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ORIGINAL PAPER

Intended, afforded, and experienced serendipity: overcoming the paradox of artificial serendipity

Annelien Smets[1]

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Abstract

Designing for serendipity in information technologies presents significant challenges for both scholars and practitioners. This paper presents a theoretical model of serendipity that aims to address this challenge by providing a structured framework for understanding and designing for serendipity. The model delineates between intended, afforded, and experienced serendipity, recognizing the role of design intents and the subjective nature of experiencing serendipity. Central to the model is the recognition that there is no single definition nor a unique operationalization of serendipity, emphasizing the need for a nuanced approach to its conceptualization and design. By delineating between the intentions of designers, the characteristics of the system, and the experiences of end-users, the model offers a pathway to resolve the paradox of artificial serendipity and provides actionable guidelines to design for serendipity in information technologies. However, it also emphasizes the importance of establishing 'guardrails' to guide the design process and mitigate potential negative unintended consequences. The model aims to lay ground to advance both research and the practice of designing for serendipity, leading to more ethical and effective design practices.

Keywords Affordances · Design intent · Information systems · Responsible design · Serendipity · Value sensitive design

Introduction

Designing for serendipity is challenging and according to some even impossible. Nonetheless, in the last decade, scholarly discourse has emphasized serendipity as a "desirable design principle for information societies" (Reviglio, 2023, p. 147). This normative call increasingly finds its way into practice, with organizations seeking to implement serendipity in their information systems. For example, in digital media, public broadcasters are implementing so-called "public service algorithms" (PSA) that would incorporate serendipity to expand users' media consumption, rather than providing them with more of the same (Fields et al., 2018; Sørensen & Hutchinson, 2018; Van den Bulck & Moe, 2018). While serendipity is considered an important design principle of such PSAs, few actually know how to design for serendipity in algorithms or how to evaluate it (Smets, 2022). Others then argue that normative values, such as serendipity, may lose out in a potential value conflict when designing information technologies that primarily value accuracy and efficiency (Bozdag, 2013). Apart from public organizations, serendipity is also actively sought in commercial applications, such as online shopping, to increase users' engagement and satisfaction (Grange et al., 2019; A. Kim et al., 2021; Lutz et al., 2017).

In other words, researchers and practitioners across diverse domains are striving to design for serendipity in information technologies. However, many questions remain; Are these the same kinds of serendipity? Are they experienced in the same way? Should or could they be designed for in the same way? Serendipity is indeed known as an umbrella term or "very broad and multifaceted phenomenon" that has resulted in the inevitable difficulty to define it (Yaqub, 2018, p. 169; McCay-Peet & Toms, 2017; Copeland et al., 2023). This paper does not aim to provide a conclusive answer to these questions, nor provide a single definition. Instead, the argument developed in this paper will illustrate that explicitly acknowledging this conceptual ambiguity allows to more comprehensively describe the phenomenon of serendipity, and how it could be designed for. By doing so, richer empirical data can be collected and analyzed,

✉ Annelien Smets
annelien.smets@vub.be

[1] imec-SMIT, Vrije Universiteit Brussel, Brussels, Belgium

which will contribute to academic advancements as well as bridge the gap between academic research and practice. To this end, this paper proposes a theoretical model of serendipity that provides mechanisms to deal with the conceptual ambiguity as well as the inherent uncertainty surrounding if and how individual end-users eventually experience serendipity. Based on this theoretical model, three concrete guidelines that can be used to guide designs for serendipity in practice are formulated. In that sense, this paper might be read as a response to Reviglio (2019, p. 162), who argued that "from a theoretical perspective serendipity can be advocated as a beneficial design principle" but added that "from a pragmatic perspective it is a highly problematic endavour".

The remainder of this paper is structured as follows. First, I elaborate on what it means to design for serendipity and how this can be achieved using an affordance approach (Björneborn, 2017). I expand on the existing work by establishing the connection with design intent, or designers' motivations behind design decisions. The latter informs the eventual design of environmental affordances and what this means for design practices for serendipity. Subsequently, I draw parallels between designing for serendipity in information technology and embedding values in technological design (van de Poel & Kroes, 2014). Building on this analogy, I propose a structured framework for understanding and designing for serendipity, which consists of intended, afforded, and experienced serendipity. Finally, I discuss the theoretical limitations and implications of the theoretical model and conclude with practical guidelines to design for serendipity in practice.

Designing for serendipity

In the last decades, there has been a significant research interest in serendipity coming from many theoretical and empirical angles (see Copeland et al., 2023; Foster & Ellis, 2014). One of these is the growing interest in how digital[1] environments can be designed to cultivate serendipity (e.g., Race & Makri, 2016; Reviglio, 2019; Taramigkou et al., 2013). In such digital environments, serendipity is often discussed in relation to Pariser's (2011) filter bubble hypothesis (e.g., Lunardi et al., 2020; Maccatrozzo, 2012). Similar to the case of the public service algorithms explained above, this line of work aims to mitigate the concern that algorithmically curated information flows would decrease users' exposure to diverse information content. Nevertheless, serendipity might also be introduced in digital systems for various other reasons, such as the gameplay of a mobile application (Bentley et al., 2011), alleviating user boredom, and increasing satisfaction in e-commerce applications (Wang et al., 2023), and many more (see Smets, 2023 for a discussion).

Despite its various meanings and objectives, this kind of deliberately cultivated serendipity is often referred to as "artificial serendipity" in contrast to "natural serendipity" that naturally occurs in the world (Melo & Carvalhais, 2018; Reviglio, 2023). This concept of artificial serendipity has, however, been contested as it would contradict the very nature of serendipity being informed by *accidents*, *chance,* and *unplannedness* (Van Andel, 1994). As a result, there seems to be an inherent paradox of 'planning the unplanned'. Scholars have countered this by arguing that it is possible to "cultivate serendipity" (Race & Makri, 2016) and hence create the *conditions* that increase the likelihood of serendipity to occur (Melo, 2018; Reviglio, 2023). This conceptualization to counter the apparent paradox aligns with the "affordance approach to serendipity", as proposed by Björneborn (2017). While this approach provides an initial framework for overcoming the paradox, I venture that there remains a gap between theoretical understandings and the practical aspects of designing for serendipity. More specifically, there are two key problems. First, the affordance approach does not allow to differentiate between different application contexts of designs for serendipity. As a result, the conceptual ambiguity that is inherent to serendipity hinders our ability to translate (theoretical and empirical) findings into practice or compare them. Second, we currently lack an understanding of the underlying objectives and decisions that have informed the design. In other words, we do not know why serendipity is designed for *in this particular way.*

Both problems have a common origin in the predominant focus on the individual experiencing serendipity, neglecting other actors who influence the design process (Smets, 2023). In prior work, I referred to these motivations as "design intents" and proposed a typology to distinguish between different design intents (Smets, 2023). While this typology contributes to the motivations for design for serendipity (i.e., *why*), it still lacks an answer to *how* it should then be designed for. To address this gap, this section will discuss the relationship between design intent (*why*) and the selection of affordance features (*how)*, which will be key to the theoretical model serendipity (presented in the "Intended, afforded, and experienced serendipity" section). This contribution extends the existing affordance approach to serendipity by providing insight into how designs for serendipity are informed by the motivations of actors other than the one who is experiencing serendipity. To substantiate this argument, this section first provides a comprehensive discussion of affordances and their relation to serendipity studies.

[1] It is important to note that this is also being studied in physical environments (e.g., libraries or cities), but this paper limits its focus to digital technologies and applications.

An affordance approach to serendipity

The concept of affordances stems from ecological psychology with Gibson defining them as "what it offers the animal, what it provides or furnishes, either for good or ill" (1977, p. 67). Gibson's account of affordances countered prevailing cognitive psychology notions that underestimated the influence of environmental constraints on autonomous agents' perception and actions (Hellström & Jacob, 2017). In contrast, Gibson argued that individual perception (and thus the actor's capabilities) impacts the possibilities for action provided by the environment and vice versa. For example, a cat door affords a passage to little animals, but not to humans; or children can be too small to be able to reach a door handle that affords opening a door. In other words, affordances denote the *possible* interactions between actors and environments, considering both the actor's capabilities and the environment's capacities.

