns that the data afford them.

In the mechanistic paradigm, chunking down from whole to parts seems to make problems more amenable to solutions. This is especially true when we look at problems and not potentials. By moving thinking to higher level of abstraction, we gain a macro perspective that allows dualities to dissolve and potentialities to emerge.

Design thinking proposes the concept of framing (Dorst, 2015b) as an avenue for more creative "problem-solving". Holistic thinking in that sense is also a creative way to problem-solve. Holistic thinking is inherently relational in that it focuses on "difference", i.e., relationships (Bateson, 1970). The mechanistic paradigm fixes problems by patching them, while a living systems approach views them holistically and interdependently. From this major point of view, the harmonic pattern which connects appears more clearly[51].

Thinking in systems is thinking in terms of relationships, in terms of flows. Here, we are considering systems, but more specifically living systems. Living also means that they are evolutionary systems. Non-living systems are bound to decay; after a while, the parts of a machine need to be replaced. This is also the case for the hardware of datafication as non-living hardware always ultimately decays. One could argue that living bodies also decay and die, which is true.

[51] A living example of this are the male deer antlers. While antlers have obvious uses (defence or attracting females), their velvety fuzz also serves as a habitat for a certain type of flies. When they fall, they become a stage for insects to attract mates, a source of calcium for mammals and they supply dentistry care for rodents and rabbits gnawing on them. In other words, antlers do not exist in isolation but are intricately embedded in their environment, thus intimately and actively participating in the maintenance of life's ecosystems. It is in this way that holistic thinking is relational.

However, living systems are predicated on renewal, allowing life to be to be sustained for nearly 4 billion years, an unequalled track-record in the mechanistic world.

Living systems enfold to unfold, which means that they are inclusive. In biological terms, inclusiveness is not an ethical concern (although of course, in more complex social systems, ethics are important). It is a health requirement; it is essential to the sustainment of life itself. Health results from an exchange of value in the system. Here, value is understood not in a reductionist manner (as in the value of a commodity, which is basically its price), but from a big picture perspective. The exchange of value between parts of the living system brings health and continuity to the whole system.

Inclusiveness also implies that all parts of the system are enfolded in the system. This creates participation and empowerment, and requires us to view datafication as a part of the system that is enfolded while also recognizing that it has a role to play in the larger system as well. This underscores the need for an epistemological rebalancing that views digital technology as a tool in service of a higher intention. The computational processes of big data can bring an ability to detect patterns from structured, cold data. This is a valuable ability when taken as part of an epistemological whole and applied appropriately. To understand living system, one has to work with nested wholes, not with fragments.

An analogy often used in regenerative circles hints that the only way to know someone is not by looking at their kidneys, lungs, limbs or heart but by looking at who they are in relation to other entities in the living systems they inhabit. This is not only true of a person, but of all wholes, which also include entities such as neighbourhoods or cities. Ways of knowing are likewise interdependent and complex, and thus in need of being understood holistically. This is partly what Haraway suggests with her concept of naturecultures and the coemergence and co-evolution of technology, nature and society. And as complex adaptive systems, wholes are singular, alive and evolving in emergent ways, meaning that they emerge in a truly innovative, creative and utterly unpredictable process. Complex and emergent are attributes of tacit knowledge as well.

- ***Embodied***

In Chapter 4, I mentioned that a characteristic of datafication is disembodiment. Today, this is often considered a positive condition - opposed to the unstable emotions of human embodied perceptions. This misconception has been largely inherited from a scientific perspective toward qualitative aspects of life. The phenomenological school made the body the centre of experience (Husserl, 1960). In his assertion "I am my body", Merleau-Ponty (1962) goes one step further and sees the body as the structuring element of experience and understanding of the self in the world. This interpretation contends that cognition is not the perception of an outer objective reality, but the bringing forth of a world (Maturana & Varela, 1992). Embodiment is therefore a central element of regenerative ways of knowing, with some going so far as to argue that the denial of embodied emotions is a major reason for the degenerative practices of technocratic design (Salazar & Baxter, 2015). For the purpose of this discussion, I want to put the question of embodiment in the context of living systems. Under this light, it quickly becomes obvious that embodied ways of knowing are a fundamental characteristic and a strength of living systems.

The notion of embodiment brings back the notion of context in the production of knowledge. In an earlier discussion about tacit vs datafied ways of knowing, I pointed out that the processes of datafication ignore context. The only way to obtain some predictability is to take phenomena out of context and set time limits. The greatest strength of computational knowledge production is the ability to collect, treat and analyse great amounts of structured data. The qualitative circumstances that gave birth to those data bits, however, are lost. In other words, big data creates patterns out of massive amounts of data, but does not care to contextualise these patterns. Lost are the stories, the experiences, the memories, the relationships, the place and time associated with these data bits. Just like the bio-regions in the biological world, the "bio-regions" of the ecology of knowledge need to retain their specific identity while working relationally.

Embodiment, or the state of inhabiting a living body, brings with it a qualitative aspect to understanding the worlds we dwell in. Without it, homo erectus would not have evolved into

homo sapiens. The qualitative and subtle understanding of the land we live in, its unique character, climate, bio-diversity, has enabled life to endure for billions of years. Far from being a liability, our capacity to emote and perceive drives the capacity to see ourselves as part of the larger living world, something that lifeless systems cannot share. It also feeds our capacity to ask what is our role in this living universe, and how we want to purposefully engage as a part of the whole. Purely quantified approaches to knowing however, are ill-suited to provoke or understand such qualitative experiences.

Embodiment also allows us to create embeddedness in the places we inhabit. As mentioned above, the membrane establishes a boundary of identity in a cell, but not a boundary of separation. This becomes crucial to understand the importance of place in regenerative epistemologies. Place is not thought of as an artificial, designed environment separate and overlaid upon nature (Salazar & Baxter, 2015), but as a relationally coherent space. Places are the nested systems where we live an embodied life. The characteristics of the place shapes the biological expression, the organisation of life. Living organisms, humans and non-humans are embodied and embedded in the places they live in. This concept is not valued by datafication which decontextualises embodied living into abstract data; however, it is crucial for living organisms. Place is the space where the qualitative dimensions of life emerge: communities, exchange, cultures, support, nourishment, and the continuation of life.

The algorithms of social media are often optimised to create engagement through hyperpolarisation where “filter bubbles” are used to create division and separation among communities of people and their ideas - leading to the breakdown within the system. In living systems, the boundaries of identity do not mean that “other” is avoided, but rather the opposite. The purpose of the cell’s membrane is not to isolate, but to support the healthy functioning of the cell’s structure so it can operate smoothly in relation to its environment. Place, or the environment within which the cell lives, is fundamental to its health. This is also true in more complex living system. When we are embedded in systems that value life, we become empowered to also nurture

life. Disembodied computational systems work along the logic of the reductionist approach to knowing, which extracts finer elements of life to understand it. This is valid in certain contexts, but it is also a generic way of knowing. Treating all living organisms non-specifically doesn't allow the understanding of the whole. Dissecting a person into discrete data bits doesn't help to understand the experience of being an embodied human living in relationship with embodied place.

Embodiment also relates to the lived experience of being embedded in our environment together with the human and non-human participants that share it with us. From the perspective of living systems, since life is the process of self-organising in an autopoietic way, form is unavoidably related to process and therefore, experience (Capra & Luisi, 2014). A regenerative ecology of knowing is intrinsically experiential, built through the stories of the interactions with the place we live in.

