Multimodal Technologies and Interaction

MDPI

Article

Dislocated Boardgames: Design Potentials for Remote Tangible Play

Bernhard Maurer * and Verena Fuchsberger

Center for Human-Computer Interaction, University of Salzburg, 5020 Salzburg, Austria; verena.fuchsberger@sbg.ac.at

* Correspondence: bernhard.maurer@sbg.ac.at

Received: 31 July 2019; Accepted: 4 November 2019; Published: 7 November 2019

Abstract: Conventional digital and remote forms of play lack the physicality associated with analog play. Research on the materiality of boardgames has highlighted the inherent material aspects to this analog form of play and how these are relevant for the design of digital play. In this work, we analyze the inherent material qualities and related experiences of boardgames, and speculate how these might shift in remote manifestations. Based on that, we depict three lenses of designing for remote tangible play: *physicality*, *agency*, and *time*. These lenses present leverage points for future designs and illustrate how the digital and the physical can complement each other following alternative notions of hybrid digital–physical play. Based on that, we illustrate the related design space and discuss how boardgame qualities can be translated to the remote space, as well as how their characteristics might change. Thereby, we shed light on related design challenges and reflect on how designing for shared physicality can enrich dislocated play by applying these lenses.

Keywords: remote play; play over distance; boardgames; hybrid play

1. Introduction

Playing games is an activity that is deeply embedded in social and situated practices [1]. Respectively, games and play can mediate connectedness between people and facilitate rich social experiences. However, related notions of social interaction and physical qualities drastically differ when comparing purely analog forms of play, digital video-game play and *hybrid* approaches [2].

Especially analog forms of play, such as boardgaming, encompass a range of aspects that relate to interpersonal interactions, such as social and material engagement based on physical components with tangible "things", as well as other co-located players [3]. These physical interactions directly address us as human beings and how we make sense with and through our environment, fostering sensorimotor engagement, as well as embodied sensemaking [4]. The physical artifacts used in boardgames can further be seen as "mediating objects in the way people deal with each other in the context of a situated practice" ([4], p. 183). In that regard, Linderoth described a perspective on gameplay as a kind of ecology, arguing for gameplay as "perceiving, acting on and transforming the affordances that are related to a game system or to other players in a game" ([5], p. 1).

In contrast to boardgames as a co-located form of play, remote gameplay often takes place via smartphones and online connectivity. Related products and concepts, in terms of boardgames, mostly focus on digitizing existing boardgames to enable their applicability in the remote space. While presenting opportunities to utilize the "digital" as a design material, this digitization of physical

play, however, neglects some of the core qualities of boardgame play. Consequently, compared to co-located play, physicality is often missing in dislocated play. Co-located boardgame play facilitates qualities underrepresented in remote digital play, e.g., physicality related to non-verbal interpersonal communication or the engagement with physical components and artifacts. In this paper, we focus on illustrating a related design space concerned with playing boardgames over distance.

2. Contribution

With this work, we want to contribute to a discourse on the design of remote tangible play by proposing leverage points for the design of dislocated boardgames. We aim at facilitating the design of boardgames over distance while harvesting from the dislocated as well as the tangible aspects involved.

Thereby, we intend to describe and articulate a very specific design space, namely that of remote tangible play in the form of dislocated boardgames. In our work, we applied the material experience framework introduced by Giaccardi and Karana [6], which articulates a notion of materials shaping ways of doing, related practices, and how this influences the associated experience of those materials. We utilized it as an analytical tool to look at the notion of remote tangible play and discuss how the inherent qualities of co-located boardgame play might translate or change in remote instantiations. Further, we look into existing research on the materiality of boardgame play and reflect on qualities inherent to boardgames under the light of designing for *remote* tangible engagement. In that regard, we discuss boardgaming characteristics (i.e., physical materiality and game mechanical considerations) and their potentials to be transferred to the hybrid digital–physical space of remote tangible play.

Based on this theoretical analysis, we depict three lenses of designing for remote tangible play: *(1) physicality; (2) agency*; and *(3) time*. We aim at facilitating a discussion on related design considerations and leverage points.

The contribution of this paper is not a formulation of a new framework that extends that of Giaccardi and Karana; rather, we utilize the materials experience framework to argue for and envision potential shifts in remote boardgame instantiations. The framework by Giaccardi and Karana motivated and guided our analysis process and lead to the derived lenses through which we looked at boardgames to unveil the described design space.

We are not focusing on specific properties of materiality and the related experiential levels as described in the original framework, since we are not proposing specific instantiations. Instead, we describe the design space that opens up when looking at boardgames in remote settings. We used the framework to identify involved aspects and further attempted to root and position these aspects in the initial framework.

Our goal is to argue for and envision a design space of remote tangible play that combines and harvests from characteristics of dislocation (and the related digital mediation involved), as well as the tangible and material qualities related to co-located boardgaming.

Although others have investigated the blending of physical and digital (e.g., [2,7,8]) and also depict design guidelines, we provide a complementary perspective, i.e., the design of remote tangible play in the form of *dislocated* physical boardgames and the different layers of materialities associated. In contrast to existing research working towards, e.g., visual overlays and external representations in regards to hybrid play, we present a notion of dislocated *tangible* interaction, as well as a broader reflection on alternative forms of hybrid play starting from associated material experiences. Our main argument is that we should focus on digitizing the "non-functional" (from the perspective of the game itself) aspects of co-located gameplay and suggest design directions such as incorporating non-verbal signals to create physicality in dislocation.

In the following, we illustrate the theoretical background and related work in regards to existing perspectives on digital–physical play, the inherent dimensions of materiality in boardgaming, as well as

research on playing over distance. We then describe our analysis of boardgame traits and characteristics by applying the materials experience framework by Giaccardi and Karana [6]. The identified domains and relationships of materials experience of boardgames presents the base for depicting three lenses on designing for dislocated boardgames. We finish the paper with a discussion of these lenses and related design sensitivities we identified.

3. Background and Related Work

3.1. Hybrid Perspectives on Digital–Physical Play

Hybrids are often referred to as combinations of "distinct and often contradictory entities" [9] or worlds. This coming together of heterogenous entities also inherently presents a certain duality inscribed into related designs. Such hybrid perspectives on the design of games have mainly emerged from the field of pervasive gaming (e.g., [2,10–12]) but lately also in commercial products being labeled "hybrid games" (e.g., [13,14]). Existing research on hybrid perspectives from pervasive gaming primarily focused on the intersection of the digital and physical in terms of co-located play and seeking ways to introduce new interactive technology to existing tangible interactions. Early work by Magerkurth et al. [15] explored the integration of digital technology in non-digital tabletop games. Other work focused on the design of mixed reality table top play [16] or, more recently, on augmenting game components, e.g., through actuated dice or wearables [17], and visual [18] or functional augmentations [19] of pieces.

Others focus more on the material aspects of hybrid play approaches and explore different concepts positioned between material and digital realms [20,21]. Bergström et al. [8] suggested utilizing computer technology to provide support and tools for the players' gaming activities rather than following a notion of technology as primary means of mediation. In that regard, Kankainen et al. [22] argued for a distinction between this more technological framing of hybrid and a broader perspective of hybridity as "the blending of different cognitive domains that are not usually associated" ([22], p. 1).

The notion of *hybrid games* is framing designs that try to combine digital with physical interaction, usually with a digital component add-on, such as a smartphone. However, most of the related concepts are very limited in scope focusing on utilizing the computational power behind their digital add-on, e.g., an app for random board setup or as a narrator during story-based gameplay [14], whereas other concepts only add physical representations and tokens to digital gameplay, without real added value to the digital game [13]. This shows that most hybrid games do not fully harvest the potential of their digital component and the computational power added to physical play, as they do not utilize it for creating new forms of interactions between players.

Mora et al. [23] reported on a thorough investigation on the benefits and general design space of interactive game pieces in the direction of hybrid games. They argued to focus on physical manipulation of interactive, computer-augmented physical artifacts on conventional surfaces rather than creating interactive surfaces for hybrid games.

To further explore new forms of hybrid game interactions, we aim at exploring the design space of remote tangible play in the form of dislocated boardgames. Hence, we focus on a very specific instantiation of hybrid games. Thereby, we discuss alternative notions of this design space characterized by the inherent material qualities of boardgames combined with the constraints of dislocation as design opportunities.

3.2. Dimensions of Materiality in Boardgaming

While there is a large body of research on the user experience of digital games, research endeavors that specifically paid attention to the user experience of boardgames is more sparse. Besides research on how (board)games could be used in research and design [24–26], mainly new technological advances have

been explored, e.g., new devices and tools to augment physical boardgames [18,27]. Other research has also looked into the requirements and design aspects of augmented tabletop games [28] as well as into the different strategies of adaptation of digital and non-digital instantiation of commercial boardgames [29].

Rogerson et al. specifically investigated the user experience of boardgame play [3,30–32]. Based on an in-depth look into existing practices and experiences of boardgame hobbyists, they identified where the enjoyment of boardgames lies and highlighted aspects of *sociality, intellectual challenge, variety*, and *materiality*. Based on interviews with players, they depicted four major domains of materiality associated with boardgames: game board and components, the game box, a game's immediate play environment, and general customization efforts of the players [3]. Other related research specifically focused on the social aspects of boardgame play [30], by investigating how the social setting of analog boardgames is rendered as the driver of cooperation and competition between players, as well as what the underlying game mechanisms facilitate. In their research, Rogerson et al. specifically highlighted how important the social aspects are as, e.g., player cooperation on multiple levels is a necessary group effort to enact the rules of the game. "Boardgame play is a form of cooperative work that is situated, embodied, distributed and articulated" ([30], p. 10). To further stress this argument, they argued that in a boardgame setting "information is not only distributed amongst the human actors; it is also distributed across components and resources throughout the duration of the play setting" ([30], p. 2).

