Interactional Aesthetics of Blockchain Technology

Michael Heidt[1(✉)], Andreas Bischof[2], and Arne Berger[2]

[1] GeDIS, University of Kassel, Pfannkuchstraße 1, 34121 Kassel, Germany
mrbheidt@gmail.com
[2] Chair Media Informatics, Chemnitz University of Technology, Straße der Nationen 62, 09111 Chemnitz, Germany
{andreas.bischof,arne.berger}@informatik.tu-chemnitz.de

Abstract. Blockchain technology holds the potential of facilitating fundamentally novel ways for users to relate to systems of finance, governance, and identity management. At the same time, the inherent complexity of blockchain systems makes designing for and interacting with the technology profoundly challenging. Furthermore, the question of how social interactions will change under the influence of Blockchain systems remains an open one. In this paper we examine how concepts and procedures adopted from interaction aesthetics can serve as an intellectual and methodological lens to creatively and critically examine the emerging technology of the Blockchain.

Keywords: Aesthetics · Blockchain · Smart contracts · Critical technical practice · Interactional aesthetics

1 Introduction

Blockchain technology holds the potential of facilitating fundamentally novel ways for users to relate to systems of finance, governance, and identity management. It promises to establish innovative ways of conducting governance, to facilitate novel forms of civic engagement, to simplify interactions with smart devices, to enable new ways of interacting with digital and non-digital assets [1–5]. At the same time, the inherent complexity of blockchain systems makes designing for and interacting with the technology profoundly challenging. Already, the capabilities of blockchain systems threaten to surpass the interactional competence of its users [6,7]. Furthermore, the question of how social interactions will change under the influence of Blockchain systems remains an open one. Should blockchain technologies indeed become a defining feature of future social life, the question of how to communicate respective technological possibilities to users likewise gains in significance.

In this paper, we discuss how design considerations aimed at blockchain systems can be enriched through incorporation of elements of interactional aesthetics. We argue that interactional aesthetics holds unique possibilities in articulating novel design features, while allowing users to observe and question the

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technological impact of blockchain systems. This is due to the ability of aesthetic elements to implicitly communicate features of a design whose representations might not be explicitly understood by its users.

2 Blockchain Technology

A Blockchain acts as a distributed database, allowing secure transactions in the absence of trusted intermediaries [8]. Every system participant is able to verify the legitimacy of every transaction made while being able to inspect the full history of transactions conducted within the system. No actor within the network is able to forge information or disregard information once it has been approved. Crucially, blockchain systems allow for the transferance of digital property in a manner ensuring that transfers are "safe and secure, everyone knows that the transfer has taken place, and nobody can challenge the legitimacy of the transfer" [9].

The class of values which can be transferred within a Blockchain backed system encompasses "birth and death certificates, marriage licenses, deeds and titles of ownership, educational degrees, financial accounts, medical procedures, insurance claims, votes, provenance of food" [10].

2.1 Smart Contracts

Furthermore, blockchain systems allow for the operation of *smart contracts* [11, 12]. Smart contracts act as software agents allowing for values to be transferred once certain criteria are met: As an example, the smart lock of a rental apartment might automatically grant access to a guest once payment is detected; a smart fridge within the apartment might automatically charge the guest for any item consumed during the stay.

Crucially, the integrity of smart-contract operation is guaranteed by the same mechanisms used for verifying transactions within the Blockchain. Hence, they cannot be hacked and their outcome is open for inspection to all parties involved. Conflicts are decided not by means of human arbitrators but by encoding conditions in the medium of formal language.

As the name implies, smart contracts are intended to partly replace contracts backed by law through those backed by algorithms: A traditional off-line contract requires participants to trust the other parties to honour the agreement made. This is not true of the smart contract, for its presence within the blockchain endows it with a self-enforcing quality. Consequently, systems built using smart contracts are described as being *trustless* [13,14].

3 Aesthetics

In its most classical form, aesthetics refers to all phenomena and faculties relating to sensory experience. As a philosophical problem it motivated studies of the

beautiful and the sublime. Resultingly, aesthetical concerns do not constitute one of the classical foci of systems design and computer-science disciplines.

The dominant traditions within computer-science conceptualize of computers as abstract machines, processing lexemes that do not possess perceptual or material characteristics. Formal conceptual devices, such as the Turing machine, indeed serve to abstract from material qualities, thereby describing computing processes on the level of mathematical functions. They are independent of any material that could impact the senses. This approach to computation has been exceptionally successful, allowing for a concise formal description of computing processes while abstracting from the immense physical complexities incurred by computing system design and implementation. However, the history of computing has been closely intertwined with the concept of visualization and interaction. Interactive games seem to be a quasi-automatic by-product of any system combining display and input capabilities [15].