As Bortoft (1996) posits, authentic, biological, non-mechanical wholes are not about parts but about relationships, and relationships are intrinsically experiential (a characteristic of tacit knowledge). Stories reveal the quality of place, and embed our experience in time and place. Through languaging, we create an embodied experience of the patterns that regulate our context (as opposed to the disembodied patterns of datafication). The stories of lived experience create a very powerful sense of belonging, of meaning, and coming together around a larger cause. Unlike the processes of datafication that render users (i.e., us) irrelevant, living systems empower people to get involved. Empowerment happens when we feel that we have the capacity to manage our environment, both physically (space) and cognitively (amount of information). This hints at a more regenerative way to work with technologies, to create the unique stories of a place so that it becomes an experience. Instead of hindering experiences of living, technology helps to create and support them. It is empowering because we see how we can make a difference (as opposed to datafication which makes us irrelevant and not needed). Biomimicry, the practice of looking at the

natural world for ideas (Benyus, 1997), is an important element that can help us create the regenerative metaphors that will help us get to regenerative places.

- ***Relational***

Modern epistemology drills down and analyses parts or units to discover its essence. The living system perspective on the other hand looks at the world and discerns it as a constant state of becoming based on the rise and fall of dynamic relationships. The fundamental importance of the relational principle is illustrated by the classic high school biology assignment requiring students to dissect a frog. The purpose of this exercise is to gain an understanding about the parts that constitute a frog. Some parts can be dissected again to see what smaller parts they are made of. While it is useful to know about parts, this process does little to help these students gain deeper insights about "frogness'. What does it mean to be a frog? How does a frog operate in the environment? What is the relationship between frog and frog, frog and water, frog and soil, frog and climate etc? Similarly, I cannot know my friends or my co-workers by dissecting them into parts and analysing their nose, lung, feet or stomach. I know them by the relationships they are embedded into.

For Maturana (1970), a living organism is organised in a circular manner as a unit of interactions which it must maintain to remain a living system. Information is not an objectively existent phenomenon, but has the meaning that the environment-embedded organism gives it. Therefore, the meaning of information emerges from the relationship between an organism and its medium. Bateson (1970) proposes a similar framework, but formulates it in terms of "difference that makes a difference", i.e., the difference that emerges from a relationship between organisms. Mind is therefore a quality of relational patterns rather than a thing located in a physical brain. In this context, knowing is discovering the "pattern which connects", so the opposite of "complex" is not "simple", the opposite of "complex" is "reductionism" (Bateson, 1979). An illustration of the reductionist effect of datafication is how social media platforms reduce the complex

interdependencies of the social fabric to an algorithmic type of sociality mapped on a social graph (Couldry & Van Dijck, 2015).

If the discrete data bits of datafication fail to adequately reflect the patterns of relationships at work in an intricately interconnected world, then how can we know those patterns? We need a new type of data giving "transcontextual information about the interrelationships that integrate a complex system" (Bateson, 2017), also called warm data. In addition to statistical data, we also need warm data to solve problems in a complex world and to understand its interdependencies. To do so, we need more appropriate techniques than the reducing and analysing that created the problems in the first place. As previously mentioned, the ability of datafication to find patterns within massive batches of data allows it to infer certain information. However, those patterns emerge from past data, and furthermore, data which have been "scrubbed" to fit the computational medium. What is stripped away in the process is often the most fundamental aspect of life, the context within which it happens, and in the same sleight of hand, our ability to qualitatively understand its diversity.

Bateson (2018) provides an apt illustration that illuminate the meaning of warm data. The meaning of a hand is different in different contexts. The hands of a violinist and of a sculptor know differently; a hand can express words and emotions when performing sign language. Each context provides a field of different relationships that needs to be explored for meaning to emerge. Meaning arises out of the contextual relationship, it does not objectively pre-exist in the world. Placing context and relationships at the centre brings empathy and improvement to the relatively straightforward process of object creation in industrial design[52] (Moore & Conn, 1985; Norman, 2005a). Information is not homogenous; it takes many forms and shapes. Warm data is complementary to cold data[53]; unlike other data, it is unstructured, subjective, contradictory and

[52] I do not mean to imply that industrial design is easy. My remark is only meant to express that problem-solving in the context of object creation is more straight forward than in the context of complex adaptive systems.
[53] The terms "warm" and "cold" are found in the literature. They do not mean to disparage, but to emphasise the quality of relational (warm) or discrete (cold) data.

ambiguous, constantly changing. It also brings context, relations and interactions back into the process of knowing that allow us to make connections at a meta level.

Relational also describes how living systems operate as a conversation. I already mentioned how nature organises itself in rhizomic networks of collaborative conversations through underground mycelium, and how life itself is sustained through those conversations (Simard et al., 2012). With his theory of cognition ("to live is to know"), Maturana proposed that conversation is at the core of the organisation of life. His perspective is particularly relevant to our discussion about tacit and datafied ways of knowing because he places the dynamic dance between emotions and language at the heart of the processes that underlie higher levels of cognition (Dell, 1985). In other words, he makes tacit ways of knowing a central feature of the intelligence of life itself. What would happen if those conversations were also at the centre of the technologies we design?

- ***Plural***

While everything is in an intricate relationship with everything else, living systems are not an undifferentiated grouping of species or organisms. At the cellular level, the cell interacts with its environment through a porous membrane, while retaining its structure, which is its distinctive identity. And it's the cell's inner structure, not the surrounding medium, that determines how it responds to environmental disturbances. Kicking a stone (a non-living organism) begins a mappable mechanism ending in a predictable outcome. Kicking a dog, however, is far more unpredictable (Capra & Luisi, 2014). Unlike mechanical systems, living systems are unpredictable, and the more complex the structure, the more unpredictable the system. All this points to a diversity of structures and behaviours in the complex adaptive systems that form the living world.

When viewed in this light, generic and uniform interventions of datafication are not ideal for understanding and influencing the system. Working regeneratively does not entail creating perfect blueprints for regenerative actions either, but committing to develop qualitative insights from the

tacit relationships between a diversity of elements and the contexts within which they occur. Questions such as *Who is speaking to whom? What quality information flows in this system? How are relationships lived in this context? What is the nature of these relationships?* will ultimately inform the system in a deeper way than more linear algorithmic ways of "thinking". Such questions not only generate warm data, but perhaps more importantly, regenerate the relational fabric of a place. Relationships are like an epistemological soil; when the soil is strong and rich, it acquires emergent properties and innovation becomes a natural attribute of an ecosystem. Life organises itself in local contexts of relationships. The shift from modern to regenerative epistemologies is from seeing land as a commodity to own to understanding ourselves as an expression of the land itself.

Embracing plurality also means opening a space for subjectivities and "situated knowledge" (Haraway, 1988). As discussed throughout this thesis, a major issue with datafication is its unchecked faith in objectivity. It is beneficial to adopt this perspective in some instances, but as a blanket way of knowing, it gives rise to epistemological errors that can be highly destructive. What is needed is a plurality of ways of knowing. Given that life excels in balancing, we need to design our technologies to allow for a rebalancing between objective and subjective knowing. This requires a radical review of the belief in the superiority of datafication as a way of knowing.

Plurality also refers to embodiment into a diversity of places, a diversity of habitats, of cultures, histories, or, to go back to the cellular analogy, to a diversity of internal structures that determine the identity of a place. Datafication obliterates differences, but differences are what make life thrive. It does not require a leap of imagination to see how digital technologies could participate in the exchange of warm data between places for life-enhancing purposes. Again, inclusivity of different ways of knowing could be a strength and a real force toward the regeneration of the planet and of communities torn apart by the extractive algorithms of datafication.

As an attendant concept to the pluriverse, borders are places of particular activity where innovation flourishes. Those joining fields in-between physical or epistemological territories

provide a natural habitat of design. Understood as a pluriversality of interconnected spaces, borders are the intersections where value is exchanged and the symbiotic ways of knowing happen. As a third culture, design is particularly cognisant and comfortable in those epistemological spaces, with a clear ability to move from disciplinary to trans-disciplinary thinking needed for a regenerative paradigm.

