Hybrid board game: Possibilities and implications from an interaction design perspective

Saverio Cavicchini
School of Design
Politecnico di Milano
Milano, Italy
cavicchini.saverio@gmail.com

Ilaria Mariani
Department of Design
Politecnico di Milano
Milano, Italy
ilaria1.mariani@polimi.it

ABSTRACT

In a context of continuous miniaturization and technological advancement, the combination of digital and analog media is becoming an element of increasing importance. The so called "IoT revolution" represents one of the major technological breakthroughs of our times that re-framed the way we interact with our surroundings, now becoming data-rich and sensor-infused environments. The boardgames field, however, appears untouched by this revolution, even though an object-based system such as a tabletop offers an interesting scenario for smart interactions. The research in the field and the development of a prototype lead to a series of ground rules, best practices and problematics related to operations of hybridisation of digital means in an analog play experience.

CCS CONCEPTS

• Human-centered computing → **Interaction paradigms**; **Interaction design theory, concepts and paradigms**; *Interaction devices; Ubiquitous and mobile computing theory, concepts and paradigms*

KEYWORDS

Interaction Design; Hybridization; Hybrid Game; IoT; Research Through Design; Affordance; Agency

COMPUTING CAPACITY AND IOT: PREMISES FOR FURTHER HYBRIDIZATION

In the last decade, the way we are interacting with objects is changing, pushed by unceasing technological advances and progressive miniaturization that open up a series of possibilities and challenges. In particular, the pervasiveness of small-size and low-cost computational elements is on the ground of a noticeable shift in how technology can be embedded in everyday objects [20,22]. A growing number of devices, equipped with sensors and computing capacity, is today able to communicate with other devices, with their users or people in general, but also with the surroundings [10,11]. In so doing, shaped as networked ecosystems, they can augment our environments, making them smarter and more interactive, but also able to learn from what surrounds them and act in consequence. They are on the ground of the so-called *smart* or *IoT revolution* that is encouraging designers to re-frame usual interactions, producing new models and patterns of use that reinterpret our relationship with the technology [24]. The result are interactions that are ubiquitous and dynamic, often tangible [19], and sometimes even natural [40].

Even though this shift is systematically influencing and altering many object-based environments, in the gaming field, the board game scenery is not yet taking advantage of the possibilities provided by technology. As a matter of fact, it is not undergoing the evolution we could expect from embedding computing capacity, towards a hybridization. Broadly speaking, tabletop games are still the same established entertainment system [33] based on dice, cards, pawns and other analog interactions unchanged from last century titles. Over the years there has been a scarce number of market and research experiments on hybrid board games [25] which did not lead to results that might suggest nor a near or a major breakthrough in the field. Observing the state of the art in terms of both literature and case studies, most of the artefacts produced seem to simply propose the juxtaposition of devices and applications that move, or at best expand, the gaming experience to the digital context. Interesting examples are *Golem Arcana* [17], *Mask of Anubis* [28], *Alchemists* [1], *Mansions of Madness: second edition* [26], *World of Yo-ho* [41], and *Beasts of Balance* [2]. All the above mentioned—except the last one which probably offers the most interesting and well integrated

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experience arising from both media out on the market—simply propose a digital app on a smart device to use in parallel with the board game. The result is an experience divided between the digital and analog channel, characterized by media which do not communicate with each other, requiring the player to act as a bridge that updates the game information on both sides. As a consequence, the resulting experience is not fully meaningful and satisfying, since the technological potentialities are not leveraged. However, the analysis of these case studies shows a slight benefit on the gameplay, and hence on the overall game experience, especially if compared to the possible advantages of adding complexity to the game's dynamics without requiring player's efforts, and introducing a new communicative level between the player and the game system, conveying previously impossible play experiences. A particular mention has to be made to Mora et al. team [29], who leveraged on Sifteo Cubes device to build a play system around its features, and understood ground necessities for a playful TUI. Yet, *Panic!* project can be somehow compared with the redefinition of smartphone capabilities in *World of Yo-Ho* [41], while the following research does not aim at reusing pre-existing devices but rather develop a boardgame in which technology is tailor-made for the play experience.