Furthermore, interaction implies the necessity for an, albeit rudimentary, aesthetic access to the realm of computers. Even if only setting up a computation on a mainframe computer, entering parameters, or checking the result or error code of a computing process, human perception and sensory experience, invariably is involved.

Despite this traditional focus, aesthetic perspectives have indeed gained traction within the discourses of HCI as part of a "turn to experience" [16]. Constructs such as user experiences invariably contain an aesthetic component, without necessarily referring to the critical and aesthetic positions present within the broader discourse on the matter.

During the course of this text, we will argue that conceptual elements of aesthetics can indeed serve to enrich a practice-based engagement of complex technological artefacts such as Blockchain technologies.

3.1 The Aesthetic Turn

Indeed there are authors who describe an *Aesthetic Turn* within the realm of computing. Udsen and Jørgensen describe aesthetics as a valuable extension of traditional approaches to interface design [17]. They identify four distinct aesthetic approaches: a cultural approach, a functionalist approach, an experience based approach, and a techno-futurist approach. Functionalist approaches employ aesthetics in order to analyse or optimise usability features within systems and artefacts. They are often task centric and typically aim at furthering goals such as efficiency and effectiveness. Cultural approaches treat artefacts and interfaces as aesthetic forms. They analyse them according to categories developed within philosophy, literaray and cultural studies, or the social sciences. Techno-futurist approaches adopt a visionary stance, combining philosophy with speculative practices in order to account for the coevolution of technology, social practices, and human experience. Experience based approaches base themselves on existing practices with interaction design, complementing existing HCI procedures through a focus on non-functional and phenomenological qualities.

Bardzell [18] treats critical theory and aesthetics as part of a single intellectual development aimed at complementing existing functional approaches towards interaction design.

Nake and Grabowski describe aesthetic computing as the realm of computing phenomena requiring aesthetic judgement [19].

3.2 Aesthetics and Polyperspectivity

In the classical treatment of the faculties of reason Kant describes aesthetic judgements as possessing both subjectivity and universality, as being both contingent and necessary [20]. This special status of aesthetic judgements allow them to serve as reconciliatory agent between diverse viewpoints and perspectives. Astrid Wagner discusses how Kant's conception of aesthetics is intertwined with the notions of freedom and autonomy [21]. Furthermore, it points to the necessity of accepting multiple viewpoints, due to the inherently subjective, yet non-arbitrary nature of aesthetic judgements. When adopting an aesthetic stance, we have to account for a multitude of ways of seeing the world, yet we attentively deal with the material reality enabling a shared social space of feeling and experiencing.

3.3 Interaction Aesthetics

Interaction aesthetics, conceived as the aesthetic treatment of phenomena arising from the interaction of humans with artefacts, constitutes a relatively novel focus both in the fields of science and art. Art has traditionally dealt with objects of lasting quality, less so with ephemeral and emergent qualities such as interaction.

From the mid-20th century onward, however, interactive elements have emerged as a staple within avant-garde art practices, gradually dissipating into the mainstream. Subsequently, artistic phenomena such as media-art, net.art, digital art, and paradigms such as relational aesthetics [22] served to rejuvenate the interest in aesthetic treatment of practices of interaction.

An interesting synoptic treatment of contemporary approaches to interaction aesthetics is provided by Katja Kwastek's text "Aesthetics of Interaction in Digital Art" which will act as a central point of reference for the current discussion.

Kwastek relates interaction aesthetics to three criteria:

- aesthetic distance as condition of aesthetic experience, counterbalancing the "flow" of interaction
- a specific ontological status of interactive works
- a specific mode of knowledge generation through reception of interactive artefacts.

It is especially this last criterion which provides helpful impulses for conducting practice-based research regarding the aesthetic dimensions of Blockchain technology.

4 Design Framework

We will now discuss a tentative design framework informed by the aesthetic stance detailed in the preceding sections. The goal is not to produce yet another framework as there are ample meticulously worked out propositions for the practitioner to choose from. Rather, it serves to illustrate how incorporating an aesthetic stance can inform, modify, and modulate processes of design in the context of practice-based inquiry. It thus employs both elements of condensation and forms of extension.

The framework is part of an ongoing inquiry into the conditions of practice-based research [23,24]. As such it complements earlier proposals [25,26], on whose categories it is based. Within the framework's context, additionally introduced concepts, such as digital materiality, act as lenses facilitating different perspectives on the artefact and the practices it enables. They thus aid the process of formulating knowledge claims in relationship to the artefact in question.