Given this interplay, the notion of affordances has also resonated in the field of design. Most notably, Norman (1988, p. 9) applied it to everyday artifacts and defined affordances as "… the perceived or actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used." According to Norman (1988), affordances provide intuitive clues to users without the need for explicit instructions. In human–computer interaction, for example, they manifest as 'clickable' buttons or 'draggable' sliders (McGrenere & Ho, 2000; Nye & Silverman, 2012). Dourish defines affordances as a "three-way relationship between an environment, a human being, and a potential activity" (2004, p. 118). This definition is particularly comprehensible and related to Björneborn's (2017) "affordance approach to serendipity" with the potential outcome, or activity, being an actor experiencing serendipity (Fig. 1).

The affordance approach to serendipity demonstrates that it is possible to design *for* serendipity. It implies that we consider serendipity as the potential outcome of an environment-actor correspondence, where the environment consists of particular features that can afford serendipity (Björneborn, 2017). This aligns with Foster and Ellis' conclusion that serendipity "does not exist within a vacuum, it is the product of context" (2014, p. 1034). Serendipity then occurs when there is an "actualization" of the affordance (Björneborn, 2020). In other words, if—not 'when' because it is a "potential" (Björneborn, 2017, p. 1066)—there is a "complementarity of the acting organism and the acted-upon environment" (Gaver, 1991, p. 2). As a result, serendipity is ontogenetic (i.e., always in a state of becoming) and therefore characterized by "ontological uncertainty", meaning that it is indeterminate what kind of interactions users will have with the environment and what outcomes (i.e., experiences of serendipity) that will lead to (de Reuver et al., 2020).

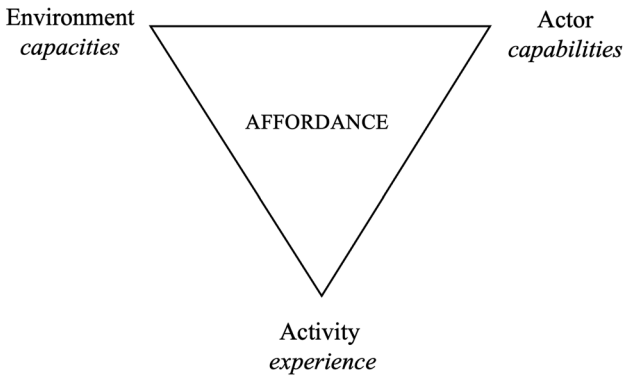

Fig. 1 Affordances seen as a triad-relationship between actor, environment, and activity (source: Author)

In his conceptual framework, Björneborn outlines three key affordances for serendipity (diversifiability, traversability, and sensoriability) and indicates which personal factors are considered to be the "person-dependent" components (i.e., capabilities) of these affordances (Björneborn, 2017, p. 1068). Sensitivity, for example, is coupled with sensoriability and relates to the personal factor of 'experience', which is a common concept in related work on serendipity that talks about a "prepared mind" (McCay-Peet & Toms, 2015) or "previous experiences" (Makri et al., 2014) impacting the likelihood of an individual experiencing serendipity. For example, Fleming's discovery of penicillin might have been impacted by his previous experience of having discovered an enzyme in bacterial growth a decade earlier (de Rond, 2014; Yaqub, 2018). Although these personal factors are essential to understanding serendipity in this actor-environment-activity triad, I will only get back to them later in this work (see "Implications and limitations"). These personal factors fall beyond the scope of the main argument developed in this paper as I focus on the deliberate design of the (information) environments and thus the design of 'capacities' or 'environmental features'.

This affordance approach to serendipity has two significant implications. First, it highlights that we can design for serendipity but cannot design serendipity itself (Björneborn, 2017, p. 1068; André et al., 2009; Makri, 2019). Second, it emphasizes the presence of a designer, who I consider as an actor external to the 'actualization' of the affordance and not involved in the triad relationship (as illustrated in Fig. 1). Despite the designer being external to the actualization, they still play a crucial role in operationalizing the environment's capabilities with a specific *intent*. In other words, when it comes to designing for serendipity, there is an important distinction between the actualization (i.e., the actor potentially experiencing serendipity) and the operationalization. This

explicit distinction between the actualization and operationalization of serendipity is absent in existing literature, which has predominantly focused on the actualization in relation to an existing operationalization, without questioning how this operationalization came into place (Smets, 2023).

As a result, there is a significant gap in our understanding of design intentions for serendipity: why would one want to design for serendipity and how does this impact the practice of designing for serendipity, if at all? To address this, I expand on my earlier notion of design intent (Smets, 2023) and connect it to the affordance approach to serendipity. This contributes an understanding of how environmental affordances (deliberately) come about, which may inform future designs for serendipity in practice.

Extension to the affordance approach: design intent

Design intent, defined as "the reasons behind design decisions" (Ganeshan et al., 1994, p. 60), primarily concerns the perspective of the designer; the one who "successfully asserts control over the environment" (Carr, 2015, p. 835). Despite being inherent in (deliberate) design practices, discussions about design intent in relation to affordances are limited in existing literature.[2] An exception is the work by You and Chen who note that "the core of [the] affordance concept in design lies not in expressing the design intent, but constructing the actions required in the user-product interaction" (2007, p. 35).

As noted above, while designers are considered external to the (actualization of the) actor-environment-activity triad, they do influence its operationalization by deciding how the environment is designed to afford serendipity. This aligns with You and Chen stating that "design intent affect[s] the selection of product features" (2007, p. 36). In this context, these product features could be referred to as "affordance features" which are "the structural elements of artifacts that provide affordances" (Kim et al., 2013, p. 2). Affordance features represent specific environmental capacities (e.g., a door handle), and You and Chen's (2007) usage of the word 'selection' implies the availability of a broader range of possibilities, similar to "affordance feature repositories" (Kim et al., 2013, p. 2). These repositories consist of "multiple affordance features for a given affordance" (ibid) offering clues to design new affordance features through analogical reasoning.

Figure 2 illustrates the relationship between these concepts, emphasizing the different ways to design affordances captured in an affordance feature repository. The selection of particular affordance features (or short: features) is guided by design intent, which ideally incorporates knowledge about the specific domain and context. For instance, when installing a door in a children's playhouse, it may be necessary to choose a push handle instead of a latch to ensure that it is easy for children to use.

Building on this rationale, I posit that design intent and the selection of affordance features are closely linked and should be analyzed together to fully grasp the practice of designing for serendipity. As argued more extensively in the "Implications and limitations" section, understanding how design intent affects the selection and shaping of affordance features, allows for the explicit capture and understanding of certain aspects that have been previously identified as open challenges in the literature, thereby advancing the field. To this end, the next section proposes a theoretical model that incorporates the previously stated rationale and lays the grounds to further our understanding of designing for serendipity.

Serendipity as a value in technological design

The previous section connected design intent and the operationalization of serendipity affordances. However, ultimately serendipity is an experience and only occurs when there is an actualization of the affordance through an individual (Björneborn, 2020). Due to the resulting ontological uncertainty, it will remain unclear upfront if and how individuals will eventually experience serendipity. This uncertainty often troubles designs for serendipity in practice, but it should not lead us to overlook or generalize the diverse ways in which serendipity is actually experienced. On the contrary, we should look for robust mechanisms for dealing with it. After all, there may be a discrepancy between what is intended and what the individual ultimately experiences (as discussed below).

The proposed theoretical model of serendipity aims to provide such a mechanism to deal with this uncertainty, by *unpacking* serendipity in different constructs related to its intent, design, and how it is eventually experienced. This approach is based on three key insights from the literature on embedding values in technological design, which are explained in the first part of this section. This understanding of serendipity as a value in technological design then serves as the foundation of the theoretical model of serendipity and

[2] It should be noted that affordances not only emerge through intentional design. Gaver (1991) already distinguished affordances from perceptual information and identified "false affordances" as being affordances perceived by the user but unintended by the designer. This also relates to what Sadler and Given describe as "perceived but not intended affordances" (2007, p. 123). In this paper, I focus on *intended* affordances, given its goal of understanding and contributing to deliberate design practices.