6.1.7 Summary

Chapter 4 established two frameworks contrasting the attributes of tacit and datafied knowing, indicating an antinomic relationship between the two. Chapter 5 then used the Benjaminian concept of phantasmagoria as a form of critique to examine datafication. Tacit knowledge is an important feature of design practice, but it is threatened by the exponential proliferation of datafication. However, as we move forward, we need to reconcile two conflicting ways of knowing. In this chapter, I have adopted a relational, ecological standpoint to shed yet another light on this relationship.

A larger paradigm shift is required to truly adopt a more regenerative way of thinking and being in the world today. To this end, this chapter proposed five principles for a regenerative ecology of knowledge in the age of datafication. This is all the more urgent, because design as a discipline is complicit in creating the global conditions threatening life on the planet at the moment. However, as a third epistemological culture, design also has the potential to lead the shift toward a rebalancing of ways of knowing in the 21st century. As this discussion highlights, there have been a number of interesting propositions for design to address the global complex problems that the planet is facing today. Many of those propositions are well argued and defensible. For example, metadesign proposes to go beyond designing (the meaning of “meta”), to create the conditions for communities to design themselves (Manzini & Coad, 2015; Wood, 2022). A significant characteristic of metadesign is the proposition to build sound ethics and governance from the onset. This is particularly crucial today, at a time when digital technologies are being designed and

swiftly deployed at scale to meet commercial demands, but without much concern for the potential larger consequences.

7 CONCLUSION

Research Findings Summary

This critical explorative research investigates how the production of knowledge in the age of datafication informs and shapes human experiences. More specifically, as qualitative aspects of life become increasingly subjected to the extractive processes of datafication, this thesis offers an in-depth analysis on how these processes skew the relationship between tacit and datafied ways of knowing. Given the role tacit knowledge plays in the design process, this research seeks to illuminate how technologies of datafication are impacting tacit designerly ways of knowing and what design can do to recalibrate this imbalance.

To bring greater awareness into what counts as valid knowledge today, this research begins by first identifying the principles that define tacit knowledge and datafied ways of knowing. By differentiating these two processes of knowledge creation, Chapter 4 offers a foundation for understanding how datafication not only augments *how* we know things, but also actively directs and dominates *what* we know. As highlighted in Chapter 5, this unchecked faith in datafication has led to a kind of 21st century phantasmagoria, reinforcing the wholesale belief that digital technology can be used to solve some of the most perplexing and complex problems we face today (a phenomenon known as techno-solutionism). As a result, more tacit processes of knowledge creation are increasingly being overlooked and side lined. Finally, Chapter 6 offers insights into how the creative and practice-led disciplines in general (and design in particular) can shift epistemological paradigm to create a more regenerative relationship with digital technology, one that enfolds the processes of datafication while at the same time support and honour the unique contributions of tacit ways of knowing.

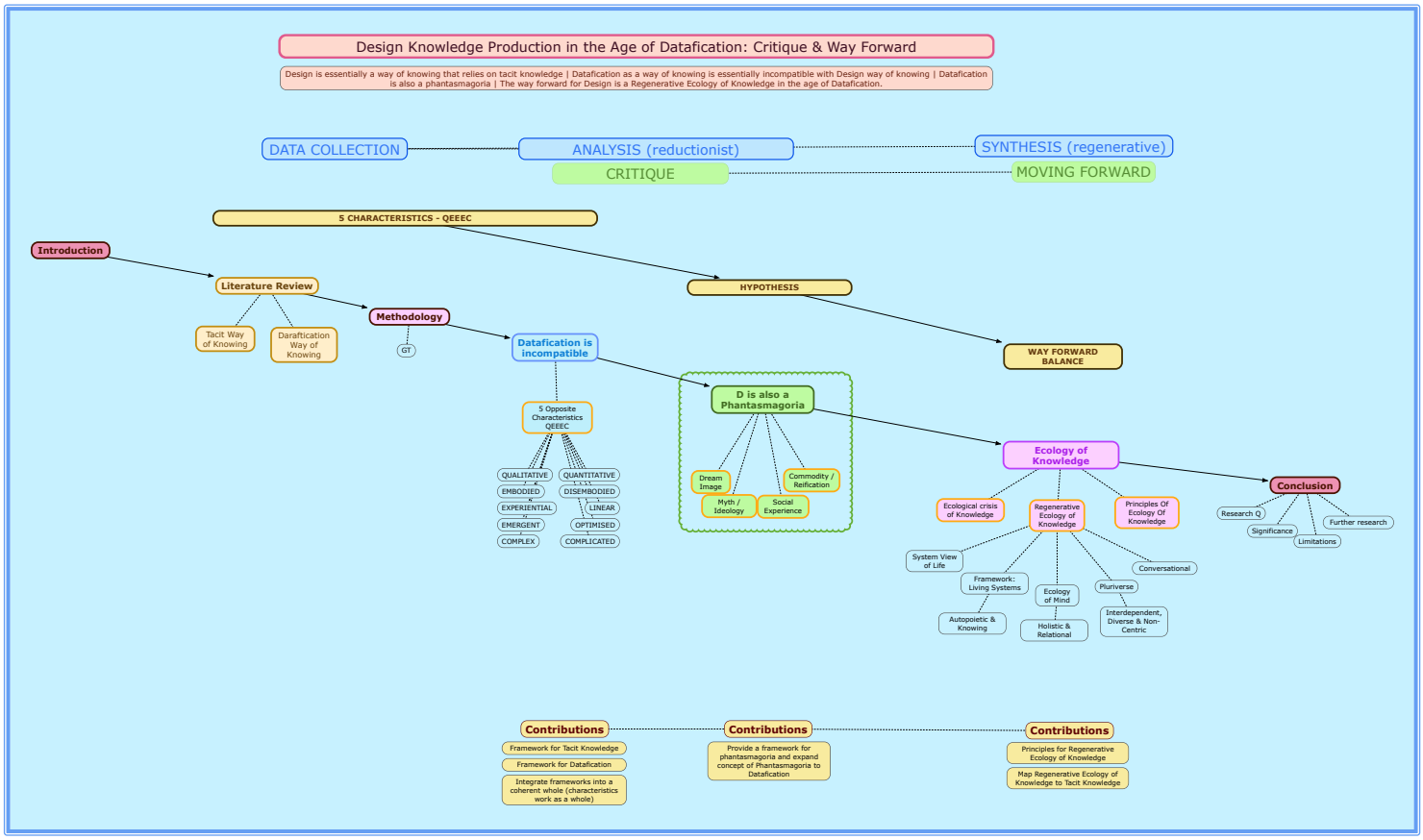

Fig. 8. Thesis Summary Chart

Findings & Significance

In the digital age, we are witnessing an increased integration of computational decision-making into all qualitative areas of human life, creating a dramatic epistemological shift in how knowledge is created and used. Given that knowledge production is a central feature in design, this shift takes on important theoretical and practical implications for the discipline. From the literature review, it is clear that tacit ways of knowing are crucially important to the design process. Due to rapid and recent developments in digital technologies, the relationship between datafied ways of knowing and design remains an open but largely under researched question. To help address this gap, this thesis offers new insights into this important topic.

This research also sheds light on how knowledge is defined in the digital age. A traditional and long-standing model widely used in data science, the DIKW pyramid, situates knowledge as a result of the processing of data, and the treatment of information. The framework not only clearly shows that information is not knowledge, but also ignores that knowledge emerges from a process of interpretation, and therefore incorporates tacit ways of knowing. Under datafication however, tacit ways of knowing are often overlooked and undervalued. As a result, information no longer sets itself apart from knowledge, but rather, begins to take over more subtle ways of knowing that are critical in helping us to understand and orient ourselves in the world. This is significant particularly for design because these technologies disrupt a designer's capacity to comprehend the living spheres we inhabit.