Besides this research into the materiality of modern boardgames, other research specifically looked at the practices around the hobby in regards to tabletop miniature games and the "data" that are associated to physical figurines. While related products (e.g., [33]) are usually not designed in a *hybrid* manner, players engage in digitizing their physical game collections, e.g., via digital tools enabling them to keep a digital inventory of their physical game collection. Thus, supporting the capturing and curation of the physical (leading to "out of game" activities) with technology [34] illustrates how the digital can complement the physical game material on a practice layer.

This research shows the importance of physical artifacts and components in boardgame play, and that the essential materiality of a game is centered around these components (e.g., miniatures, tokens, dice, etc.), their physical manipulation as well as their relation to social interactions. Compared to analog co-located boardgame play, these layers of physicality are often missing in dislocated and digital forms of play. Thus, drawing upon these material aspects of boardgames, the lenses presented in this paper reflect how these aspects could be translated to the digital remote space.

3.3. Playing Over Distance

In contrast to the same time and same place interactions taking place in co-located face-to-face play, remote interactions are to a large extent characterized and determined by their inherent asynchronicity (different time) and/or different place interactions. Although this is addressed through conventional digital online play, related physical/tangible forms of remote play face a range of design challenges.

Existing concepts of (physical) play over distance focus, e.g., on the role of body-based interaction and guidelines for exertion games over distance [35–38] or how bodies mediate social connectedness and feelings [39]. Related concepts around tangible interfaces for remote communication, range from older concepts of groupware [40] to, e.g., electronic accessories that provide children with a playful way to communicate between remote locations [41]. Other investigations of playing over distance have focused, e.g., on distributed tangibles puzzle pieces [42] or, more specifically within the realm of digital games, tools that support digital distributed multiplayer games [43] or non-verbal signals facilitating social presence between remote players [44].

The built-in asynchronicity in interaction (e.g., in terms of when and how frequent a player interacts with a given system to communicate with another remote player), as well as the lack of bodily presence of another person, results in a disconnect that might require mediation.

The digital "in-between" space could be argued as a (necessary) mediator in dislocated play to overcome the inherent asynchronicity in remote interactions. Thereby, the digital (i.e., the game) increasingly shifts towards the role of a communicative actor with a social function. This assigns a special role within a social setting to the game as a mediator in-between players. It also relates to the perspective that the social is constructed from, and through, technologically mediated processes and infrastructures of communication [45]. Within the scope of our work, the role of technology in hybrid games is characterized by being a mediator of bodily qualities and shared materiality.

4. Material Experiences of Boardgames

Starting from the material experience framework introduced by Giaccardi and Karana [6] as an analytical tool to look at the material experiences of boardgame play, we describe the core traits and attributes associated with boardgame play. We chose this framework as an analytical tool as it intends to discuss how materials shape our ways of doing and how this relates to the emergence of practices. As boardgames are to a large extent centered around physical interaction with specific materials, thus accompany specific material experiences, this framework was a valuable tool to dissect the different traits and characteristics of boardgame play. This materiality-centered perspective specifically helped us to understand boardgame materials in the analysis of related practices. We further drew upon Rogerson et al.'s work on the materiality of boardgaming [3] as well as work on the topic of digital–physical play.

4.1. Analysis Process

Our analysis was grounded in applying a theoretical framework by Giaccardi and Karana [6] who articulated "a framework for materials experience that discusses how materials shape ways of doing and ultimately, practice, and how this is rooted in the experience of those materials" ([6], p. 2545). This framework foresee's three main domains that influence each other, together shaping our materials experience (see Figure 1). The relationships between these nodes are referred to as *encounters*, *performances* and *collaborations*.

According to the authors of the framework, *encounters* are understood as the initial interactions with a material. Interactions informing our judgements and that establish certain *performances*, which are the base for the development of practices. *Collaborations* are seen as alterations in the material that are caused by re-occurring performances, which change the way we encounter something.

Starting from this notion of materials experiences, we analyzed the inherent material qualities of boardgames and speculate how these might shift in remote manifestations as well as related design potentials emerging. In our analysis, we associated the core qualities and traits of boardgames (based on existing research [3,30,32]) to the three domains proposed by the framework, i.e., *materials*, *people*, and *practices*. This helped us to understand the role of physical materials in the analysis of practices related to boardgames. Based on that, we speculated how the qualities inherent to boardgames might translate and/or change in remote instantiations. Building on that, we depicted three lenses of designing for remote tangible play: (1) physicality; (2) agency; and (3) time. They led to a discussion on related design considerations and leverage points.

We are not proposing remote variations of the nodes of the original framework, but conceptually shifted the nodes to infer how related design aspects might change. This conceptual translation of the

nodes and relationships of the original framework is the core of our arguments and guided the formulation of our lenses.

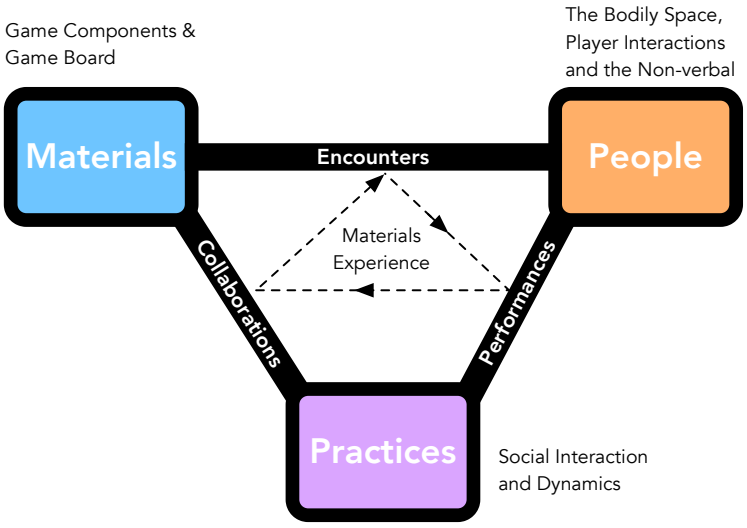

Figure 1. An illustration of the materials experience framework [6] applied to the core traits and characteristics of boardgames: the three domains *materials, people*, and *practices* are connected by specific relationships (i.e., *collaborations, encounters*, and *performances*), which together create the inherent materials experience.

Primarily, we focus on Giaccardi and Karana's definition of the "materials" node as described in the original framework as a conceptual starting point. In our analysis, we emphasize the transfer of physicalities associated with co-located interactions in boardgames to the design of remote instantiations. In line with Giaccardi and Karana, we understand *materiality* as a theorization of work on material-centered design and research, while the notion of *materials* emphasizes "the physicality of artifacts as opposed to the properties of materials" ([6], p. 2448). We are focusing on this notion *materials* in relation to the physicality of boardgame artifacts and related interactions.

Starting our analysis from the physical artifacts involved in boardgaming, we increasingly broadened our notion of involved physical aspects towards a broader take on how to enable a shared physical space (e.g., transferring bodily signals of another player and related non-functional actions). We thereby highlight a notion of physicality understood as being broader than the properties of the involved physical materials, but also non-verbal bodily aspects as being a potential design material. We see physical components as triggers of a broader set of tangible and embodied interactions that we conceptually explore and argue for (see Sections 5.1 and 6).

Consequently, remote physicality is established and negotiated through a broader set of aspects besides "transferring" the physical artifacts involved. Acknowledging the players body, related signals and interactions as inherent aspects of the co-located physical space, renders these aspects also a potential design material for remote instantiations of tangible play.

The lenses presented in this paper emerged in extensive discussions and reflection workshops between the authors. Our analysis was driven by: (1) engaging with the boardgame materials as such (i.e., playing a wide selection of boardgames in dedicated sessions); and followed by (2) reflections with guiding questions related to how the inherent aspects of boardgames could be translated to remote settings (e.g., how the remote aspects could be used as a design resource). The materials experience framework was guiding this analytical process, reflections and also helped in describing the envisioned shifts in remote tangible play.

This led to the lenses as described in Section 5): (1) physicality as inherent to tangible interaction; (2) issues of agency as inherently tied to automation in distributed digital systems; and (3) time as a main aspect and design materials of boardgames that shifts its quality in remote settings.

4.2. Domain (1) Materials: Game Board and Components

> *"Materials are characterized by properties (such as chemical properties, computational properties, etc.) and the embodiments through which properties can be experienced and performed (such as physical form, temporal form, state of matter, etc.)."* ([6], p. 2450)

As initially mentioned, the interactions in boardgame play are primarily characterized by the physical space they create [3]. The game board itself, to a certain extent, dedicates and sets the physical space of a boardgame sessions. By putting the board on a table, players set the context for engagement. A game's physical components as well as the spatial relation between components, players and the way they are positioned around a table is largely determined by the game board (see Figure 2).

Figure 2. Different concepts of how the game board affords players' positions around a table and how this relates to roles, different interactional spaces and distribution of information: (**A**) two teams compete in Captain Sonar [46] with each player having a different role within the game; and (**B**) shared and individual player boards side by side in Terra Mystica [47].

The interaction with other players as well as the game components is based on physical interactions, meaning physically manipulating components and game pieces. The components at the same time represent the functional space of the game and the interactional space the players can respond to. These components and the game board are the embodied game state and the primary way of interfacing. Game pieces can for instance range from wooden cubes, plastic figurines and cards, to individual player screens enabling hidden information and a personal interactional space for a player. These components act as means to track points on a collective track, round tracking, turn taking, assigning and indicating starting players, as well as tokens for resources. In that regard, the game board acts as a central interface to the shared knowledge and embodied game state.