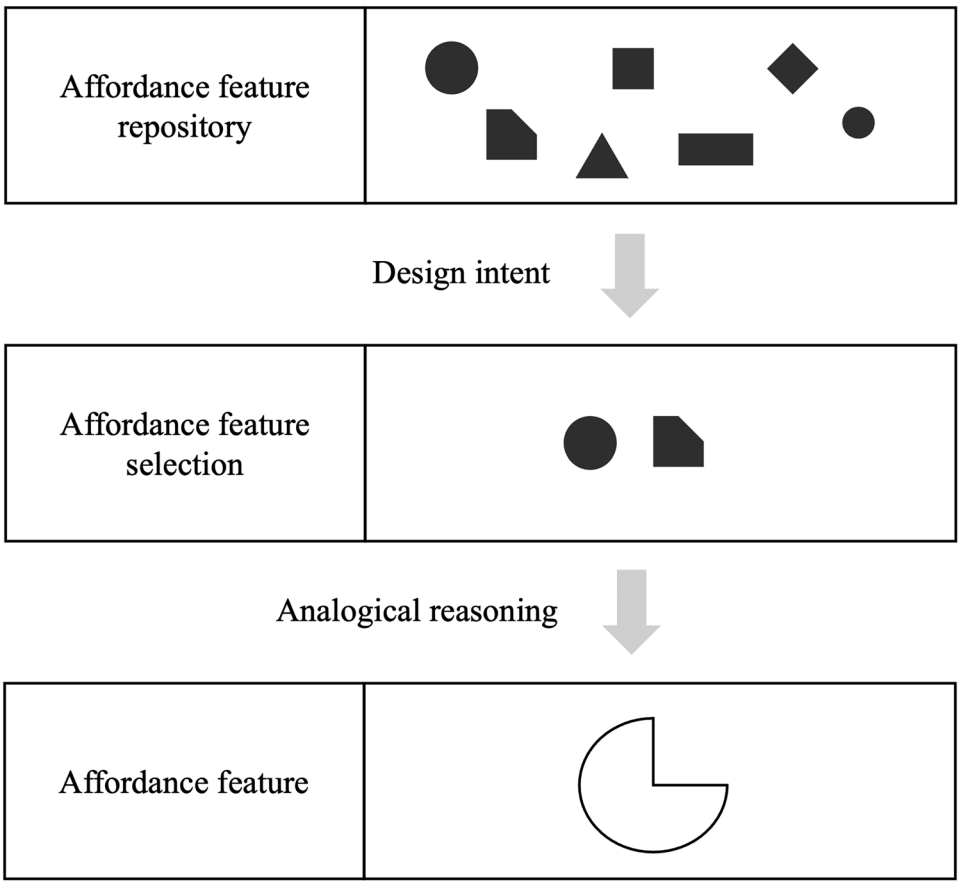

Fig. 2 Affordance feature repositories consist of a collection of multiple features that contribute to an affordance (source: Author)

is synthesized in the "Intended, afforded, and experienced serendipity" section.

Embedding values in technological design

The most significant contributions underlying the proposed model of serendipity in this paper, stem from the literature on embedding values in technological design. In this strand of work, value-sensitive design (VSD) is one of the most widely discussed theoretically grounded approaches that seeks to consider human values during technology design (Friedman, 1996). However, in today's digital platforms it cannot be foreseen how users behave on the platform and hence which values will be realized (de Reuver et al., 2020). The latter is because platforms mediate between different actors and therefore have little control over what purpose users will interact with each other. For example, social media can be exploited for the dissemination of disinformation by individuals with malicious intent. As a result, one should be able to take into account the unintended consequences of a particular design strategy and allow for reflexivity throughout the entire life cycle (de Reuver et al., 2020). This has been less emphasized in the original VSD approach, which focused more on the mere design of the system, rather than its actual usage. Unlike the original VSD approach, which mainly concentrates on system design, a more recent perspective by van de Poel and Kroes (2014) emphasizes the *actual usage* of technologies and distinguishes between intended and realized values. More specifically, this line of work on embedding values in technological design deals with three particular questions that inform the theoretical model of serendipity: (i) how values become embedded in technological design, (ii) how they can be operationalized and (iii) how to deal with conflicting values in design.

Intentions vs. realizations: unintended consequences

Central to the literature on embedding values in technological design is the distinction of three types of values (van de Poel & Kroes, 2014): intended value, embodied value, and realized value (see also Table 1). *Intended value* represents the designer's aim to embody a specific value in their design, hoping that it materializes in practice. This aligns with the focus on design intent (see "Extension to the affordance approach: design intent"), since van de Poel and Kroes explicitly emphasize "intentionally designed features […] because design is an intentional activity" (2014, p. 113). *Embodied value* denotes

Table 1 A theoretical model of serendipity that distinguishes between intended serendipity, afforded serendipity, and experienced serendipity: definitions and comparison with values in technological design

Value (van de Poel & Kroes, 2014)		Serendipity	
Intended	The value which designers aim to embody in their design and which they hope to be realized in practice	Intended	The designer's intent of delivering which utility (value) to whom (i.e., directionality)
Embodied	The potential to realize a value in an appropriate context	Afforded	The capacities of the system to afford experienced serendipity. In other words, the selected affordance features
Realized	The value that is realized in actual use	Experienced	What happens when the end-user, in unplanned ways, encounters resources (information, things, people, etc.) that they find interesting (following Björneborn, 2017)[a]

[a]The main focus of this work is not to discuss the definition of experienced serendipity, and rather argues in favor of not limiting it to one single definition (see "Theoretical contestations"). In this work, I follow Björneborn's (2017) definition to define experienced serendipity as I consider it to be one of the least restrictive ones. For a comprehensive discussion and argumentation for this choice, please refer to Smets (2022).

the potential to realize a value in an appropriate context. The value eventually realized in actual use, is termed *realized value*.

Essentially, an embodied value results from a particular design intent, holding the potential to *afford* ('contribute to') a value of which the actual realization depends on a broader context of use. In that sense, embodied value is part of the actor-environment-activity triad (see Fig. 1 above) wherein, through use and correspondence with the *capacities* of the user, it may lead to a realized value (Klenk, 2021). This realized value can then be considered the activity (e.g., experiencing serendipity) that is afforded through the actor-environment correspondence.

This distinction between intentions and realizations opens up the opportunity to think about unintended consequences (e.g., filter bubbles or discrimination) when the technological artifact starts to embody new values when they are redesigned either through designers but also through their context of use and hence the users (de Reuver et al., 2020; van de Poel, 2020). For example, van de Poel (2020, p. 393) describes how a recommender system could "unintendedly (and systematically) contribute to filter bubbles and echo chambers and thus contribute to (dis)values such as a lack of respect and untruth, although that was never intended by its designers." Such unintended (negative) consequences may also emerge in the context of designing for serendipity. For example, Waugh et al., (2017, p. 278) describe a "seeking-encountering tension" where too much serendipity eventually "drew participants back to the lower-risk activity of goal-directed information-seeking". It is argued that when such negative unintended consequences systematically occur, there is an obligation to avoid disvalue and intentionally design for the opposite positive value (van de Poel, 2020). The importance of considering these unintended consequences when designing for serendipity will become apparent later in this paper.

Operationalizing values in context

The second challenge relates to how values can be operationalized in technological design. Van de Poel (2013) describes how values can be translated into design requirements through the "values hierarchy". As depicted in Fig. 3, such a hierarchy illustrates the relationship between values, norms, and design requirements, with the norms referring to "properties, attributes or *capabilities* that the designed artefact should possess" (van de Poel, 2013, p. 258, emphasis added). Using the terminology established earlier in this paper, serendipity would be considered the value, affordances the norms, and affordance features represent the design requirements.