The central focus of this theoretical research is embedded in the fast and unfolding world of technology and traverses across a rich and diverse landscape of academic disciplines. Constructivist Grounded Theory proved to be an ideal methodology for this as it allowed the flexibility needed to follow a fast-changing reality while also allowing me to organically navigate a number of disciplines and fields of literature (e.g., communication, technology, media studies, critical theory, psychology, behavioural economics, life sciences, theories of knowledge, etc.).

7.1.1 Mapping Tacit Ways of Knowing & Datafication

It became quite clear, from the literature review, that tacit ways of knowing are central to the practices of design. (This is not to say that design solely relies on tacit knowledge, but rather, that it is a defining element of design). It was also quite clear that we live in an age when the explicit overwhelms the tacit. While tacit knowledge and the processes of datafication have been independently studied, each rendering a vast body of research, little work has been done on how these two processes inter-relate. To help bridge this gap, it became clear that a trans-disciplinary synthesis was needed. Chapter 4 situates tacit knowledge and datafication in ways that enabled a comparative and cross-disciplinary enquiry. From the literature review, a framework emerged to understand the tacit knowledge of design as essentially qualitative, embodied, emergent,

experiential and complex. A grid synthesizing the principles of datafication likewise revealed a framework that defined datafied ways of knowing as quantitative, disembodied, linear, optimised and complicated. Having probed into the essence of both ways of knowing, this research offers insights into how these processes are incompatible. The significance of this comparative study becomes clear as an increasing number of domains of life are filtered through computational processes that are overwhelming tacit designerly ways of knowing.

It is important to note here that while this research breaks down the individual attributes defining tacit knowledge and datafication, these principles need to be understood in their totality and, importantly, in their relationship to each other. Each attribute does not occupy a separate space but rather, they collectively inter-relate with each other. In other words, while this research initially used a reductionist approach to frame tacit knowledge and datafication based on existing bodies of literature, they are to be used and understood holistically.

As stated above, this research aims to understand how datafication shapes the production of knowledge and what this means for the designerly ways of knowing. From the literature review, it was clear that research on datafication, and especially about its impact on tacit ways of knowing is nascent and thin. Today, the scope of datafication is not clearly delineated. This is largely due to the positivist assumption that quantification is a prerequisite to the production of valid knowledge.

This research contributes to filling this gap by bringing more awareness to the consequences of this problematic belief. Furthermore, this thesis posits that datafication is a revolution in medium but not in epistemology. The term “digital revolution” is widely accepted today. One of the aims of this research is to illuminate what this really means. While it is true that digital technologies have revolutionised the medium from a mass-communication model to a networked, hyper-personalised, data-centric model, the underlying epistemological assumptions align with a reductionist ideology. This ideological continuity is obfuscated, as one of the maître mot of the digital age is disruption, as illustrated by the now abandoned Facebook motto “move fast and

break things"[54]. In the play of lights and shadows on the theatrical stage of life in the digital era, the ideological assumptions of datafication are kept hidden.

7.1.2 Datafication is a Phantasmagoria

Since datafication is employed and applied to inform an increasing number of qualitative areas of life, an important question we need to ask is whether our faith in datafication is justified. Chapter 5 takes another perspective on the relationship between tacit knowing and datafication, and examines whether datafication is really a superior way of knowing and whether our collective belief in its powers is justified. The inspiration for this exploration relies to a great extent on the work of Walter Benjamin. In the early 20th century, Benjamin sought to understand the social, cultural and economic impact the technology of consumerism was having on the world at large. His decades-long investigation led him to conclude that each epoch in history is defined by a particular technological shift that in turn, contributes to a distorted, i.e., phantasmagoric, interpretation of reality. Sadly, Benjamin passed in 1940 while trying to escape Nazi-occupied France, but his legacy perdured through the years, and this research shows that his visionary insights hold true today.

As I delved more deeply into Benjamin's work, it became clear that the parallels were striking; just as consumerism was a central phantasmagoria of the nascent industrial age, datafication is a central phantasmagoria of the nascent digital age and anchored in a reductionist paradigm. It also became clear that phantasmagoria was a critical concept in understanding the shifts brought about by the digital revolution, compelling me to develop a framework to synthesise the underlying attributes of phantasmagoria (i.e., as a dream image, as a myth, as an experience and as a commodification).

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[54] The motto was officially abandoned by Facebook in 2014, but its symbolic power stayed, especially after the 2016 U.S. presidential election, and the Cambridge Analytica scandal the following year which opened the public awareness to the destructive consequences of the policy. A book by Jonathan Taplin bearing the same name, subtitled *How Facebook, Google and Amazon Have Cornered Culture and Undermined Democracy*, was even published in 2017.

While the comparative investigation of Chapter 4 showed that datafied and tacit ways of knowing are antinomic and the exploration into datafication as a phantasmagoria in Chapter 5 revealed that our faith in it is misplaced, I could not ignore that it is here to stay. In this context, the question arose as to some possible avenues to move forward.

7.1.3 Toward a Regenerative Ecology of Knowledge

Chapter 6 started with the observation that the ecological crisis of the environment we are facing today is also an ecological crisis of epistemology, an imbalance brought about by an over reliance on datafied ways of knowing and the ideologies underlying them. However, it is clear that we have no choice but to live with these digital technologies and that we need to reconcile and redefine how we use these tools. As previously mentioned, datafication is not destructive in and of itself, but rather becomes so when it subjugates other more tacit ways of knowing. What is required is a new epistemological paradigm. The world is too complex to comprehend with the current utilitarian epistemology, and it is a fallacy to believe that comprehension and management of this complexity is best left to computational systems. Such an approach only hinders our capacity to understand the world we live in (Andrejevic & Gates, 2014) and ultimately leads to irrelevance and disempowerment. We as a species, and more specifically design as a way of knowing, are challenged to develop a new epistemology better suited to apprehend this complexity and its attendant global dilemmas.

This research contends that we need to find a new epistemological balance, based on the regenerative principles of living systems. While there is a rich body of literature in support for new epistemologies for design in the 21st century, this discussion mostly resides outside the context of datafication. Today, partly as a result of the developments in digital technologies, design is faced with a myriad of complex problems emerging from an increasingly interconnected world. Some in the design field have argued that in the service of industry, design has been an active participant in creating some of those issues (Fry & Dilnot, 2003; Monteiro, 2019; Papanek & Fuller, 1972). Today, the focus of human or user-centred design has shown its limits. While

human-centricity serves a purpose as a counterbalance to purely scientific approaches to understanding the social, it also establishes a clear vertical hierarchy of values, where everything is subordinated to humans. This focus ignores the delicate ecological balance between human and non-human entities, whether they be animals, plants, technological artefacts, or even seemingly inanimate objects, which possess agency and can act upon the world (Barad, 2007; Haraway, 2015; Latour, 2012). It does not necessarily encourage community building either. This view endorses the commodification of the ecosystems within which we live and which we are a part of. In doing so, it contributes to their destruction, and ours at the same time. In this sense, centricity can be said to be detrimental to the larger ecology.