Although mostly being positioned *between* co-located players, many games follow a notion of shared and individual player spaces (often represented through individual player boards besides the shared space of the game board itself). This notion of shared vs. individual resources is also reflected in the components themselves which can for instance either be common to all players, as well as individually "owned" by a specific player.

4.3. Domain (2) People: The Bodily Space, Player Interactions and the Non-Verbal

> *"People have different competences and values that come into play, and may as well develop, in a way similar to how properties and embodiments of a material artifact may change in interaction and through performance."* ([6], p. 2450)

Besides the interaction with physical components, another major factor related to the experience of boardgaming is interacting with other players. This happens either directly (moving common pieces and changing the overall game state) or indirectly (e.g., blocking actions for others) by physical actions "on the board". Additionally, there are also direct ways (e.g., negotiating with other players) and indirect ways of communicating with other players. For instance, if a player is looking at a specific area of interest on the board, it might reveal crucial information on this very players strategy to opponents [48,49]. This layer of inherent non-verbal interaction of co-located play is primarily related to the physical presence of others. The bodily presence of others necessarily communicates something to others.

Research has shown that bodily presence of others influences performative aspects of play and the overall gameplay experience [50] and that the inclusion of non-verbal signals in digital play can facilitate new forms of collaboration [51,52]. This also shows how players are constantly communicating based on their bodily presence, their actions on the shared and individual space of the boards and their direct communication with others. However, players also implicitly communicate based on their in-game actions and non-verbal signals. In that regard, research from digital play shows what influence gaze interaction in play can have and how it can reveal strategies [48] and act as a direct/indirect communicator between players [44]. Some modern boardgames even mechanically shift their focus from interacting with "a board" towards relying on the inclusion of the bodily space of players and facilitating related interactions (e.g., bodily mimicking animals [53]).

4.4. Domain (3) Practices: Social Space and Dynamics

> *"Practices are considered here as situated 'ways of doing' that unfold and become assimilated into an ongoing set of everyday performances."* ([6], p. 2450)

Strongly interconnected with the notion of the bodily space and the emerging inter-player communication are the related social dynamics of boardgame play. These social dynamics are not only related to how players are situated next to each other and what communication and information exchange the game itself affords but also to the mechanical considerations regarding the design of a game. The ranges of social dynamics and player interrelations in a boardgame setup are rooted in its design of conflict between players. Conflicts enforce decision-making; decisions that might be connected to goals of another player. In modern strategy games (often referred to as "Euro Games" [54]), conflict between players tends to be a rather indirect conflict [30]. For instance, rather than focusing on "winning a battle" against another player, these games create their conflict momentum from limitation of resources or available actions on the board. Some games of this genre are even considered being "multiplayer solitaire", framing a notion of games with little to no direct player interaction, and conflict between players is mostly an indirect conflict of resources. On the other hand, tabletop miniature games such as Warhammer [33] focus on direct combat-based conflict centered around resolving positional play of miniatures. These direct conflicts tend to be resolved through dice-rolling (simulating uncertainty), thus usually focus their enjoyment on same-time/simultaneous interactions.

Besides player competition, within recent years, more and more cooperative boardgames that require the player to work together towards a certain goal emerged, and, consequently, play "against" the game itself. These games often assign different roles and related in-game powers to the players. Thus, related social dynamics are to a large extent rooted in variable player powers or unequally distributed information

between players, forcing the players to communicate and work together. Game mechanics that harness this space utilize hidden information as a necessary means to force player communication through various implicit our explicit means of communication, also emerging through social deduction.

5. Designing for Remote Tangible Play: Three Lenses

In the following, we interrelate the qualities and characteristics of boardgames with the notion of playing over distance. In doing so: (a) we envision how boardgame play could be translated to the hybrid remote space; and (b) we illustrate related design challenges and potentials. Our goal is not to contribute a comprehensive model of remote tangible play. We rather aim at shedding light on and illustrate the design space of dislocated boardgames as manifestations of remote tangible play.

Therefore, we articulate lenses that represent the core leverage points we identified in regards to designing for dislocated boardgames, i.e., *physicality, agency* and *time* (see Figure 3).

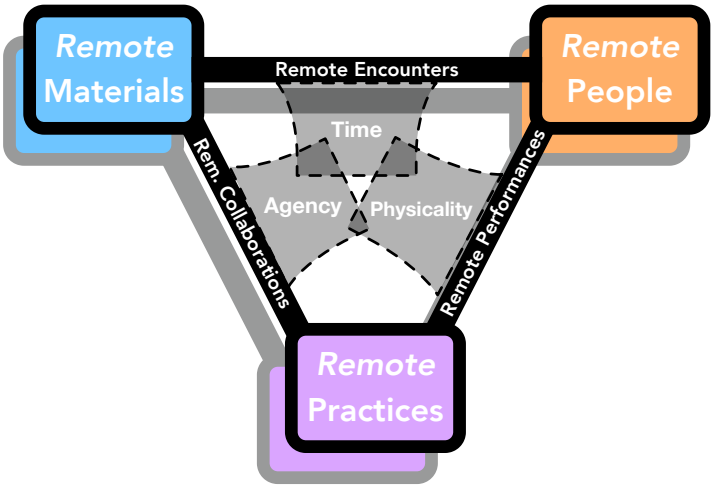

Figure 3. Illustration of the analysis process and corresponding articulation of three design lenses (i.e., *physicality, agency* and *time*) that aim at describing the relations between these domains and related design potentials.

Our arguments are based on the illustrated domains of materials experience (i.e., materials, people, and practices) in regards to boardgames, as well as how we envision the notion of these domains would shift in potential remote manifestations of boardgames. The three proposed lenses are based on speculations about these shifts and related design potentials.

Epistemic actions of players are often inherent in the communication between co-located players; players implicitly communicate tension, relaxation, or excitement. As an example, fidgeting with components may be done by players, either with board game components (e.g., a die) or other physical objects in the shared space (e.g., a pen). In remote settings, however, these implicit actions are rarely conceivable by a remote player. The physicality that is shared remotely would then completely rely on the physicality of the game, which is related to function and agency. To provide a richer shared *physicality*, related *remote performances* are needed. It is not the dislocation of the human and the physical thing that the player fidgets with, but the dislocation of the other player, who does not get a sense of the opponents fidgeting behavior that is often highly relevant in gameplay (e.g., as an indication of being nervous, bluffing, etc.) and in social exchange overall.

Remote encounters are distributed between materials and people, thus inherently create asynchronous engagements relating to different notions of *time*.

Remote collaborations would be inherently mediated through technology, which relates to questions of player *agency* in an envisioned digitally augmented and automated play environment with physical components.

We contrasted existing traits and characteristics of boardgames (e.g., physical artifacts, mechanisms, different genres, etc.) with the emerging shifts of these qualities we envision in a remote instantiation. We want to highlight that, although conceptually originating from the two respective domains in our analysis (e.g., people and materials), the identified lenses should not be understood as exclusive connection points between two of these domains. The digitally mediated, hybrid space of remote tangible play requires looking at associated *material* aspects that emerge through combining the digital with the physical: What materials and interactional qualities could be promising for reconnecting players over distance? How can a shared material space be designed?

Agency, especially in relation to the manipulation of physical things, is an essential aspect of analog boardgame play, which is potentially less visible in dislocated settings, but which is essential for the play experience. How would the inherent digital mediation between remote players create different notions of player agency? What would different levels of agency facilitate and/or hinder?

Further, compared to co-located play, the notion of *time* drastically changes in a remote setting, and thus, requires specific attention when designing for dislocated play: How can different notions of time be utilized in a remote boardgame?

In the remainder of this work, we reflect on intersections and design sensitivities related to these traits as well as their application to the hereby drawn design space of remote tangible play. We further speculate about related design potentials along these lenses.

5.1. Lens 1: Physicality

Deliberately designed shared physicality is needed to account for the fact that material experiences of distributed boardgames are encountered asynchronously, in terms of both interactional space and time.

5.1.1. Physical Manifestations and a Shared Material Space

Play over distance inherently unfolds in different interactional spaces for the dislocated players. Players are engaging in potentially different spatial realities and environments. Thus, designing ways to create a shared material space and to mediate bodily interactions in a remote setting is crucial for the players to experience shared physicality.

In co-located play, physicality is shared, in terms of sharing both the same space and the same time, as well as being positioned bodily next to each other. A speculative setup of a remote boardgame might be a mixed ecosystem of physical and digital embodiments. For instance, individual player boards might be digitally embodied (e.g., via a remote screen), but the main shared interactional space might be mirrored also physically (e.g., through actuated objects) to facilitate the experience of shared physicality.

In a remote setting, the notion of shared and individual interactional spaces (e.g., individual player boards as described in Section 4.2) becomes a matter of potentially different timezones, spatial realities and interactional contexts. Based on this "asynchronicity", players would, for instance, interact with a given game system under different contextual influences (e.g., lighting conditions, noise, etc.), as well as in different frequencies.

Many existing boardgames already work with a physical divide between player to enforce different levels of information between players, or even hidden information, e.g., enforced through different positions around a table. The physical environment enforced through the game and its artifacts can even relate to different roles for the players within the game (e.g., separation of available information through a physical screen). In dislocation the inherent spatial and temporal "division" could be seen as a deliberate

design resource. The notion of individual and shared interactional spaces can be radically reconsidered in remote boardgames, which in turn opens up a new design space of qualities that specifically focus on the remote aspect.