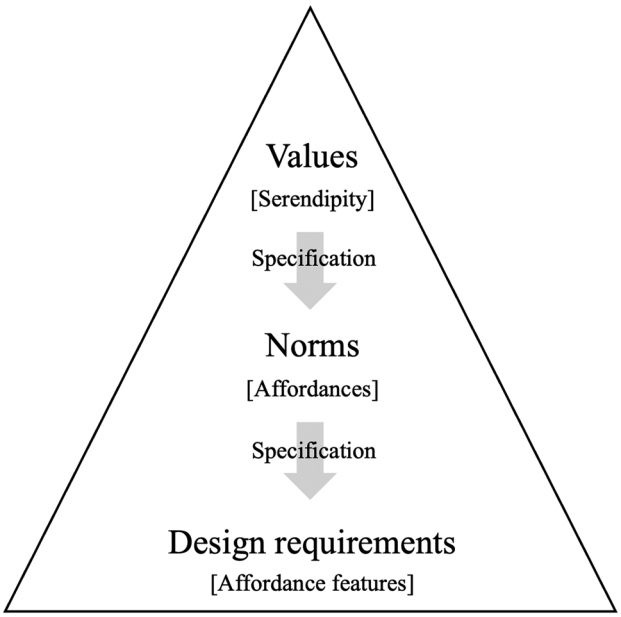

Fig. 3 Values hierarchy based on van de Poel (2013) and mapped to the terminology used in this paper (source: Author)

The relationship between the layers of the values hierarchy is known as "specification", and according to van de Poel (2013), lower levels cannot be logically deduced from higher levels due to two reasons. Firstly, contextual information of the design project should be considered during the value specification process. For example, safety in the context of a car means something different than safety in the context of an oven. Similarly, one could argue that serendipity in a Public Service Algorithm might have a different meaning compared to serendipity in a digital classroom, for example. Secondly, usually, multiple specifications are possible. For example, various methods exist to prevent burns when using an oven. This ties into the discussed "affordance feature repositories" that consist of "multiple affordance features for a given affordance" (Kim et al., 2013, p. 2). Therefore, one could argue that the selection of affordance features is a specification process and thus requires domain knowledge.

This specification process implies that the operationalization of values cannot be defined in a uniform way. In fact, Kroes and van de Poel more firmly claim that in fact values cannot be objectively measured because the "translations" of values into operationalizations involve "second-order value judgements" (2014, p. 16). These second-order value judgments are specific to the designed product and its context, and represent decisions informed by domain knowledge. For example, recognizing that safety means something different in a car or an oven, requires knowledge of the concepts (and contexts) of cars and ovens. Extending this argument to understanding serendipity as a value that can be designed for, implies that the operationalization of serendipity depends on the specific context. For instance, in a news recommender designed to combat filter bubbles, 'diversity' might be a crucial component of serendipity, whereas it may not be as essential in a movie recommender designed to increase the discoverability of items. While this context specificity may seem evident, there is currently no theoretical understanding of serendipity that allows for such differentiation, potentially contributing to the ambiguity in the field of study (see also "Implications and limitations").

Dealing with conflicting values

Finally, there is the question of conflicting values. This is particularly relevant in the context of multi-sided digital platforms with different (often competing) objectives (Evans & Schmalensee, 2016), but also holds in other contexts as value conflicts in design are commonplace (van de Poel, 2014). For example, Pariser's (2011) filter bubble hypothesis assumes that the personalization of media content is often motivated by companies' commercial objectives, which can impede other values such as exposure diversity and serendipitous information encounters.

Various approaches have been proposed to address such value conflicts, including the (re)specification of the values underlying the conflicting design criteria (see van de Poel, 2014, for a more detailed discussion of the approaches). The process of (re)specification involves identifying the implications and significance of the values, addressing questions such as "what do these values imply and why are these values important" (van de Poel, 2014, p. 16). This relates to the "directionality of a design for serendipity" and questions the intended utility (value) for whom (Smets, 2023, p. 590). Van de Poel (2014) argues that by clarifying the directionality of a value, such as serendipity, can help resolve value conflicts by identifying when, how, and by whom the value is assumed to be necessary. This additional information might identify ways to mitigate the value conflict, as there are usually more specifications (operationalizations) of the value. For example, consider a music streaming platform that wants to design for serendipity to expose end-users to artists they were not actively searching for. While this can lead to a meaningful experience for the user, perhaps even indistinguishable from experienced serendipity in other domains, the underlying design intent may be to increase user engagement and retention. In this case, serendipity is not pursued as an end in itself, but rather instrumentalized to increase engagement (Smets, 2023).

It should be noted, however, that (re)specifying values may not always resolve the value conflict or be a desirable solution (van de Poel, 2014). It is particularly unfavorable if it results in "a serious weakening of the values compared to the original specification" (Hansson, 1998; van de Poel, 2014). This concern relates to what Reviglio (2023, p. 159) calls "manipulative serendipity […] that would hardly lead to reliable and meaningful serendipitous experiences". The question, then, remains of how to strike the precarious balance between what qualifies as a design for serendipity and what does not. Is everything a design for serendipity if it is intended as such? I will address this question in the "Implications and limitations" section, after having presented the theoretical model of serendipity.

Intended, afforded, and experienced serendipity

The previous section has illustrated how understanding serendipity as a value in technological design could help to overcome questions about its operationalization and resolve potential value conflicts. More specifically, it has provided three relevant insights that are incorporated into the proposed model of serendipity. First, the distinction between intended, embodied, and realized value. Second, the process of specifying values in design requirements, which emphasizes that there is no unique operationalization of values. Third, the process of (re)specification as a strategy for mitigating value conflicts by adding more information

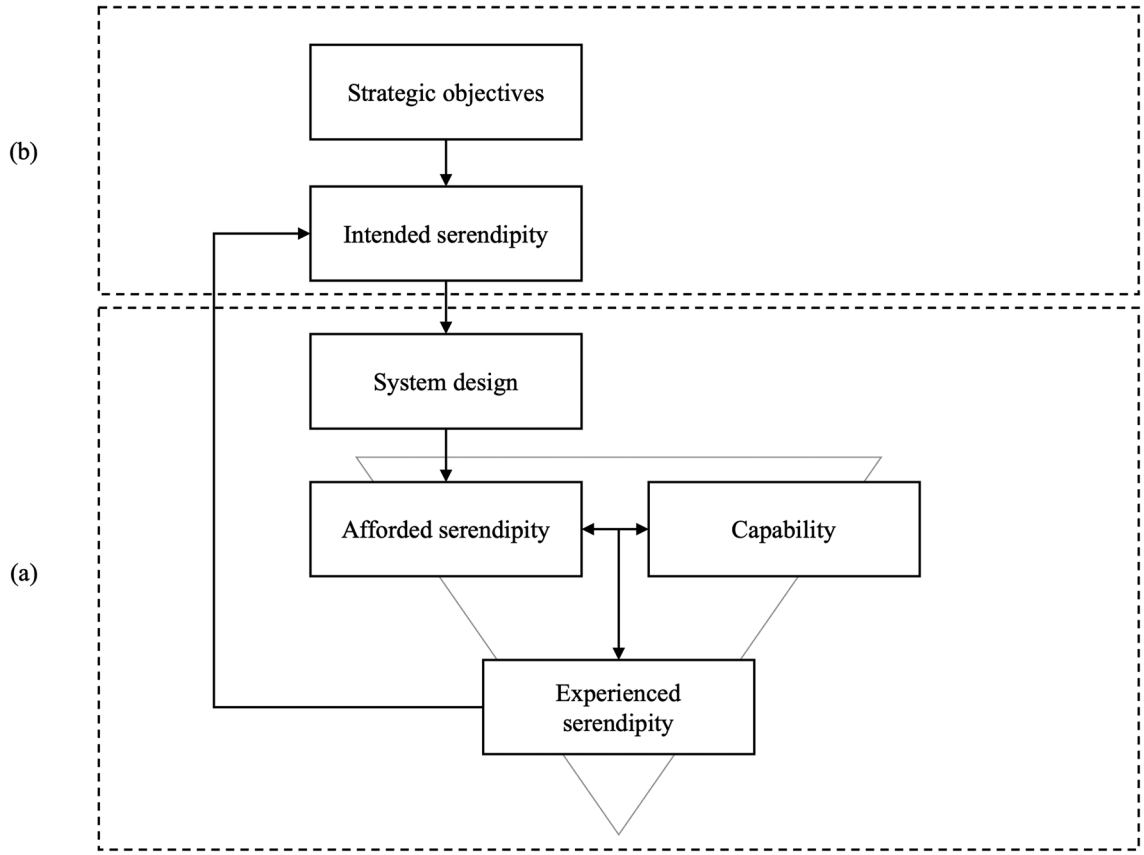

Fig. 4 A theoretical model of serendipity that distinguishes between intended serendipity, afforded serendipity, and experienced serendipity (source: Author)

about the directionality of the value. Building on these key learnings, I propose a theoretical model of serendipity that distinguishes between intended serendipity, afforded serendipity, and experienced serendipity (Table 1).