4.1 The Interactive Artefact

Following Kwastek's analysis, interaction artefacts are conceived as tripartite entities, comprised of the following components:

Interaction Proposition. The interaction proposition describes the auctorial intention of the interactive artefact's makers.

Material Artefact. The material components of the artefact realising the interaction proposition. This encompasses physical elements such as props, decorations, sensors, displays but also rule systems structuring, incentivising, and shaping interactions.

Interaction Processes. The processes of interaction unfolding in relationship to the artefact.

4.2 Vicarious Interaction

Furthermore, in order to account for the genuine interactional qualities of blockchain devices, their capacity to pervasively shape social interactions, it is instructive to consider the concept of *vicarious interaction.*

A key concept within the aesthetics of interaction [27], vicarious interaction occurs, when an individual not actively participates in an interactive process, yet consciously observes and processes the interactions of others (see Fig. 1). First examined within the context of educational science [28], vicarious interactions allow prospective users to learn about system behaviour even while not engaging actively with the artefact in question. Crucially, observing and learning from others' interactions allows the formation of understanding regarding the impact of the technological artefact presented. In effect, vicarious interaction allows for trust to be formed without a need for direct user-system interaction (such as seeing others making withdrawals at an ATM machine might persuade us to believe that it is safe to use).

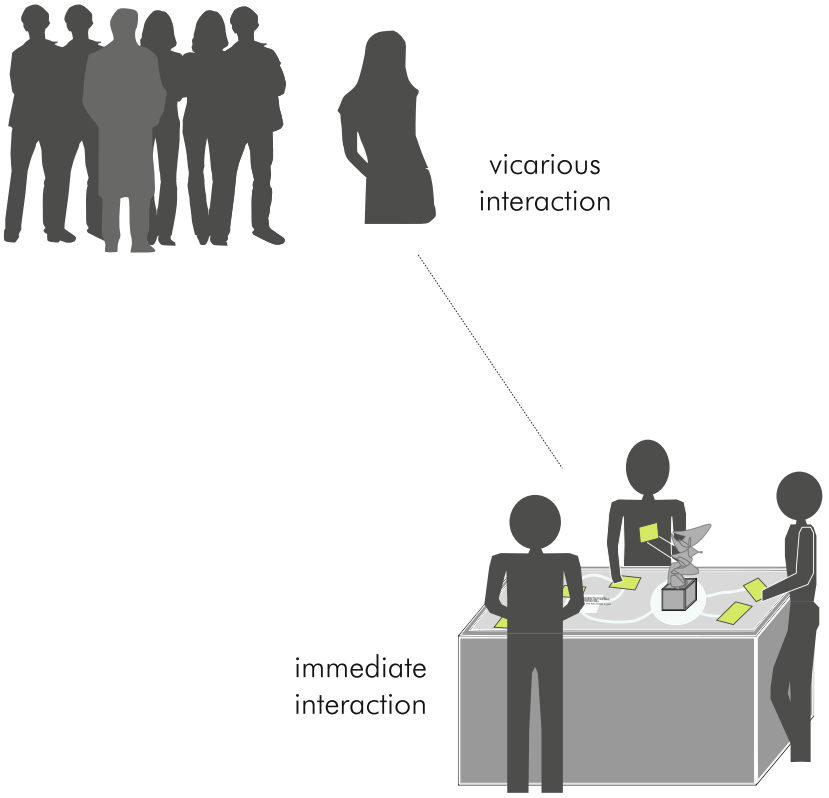

Fig. 1. Vicarious interaction

4.3 Digital Materiality

In order to identify the unique characteristics of digital structures in relationship to interaction aesthetics, we deem it instructive to inquire into the specifics of the digital as material for artefact production. This is in line with recent trends in aesthetics "to not only view material as a technical circumstance, but also to value it as an aesthetic category" [29][1].

The reason for the popularity of the concept of materiality can also be attributed to the demise of the concept of reality [27, 139]. Talking about materiality allows for conceptualising a mutual plane of reference and interaction without having to deal with philosophically contentious concepts such as reality.

One of the most influential concepts of digital materiality was formulated by Leonardi [30,31]. Leonardi shifts emphasis away from the realm of the physical, instead focussing on questions of practical instantiation and significance. No ontological difference exists between physical and formal artefacts, they are material insofar as they make a difference, insofar as "they matter". This allows

[1] English translation quoted from [27].

a discussion of digital artefacts on par with other objects of study, for the only relevant question is which kind of impact a relevant artefact has on observable practice.