Therefore, we argue specifically designing for mechanisms that utilize the spatial asynchronicity of players in different locations, e.g., by making these contextual differences and the spatial characteristics between locations part of the game. A game could for instance use the lighting conditions in a room, the time of day, temperature, or the number of people present in a room, and integrate these data into the gameplay experience (see Figure 4). This might facilitate a sense of shared physicality and a shared material space through mutually transferring contextual qualities via the game itself, thereby fostering physical connection at a distance.

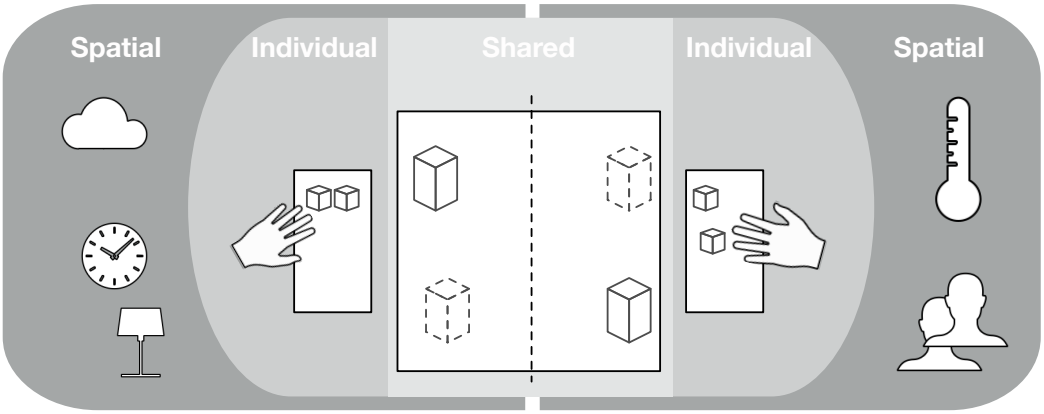

Figure 4. Different shared and individual interactional spaces within an ecosystem of physical and digital embodiments.

Further, in regards to creating a shared material space and related material expressions a big design challenge for remote instantiations of boardgames is to enable the (extreme) material interactions that are associated to, e.g., the notion of Legacy Games (Legacy Games: https://boardgamegeek.com/boardgamefamily/25404/legacy), which facilitate permanent changes in the material to create a narrative (e.g., tearing apart cards, destroying components, opening sealed packages) (the physical changes made in a Legacy Game are designed to be permanent, based on the outcome of each game and player decisions).

Consequently, designing for physicality should not primarily rely on the physical artifacts involved, but on the human bodily actions and related non-verbal signals that are triggered *through* the physical artifacts as the main interface for players.

5.1.2. Non-Verbal Signals as Material: Embodying the Immaterial

Further, in co-located play, the bodily signals and physical presence of other players inherently communicates to other players. This constant communication through bodily non-verbal signals is lacking in remote play, which is also reflected in current online gameplay concepts mainly relying on voice chat and in-game actions for communication. Non-verbal interactions are a main driver of the boardgame experience and should thus find their way into designs of remote tangible play.

Transferring non-verbal signals (e.g., eye contact [55]) and epistemic player actions (e.g., sorting components, bending cards, etc.) that are omnipresent in co-located boardgame play to the digital/remote space can create a layer of interaction that is "non-functional" to the game state, but important to the perception of shared physicality of the players and the related interactional space [30]. Due to the different time and space of players, the embodiment and representation of, to this design space, immaterial qualities

is one of the main leverage points we see. By using and enabling the bodily communication in a remote setting, the otherwise invisible or immaterial qualities in that very space (e.g., body language), become manifested through the game and its physical components creating a shared material space. Physical artifacts could, e.g., react to and/or mirror bodily player signals remotely, thereby embody, transfer and mediate the immaterial "remote player" to another location. This focus on physical components as mediators would also shift the notion of player actions as direct communicators and rules enactment to (actuated) objects and hybrid digital–physical representations as communicators of material qualities.

Further, "Euro Games" [54] focus on luck mitigation and resource management, thus are centered around creating an interesting and complex decision space for the players. We argue that observing and experiencing this decision making process of others is a main part of the experience related to co-located boardgame play. This decision making process might be manifested in the way players sort resources to plan future turns, thereby also allowing other players to infer and change their strategy. Thus, designing ways for this decision making to unfold and materialize in remote play is one of the key aspects to experience a shared material space in a remote setting. Making complex decisions and the related epistemic player actions (e.g., sorting and fidgeting with components) to transparent/tangible to a remote player could thereby be another layer of creating a sense of remote physicality.

Design Sensitivities Related to Physicality

In boardgaming, the inherent physical materials imply a certain function, and relate to input and output of a physically embodied system. These functions are so closely tied to the materials themselves that they can be understood as *material induced interactions* (as framed by Schmid et al. [56]). The leverage points identified within this lens revolve around rethinking the role of physical boardgame components, designing ways to translate and utilize non-verbal signals in digitally mediated remote instantiation of a boardgame (e.g., letting components react to a player's gaze behavior) and utilizing the spatial environment of dislocated players as a design material. We argue that, to reach a sense of a shared material space, a major design opportunity is the translation of physicalities that are not directly related to in-game functionality, such as epistemic actions that resemble the presence and physicality of another person. Further, a shared material space could be created by actively interrelating the different shared and individual interactional layers with the spatial characteristics of the dislocated other.

5.2. Lens 2: Agency

An automated system that mediates physical player input and related actuations of physical objects in a remote location is needed, in order to facilitate physicality aspects of boardgame play while facing a distributed (digital) environment. This "automation" of physical actions requires taking (the player's) agency into consideration.

5.2.1. Agency, Dislocation and Digital Mediation

The term *agency* in virtual worlds and digital interaction is often mentioned in its relation and distinction to *control*. In that regard, Gozli et al. framed agency based on the case of using a computer mouse as follows: "the ability to move the cursor (i.e., agency) vs. the ability to make the movements efficiently and accurately (i.e., control)..." [57]). In digital worlds and games in general, it is often framed in regards to how much agency someone experiences when being primarily represented digitally, e.g., through an avatar (e.g., [58]). Within the scope of this paper, we consider agency as the player actions' and decisions' influence on the game state, both in physical manifestation such as the position of pieces and in the related functional manifestations of the component's board position. Thus, we argue that in terms of boardgames, agency is to a large extent experienced as the relation of a player's actions and the related change to physical and functional game state. These aspects would drastically change in a remote

setting as the game state might potentially not only be manipulated by physical actions of player but automated by a system (e.g., see Figure 5).

The physical components are the main means to interface with and alter the game state. Physical components relate to a player's actions and resources. Thus, physical components represent a player personally, to some extent could even be considered a "physical avatar". Further, the players "themselves are directly responsible for the operations and management of the game" ([59], p. 2). These necessary tasks require a certain level of collaboration between players to adopt and implement an agreed set of operational rules [60].

In dislocated play, this notion of an agreed place and time shifts towards a notion of space and time that is mediated by an in-between of a potential game system necessary to facilitate dislocated play. The fact that a communication system in-between players would need to handle communication and transmission of the game state changes a range of aspects inherent to co-located boardgame play.

The necessary digital mediation—as well as the focus on physical components—presents the opportunity to design for hybrid digital–physical artifacts (e.g., tangible objects that allow the manipulation of the digital game state). However, this would also mean that the actions of another player are mediated through the digital "in-between". In a setup where actuated artifacts are in the center of remote tangible play, the questions of how much is mediated and simulated—how much left to be managed by the players—emerge as a big design challenge (referring to the inherent bookkeeping in boardgames [61]). Taking these bookkeeping actions away from players would also take away some core qualities of physical boardgame play.

5.2.2. Hybrid Artifacts as Actors

In a remote (digitally mediated) setting the required technology involved would necessarily have to become part of the game, in turn also subject to the social agreement among the players entering the "magic circle" of the game. Thus, players would potentially lose some level of agency by accepting the rules of play in such a setting. Players collectively enact, follow and interpret the rules of the game, which in itself enable competition at the table [30]. In dislocated play, this negotiation of rules needs to happen via different, mediated channels, or could further be partly or entirely be managed by a system. Usually, "when errors occur, they are corrected by the players, with no outside agency beyond the collaboratively interpreted rules." ([30], p. 10). As there needs to be a digital mediator of some sort in between, the potential loss of agency through the digital could also have essential benefits, such as automatic rules correction.

This notion of hybrid artifacts as "outside agency" would facilitate new design material and would render related artifacts as actors "in-between" players, enacting and interpreting the rules alike, just as the players do. Agency is usually something that is attributed to humans, not to things or physical artifacts. Respectively, in a remote setting, different notions of non-human agency could become a design aspect/material (e.g., [62,63]). If dislocated tangible play relies on actuated and connected artifacts, these artifacts could be considered non-human "actors", thereby shifting to a more active role compared to the role of passive physical components in conventional co-located play.

Design Sensitivities Related to Agency

We argue for utilizing the "in-between" of players different locations and times as an opportunity to let the digital come into play and augment physical objects with computational properties. This would shift their notion as mere embodiments of game state and interface for the players to mediating artifacts and enactors of the game. Shifting the role of physical artifacts to co-actors in carrying out the practices and "chores" encompassing a boardgame experience [61].