The definitions of each of these three constructs can be found in Table 1, which also lists the correspondence with the terminology[3] and definitions of van de Poel and Kroes (2014). One of the main contributions of this model is that it embodies the perspectives of different actors involved in the design of serendipity, which has been lacking in current research (Smets, 2023). Specifically, *intended serendipity* is defined from the perspective of the designer, *afforded serendipity* reflects the characteristics of the system (environment) itself, and *experienced serendipity* represents the perspective of the individual end-user (i.e., the one who interacts with the system and may experience serendipity).

In this regard, I posit that the current literature on serendipity has mainly covered afforded and experienced serendipity (see Fig. 4a). Following the distinction I made (Smets, 2023), one could argue that the phenomenological strand of serendipity research (e.g., Foster & Ellis, 2014; Rubin et al., 2010) focuses on experienced serendipity, while the design-oriented approach (e.g., Makri & Race, 2016; Melo, 2018) targets afforded serendipity and its relation to experienced serendipity. Both lines of work also address the capabilities of end-users (i.e., person-dependent components as described above (Björneborn, 2017)). In that sense, the existing literature has mainly studied how people experience serendipity and how they experience it when we design for it. Although some work has considered why serendipity is designed for and what its consequences might be, these reflections are often implicit or not systematically linked to design practices and outcomes. As I have argued elsewhere (Smets, 2023), understanding *why* we design for serendipity is crucial for grasping how serendipity is understood and operationalized in different contexts. This paper builds on that foundation by proposing a structured model that more clearly delineates different serendipity constructs, the actors involved, and their respective intentions, without aiming to

[3] The terminology I use here deviates in two ways from the one used by van de Poel & Kroes (2014), namely 'afforded' instead of 'embodied' and 'experienced' instead of 'realized' (see Table 1). That is because the terms 'afforded' and 'experienced' are more common in the existing literature on serendipity while their meaning still aligns with the terminology used by van de Poel & Kroes (2014).

contradict or subvert any of the current understandings of serendipity.

The proposed model of serendipity then contributes intended serendipity and how this is informed by strategic objectives, including design intent[4] (see Fig. 4b). This layer captures the dynamics that have been the main focus of this paper. In the "Extension to the affordance approach: design intent" section, I have explained how the selection of affordance features (i.e., afforded serendipity) is informed by a particular design intent (see Fig. 2 above), which was further elaborated in the "Operationalizing values in context" section by explaining the "specification" process (van de Poel, 2013). This implies that there is, in fact, no single definition nor a unique operationalization of serendipity, and that both are greatly informed by the specific context. The consequences and limitations of this statement will be further discussed in the section on "Theoretical contestations".

Finally, Fig. 4 illustrates a feedback loop between experienced serendipity and intended serendipity. This refers to evaluating experienced serendipity and comparing it to intended serendipity. A comprehensive discussion of how to measure experienced serendipity would largely exceed the scope of this paper (see e.g., McCay-Peet and Toms,2017, for a discussion on researching serendipity in digital environments). However, in the next section, I will argue that defining intended serendipity can guide researchers and practitioners in how to measure and evaluate experienced serendipity. Moreover, this feedback loop, and hence being able to contrast intended and experienced serendipity, is an important step to evaluate the effectiveness of the design and to detect issues of misalignment and/or unintended consequences.

Implications and limitations

This theoretical model of serendipity has several theoretical implications, offering the opportunity to advance the current state of the art. However, the proposed model could also be challenged, which might raise some additional avenues for future work. In this section, I briefly expand on both the theoretical implications and limitations of the proposed model. Finally, I conclude by discussing how the proposed theoretical model can guide the design for serendipity in practice and thus has the potential to overcome the "highly problematic endeavour" of designing for serendipity in practice (Reviglio, 2019, p. 162).

[4] In Smets (2023), I have described these different design intents more generally by classifying them as serendipity as an ideal, a mediator, a common good, and a feature, which thus all represent a form of intended serendipity. The framework presented in Smets (2023) could therefore be considered a typology of intended serendipity.

Theoretical implications

First and foremost, this model more explicitly counters the alleged paradox of designing for serendipity. Although Björneborn (2017, p. 1068) already stated that "serendipity may thus be intended by designers, but must always be unplanned by users", our current theories of serendipity do not distinguish between the different actors involved, namely designers and users. The proposed model, on the other hand, makes a clear distinction between the intentions of the designer, the characteristics of the system (environment), and the experiences of the end-user. As a result, there can be an intention to design for serendipity, which differs from the potential experienced serendipity. In other words, one could argue that distinguishing between intended and experienced serendipity leads to resolving the paradox. This is because designing for serendipity always refers to intended serendipity.

Secondly, the literature on serendipity is characterized by a myriad of definitions of serendipity, often specific to the context. Even if a consensus on its definition were reached, there would still be distinct ways to operationalize or evaluate serendipity in practice. This is congruent with the highly subjective and ontogenetic nature of serendipity, and the various ways in which it manifests itself (e.g., Binst et al., 2025; Bogers & Björneborn, 2013; Makri & Blandford, 2012a, 2012b). Nonetheless, the use of serendipity as an umbrella term for all these manifestations without any means to consider the specific context, how it is designed for, or the purpose for which it is designed, only leads to "the vogue word" becoming even more "a vague word" (Merton & Barber, 2004, p. 289). While this concern is valid, it arguably reflects a particular historical and disciplinary context. In today's interdisciplinary landscape, however, employing serendipity as a bridging concept may enable valuable dialogue across domains, and inspire broader reflection and experimentation. This paper does not attempt to resolve the conceptual ambiguity by offering a singular definition. Instead, it accepts serendipity's conceptual openness as a starting point and proposes a theoretical model that allows the phenomenon to be specified within particular design contexts. By distinguishing between intended, afforded, and experienced serendipity, the model provides a structure for situating the term meaningfully without collapsing its diverse manifestations.

Indeed, thirdly, adopting the model of serendipity could contribute to more systematically collecting empirical knowledge about experiences of serendipity and their relation to environmental characteristics (i.e., afforded serendipity). Experienced serendipity is highly subjective (Makri & Blandford, 2012a), which means that there will always remain unobservable or uncontrollable factors, such as personality traits. However, experiences of serendipity are also known to evolve differently in different contexts (Lutz

et al., 2017; Olshannikova et al., 2020; Sun et al., 2011). For example, including broader item categories in a movie recommender might result in more experienced serendipity, while in a news recommender, it may lead to negative experiences because of too much ambiguity (similar to a "seeking-encountering tension" described in Makri et al., 2019; Waugh et al., 2017). Furthermore, these differences may also occur across user groups, for instance, depending on factors such as domain expertise, prior knowledge or task orientation (e.g., McCay-Peet & Toms, 2015). Although research on serendipity spans various contexts, it is difficult to assess the applicability or comparability of research methods and results due to the ambiguity of the concept. Therefore, I posit that it is important to differentiate between these various constructs to systematically gather insights into the relationship between intended, afforded, and experienced serendipity. This will enable more comparative research and eventually advance our understanding of designing for serendipity.

Finally, this distinction allows for capturing the potential misalignment between design intentions and the actual experience. Indeed, an intent to facilitate experiences of serendipity does not necessarily result in actual experienced serendipity. For example, sometimes there might be too much serendipity, such as the example of the bookshop that has been designed to help you discover new books and ideas but as a result, it has become nearly impossible to find "anything you already wanted" (Makri et al., 2019, p. 16). When we are not able to explicitly account for intentions, it is hard to detect any issues of misalignment and even more difficult to mitigate them. Moreover, this proposed model of serendipity allows for the capture of unintended negative consequences. In the case of the bookshop, the inability to find what one is looking for might be an unintended negative consequence of a design for serendipity. Therefore, I posit that more systematical insights into such issues of misalignment and unintended (negative) consequences should eventually improve our knowledge of and abilities to design for serendipity in a sustainable way.