In Chapter 6, this research offers a more future-oriented perspective. If datafication is antinomic to the tacit knowledge of design, and if our trust in it is misguided, then we must find other epistemological starting points to navigate through the many challenges of the 21st century. The next question of course is: "which one(s)?" To paraphrase Tony Fry (2017b), there is no territory to map at the moment in devising a new ecology of knowledge. This is a field that needs to emerge, and this thesis supports such an emergence. An important consideration is that neither tacit knowledge nor datafication in and of themselves are sufficient and best suited to every situation; they need to work together in concert. This is a theme that suffuses this PhD. This research proposes that the age of datafication is both an opportunity and a call for design to move toward a regenerative ecology of knowledge that enfolds both knowledge arising from digital technologies and other more tacit ways of knowing. By viewing knowledge as a kind of autopoietic, self-generating living system, this thesis offers an alternative framework that allows design to hit the reset button and recalibrate how technologies of datafication are managed and applied.

As a major mode of engagement with the world which both reflects and shapes but also informs the essence of the civilisation it is a part of, design is well placed to lead this endeavour. Designerly ways of knowing engage in doing and acting as methods to bring form to knowledge.

In this sense design becomes a political act of doing and thinking at the same time. It is not only a practical reflection-in-action, but as a third epistemological culture (between the hard sciences and the arts), it holds both ways of knowing in balance, and is well situated to offer a different way of seeing and thinking in the world (Dilnot, 2017).

Discussion and Suggested Future Research

Like all forays into emerging phenomena, this research raises a number of adjacent questions. This research was initiated and developed during the platformisation of the web and the rise of the main medium of datafication, the social platform. Around the time when this research was completed, the exponential rise in so-called "AI" technologies was starting. The term "Artificial Intelligence" was coined by John McCarthy at the Dartmouth workshop during the summer of 1956. The concept is based on the idea that human thinking can be replicated by machines. Today, the word "AI" figures prominently in the public discourse, often to describe systems that seem to perform "cognitive" feats, but it is very vaguely defined and has come to cover a multiplicity of digital epiphenomena (from facial recognition to large language models and generative AI). With the rapid development of increasingly inescapable technologies of datafication, there is an urgent need to clarify what realities come under that term. This research aimed to excavate the essential attributes of the technologies of datafication. It identified datafication as the common attribute of different epiphenomena of the digital era. It suggests that despite the different names, the core epistemological principles remain. Further research is needed and the frameworks developed in chapters 4 and 5 can serve as useful guidelines to contextualise and comprehend the nature of those realities.

Furthermore, since the mid 1950s, the language referring to the "digital" has anthropomorphised those technologies: smart objects, smart cities, bots defined by their "personality", "hallucinating" LLMs and most of all "Artificial Intelligence". Using this kind of language and disseminating it through media and in the public discourse establishes the digital as a de facto human equivalent. We domesticate the unprecedented through language (Zuboff, 2019), but how something unknown

is described is not neutral. The consequences of labelling the unprecedented with known categories can lead to epistemological mistakes with phantasmagorical attributes. As Haraway argued, “it matters what matters we use to think other matters with; it matters what stories we tell to tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds, what worlds make stories.” (2016, p. 12). To a large extent language not only describes but worlds our reality into existence as well. In this thesis, this was hinted at in Benjamin’s phantasmagoria, where reality is manipulated by the spectacle of consumer culture, and in living systems theory, where each organism constructs its own reality based on its unique interactions with the environment. A critical study clarifying those realities and leading to the development of a better adapted language that helps us reframe them is both necessary and urgent.

This research is focused on knowledge, but as it has become clear over the recent past, knowledge and power are intricately connected. Further study is needed to understand the reconfigurations of power emerging from the technological shift. The early stages of this research identified four pillars or main areas of possible study in relation to the rise of datafication: knowledge and power, medium and space. In the Age of Information, knowledge is a close companion to power, a dimension that was omnipresent in this critical exploration. As such, while this thesis focused mostly on the knowledge aspect of datafication in order to establish some framework for future research, the intention of this study is to implicitly highlight a much larger context, namely, the (re)configurations of power that accompany incredibly rapid spread of datafication. Indeed, this exponential expansion does not happen in a void and is accompanied by a parallel rise in surveillance through datafication, or what has been called “dataveillance” (Raley, 2013). Its wild success and widespread adoption satisfy the very specific agendas of identifiable interests[55]. A

[55] As an illustration of this, most of the physical infrastructure supporting all activity on the internet is developed by behemoths corporations who design technologies to serve their needs. The lure of the architectures of surveillance is powerful. The past 10 years or so have seen an increasingly tight collaboration between large tech corporations and governments. Nowhere is this more complex and problematic than in the amalgamation between digital technology and military power, leading to a race toward technological supremacy on a global scale.

study of knowledge-power through a posthuman or new materialist lens could help provide further insights into the phenomenon of datafication. For example, Haraway (1988) criticises the idea of a universal and disembodied standpoint claiming to be objective and detached from the biases of the knower - a claim often put forward by the proponents of datafication. She argues that this claim to objectivity masks the underlying power dynamics and social relationships that shape the production and dissemination of knowledge. Instead, she calls to recognise the situatedness of knowledge, and in doing so, seeks to challenge these power dynamics and open up new possibilities for alternative ways of knowing.

As a reality-generating practice, design can easily become complicit in the (re)shaping of power structures (Papanek & Fuller, 1972). This happens for example when it tames users' discrimination by overemphasising ease of use or using cognitive biases to manipulate online behaviours thereby actively weighing in the balance between power and agency. Today, with the advance of ever more inescapable technologies of datafication and surveillance[56], it is more crucial than ever to review the critique of design as a servant to the main centres of power (Monteiro, 2019) and to reconsider design's epistemological assumptions and place in the world (Fry, 2020). In other words, the problems that the world faces today are of and by design. The proliferation of AI makes it more urgent to further research into new ecologies of knowledge as latticework for multiple and innovative design practices to entangle. To paraphrase Haraway, it matters what designs design designs. Chapter 6 proposed a theoretical framework for a regenerative ecology of knowledge, and further research is needed to bring those principles not only into actual design praxis but also as a foundation for design as a political act of worlding. While such research is beginning to emerge, it is seldom linked to the datafication of the worlds we live in.

[56] Very recently, several researchers, data scientists, tech CEOs and some founders of the modern internet (Geoffrey Hinton, Tim Berners-Lee, Douglas Rushkoff and Jaron Lanier to name a few) have publicly expressed their deep concern for the developments in AI and have called for a moratorium to examine and take stock. Whether their call is being (or can be) heard is debatable, but such an unmitigated public declaration of concern is, in and of itself, a strong indication of the urgency around this topic.

This research aimed to set some foundations as a scaffolding for future design study of the phenomenon of datafication. An important avenue to continue the investigation into the future role and involvement of design is the posthuman and new materialist perspective, which critiques the traditional notion of the "human" as a distinct, superior organism separate from nature, animals, or machines and sees non-human entities (animals, plants, technological artifacts, or even seemingly inanimate objects), as possessing agency and the ability to act upon the world. For example, through her concept of cosmopolitics, Stengers (2010, 2011) argues that science is not a neutral or objective practice, but rather a situated process that is deeply entangled with power, politics, and social values, and that the scientific paradigm solidifies existing interests by legitimising what is valid knowledge and therefore excluding alternative forms of knowing. Echoing the work of indigenous scholars (Yunkaporta & Shillingsworth, 2020) and voices calling for a Pluriverse (Escobar, 2018b; Sardar, 2022) and for a critical examination of dominant narratives (Haraway, 1991, 2015), she calls for a multiplicity of perspectives and values to inform our understanding of the world. As mentioned in this thesis, the phantasmagoric belief that datafication can advantageously replace other more tacit forms of knowing has led to a deep imbalance in the tools, practices and belief systems available to us to comprehend and orient ourselves in the world. As mentioned above, datafication is not detrimental in and of itself; it is the lack of balance that is harmful. Chapter 6 was centred around living systems theory and the concept of autopoiesis or self-generation to support the emergence of a framework for a new ecology of knowledge. However, this needs to be accompanied by a critical reflection on new avenues for an ecology of practices focused on relationships between human and a wide range of non-human actors.