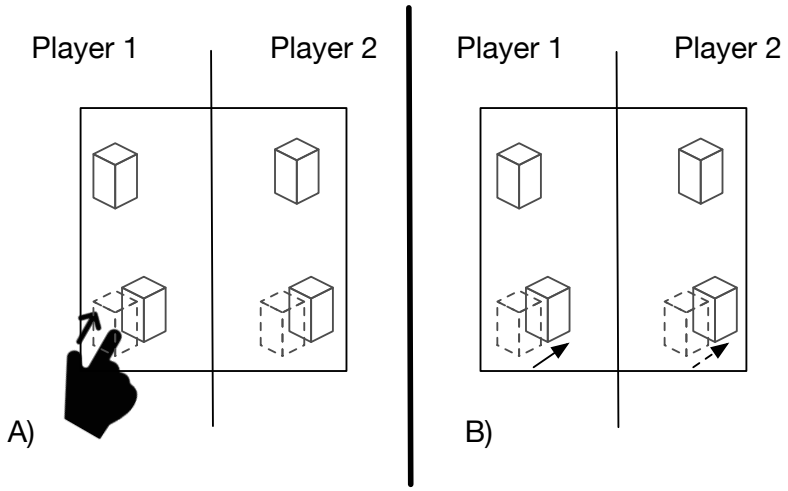

Figure 5. Speculation on actuated artifacts in dislocated boardgames: (**A**) player actuated: physical manipulation of a component on one player's side and related actuation at other location; and (**B**) system actuated/automated: actuation of physical components based on digital enactment of rules by the system.

5.3. Lens 3: Time

Innate to playing over distance are various temporal aspects of engaging with play (e.g., players interacting in different frequencies or delay between player turns). Co-located boardgame play facilitates shared-timing and related shared moments (e.g., player simultaneously interacting with the game and related game events unfolding during play). We argue that it is important to design for shared time experiences while at the same time leveraging the inherent asynchronicity for new gameplay mechanics.

5.3.1. Leveraging Asynchronicity

We argue that designing for shared-timing and related shared interactional moments in a remote setting, while also utilizing the inherent asynchronicity (in time *and* place) is a key design aspect unique to dislocated play. A game could require players to engage synchronously to make their actions (i.e., through turns) on a shared space while facilitating other interactions "out-of turn" on an individual space. For instance, strategic planning and actions could be handled asynchronously on an individual space, while the outcome of related player actions (e.g., a resolve phase) is handled synchronously. Following this line of thought of leveraging asynchronicity would potentially result in a changing definition of "a player's turn". A further challenge is to consider the design of dedicated "out-of-turn" mechanics because downtime would potentially be an even bigger problem in a remote setting.

Digital mediation would further facilitate different notions of delay and timing as a design resource. Providing synchronous short term interactions vs. long-term "input" into the system such as play-by-mail chess (see Figure 6) through dedicated game mechanics would allow synchronous and asynchronous engagement (e.g., implemented through dedicated player actions and related delays of "sending input to the system").

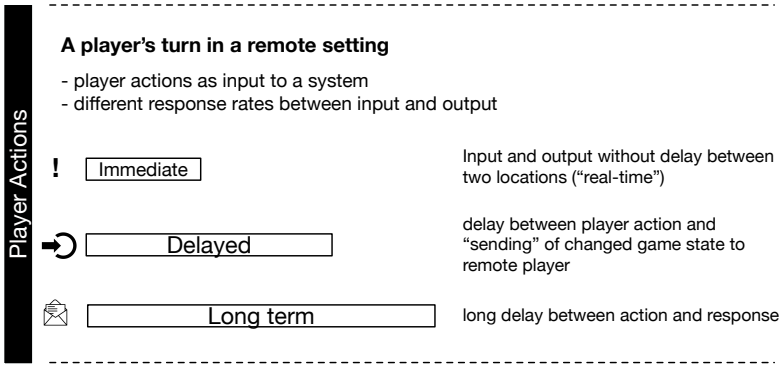

Figure 6. Different notions of timing and turn taking: a conceptual illustration of utilizing time delay in remote play related to a player's turn and related input and response of a remote game setup/system.

5.3.2. Mechanical Asynchronicity

With this different notion of timing in a remote setting, designers could utilize different alternative turn structures to facilitate asynchronicity through game mechanics. Utilizing different notions of time could further become a game mechanical momentum for designers. Research on "slow technology" [64,65] informed the design of artifacts centered around different manifestations of time by, e.g., deliberately slowing down interactions with technology. Following this line of thought, gameplay artifacts and components could be designed towards embodying the quality of time "between" players as well as utilizing different notions of time as a material (e.g., designing with new interactional constraints like allowing only one action per day [66]).

Another game mechanical consideration related to timing is how it relates to decision making. In boardgames, real-time elements are usually incorporated to create time pressure and enforce decision making on a rapid basis, e.g., being quick and having mediocre decisions vs. taking more time and making better choices.

To account for and at the same time leverage this mechanical notions of time, dislocated boardgames should arguable provide a range of game mechanics that provide different levels of interactivity and related timing to account for the characteristic asynchronicity in remote play (i.e., providing interesting ways to the players to engage in meaningful interactions with the game while currently not being "the active player").

5.3.3. Design Sensitivities Related to Time

Leveraging and specifically designing for asynchronous engagement requires rethinking existing notions of mechanical considerations related to boardgames (e.g., a player's turn or simultaneous action selection). Thereby providing different levels of interactivity and interactional frequency to the players is a key design challenge. This is how dislocated boardgames, as very specific manifestations of digital–physical hybrid games, could be rendered unique.

6. Discussion

Along the three lenses of *physicality*, *agency* and *time*, we discuss design considerations and potentials in regards to the design space of dislocated boardgames. We reflect on designing for a shared material space in dislocation, shifting notions of agency as a design sensitivity as well as utilizing time as a design material. Thereby, we illustrate possible ways that the digital and physical can complement each other in the hybrid space of tangible play over distance. Following the materials experience framework [6] throughout our analysis enabled us to pursue a material-centered view on boardgames, which in turn afforded

understanding the role of physical materials in the emergence of practice related to boardgames. Based on that, we hereby discuss the role of the analog and "non-functional", in turn leading to an alternative notion and focus of hybrid play, building an argument for dislocated boardgames as digital-physical hybrids.

6.1. Designing for Non-Functional Interactions

In an analog board or card game, the way that physical engagements (e.g., administrative actions and "chores") with the game unfold play an important part in the overall experience and are a rich sources of social interaction [61,67]. The way that a player throws a die hoping for a high number, the way players hold their cards and arrange them in their hands to plan future turns, and fidgeting with game components are qualities innate to the physicality of components, thereby adding a dimension to analog play that purely digital play can usually not offer. However, the mentioned qualities do not necessarily relate to any functional dimension in the game.

In digital play, especially digital ports of boardgames, primarily the functional space is implemented (i.e., the representation necessary to enact the rules) [31]. Things may happen automatically as a player only sees the end results of another player's remote actions, but not the way this unfolds physically (e.g., the exact way a card was put on the table or how resources were organized).

Carter et al. [67] specifically looked into the notion of dice-rolling in the tabletop miniature game "Warhammer" as a "shared experience" and illustrated how important the associated physicality of a die roll is to the underlying experience. They further suggested to retain the notion of physical dice also in digital play and speculated how this could be accomplished by, e.g., simulating the amount of dice rolled through different sounds. This underlines one of our main arguments of enabling rich hybrid play in its remote instantiations by also transferring these non-functional physical qualities associated to tangible interactions with components.

Digital games usually use very discrete information. However, the bodily space involved in co-located play facilitates signals and actions that are inherently analog, not as definite, precise, and unambiguous as the virtual/digital. These analog qualities, their inherent ambiguity, e.g., the "fuzziness" of tangible interactions, are a core part of the experience that should, as we argue based on our reflections, be leveraged in (digital) play over distance, especially through the design of digital–physical hybrid interactions (e.g., dislocated boardgames).

One way to allow for the imprecise and analog in digital play could, e.g., be to map bodily qualities to shared distributed spaces and further to find ways how to translate and embody epistemic actions of players in the digital. The ambiguity of, e.g., non-verbal communication, can be a driver of new game experiences and cooperation in digital play [44], thereby rendering a new hybrid digital–physical space. Thus, we argue for a notion of tracking technology as enablers of the *non-functional* by, e.g., creating non-verbal interactions as multimodal add-ons to tangible interactions.

To maintain some of the core qualities of boardgame play, different types of, e.g., non-verbal mechanics and interfaces that currently exist within distributed multiplayer video games could potentially also be used in distributed boardgames.

For example, using awareness cues (e.g., as already suggested for digital games [68]) could mediate turn taking or presence of a dislocated player and related actions; annotation interfaces [43] could facilitate strategy planning in cooperative games that require the dislocated cooperation of team members over distance; or shared eye gaze (as researched within the digital realm [44] as well as in regards to boardgames [69]) could be utilized to design mechanics around revealing the intentions and potential strategies of a remote player.

Further, especially in the case of play of over distance, designing game mechanics that require physical dexterity/skill could further allow for performative aspects (also making the act of watching enjoyable) and utilize the tangibility of physical components for new game mechanics.

6.2. Tracking Technology to Enable Bodily Signals—Designing for New Kinds of Multimodal Interactions

Bodily signals and actions are inherently analog, not as definite, precise, and unambiguous as the virtual/digital. Understanding technologies and their use in hybrid play as enablers of these interactional granularities of human physical actions, we can reach a very different understanding of what hybrid play can be and could harvest from. Hybrid play and related hybrid interactions, if framed differently, could have their strength in allowing and inviting for the imprecise, the analog, the human physicality in play, beyond the functional dimensions of a game. Transferring the mentioned immaterial qualities of co-located play to the digital can allow the rich source of bodily actions and related "non-functional" signals to be part of the digital play experience. In the mostly disembodied space of digital play, this can in turn create a layer of intimacy and exchange between players but also between player and artifact.