Theoretical contestations

In the section on "Dealing with conflicting values", I have raised the concern that if values, such as serendipity, cannot be objectively defined and measured (Kroes & van de Poel, 2014), one may conclude that everything can be defined as a design for serendipity as long as it is intended as such. This is an unsettling conclusion and relates to concerns that were raised in recent literature. In Smets (2023), I discussed the threat of "the commodification of serendipity", referring to the concern that experiencing serendipity may become a key element of the value proposition towards end-users, such as online platforms that promise to help users discover new items. This may become problematic when users' expectations of experiencing serendipity are not consistently met (see Smets, 2023). In a similar vein, Reviglio (2023) points to "manipulative serendipity", where a design for serendipity is seen as ethics bluewashing. The proposed model of serendipity does indeed not actively rule out these (undesirable) manifestations of serendipity. While it is thus a valid objection to the model, it could also be made against the current state of the art in serendipity studies, where there is neither a consensus on a(n) (operationalizable) definition of serendipity. Accordingly, I venture that the proposed model of serendipity is more appropriate as it is oriented towards different definitions and interpretations, that have proven useful in their specific contexts, and also enables them to coexist. Moreover, the theoretical model suggests a feedback loop that may be used to identify—or at least be aware of—any discrepancies between intended serendipity and what users (expect to) experience as serendipity. Additionally, the literature on embedding values in technological design acknowledges that "the absence of objective measurement of values, however, does not imply that the operationalization and measurement of values in design is arbitrary" (Kroes & van de Poel, 2014, p. 21). Kroes & van de Poel (2014, p. 21) elaborate on the role of technical codes and standards to come to a "reasonable or justified consensus on how to operationalize and measure moral values in design":

> "Technical codes are legal requirements that are enforced by a governmental body to protect safety, health, and other relevant values (Hunter 1997). Standards are usually not legally binding, but they might be designated as a possible, and sometimes even mandatory, way to meet a code; they may also play a role in business contracts and are sometimes seen as describing good design practice, and as such they may also play a role in litigation." (Kroes & van de Poel, 2014, p. 17)

Therefore, I recommend that we abandon the idea that there must be a consensus on the definition of serendipity. Instead, we should focus our attention on finding a 'reasonable or justified consensus' or 'guardrails' on how to operationalize serendipity in design.[5] Here, a promising avenue for further work is to continue the analogy with other values in design (e.g., safety or fairness) and how technical codes and standards are explored to arrive at such a consensus or

[5] It should be noted that Reviglio (2019, p. 161) briefly referred to this statement in his discussion on the subjectivity of (experiences of) serendipity and that it therefore cannot be considered a "good measurement". In this 2019 work, this is put forward as one of the (many) limitations of serendipity in practice. The aim of the work at hand, is to provide more concrete avenues for arriving at such a justified consensus.

'guardrails' on what is considered (intended/experienced) serendipity. In addition, several other strands of relevant work could inform such research. For example, platform studies that discuss (self-)regulation in terms of standards and codes of practice related to, for example, privacy (e.g., Mansell & Steinmueller, 2020), or media policy research where discussions are ongoing in relation to defining media pluralism, prominence, and discoverability in technologically mediated communication (Dwyer & Martin, 2017; Mazzoli, 2020). Furthermore, such guardrails may extend to negative unintended consequences. For example, anecdotical evidence exists of organizations, endeavoring to cultivate serendipitous outcomes, paradoxically found themselves engendering filter bubbles through their design (Smets, 2022). Evidently, the exact specification of these guardrails is highly context specific. For example, what might be a negative consequence in one case may not present an issue in another case. We should therefore aspire to work toward general guardrails that are agreed upon to be valid in any specific context. To achieve such a consensus, we should first start looking at designs for serendipity through this perspective and gathering more insights to detect patterns.

Practical implications

The proposed model of serendipity not only aims to inform further research on designing for serendipity but ideally also informs future designs for serendipity in practice. Therefore, to conclude, I propose three questions that may guide any design for serendipity:

> What is the objective of the design for serendipity and for whom?
> What specifies experienced serendipity in this context, and what are potential negative outcomes?
> How can we put this into practice?

The first question relates to defining intended serendipity. More specifically, it implies that one should identify what utility (value) the design for serendipity is supposed to create for whom. This is essential as in practice, most design for serendipity intends to create value for more than one actor, and therein lay the concerns related to "manipulative serendipity" (Reviglio, 2023) or "commodification" (Smets, 2023). Moreover, as argued extensively in the present work, the design intent greatly informed the design process and subsequent decisions. In this sense, explicitly formulating intended serendipity not only serves as a guide for the design process but also makes the context explicit for others and increases the comparability and lessons that can be learned for other applications.

The second question then deals with experienced serendipity and any potential unintended consequences. Depending on the application domain, this might be a straightforward question or not at all. Especially when designers do not have any prior knowledge of how serendipity is experienced in their system, it may be recommended to first conduct some (qualitative) user studies to uncover this. Following the definition adopted in the paper at hand, I contend that experienced serendipity should relate to an 'unplanned' and 'interesting' encounter. This implies that any system provider should reflect on what 'unplannedness' and 'interesting' mean in their particular context. At the same time, designers should also consider potential (negative) unintended consequences when introducing serendipity. These consequences are not universal or objective: what is experienced as disruptive or frustrating by one user may be seen as desirable or effective by the designer, provider or even another user, depending on their perspective and underlying goals. This reinforces the importance of reflecting not only on the intended serendipity, but also on how it may be received and interpreted differently across user groups. Here, the bookshop designed for serendipity serves as a great example: while this may succeed in encouraging unexpected encounters with unfamiliar books, it can also frustrate users who come with a specific goal in mind. The same design thus creates a valuable experience for some, while undermining usability for others, revealing a tension between the intended serendipity and how it is actually experienced by different users.

Finally, the third question is how to turn this into practice. This means that the established norms and normative values are translated into affordance features. Here, one can build on the extensive existing academic work (and real-life examples) on designing for serendipity. Ideally, we see a collective shift to the use of affordance repositories such that designers can be informed by analogical reasoning (see "Extension to the affordance approach: design intent"). What is important to evaluate the effectiveness of the design, is establishing a feedback loop between intended and experienced serendipity, which allows validating if the intended value has indeed been realized in practice. Here, the practice of measuring experienced serendipity will become key, which, as argued earlier, falls beyond the scope of this paper (see Binst et al., 2025, for a discussion). However, having identified intended and afforded serendipity may inform how experienced serendipity is evaluated. For example, in the case of designing for serendipity to increase exposure diversity in recommender systems, one component of the evaluation may be whether there is a measurable increase in exposure diversity for individual users. Yet this cannot be the only metric: it is possible for end-users to experience an encounter as serendipitous even in the absence of increased diversity, or conversely, not to perceive diversity-enhancing recommendations as serendipitous at all. This highlights the importance of examining how experienced

serendipity aligns with what was afforded by the system, for instance, whether affordance features were embedded in the recommendation pipeline (e.g., item selection) or in the user interface (e.g., textual cues or explanation labels; see Smets et al., 2022). In this sense, the model does more than suggest "user feedback" in general terms; it encourages structured reflection on how experienced outcomes relate to the design's underlying intent and operational mechanisms. Misalignments may point to a need to adjust the design intent, reinterpret the affordance strategy, or reconsider the context in which serendipity is being evaluated.

Beyond serving as separate analytical prompts, the three questions may also be read as successive phases in a broader design process. In that sense, they may be understood as (1) contextualization, which asks why serendipity is pursued in a given environment; (2) consequentialization, which considers the envisioned end-user experience and the potential unintended consequences of the design intention; and (3) configuration, which focuses on how this can be operationalized through affordance features. This reading highlights the internal logic of the questions and may help position the proposed model more clearly within design-oriented reflection and practice.

Conclusions

This paper has proposed a theoretical model of serendipity, addressing the complexities inherent in designing for this multifaceted phenomenon. The model distinguishes between intended, afforded, and experienced serendipity, emphasizing the role of different actors involved in the design process, as well as the ontological uncertainty of contemporary digital technologies. The proposed model contributes to both theoretical discussions of serendipity and its practical application in design contexts.