In order to develop an account of digital materiality conducive to a discussion of phenomena of interaction aesthetics, the aforementioned positions are related to a characterisation developed by Nake and Grabowski [32]: Material is conceptualised as that what offers resistance. Software or systems of formal rules are material since they offer resistance to our efforts to shape them. Resultingly, work is required to bend them into the shapes required for interactive artefacts. Digital materiality is involved when work is expended in order to shape digital structures.

5 Related Work

The `terra0` system builds a "self-owning" forest, able to reproduce itself through Blockchain technology [33]. Through smart contracts, the forest generates revenue by selling licenses to log trees, thereby compensating for running costs. It provides social commentary on ideas connected to Blockchain technologies in the context of an artistic project. The self-referential nature of the system (selling parts of itself) points towards the problematic of complexity while highlighting the economic implications of Blockchain technologies.

Bittercoin [34] "The World's Worst Bitcoin Miner" serves to illustrate the computational work embodied within Blockchain systems. The system consists of a mechanical calculator performing computations as dictated by Bitcoin's Blockchain protocol. Results are printed on paper. The system does not constitute a feasible approach to mining due to the incredibly slow nature of the computation. Instead it renders Blockchain's formal procedures tangible by virtue of mechanisation. It thus points both to the materiality of Blockchain technologies while facilitating critical perspectives through implicit reference to phenomena such as the enormous energy consumption of the Bitcoin system.

Di Battista et al. describe a system for visualization of flows within the Bitcoin system [35].

McGinn et al. describe visualizations of Bitcoin transaction patterns [36].

6 Observations

6.1 Trustlessness and Aesthetics

In order to account for the phenomenon of trustlessness exhibited by smart contract technology, it is instructive to frame it within the terms of sociology. Following social systems theory, trust can be conceptualised as a mechanism for reduction of social complexity: Trust allows individuals to relate to a stable set of expectations in the face of uncertainty [37].

Following this systems theoretic construal of trust allows us to put it in constructive dialogue with aesthetics: The aesthetics of a designed artefact allow

users to form expectations, thereby enhancing their ability to detect affordances [38]. Hence, aesthetic qualities aid the communication of designs from designers to users, in turn reducing *design-uncertainty*.

6.2 Aesthetics of Trust

As a quality arising from and within social interaction, trust at first appears hard to visualize. It is not immediately grounded in data and possesses multiform manifestations in social life—"trust takes on many various shapes" [37, 103].

At the same time, one should not dismiss any potential mode of dialogue between conceptualisations of trust and aesthetic categories. In fact, different conceptualisations of the phenomenon of trust inform different aesthetic representations which in turn evoke different aesthetic experiences. A further complicating factor is its ubiquity [37, 5]. Since trust is an ubiquitous facet of social life, we might overlook it.

An interesting approach towards the discussed problematic is provided by Sas and Khairuddin [39], who call for "Materializing Trust in Blockchain". Their approach calls for visualization of reputation data in order to increase the social embededdness of Blockchain transactions.

Aesthetics possesses the ability to communicate aspects of a design by virtue of evoking adequate emotions. The aesthetic qualities of an artefact help to shape user expectations and thus to decrease *design uncertainty*.

If we follow the premise that trust is based on the feeling of posessing more information than is actually present [37, 36 ff.], this presents an interesting challenge for the visualization of Blockchain technologies. The problem becomes that not of providing exhaustive information or conveying a maximum amount of data, but of balancing perceptions of risk with expectation of success.

7 Conclusion

7.1 Aesthetics as Mechanism of Complexity Reduction

We argue that aesthetics is important precisely due to the highly abstract nature of Blockchain technology. Aesthetics possesses the ability to communicate aspects of a design, even if the underlying abstractions are not fully understood by system users. In line with the argumentation of Xenakis and Arnellos [38], aesthetics acts as a way of reducing *design uncertainty*. Interaction aesthetics thus parallels the social function of trust, understood as a mechanism of reducing social complexity [37,40]. Furthermore, through vicarious interaction, interactional aesthetics allow for users to observe and reflect on the technological impact of blockchain systems.

7.2 Aesthetics as Agent of Polyperspectivity

Not only does the stance of aesthetics allow for interesting impulses regarding construction of Blockchain based artefacts. Through its inherent problematisation of questions of freedom and polyperspectivity it points to the complexity of

affected social systems and processes. It thus reminds us of the social problems at stake when employing potentially far reaching technological artefacts such as smart contracts.

Aesthetics provides a way for accounting for the richness of human experience, the complexity of social processes, and the challenging problem of supporting both through complicated technical structures. It thereby might provide a helpful arena for approaching the problematic of relating complicated technical systems and complex social practice.

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