Design education is a central piece of the epistemological shift puzzle. In the opinion piece “design after design”, Tony Fry (Fry, 2017a) asks what is good design education at a time when design crucially needs to be both a means and an agent of affirmative change. Future research into how to integrate a living system view of designing into design education is critical. Finally, as the epistemological impact of datafication is still in its infancy, further ethnographic and sociological

research is needed to better understand how datafication impacts how we orient ourselves in the world. This also encompasses a dimension of education to raise awareness in the larger public. Further empirical studies into how design can serve as an agent not to improve user's experience but to encourage users and designers situated awareness of where they stand in relation to the datafied environments would be most welcome.

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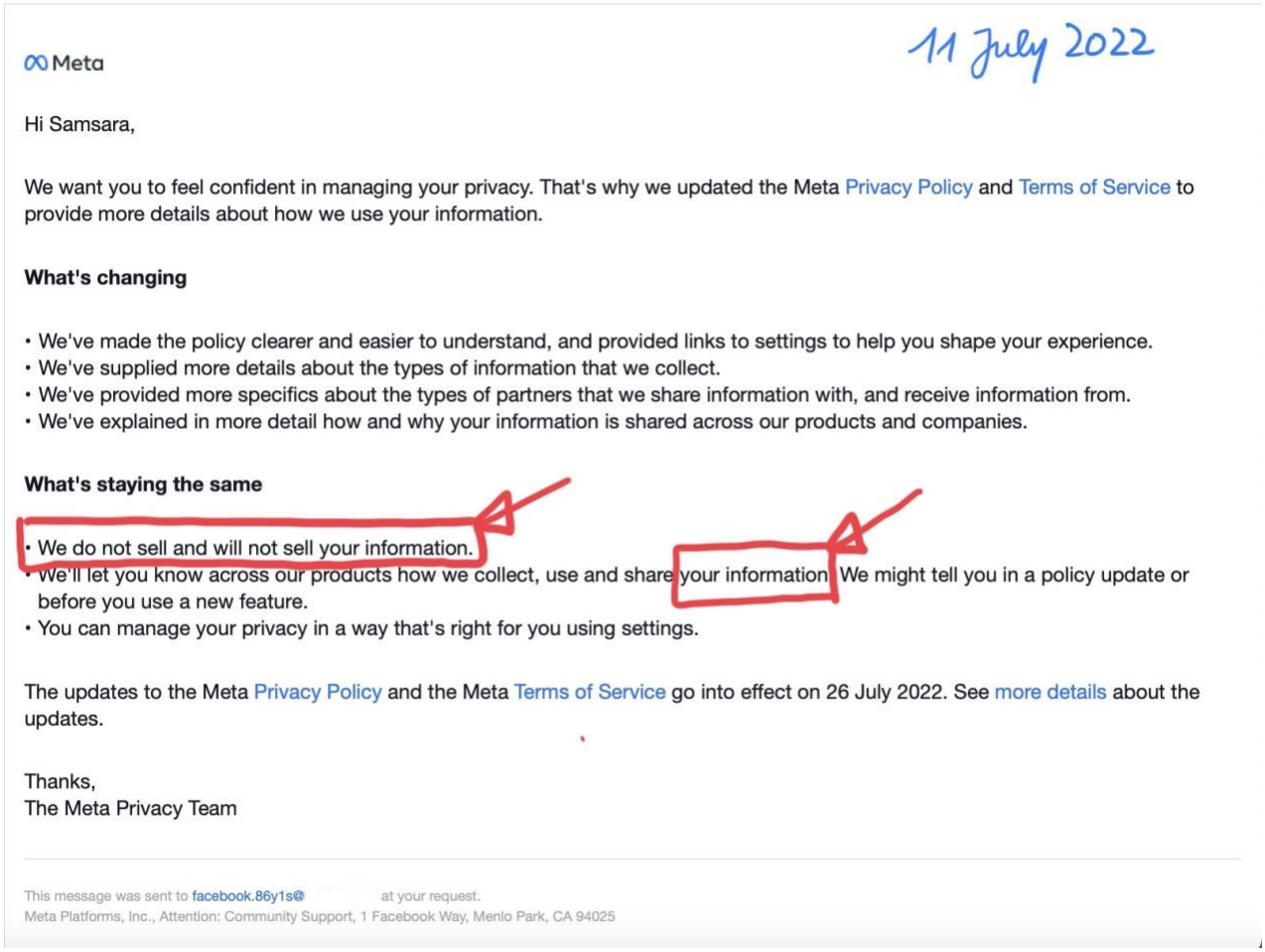
9 APPENDICES

Appendix A – Facebook Email "We Do Not Sell Your Information"



Meta

11 July 2022

Hi Samsara,

We want you to feel confident in managing your privacy. That's why we updated the Meta Privacy Policy and Terms of Service to provide more details about how we use your information.

What's changing

- We've made the policy clearer and easier to understand, and provided links to settings to help you shape your experience.
- We've supplied more details about the types of information that we collect.
- We've provided more specifics about the types of partners that we share information with, and receive information from.
- We've explained in more detail how and why your information is shared across our products and companies.

What's staying the same

- We do not sell and will not sell your information.
- We'll let you know across our products how we collect, use and share your information. We might tell you in a policy update or before you use a new feature.
- You can manage your privacy in a way that's right for you using settings.

The updates to the Meta Privacy Policy and the Meta Terms of Service go into effect on 26 July 2022. See more details about the updates.

Thanks,
The Meta Privacy Team

This message was sent to facebook.86y1s@ at your request.
Meta Platforms, Inc., Attention: Community Support, 1 Facebook Way, Menlo Park, CA 94025

Appendix B – Areas, Disciplines, Fields and Theories Investigated for This Research

- Design (notably design thinking, social design, and areas of design associated with online life, such as HCI, IxD, UX etc.)
- Captology (and disciplines at the intersection of psychology and digital design)
- Psychology, social psychology
- Behavioural economics
- Media studies, social media studies
- Theories of communication and information
- Epistemology
- Sociology of media
- Political economy, capitalist studies, surveillance studies, power studies
- Theories of spatialisation, Geography studies
- Technology studies, Critical data studies
- Systems thinking, second order cybernetics
- Life sciences
- Ecology, living systems

Appendix C – Core Questions

Main questions (wide bodies of literature)

What is happening with technology at the dawn of the 21st century?

What is the defining element of this new technology?

What is the new civilisation that is emerging of which this medium is the manifestation? What is the defining element of this new civilisation?

Is this a new paradigm (as the word revolution seem to suggest), or are we still in the old paradigm of the industrial revolution but with new clothes? Have we arrived at the end of a new trajectory or are we on the same track but at a higher speed?

What are these mediated environments aiming to achieve? Who is designing these mediated experiences? Who is benefiting more from these spaces: the user or the creator? How successful are those architectures of control in shaping tacit experiences?

How is knowledge being redesigned in the Digital Age? How does this shift influence how designers integrate experiential knowledge – i.e., tacit knowledge? What are the long-term implications emerging from this increased dependency on datafication?

What is knowledge in this context? What does it mean to "know" today?

Technology / social media

The "digital revolution": what does "digital" really mean? Is it a revolution? How?

What is the unique characteristic of this medium (as opposed to mass media for example)?

What is the real the architectures of the social web, behind what we can see? Are the behaviours displayed on social platforms indirectly designed, emerging from the choice architectures? How?