Digital games usually do not represent these "non-functional" aspects in their implementations and do not harvest from the related "fuzzyness" in interaction as a design resource. Besides the aforementioned "fuzzyness" and interactional granularity of enabling technology of bodily signals, the use of new physical material for interaction (e.g., fluids) could be promising (i.e., using materials that are impossible to precisely manipulate manually to enforce fuzzyness). In that regard, we argue for utilizing tracking technology not primarily for measurement but for creating interactional and performative uncertainty [70].

We consider especially those technologies that grant designers access to the bodily non-verbal signals of players as relevant to create a shared remote physical space. Tracking technologies (e.g., motion and body-tracking, eye-tracking) or wearable technology (e.g., smart watches) could be used to gather bodily data and map those to the shared digital space in a remote boardgame in manifold ways (e.g., through making that data available and manifest it through physical interactions).

Further, with the advent of personal fabrication technologies [71], related inventions of new physical materials also emerged that can be utilized for creating new forms of interaction (e.g., shape-changing material [72], materials as sensors [73] or utilizing fabrication technology for new hybrid game approaches [74,75]).

For the design of hybrid *remote* interactions, we argue to go a step further and try to integrate the "computation" into the physical materials themselves (e.g., in the direction of computational meta-materials that integrate computational functionality embedded in the very physical material itself, beyond embedded electronics [76,77]). In that regard, Mora et al. [23] provided a thorough argument to go beyond the design of interactive surfaces but focus on the design of interactive game pieces in hybrid boardgames. In this direction of integrating computation into the physical material (e.g., for the implementation of reactive boardgame pieces), a new category of seemingly *smart* materials would be added to the palette of (remote) boardgame design that are inherently hybrid.

Correspondingly, embedding bodily signals into remote tangible interactions could potentially create "windows" that let a player experience the bodily experience of another player, facilitating embodied simulation [78] over distance (which describes how we create meaning through constructing mental models of the currently perceived scene).

6.3. Interdependencies between the Lenses

There are inherent correlations between design choices associated with our lenses. The general design space illustrated is one that is also strongly characterized by these inter-dependencies, meaning that a design choice in one direction sets the scope of design options in another area. Especially the notion

of *agency* is very much inter-connected to the other lenses and related design sensitivities. The more agency a primarily automated smart boardgame piece might have, the less it potentially invites for the inherent small physical chores and bookkeeping endeavors that are associated with physical boardgame play [61]. In turn, the more physical material engagement is designed for the players, the less we might take advantage of the *digital*, e.g., for (physical) rules automation through automated pieces. Further, the more we utilize the aspects of *time* and dislocation (e.g., out-of-turn mechanics, see also Section 5.3), the less we can potentially assure the mentioned same-time same-space interactions that co-located boardgame play lives from. Potentially, the more a dislocated boardgame design relies on physical interactions, the lesser the role and design momentum of digital mediation in-between locations will be (e.g., fostering asynchronous engagement of players).

Balancing and orchestrating these interconnected aspects is primarily determined by the underlying game and what its mechanics require. In that regards, a big design challenge will be to design boardgames that are specifically designed for being played in dislocation, while not just emulating existing co-located experiences to the remote and digital space.

6.4. Dislocated Boardgames as Digital–Physical Hybrids

The in-between and contrasts of digital and physical, as well as considerations related to different space and time, fundamentally characterizes dislocated boardgames as hybrid ecologies of players, physical artifacts and digital mediation. As Rogerson et al. stated "players must not only agree on a rule set, they must enact and enforce it as well" ([30], p. 3). In remote settings, there is a potential shift from the players to the physical–digital hybrid artifacts as drivers and enactors of rules. Thus, these artifacts would become central actors in a gameplay setting. If players "enact and enforce the rules" [30], the hybrid artifacts in a remote setting become artifacts of co-performance [79], potentially also shifting their role from functional objects to actors in a social setting.

Existing hybrid play concepts focus on adding computation, e.g., for visual add-ons to physical components or as a narrative element [14], whereas our perspective seeks to incorporate and interrelate analog qualities with the digital as the core aspect where hybridity in play emerges. We want to stress a perspective on the notion of hybridity in play as a translation of non-functional physical qualities of co-located play to the digital, where technology is seen as the enabler of the analog.

The lenses through which we reflected on remote tangible play facilitate investigations of an under-explored design space, striving for the design of digital–physical play ecologies over distance.

Hybrid play and related hybrid interactions, if framed differently, could have their strength in allowing and inviting for the imprecise, the analog, the human physicality in play beyond the functional dimensions of a game. Transferring the mentioned immaterial qualities of co-located play to the digital can allow the rich source of bodily actions and related "non-functional" signals to be part of a digital play experience. In the disembodied space of digital play, this can in turn create a layer of intimacy and exchange between players, as well as between player and artifact.

7. Conclusions

We present a theoretical reflection on understanding and framing remote tangible play in the form of dislocated boardgames. Based on that, we propose three lenses of looking at the inherent material aspects of boardgames and how these (dis-)appear in dislocated play.

Through these lenses we reflected on: (1) designing for a shared material space through, e.g., communicating non-verbal signals; (2) shifting notions of agency as a leverage point for design, e.g., physical smart artifacts as co-performers of gameplay and enactors of rules; and (3) different notions

of time and how these might lead to new designs, e.g., rethinking remote turn structures and facilitating asynchronous player engagement.

We argue that dislocated boardgames as manifestations of remote tangible play can facilitate rich digital–physical interactions, constituting the related design space as inherently hybrid. Thereby, we depict a notion of hybrid play that centers its hybridity on digital-physical interrelations and embodiments of non-functional "immaterial" qualities to create a shared material space.

We acknowledge that our work presents a purely theoretical analysis and speculation on related design potentials and challenges. Starting with the proposed lenses and the identified design sensitivities, we plan to design concrete artifacts and interactive instantiations of dislocated boardgames in future work to explore how the related material qualities are negotiated and communicated. However, we believe that our work can be a first step to specifically design for remote *tangible* engagements in play and can contribute to a broader understanding of hybrid digital physical play.

What ultimately characterizes hybridity in play is more than complementing the digital with the physical. Interrelating a variety of entities and actors, such as the players, physical objects, and social aspects, as well as introducing the non-verbal, the fuzzy, analog and ambiguous, is what constitutes rich hybridity in play.

Author Contributions: Conceptualization, B.M.; Methodology, B.M. and V.F.; writing–original draft preparation, B.M. and V.F.; writing–review and editing, B.M. and V.F.; visualization, B.M.; supervision, V.F.

Funding: We gratefully acknowledge the financial support by the Austrian Science Fund (FWF): I 3580-N33, as well as EFRE (European Funds for Regional Development), AWS (Austria Wirtschafts Service) and the region of Salzburg for the support in the development of the Salzburg Center for Smart Materials (P1727558).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Sjöblom, B. Gaming as a situated collaborative practice. *Hum. IT* **2008**, *9*, 128–165.
2. Björk, S.; Falk, J.; Hansson, R.; Ljungstrand, P. Pirates! Using the Physical World as a Game Board. In Proceedings of the IFIP INTERACT 01: Human-Computer Interaction, Tokyo, Japan, 9–13 July 2001; pp. 423–430.
3. Rogerson, M.J.; Gibbs, M.; Smith, W. I Love All the Bits: The Materiality of Boardgames. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose, CA, USA, 7–12 May 2016; ACM: New York, NY, USA, 2016; pp. 3956–3969.
4. Van Dijk, J.; van der Lugt, R.; Hummels, C. Beyond distributed representation: Embodied cognition design supporting socio-sensorimotor couplings. In Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction, Munich, Germany, 16–19 February 2014; ACM: New York, NY, USA, 2014; pp. 181–188.
5. Linderoth, J. Beyond the digital divide: An ecological approach to gameplay. *Trans. Digit. Games Res. Assoc.* **2013**, doi:10.26503/todigra.v1i1.9
6. Giaccardi, E.; Karana, E. Foundations of Materials Experience: An Approach for HCI. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, Seoul, Korea, 18–23 April 2015; ACM: New York, NY, USA, 2015; pp. 2447–2456, doi:10.1145/2702123.2702337.
7. Ip, J.; Cooperstock, J. To Virtualize or Not? The Importance of Physical and Virtual Components in Augmented Reality Board Games. In *Entertainment Computing—ICEC 2011*; Anacleto, J.C., Fels, S., Graham, N., Kapralos, B., Saif El-Nasr, M., Stanley, K., Eds.; Springer: Berlin/Heidelberg, Germany, 2011; pp. 452–455.
8. Bergström, K.; Björk, S. The case for computer-augmented games. *Trans. Digit. Games Res. Assoc.* **2014**, doi:10.26503/todigra.v1i3.32
9. Devendorf, L.; Rosner, D.K. Beyond Hybrids: Metaphors and Margins in Design. In Proceedings of the 2017 Conference on Designing Interactive Systems, Edinburgh, UK, 10–14 June 2017; ACM: New York, NY, USA, 2017; pp. 995–1000, doi:10.1145/3064663.3064705.