On a theoretical level, the model seeks to overcome the ambiguity present in the multitude of definitions and operationalizations of serendipity in the current literature. Paradoxically, it achieves this by explicitly avoiding the pursuit of a consensus on its definition. While this may be a daunting conclusion, and also forms the foundation of a contestation of the proposed model, I venture that the Science of Serendipity (Copeland et al., 2023) does not center around finding a consensus on defining serendipity, but instead revolves around grasping its many manifestations. The central premise of the theoretical model exactly enables the specification of serendipity within a specific context, allowing researchers to systematically investigate the mechanisms underlying serendipitous experiences and designs across diverse contexts.

To address the main theoretical limitation and avoid defining everything as a design for serendipity as long as it is intended as such, I have built upon the analogy with other values in technological design (van de Poel & Kroes, 2014). I argue that it is essential to focus our efforts on defining 'guardrails' on how to operationalize serendipity in design and understanding negative unintended consequences. The concept of guardrails refers to ethical guidelines and technical standards that guide the responsible implementation of designs for serendipity, ensuring that they avoid manipulation or commodification. Additionally, exploring negative unintended consequences is essential for identifying and mitigating potential risks, such as filter bubbles or unintended user dissatisfaction. Continued research in these areas will deepen our understanding of serendipity and inform the development of responsible and effective design practices.

In addition to its theoretical contributions, the proposed model offers practical guidance for designing serendipity in various contexts. By framing design decisions around three key questions—the objective of design for serendipity, the specification of experienced serendipity, and the actual system features—designers can systematically approach the design process and evaluate its effectiveness. Furthermore, the model emphasizes the importance of establishing feedback loops between intended and experienced serendipity, enabling iterative refinement and validation of design outcomes, including both intended and unintended ones.

Concluding, this theoretical model provides insights that seek to advance research and the practice of designing for serendipity. By offering a structured framework for conceptualizing serendipity and its role in design, this work contributes to the ongoing dialogue on responsible designs of information technologies.

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Declarations

Conflict of interest The author declares that there is no conflict of interest.

References

André, P., Schraefel, M. C., Teevan, J., & Dumais, S. T. (2009). Discovery is never by chance: Designing for (un)serendipity. *Proceeding of the Seventh ACM Conference on Creativity and Cognition - C&C '09*, 305. https://doi.org/10.1145/1640233.1640279

Bentley, F. R., Basapur, S., & Chowdhury, S. K. (2011). Promoting intergenerational communication through location-based asynchronous video communication. *Proceedings of the 13th International Conference on Ubiquitous Computing - UbiComp '11*, 31. https://doi.org/10.1145/2030112.2030117

Binst, B., Michiels, L., & Smets, A. (2025). What is Serendipity? An Interview Study to Conceptualize Experienced Serendipity in Recommender Systems. *Proceedings of the 33rd ACM Conference on User Modeling, Adaptation and Personalization*.

Björneborn, L. (2017). Three key affordances for serendipity: Toward a framework connecting environmental and personal factors in serendipitous encounters. *Journal of Documentation, 73*(5), 1053–1081. https://doi.org/10.1108/JD-07-2016-0097

Björneborn, L. (2020). Adjacent possible. *The Palgrave encyclopedia of the possible* (pp. 1–12). Springer. https://doi.org/10.1007/978-3-319-98390-5_100-1

Bogers, T., & Björneborn, L. (2013). *Micro-serendipity: Meaningful Coincidences in Everyday Life Shared on Twitter*. 196–208. http://hdl.handle.net/2142/36052

Bozdag, E. (2013). Bias in algorithmic filtering and personalization. *Ethics and Information Technology, 15*(3), 209–227. https://doi.org/10.1007/s10676-013-9321-6

Carr, P. L. (2015). Serendipity in the Stacks: Libraries, Information Architecture, and the Problems of Accidental Discovery. *College & Research Libraries, 76*(6), 831–842. https://doi.org/10.5860/crl.76.6.831

Copeland, S., Ross, W., & Sand, M. (Eds.). (2023). *Serendipity science: An emerging field and its methods*. Springer. https://doi.org/10.1007/978-3-031-33529-7

de Reuver, M., van Wynsberghe, A., Janssen, M., & van de Poel, I. (2020). Digital platforms and responsible innovation: Expanding value sensitive design to overcome ontological uncertainty. *Ethics and Information Technology, 22*(3), 257–267. https://doi.org/10.1007/s10676-020-09537-z

de Rond, M. (2014). The structure of serendipity. *Culture and Organization, 20*(5), 342–358. https://doi.org/10.1080/14759551.2014.967451

Dourish, P. (2004). *Where the action is: The foundations of embodied interaction*. MIT press.

Dwyer, T., & Martin, F. (2017). Sharing news online: Social media news analytics and their implications for media pluralism policies. *Digital Journalism, 5*(8), 1080–1100.

Evans, D. S., & Schmalensee, R. (2016). *Matchmakers: The new economics of multisided platforms*. Harvard Business Review Press.

Fields, B., Jones, R., & Cowlishaw, T. (2018). The case for public service recommender algorithms. *CEUR Workshop Proceedings*, 22–24.

Foster, E. A., & Ellis, D. (2014). Serendipity and its study. *Journal of Documentation, 70*(6), 1015–1038. https://doi.org/10.1108/JD-03-2014-0053

Friedman, B. (1996). Value-sensitive design. *Interactions, 3*(6), 16–23.

Ganeshan, R., Garrett, J., & Finger, S. (1994). A framework for representing design intent. *Design Studies, 15*(1), 59–84. https://doi.org/10.1016/0142-694X(94)90039-6

Gaver, W. W. (1991). Technology affordances. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Reaching through Technology - CHI '91*, 79–84. https://doi.org/10.1145/108844.108856

Gibson, J. J. (1977). The theory of affordances. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing: Toward an ecological psychology* (pp. 67–82). Halsted Press.

Grange, C., Benbasat, I., & Burton-Jones, A. (2019). With a little help from my friends: Cultivating serendipity in online shopping environments. *Information & Management, 56*(2), 225–235. https://doi.org/10.1016/j.im.2018.06.001

Hansson, S. O. (1998). Should we avoid moral dilemmas? *The Journal of Value Inquiry, 32*(3), 407–416.

Hellström, T., & Jacob, M. (2017). Policy instrument affordances: A framework for analysis. *Policy Studies, 38*(6), 604–621. https://doi.org/10.1080/01442872.2017.1386442

Kim, A., Affonso, F. M., Laran, J., & Durante, K. M. (2021). Serendipity: Chance encounters in the marketplace enhance consumer satisfaction. *Journal of Marketing, 85*(4), 141–157. https://doi.org/10.1177/00222429211000344

Kim, Y. S., Noh, J. H., Kim, S. R., & others. (2013). A case study for application of design for affordance methodology using affordance feature repositories. *DS 75–5: Proceedings of the 19th International Conference on Engineering Design (ICED13) Design For Harmonies, Vol. 5: Design for X, Design to X, Seoul, Korea 19-22.08. 2013*, 011–020.

Klenk, M. (2021). How Do Technological Artefacts Embody Moral Values? *Philosophy & Technology, 34*(3), 525–544. https://doi.org/10.1007/s13347-020-00401-y

Kroes, P., & van de Poel, I. (2014). Design for values and the definition, specification, and operationalization of values. In J. van den Hoven, P. E. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design* (pp. 1–23). Springer. https://doi.org/10.1007/978-94-007-6994-6_11-1

Lunardi, G. M., Machado, G. M., Maran, V., & de Oliveira, J. P. M. (2020). A metric for Filter Bubble measurement in recommender algorithms considering the news domain. *Applied Soft Computing, 97*, Article 106771. https://doi.org/10.1016/j.asoc.2020.106771

Lutz, C., Hoffmann, C. P., & Meckel, M. (2017). Online serendipity: A contextual differentiation of antecedents and outcomes. *Journal of the Association for Information Science and Technology, 68*(7), 1698–1710. https://doi.org/10.1002/asi.23771

Maccatrozzo, V. (2012). Burst the Filter Bubble: Using Semantic Web to Enable Serendipity. In P. Cudré-Mauroux, J. Heflin, E. Sirin, T. Tudorache, J. Euzenat, M. Hauswirth, J. X. Parreira, J. Hendler, G. Schreiber, A. Bernstein, spsampsps E. Blomqvist (Eds.), *The Semantic Web – ISWC 2012* (Vol. 7650, pp. 391–398). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-35173-0_28

Makri, S. (2019). *Serendipity is not bullshit*. 4.