What is it that the social platforms do not want me to see? What is purposefully hidden out of view? And for what agenda? Who benefits?

What are the main architectures of control? What is the essence of the social platform as a medium? What are the boundaries?

What are the links between social media, the platformisation of the medium and the larger society?

What are algorithms? How do they impact life on social platforms? Do they have a larger social impact apart from the interactions on the platforms themselves?

What does "social" really mean in "social media"?

What is the logic of social media?

What are the key fields to interrogate to discover the essence of the new medium?

Surveillance

What is the nature of surveillance in the 21st century?

Space

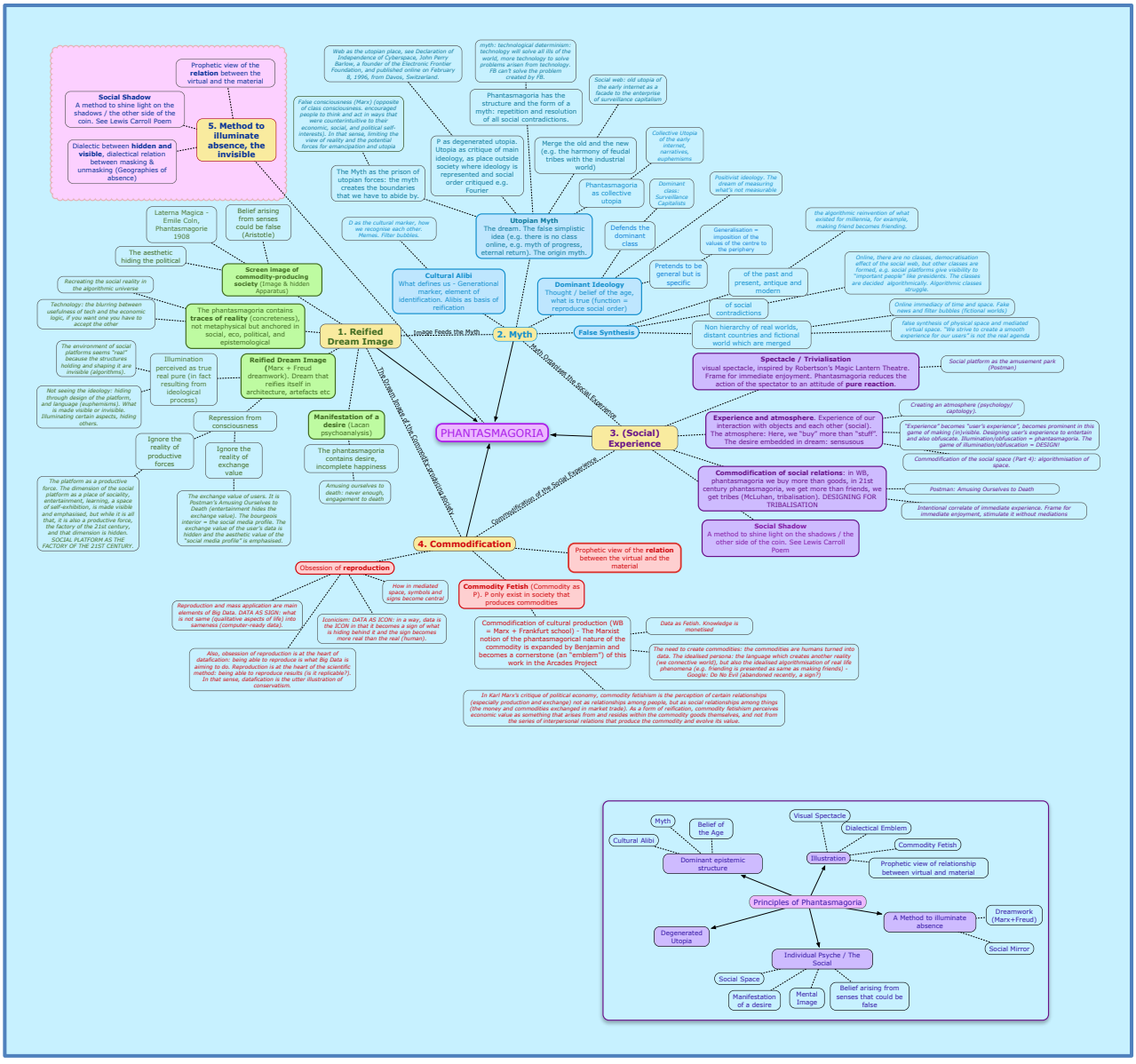
What is the nature of platforms as space? As social space? As land subject to territorialisation?

What are these mediated environments aiming to achieve?

Who is designing these mediated affordances?

Who is benefiting more from these spaces: the user or the master architect? How successful are those architectures of control in controlling behaviours?

Appendix D – Mapping Phantasmagoria



Appendix E – Keywords

1

Keywords Mechanistic - Holistic

Mechanistic

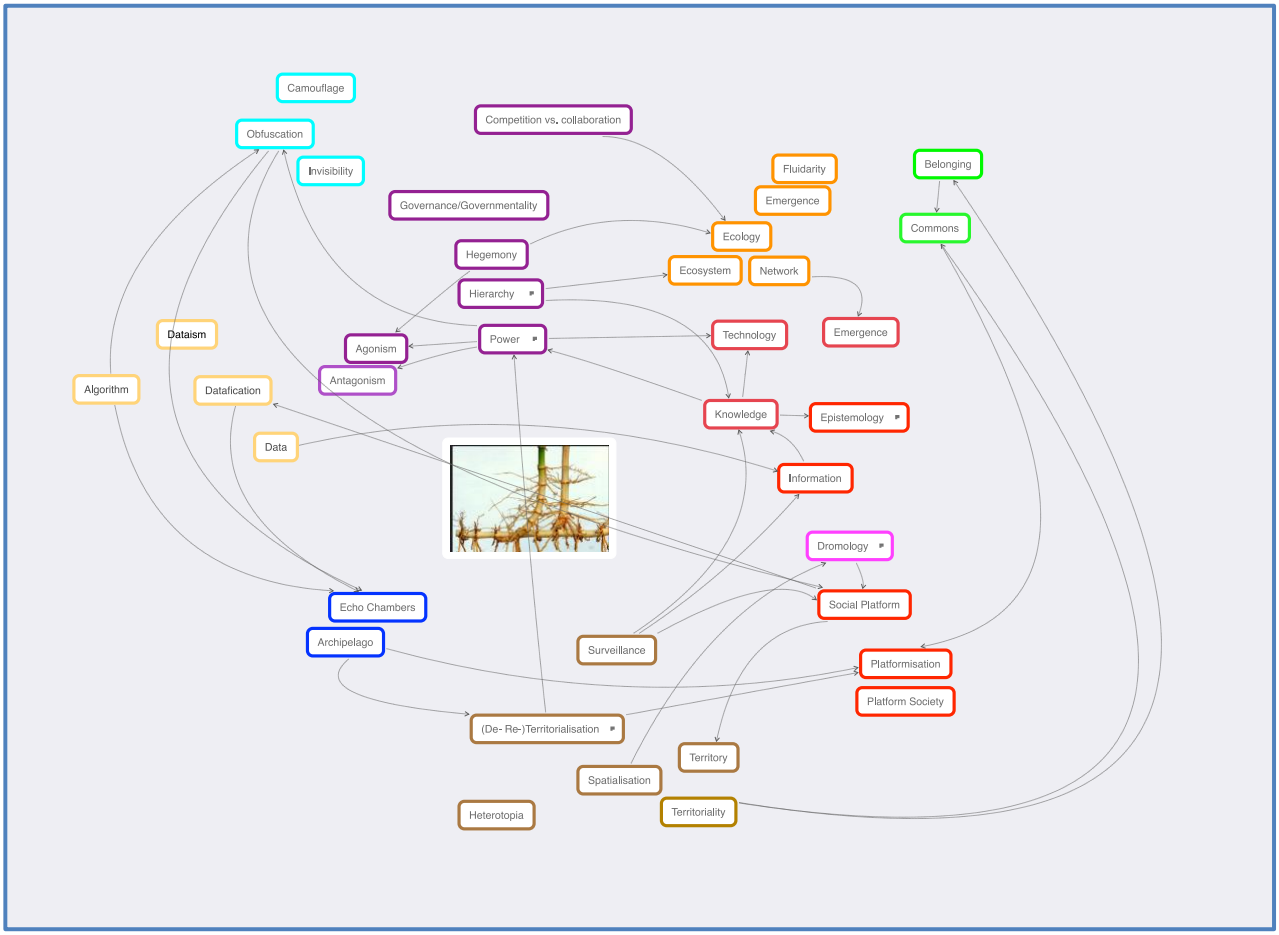
- Reductionist
- Atomistic
- Quantitative
- Quantities
- Self-assertive
- Rational
- Expansion
- Analysis
- Competition
- Reductionist
- Quantity
- Linear
- Domination
- Values: anthropocentric (human-centred)