10. Magerkurth, C. Hybrid gaming environments: Keeping the human in the loop within the Internet of things. *Univ. Access Inf. Soc.* **2012**, *11*, 273–283.
11. Benford, S.; Magerkurth, C.; Ljungstrand, P. Bridging the physical and digital in pervasive gaming. *Commun. ACM* **2005**, *48*, 54–57.
12. Magerkurth, C.; Engelke, T.; Memisoglu, M. Augmenting the virtual domain with physical and social elements: towards a paradigm shift in computer entertainment technology. In Proceedings of the 2004 ACM SIGCHI International Conference on Advances in computer entertainment technology, Singapore, 3–5 June, 2005; pp. 163–172 .
13. Nintendo. Amiibo, 2014. Available online: https://www.nintendo.com/amiibo (accessed on 17 March 2019).
14. Fantasy Flight Games. Descent Road to Legend App. 2016. Available online: https://www.fantasyflightgames.com/en/news/2016/3/15/road-to-legend/ (accessed on 4 April 2019).
15. Magerkurth, C.; Stenzel, R.; Prante, T. STARS—A ubiquitous computing platform for computer augmented tabletop games. In Proceedings of the Video Track of Ubiquitous Computing, Washington, DC, USA, 12–15 October 2003.
16. Leitner, J.; Haller, M.; Yun, K.; Woo, W.; Sugimoto, M.; Inami, M. IncreTable, a Mixed Reality Tabletop Game Experience. In Proceedings of the 2008 International Conference on Advances in Computer Entertainment Technology, Yokohama, Japan, 3–5 December 2008; ACM: New York, NY, USA, 2008; pp. 9–16, doi:10.1145/1501750.1501753.
17. Buruk, O.T.; Özcan, O. Extracting Design Guidelines for Wearables and Movement in Tabletop Role-Playing Games via a Research Through Design Process. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; pp. 513:1–513:13, doi:10.1145/3173574.3174087.
18. Günther, S.; Müller, F.; Schmitz, M.; Riemann, J.; Dezfuli, N.; Funk, M.; Schön, D.; Mühlhäuser, M. CheckMate: Exploring a Tangible Augmented Reality Interface for Remote Interaction. In Proceedings of the Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; pp. LBW570:1–LBW570:6, doi:10.1145/3170427.3188647.
19. Kirshenbaum, N.; Robertson, S. PEPA Deck: Bringing Interactivity to Playing Cards. In Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts, Melbourne, Australia, 28–31 October 2018; ACM: New York, NY, USA, 2018; pp. 479–486, doi:10.1145/3270316.3271521.
20. Maurer, B.; Van Rheden, V.; Murer, M.; Krischkowsky, A.; Tscheligi, M. Reign in Blood: Exploring Blood As a Material for Game Interaction Design. In Proceedings of the 16th International Conference on Mobile and Ubiquitous Multimedia, Stuttgart, Germany, 26–29 November 2017; ACM: New York, NY, USA, 2017; pp. 541–547, doi:10.1145/3152832.3156610.
21. Tyni, H.; Kultima, A.; Nummenmaa, T.; Alha, K.; Kankainen, V.; Mäyrä, F. *Hybrid Playful Experiences: Playing between Material and Digital-Hybridex Project, Final Report*; University of Tampere: Tampere, Finland, 2016.
22. Kankainen, V.; Arjoranta, J.; Nummenmaa, T. Games as Blends: Understanding Hybrid Games. *J. Virtual Real. Broadcast.* **2017**, *14*, doi:10.20385/1860-2037/14.2017.4.
23. Mora, S.; Di Loreto, I.; Divitini, M. From interactive surfaces to interactive game pieces in hybrid board games. *J. Ambient Intell. Smart Environ.* **2016**, *8*, 531–548.
24. Slegers, K.; Maurer, B.; Bleumers, L.; Krischkowsky, A.; Duysburgh, P.; Blythe, M. Game-based HCI Methods: Workshop on Playfully Engaging Users in Design. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, San Jose, CA, USA, 7–12 May 2016; ACM: New York, NY, USA, 2016; pp. 3484–3491, doi:10.1145/2851581.2856476.
25. Slegers, K.; Bleumers, L.; Maurer, B.; Krischkowsky, A.; Blythe, M. Special Issue HCI Research Games—An Editorial. *Simul. Gaming* **2019**, *50*, 266–271, doi:10.1177/1046878119861650.
26. Slegers, K.; Ruelens, S.; Vissers, J.; Duysburgh, P. Using Game Principles in UX Research: A Board Game for Eliciting Future User Needs. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, Seoul, Korea, 18–23 April 2015; ACM: New York, NY, USA, 2015; pp. 1225–1228, doi:10.1145/2702123.2702166.

27. Hartelius, U.; Fröhlander, J.; Björk, S. Tisch Digital Tools Supporting Board Games. In Proceedings of the International Conference on the Foundations of Digital Games, Raleigh, NC, USA, 29 May–1 June 2012; ACM: New York, NY, USA, 2012; pp. 196–203, doi:10.1145/2282338.2282376.
28. Kosa, M.; Spronck, P. What Tabletop Players Think About Augmented Tabletop Games: A Content Analysis. In Proceedings of the 13th International Conference on the Foundations of Digital Games, Malmö, Sweden, 7–10 August 2018; ACM: New York, NY, USA, 2018; pp. 6:1–6:8, doi:10.1145/3235765.3235782.
29. Jørgensen, I.K.H. Adaptations in Play: Strategies of Adaptation in Digital and Non-Digital Games. 2017. Available online: https://www.forskningsdatabasen.dk/en/catalog/2392842924 (accessed on 6 November 2019).
30. Rogerson, M.J.; Gibbs, M.R.; Smith, W. Cooperating to Compete: The Mutuality of Cooperation and Competition in Boardgame Play. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; pp. 193:1–193:13, doi:10.1145/3173574.3173767.
31. Rogerson, M.J.; Gibbs, M.; Smith, W. Digitising Boardgames: Issues and Tensions. In Proceedings of the 2015 DiGRA International Conference, Lüneburg, Germany, 14–17 May 2015; Digital Games Research Association: Tampere, Finland, 2015.
32. Rogerson, M.; Gibbs, M.; Smith, W. Me and My Shelfie: Hobbyists' domestication of boardgames. In Proceedings of the Extended Abstracts Proceedings of DIGRA 2017, Melbourne, Australia, 3–6 July 2017.
33. Workshop, G. Warhammer: Age of Sigmar. 2015. Available online: https://www.games-workshop.com/en-US/Warhammer (accessed on 17 September 2018).
34. Darzentas, D.P.; Brown, M.A.; Flintham, M.; Benford, S. The data driven lives of wargaming miniatures. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, Seoul, Korea, 18–23 April 2015; ACM: New York, NY, USA, 2015; pp. 2427–2436.
35. Mueller, F.F.; Cole, L.; O'Brien, S.; Walmink, W. Airhockey over a Distance: A Networked Physical Game to Support Social Interactions. In Proceedings of the 2006 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology, Hollywood, CA, USA, 14–16 June 2006; ACM: New York, NY, USA, 2006; doi:10.1145/1178823.1178906.
36. Mueller, F.; Agamanolis, S.; Picard, R. Exertion Interfaces: Sports over a Distance for Social Bonding and Fun. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Ft. Lauderdale, FL, USA, 5–10 April 2003; ACM: New York, NY, USA, 2003; pp. 561–568, doi:10.1145/642611.642709.
37. Mueller, F.F.; Agamanolis, S. Sports over a Distance. *Comput. Entertain.* **2005**, *3*, 4, doi:10.1145/1077246.1077261.
38. Yarosh, S.; Inkpen, K.M.; Brush, A.B. Video Playdate: Toward Free Play Across Distance. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Atlanta, GA, USA, 10–15 April 2010; ACM: New York, NY, USA, 2010; pp. 1251–1260, doi:10.1145/1753326.1753514.
39. Isbister, K.; Márquez Segura, E.; Kirkpatrick, S.; Chen, X.; Salahuddin, S.; Cao, G.; Tang, R. Yamove! A movement synchrony game that choreographs social interaction. *Hum. Technol.* **2016**, *12*, 74–102.
40. Brave, S.; Ishii, H.; Dahley, A. Tangible Interfaces for Remote Collaboration and Communication. In Proceedings of the 1998 ACM Conference on Computer Supported Cooperative Work, Seattle, WA, USA, 14–18 November 1998; ACM: New York, NY, USA, 1998; pp. 169–178, doi:10.1145/289444.289491.
41. Bonanni, L.; Vaucelle, C.; Lieberman, J.; Zuckerman, O. PlayPals: Tangible Interfaces for Remote Communication and Play. In Proceedings of the CHI '06 Extended Abstracts on Human Factors in Computing Systems, Montréal, QC, Canada, 22–27 April 2006; ACM: New York, NY, USA, 2006; pp. 574–579, doi:10.1145/1125451.1125572.
42. Pan, R.; Neustaedter, C.; Antle, A.N.; Matkin, B. Puzzle Space: A Distributed Tangible Puzzle for Long Distance Couples. In Proceedings of the Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, Portland, OR, USA, 25 February–1 March 2017; ACM: New York, NY, USA, 2017; pp. 271–274, doi:10.1145/3022198.3026320.