Makri, S., & Blandford, A. (2012a). Coming across information serendipitously—Part 1: A process model. *Journal of Documentation, 68*(5), 684–705. https://doi.org/10.1108/00220411211256030

Makri, S., & Blandford, A. (2012b). Coming across information serendipitously—Part 2: A classification framework. *Journal of Documentation, 68*(5), 706–724. https://doi.org/10.1108/00220411211256049

Makri, S., Blandford, A., Woods, M., Sharples, S., & Maxwell, D. (2014). "Making my own luck": Serendipity strategies and how to support them in digital information environments. *Journal of the Association for Information Science and Technology, 65*(11), 2179–2194. https://doi.org/10.1002/asi.23200

Makri, S., Chen, Y.-C., McKay, D., Buchanan, G., & Ocepek, M. (2019). Discovering the unfindable the tension between findability and discoverability in a bookshop designed for serendipity. In D. Lamas, F. Loizides, L. Nacke, H. Petrie, M. Winckler, & P. Zaphiris (Eds.), *Human-computer interaction—INTERACT 2019* (Vol. 11747, pp. 3–23). Springer. https://doi.org/10.1007/978-3-030-29384-0_1

Makri, S., & Race, T. M. (2016). Serendipity in current digital information environments. In T. M. Race & S. Makri (Eds.), *Accidental*

information discovery (pp. 53–80). Chandos Publishing. https://doi.org/10.1016/B978-1-84334-750-7.00004-2

Mansell, R., & Steinmueller, E. (2020). *Advanced introduction to platform economics*. Edward Elgar Publishing.

Mazzoli, E. M. (2020). Online content governance: Towards a framework for analysis for prominence and discoverability. *Journal of Digital Media & Policy, 11*(3), 301–319. https://doi.org/10.1386/jdmp_00027_1

McCay-Peet, L., & Toms, E. G. (2015). Investigating serendipity: How it unfolds and what may influence it. *Journal of the Association for Information Science and Technology, 66*(7), 1463–1476. https://doi.org/10.1002/asi.23273

McCay-Peet, L., & Toms, E. G. (2017). Researching serendipity in digital information environments. *Synthesis Lectures on Information Concepts, Retrieval, and Services, 9*(6), i–91. https://doi.org/10.2200/S00790ED1V01Y201707ICR059

McGrenere, J., & Ho, W. (2000). Affordances: Clarifying and evolving a concept. *Graphics Interface, 2000*, 179–186. https://doi.org/10.1007/978-1-4419-1428-6_369

Melo, R. (2018). *On serendipity in the digital medium: Towards a framework for valuable unpredictability in interaction design* [PhD Thesis]. Universidade do Porto.

Melo, R., & Carvalhais, M. (2018). The Chance of Serendipity. *AISB Workshop on Cybernetic Serendipity Reimagined, at the AISB Convention, Liverpool, UK*.

Merton, R. K., & Barber, E. (2004). *The Travels and Adventures of Serendipity*. Princeton University Press.

Norman, D. A. (1988). *The psychology of everyday things*. Basic books.

Nye, B. D., spsampsps Silverman, B. G. (2012). Affordance. In N. M. Seel (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 179–183). Springer US. https://doi.org/10.1007/978-1-4419-1428-6_369

Olshannikova, E., Olsson, T., Huhtamäki, J., Paasovaara, S., & Kärkkäinen, H. (2020). From Chance to Serendipity: Knowledge Workers' Experiences of Serendipitous Social Encounters. *Advances in Human-Computer Interaction, 2020*, 1–18. https://doi.org/10.1155/2020/1827107

Pariser, E. (2011). *The filter bubble: What the Internet is hiding from you*. Penguin.

Race, T. M., & Makri, S. (2016). *Accidental information discovery: Cultivating serendipity in the digital age*. Chandos Publishing.

Reviglio, U. (2019). Serendipity as an emerging design principle of the infosphere: Challenges and opportunities. *Ethics and Information Technology, 21*(2), 151–166. https://doi.org/10.1007/s10676-018-9496-y

Reviglio, U. (2023). Serendipity as a design principle of personalization systems—theoretical distinctions. In S. Copeland, W. Ross, & M. Sand (Eds.), *Serendipity science* (pp. 145–165). Springer. https://doi.org/10.1007/978-3-031-33529-7_8

Rubin, V. L., Burkell, J., & Quan-Haase, A. (2010). Everyday serendipity as described in social media. *Proceedings of the American Society for Information Science and Technology, 47*(1), 1–2. https://doi.org/10.1002/meet.14504701409

Sadler, E., & Given, L. M. (2007). Affordance theory: A framework for graduate students' information behavior. *Journal of Documentation, 63*(1), 115–141. https://doi.org/10.1108/00220410710723911

Smets, A. (2023). Designing for serendipity: A means or an end? *Journal of Documentation, 79*(3), 589–607. https://doi.org/10.1108/JD-12-2021-0234

Smets, A. (2022). Serendipity as a Shared Value in Urban Recommender Systems [PhD Thesis]. Vrije Universiteit Brussel.

Smets, A., Michiels, L., Bogers, T., & Björneborn, L. (2022). Serendipity in recommender systems beyond the algorithm: A feature repository and experimental design. *CEUR Workshop Proceedings, 3222*, 46–66.

Sørensen, J. K., & Hutchinson, J. (2018). Algorithms and public service media. In *Public Service Media in the Networked Society: RIPE@ 2017* (pp. 91–106). Nordicom.

Sun, X., Sharples, S., & Makri, S. (2011). A user-centred mobile diary study approach to understanding serendipity in information research. *Information Research, 16*(3), 16–23.

Taramigkou, M., Bothos, E., Apostolou, D., & Mentzas, G. (2013). Fostering serendipity in online information systems. *2013 International Conference on Engineering, Technology and Innovation (ICE) & IEEE International Technology Management Conference*, 1–10. https://doi.org/10.1109/ITMC.2013.7352707

Van Andel, P. (1994). Anatomy of the unsought finding. Serendipity: Origin, history, domains, traditions, appearances, patterns and programmability. *The British Journal for the Philosophy of Science, 45*(2), 631–648.

van de Poel, I. (2013). Translating values into design requirements. *Philosophy and engineering: Reflections on practice, principles and process* (pp. 253–266). Springer.

van de Poel, I. (2014). Conflicting values in design for values. In J. van den Hoven, P. E. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 1–23). Springer. https://doi.org/10.1007/978-94-007-6994-6_5-1

van de Poel, I. (2020). Embedding values in artificial intelligence (AI) systems. *Minds and Machines, 30*(3), 385–409. https://doi.org/10.1007/s11023-020-09537-4

van de Poel, I., & Kroes, P. (2014). Can technology embody values? In P. Kroes & P.-P. Verbeek (Eds.), *The moral status of technical artefacts* (Vol. 17, pp. 103–124). Springer. https://doi.org/10.1007/978-94-007-7914-3_7

Van den Bulck, H., & Moe, H. (2018). Public service media, universality and personalisation through algorithms: Mapping strategies and exploring dilemmas. *Media, Culture & Society, 40*(6), 875–892.

Wang, Z., Zou, Y., Dai, A., Hou, L., Qiao, N., Zou, L., Ma, M., Ding, Z., & Xu, S. (2023). An Industrial Framework for Personalized Serendipitous Recommendation in E-commerce. *Proceedings of the 17th ACM Conference on Recommender Systems*, 1015–1018. https://doi.org/10.1145/3604915.3610234

Waugh, S., McKay, D., & Makri, S. (2017). "Too Much Serendipity": The Tension between Information Seeking and Encountering at the Library Shelves. *Proceedings of the 2017 Conference on Conference Human Information Interaction and Retrieval*, 277–280. https://doi.org/10.1145/3020165.3022132

Yaqub, O. (2018). Serendipity: Towards a taxonomy and a theory. *Research Policy, 47*(1), 169–179. https://doi.org/10.1016/j.respol.2017.10.007

You, H., & Chen, K. (2007). Applications of affordance and semantics in product design. *Design Studies, 28*(1), 23–38. https://doi.org/10.1016/j.destud.2006.07.002