Holistic

- Ecological
- Organic
- Living systems
- Emphasis on the whole
- Organismic
- Systemic
- Integrative
- Intuitive
- Conservation
- Synthesis
- Cooperation
- Holistic
- Quality
- Nonlinear
- Partnership
- Values: ecocentric (Earth-centred)

Glossary for research into concepts (underlined: chapter/important words)

- Territory (Deleuze, Edouard Glissant (father of globalisation concept, le "tout monde", la poetique de la relation), Henri Lefebvre (spatialisation, what defines a territory), Bateson
- Territoriality (Foucault, Deleuze, Elden)
- Heterotopia
- Surveillance (panopticon, cryptopticon) (dataveillance)
- Territorialisation (Phoebe Sengers: the powerful centres - Alice Marwick: Status as it creates territories)
- Spatialisation (Lefebvre)
- Affordances (as relating to territory) - mediated, virtual but also look at the territorial affordances not for users, but for corporations.
- Archipelago (see also as it relates to echo chambers and also to valid knowledge). Also relates to territorialisation.
- Echo chambers (see also as it relates to archipelago and also to valid knowledge)
- Ecology (relationship). Ecology of the territory. How relationships shape a territory.
- Ecosystem
- Network
- Emergence
- Fluidarity
- Belonging
- Commons - Public Sphere (Habermas) - Political, civic sphere
- Culture - Cultural artefact (social platform as cultural artefact —> contextual ≠ universal values)
- Agonism (Chantal Mouffe)
- Antagonism
- Hegemony
- Power (power play) - media power
- Governance/Governmentality (Foucault)
- Competition or collaboration (Darwin vs Kropotkin) (see Gerhard: Europe was built on contestation. Social designers want collaboration, but contestation has a place in shifting eras or paradigms).
- Obfuscation
- Camouflage (“Camouflage” by British scholar, Neil Leach)
- Invisibility
- (Social) Platform (see images of platforms) - Plateau vs Platform
- Platformisation - Centralisation
- Platform society (state of being) (JVD) / public values
- Datafication -
- Data
- Algorithm
- Dataism (Ideology) JVD, Postman (Technopoly)
- Information (Postman) - Information vs. deception (fake news) - Environment of "information asymmetry” (Tufekci Engineering the public: big data, surveillance and computational politics)
- Surveillance/Dataveillance
- Technology
- Dromology (study of speed: Paul Virilio)
- Epistemology, (Valid) Knowledge - Customary knowledge (“adat" in Malay language)
- Axiology
- Attention (Tim Wu)
- Persuasion (B.J. Fogg: at the intersection of design and psychology)
- Surveillance Capitalism (Zuboff)


Camouflage
Obfuscation
Invisibility
Competition vs. collaboration
Governance/Governmentality
Hegemony
Hierarchy
Power
Agonism
Antagonism
Dataism
Algorithm
Datafication
Data
Echo Chambers
Archipelago
Heterotopia
Fluidarity
Emergence
Ecology
Ecosystem
Network
Technology
Emergence
Knowledge
Epistemology
Information
Dromology
Social Platform
Surveillance
Platformisation
Platform Society
(De- Re-)Territorialisation
Territory
Spatialisation
Territoriality
Belonging
Commons

Appendix F – Glossary

Big data: large computational systems endowed with the capacity to treat unprecedented amounts of digital data. The term also refers to the architectures of these systems, the nature of the data treated and the attendant techniques of knowledge production.

Datafication: the process of turning knowledge into searchable and indexable digital data (general definition). This research specifically understands datafication as the process of turning qualitative aspects of life and human experience into quantitative, discrete, computer-ready data.

Datafied knowing: refers to knowledge arising from datafication. As mentioned in the introduction, this thesis refers to "datafied knowing" instead of "datafied knowledge" to reflect 1. the controversial character of datafication as an epistemology, and 2. its dynamic, worlding aspect.

Design: a creative discipline, an ecology of lived practices, but also an ethos that guides the materialisation of lived experiences into all sorts of environments centred around tacit ways of knowing and being in the world. As a worlding project, design is a political act.

Designerly ways of knowing: Design as a discipline and a practice employs a wide diversity of ways of knowing. In this thesis, the term emphasises the tacit dimension of knowing that is a hallmark of design.

Digital: etymologically, from the Latin "digitus", finger or toe, i.e., that which can be counted, or measured. Usually in opposite pair with analogue.

Digital technologies: a general term referring to electronic or computational technologies based on computers quantitative (or digital) language.

Digitisation / Digitalisation: Digitisation refers to the process of turning symbolic knowledge (text, photo, audio or video) into digital form (Mejias & Couldry, 2019), e.g., scanning a printed document. Digitalisation refers to the wide adoption of digital technologies in all areas of life.

Ecology: Ecology (from the Greek (oîkos) 'household' or home, and (-logía) 'study of') is the study of the interactions between individual organisms and their environment (Sarkar, 2016). In a larger sense, ecology is really the study of the complexity of interrelationships.

Explicit knowledge: that which is known unequivocally, “without vagueness or ambiguity” (Merriam Webster). Usually in opposite pair with implicit knowledge (see below).

Implicit knowledge: that which is implied, known tacitly without being expressed, through inference. Usually in opposite pair with explicit knowledge (see above).

Qualitative knowledge: refers to quality as opposed to quantity, therefore equates diversity, plurality, interpretative approach, accounts or the local and situated, and is ambiguity and fuzzy boundaries friendly. “Know-how” (as opposed to “know what” of quantitative knowledge). Usually in opposite pair with quantitative knowledge (see below). Not equal to but closely related to tacit knowledge.

Quantitative knowledge: refers to knowledge arising from that which can be counted, that lends itself to being measured and broken down into parts. “Know what” (as opposed to “know how” of qualitative knowledge). Usually in opposite pair with qualitative knowledge (see above). Not equal to but closely related to quantitative knowledge.

Tacit knowledge: etymologically, from the Latin “tacitus”, silent (Merriam Webster), i.e., “unsayable” or which can’t be fully expressed. For philosopher of science Mikhail Polanyi, it refers to that which is known privately (personal knowledge), intuitively, without clear codes, through embodied experience. In this thesis, tacit knowledge is viewed as a central element of the design process and the production of design knowledge.

Warm (cold) data: the term “warm” data was coined by Nora Bateson. It refers to the “information about the interrelationships that integrate elements of a complex system”. It is paired with “cold” data which refers to quantitative, discrete information about that system.