43. Alharthi, S.A.; Torres, R.C.; Khalaf, A.S.; Toups, Z.O.; Dolgov, I.; Nacke, L.E. Investigating the Impact of Annotation Interfaces on Player Performance in Distributed Multiplayer Games. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; pp. 314:1–314:13, doi:10.1145/3173574.3173888.
44. Maurer, B.; Lankes, M.; Tscheligi, M. Where the eyes meet: Lessons learned from shared gaze-based interactions in cooperative and competitive online games. *Entertain. Comput.* **2018**, *27*, 47–59, doi:10.1016/j.entcom.2018.02.009.
45. Couldry, N.; Hepp, A. *The Mediated Construction of Reality*; John Wiley & Sons: Hoboken, NJ, USA, 2018.
46. Matagot. Captain Sonar. 2016. Available online: https://boardgamegeek.com/boardgame/171131/captain-sonar (accessed on 17 September 2018).
47. Feuerland Spiele. Terra Mystica. 2012. Available online: https://boardgamegeek.com/boardgame/120677/terra-mystica (accessed on 6 November 2019).
48. Newn, J.; Velloso, E.; Allison, F.; Abdelrahman, Y.; Vetere, F. Evaluating Real-Time Gaze Representations to Infer Intentions in Competitive Turn-Based Strategy Games. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play, Amsterdam, The Netherlands, 15–18 October 2017; ACM: New York, NY, USA, 2017; pp. 541–552, doi:10.1145/3116595.3116624.
49. Lankes, M.; Maurer, B.; Stiglbauer, B. An Eye for an Eye: Gaze Input in Competitive Online Games and Its Effects on Social Presence. In Proceedings of the 13th International Conference on Advances in Computer Entertainment Technology, Osaka, Japan, 9–12 November 2016; ACM: New York, NY, USA, 2016; pp. 17:1–17:9, doi:10.1145/3001773.3001774.
50. Kappen, D.L.; Mirza-Babaei, P.; Johannsmeier, J.; Buckstein, D.; Robb, J.; Nacke, L.E. Engaged by boos and cheers: The effect of co-located game audiences on social player experience. In Proceedings of the First ACM SIGCHI Annual Symposium on Computer-Human Interaction in Play, Toronto, ON, Canada, 19–21 October 2014; ACM: New York, NY, USA, 2014; pp. 151–160.
51. Maurer, B.; Aslan, I.; Wuchse, M.; Neureiter, K.; Tscheligi, M. Gaze-based onlooker integration: Exploring the in-between of active player and passive spectator in co-located gaming. In Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play, London, UK, 5–7 October 2015; ACM: New York, NY, USA, 2015; pp. 163–173.
52. Maurer, B.; Lankes, M.; Stiglbauer, B.; Tscheligi, M. EyeCo: Effects of Shared Gaze on Social Presence in an Online Cooperative Game. In *Entertainment Computing*; Springer: Berlin/Heidelberg, Germany, 2016; pp. 102–114.
53. Edition, C.G. Bunny Bunny Moose Moose. 2009. Available online: https://boardgamegeek.com/boardgame/59149/bunny-bunny-moose-moose (accessed on 17 September 2018).
54. Woods, S. *Eurogames: The Design, Culture and Play of Modern European Board Games*; McFarland & Company, Inc.: Jefferson, NC, USA; London, UK, 2012.
55. Neureiter, K.; Murer, M.; Fuchsberger, V.; Tscheligi, M. Hand and Eyes: How Eye Contact is Linked to Gestures in Video Conferencing. In Proceedings of the CHI '13 Extended Abstracts on Human Factors in Computing Systems, Paris, France, 27 April–2 May 2013; ACM: New York, NY, USA, 2013; pp. 127–132, doi:10.1145/2468356.2468380.
56. Schmid, M.; Rümelin, S.; Richter, H. Empowering Materiality: Inspiring the Design of Tangible Interactions. In Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction, Barcelona, Spain, 10–13 February 2013; ACM: New York, NY, USA, 2013; pp. 91–98, doi:10.1145/2460625.2460639.
57. Gozli, D.G.; Brown, L.E. Agency and Control for the Integration of a Virtual Tool into the Peripersonal Space. *Perception* **2011**, *40*, 1309–1319, doi:10.1068/p7027.
58. Banks, J.; Bowman, N.D. Close intimate playthings? Understanding player-avatar relationships as a function of attachment, agency, and intimacy. *AoIR Sel. Pap. Internet Res. 14.0* **2013**, *3*, 1–4.
59. Kirman, B.; Rowland, D. Socially Respectful Enjoyment Tracking for Tabletop Games. In Proceedings of the CHI '08 Extended Abstracts on Human Factors in Computing Systems, Florence, Italy, 5–10 April 2008; ACM: New York, NY, USA, 2008; pp. 3393–3398, doi:10.1145/1358628.1358863.
60. Katie, S.; Zimmerman, E. *Rules of Play: Game Design Fundamentals*; MIT Press: Cambridge, MA, USA, 2003.

61. Yan, X.; Evan, B.; Iulian, R.; Maribeth, G.; Blair, M. Chores Are Fun: Understanding Social Play in Board Games for Digital Tabletop Game Design. In Proceedings of the DiGRA 2011, Utrecht, The Netherlands, 14–17 September 2011.
62. Fuchsberger, V.; Murer, M.; Tscheligi, M. Materials, Materiality, and Media. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Paris, France, 27 April–2 May 2013; ACM: New York, NY, USA, 2013; pp. 2853–2862, doi:10.1145/2470654.2481395.
63. Tholander, J.; Normark, M.; Rossitto, C. Understanding Agency in Interaction Design Materials. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM: New York, NY, USA, 2012; pp. 2499–2508, doi:10.1145/2207676.2208417.
64. Odom, W.; Banks, R.; Durrant, A.; Kirk, D.; Pierce, J. Slow Technology: Critical Reflection and Future Directions. In Proceedings of the Designing Interactive Systems Conference, Newcastle Upon Tyne, UK, 11–15 June 2012; ACM: New York, NY, USA, 2012; pp. 816–817, doi:10.1145/2317956.2318088.
65. Hallnäs, L.; Redström, J. Slow technology—Designing for reflection. *Pers. Ubiquitous Comput.* **2001**, *5*, 201–212.
66. Odom, W.; Wakkary, R.; Bertran, I.; Harkness, M.; Hertz, G.; Hol, J.; Lin, H.; Naus, B.; Tan, P.; Verburg, P. Attending to Slowness and Temporality with Olly and Slow Game: A Design Inquiry Into Supporting Longer-Term Relations with Everyday Computational Objects. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; pp. 77:1–77:13, doi:10.1145/3173574.3173651.
67. Carter, M.; Harrop, M.; Gibbs, M. The roll of the dice in Warhammer 40,000. *Trans. Digit. Games Res. Assoc.* **2014**, doi:10.26503/todigra.v1i3.20.
68. Wuertz, J.; Alharthi, S.A.; Hamilton, W.A.; Bateman, S.; Gutwin, C.; Tang, A.; Toups, Z.; Hammer, J. A Design Framework for Awareness Cues in Distributed Multiplayer Games. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; pp. 243:1–243:14, doi:10.1145/3173574.3173817.
69. Rogerson, M.J.; Gibbs, M.R.; Smith, W. What Can We Learn from Eye Tracking Boardgame Play? In Proceedings of the Extended Abstracts Publication of the Annual Symposium on Computer-Human Interaction in Play, Amsterdam, The Netherlands, 15–18 October 2017; ACM: New York, NY, USA, 2017; pp. 519–526, doi:10.1145/3130859.3131314.
70. Costikyan, G. *Uncertainty in Games*; MIT Press: Cambridge, MA, USA, 2013.
71. Baudisch, P.; Mueller, S.; Personal fabrication. *Found. Trends® Hum. Interact.* **2017**, *10*, 165–293, doi:10.1561/1100000055.
72. Wang, G.; Tao, Y.; Capunaman, O.B.; Yang, H.; Yao, L. A-line: 4D Printing Morphing Linear Composite Structures. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, Glasgow, UK, 4–9 May 2019; ACM: New York, NY, USA, 2019; pp. 426:1–426:12, doi:10.1145/3290605.3300656.
73. Yamaoka, J.; Dogan, M.D.; Bulovic, K.; Saito, K.; Kawahara, Y.; Kakehi, Y.; Mueller, S. FoldTronics: Creating 3D Objects with Integrated Electronics Using Foldable Honeycomb Structures. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, Glasgow, UK, 4–9 May 2019; ACM: New York, NY, USA, 2019; pp. 628:1–628:14, doi:10.1145/3290605.3300858.
74. Tanenbaum, J.; Tanenbaum, K.; Cowling, M. Designing Hybrid Games for Playful Fabrication: Augmentation, Accumulation & Idleness. In Proceedings of the Extended Abstracts Publication of the Annual Symposium on Computer-Human Interaction in Play, Amsterdam, The Netherlands, 15–18 October 2017; ACM: New York, NY, USA, 2017; pp. 413–419, doi:10.1145/3130859.3131334.
75. Eickhoff, D.; Mueller, S.; Baudisch, P. Destructive Games: Creating Value by Destroying Valuable Physical Objects. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose, CA, USA, 7–12 May 2016; ACM: New York, NY, USA, 2016; pp. 3970–3974, doi:10.1145/2858036.2858113.
76. Ion, A.; Frohnhofen, J.; Wall, L.; Kovacs, R.; Alistar, M.; Lindsay, J.; Lopes, P.; Chen, H.T.; Baudisch, P. Metamaterial Mechanisms. In Proceedings of the 29th Annual Symposium on User Interface Software and Technology, Tokyo, Japan, 16–19 October 2016; ACM: New York, NY, USA, 2016; pp. 529–539, doi:10.1145/2984511.2984540.

77. Ion, A.; Wall, L.; Kovacs, R.; Baudisch, P. Digital Mechanical Metamaterials. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, Denver, CO, USA, 6–11 May 2017; ACM: New York, NY, USA, 2017; pp. 977–988, doi:10.1145/3025453.3025624.
78. Bergen, B.K. *Louder Than Words: The New Science of How the Mind Makes Meaning*; Basic Books: New York, NY, USA, 2012; ISBN 9780465028290.
79. Kuijer, L.; Giaccardi, E. Co-performance: Conceptualizing the role of artificial agency in the design of everyday life. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; p. 125.