Starting from such assumptions and premises, and taking a design perspective, we hereby present a series of reasonings that we recognize as worthy of investigation, and for which we have activated field trials. As a matter of fact, the rumination that follows is on the ground of a research through design [14,21] conducted in parallel at the Politecnico di Milano, School of Design by Saverio Cavicchini [7] and at the Università degli Studi di Milano, Computer Science Department by Alberto Ronchetti [35], as part of two MSc theses that investigated the possibilities connected to the integration of electronic components and computing capacities in a board game. The study started digging into the benefits of embedding sensors as smart bridges among the analogue and the digital, recognizing that making certain game elements become hybrid requires to tap into their *affordances* [5,6,16,24,32] and *agency* [13,39], as perceived as effective, also dealing with significant design dilemmas. Both affordances and agency can be seen as opportunities for action [6,39]. Considering that the first describes how a designed system operates, defining the possibilities and opportunities made available by an artefact or interface, while the latter refers to "the satisfying power to take meaningful action and see the results of our decisions and choices" [30:126], the two concepts are closely intertwined. Especially dealing with embedded sensors, smart objects and interfaces that are not always graphical [19,23,40], what we were used to taking almost for granted becomes a paramount issue, as that an interface or object should make explicit the interaction it allows to perform in order to be used to execute such an action [31]. The relationship between the possibilities and their communication has required particular reflections during the experimentation phase. Moreover, the hands-on experimentation carried out made evident a series of implications that also argues and reduces the feasibility of designing hybrid artefacts. Establishing a data exchange between different electronic components with tasks so specific might lead to problems related to the very nature of the chosen communication mean and its efficiency, noise and latency; aspects that require expertise and technical competences from different professional profiles.

THE BENEFITS OF HYBRIDIZATION

Adding computational power into board games implies evident benefits, as the fact that the board game system on its own can make calculation and make decisions according to the way in which it has been programmed and instructed. In the following we make explicit a series of advantages, presented from the specific point of view of the player, rather than the one of the designer. Then, we will also explore the consequences on the gameplay and on the game experience that results from adding hidden artificial intelligence into a board.

Cognitive load reduction

The first advantage that pops up from empowering board games with computational capacity is the possibility to reduce the amount of information that the player needs to process while playing. Sweller [37] defines *cognitive load* the amount of effort imposed on the working (or short-term) memory of an individual. Albeit fundamental for everyday quick tasks, the working memory is ephemeral and subject to sudden loss of information if distractions or overloads occur. Relying on short-term memory is discouraged in many design fields [31] and game design is no exception. Cognitive overload may eventually lead to flaws such as *fiddliness* and *paralysis by analysis* [3] play experience that are not meaningful nor satisfying.

A hybrid board game, on the contrary, can largely simplify the playing experience entrusting data to the game system itself rather than forcing players to elaborate and remember the information necessary to set up a gaming strategy. Putting knowledge in the world [31] is,

after all, one of the main reasons that led humans to develop digital artifacts in the first place: relying on digital storage systems and calculators that take care of processes our mind is not precise enough for. Leaving all minor calculations and mnemonic efforts to an electronic system relieves the player of a series of activities, while providing accurate and timely information. In doing so, the player is granted the cognitive freedom to enjoy all the aspects of a game beyond the mere strategy setting, such as material and visual components or the game narrative.

Artificial Intelligence integration

A second positive impact of digital hybridization is the chance to integrate a real artificial intelligence (AI) in the analog gaming experience. Non-Player Characters (NPC) and auto-activated game mechanics are nowadays widely used in tabletop games such as *Zombicide* [43], in which the opponent's behavior in all possible situations is meticulously described in the rule book. Nonetheless, it is the player who ultimately has to learn additional rules in order to determine NPC actions according to the circumstances, and it is still the player who has to carry them out. Being completely automatic, introducing an AI to run NPC and their decision-making processes allows not to weight over players' cognitive load nor to increase the downtime [8,38] needed for completing the actions of such characters. Since it does not require human intervention during the game, the AI can be designed with a higher degree of complexity and freedom of choice, thus offering more interesting gaming experiences. Recent developments in the Machine Learning field [34] can further contribute in delivering meaningful experiences benefiting of an AI capable of learning and adapting, making it less predictable to players, but also able to respond to changes in tactics, during gameplay.

New game mechanics and interactions

Another potential benefit of hybridization concerns the vast horizon of game mechanics allowed by a system interacting directly with the surrounding environment and its variables (player's included). Thinking back to Salen and Zimmerman's [36] definition of game, as a system with both endogenous and exogenous connections, it is evident that until now exogenous interactions have been directed towards players only. The introduction of sensors and computational capacity questions the fact that human action traditionally represents the only source of input towards a board game, opening the system to broader interactions, as with the player and the surrounding environment also seen as set of variables that can impact on the gameplay and the decision-making processes of the game. Physical parameters such as temperature, humidity, light, and sound can be affected by the game to automatically activate new mechanics.

Furthermore, this new set of mechanics allowed by digital enhancement can be translated by the game designer into interactions closer and coherent with the narrative world. Until now, game actions carried over by players have always been significantly different from the actions taking place into the narrative world. The best example in this sense can be found in *Dungeons and Dragons* [9], where the only two game actions allowed are verbal explanations of the act taking place and dice rolls. Both these interactions are extremely far from the narrative level. However, with the environmental awareness enabled by sensors, board games can be enriched with interactions closer to the story being told.

The research conducted includes as a proof of concept the design of an early stage prototype of a hybrid board game that allowed us to test the pros and cons of embedding technology into a physical artefact. The tabletop designed, called *In Tenebras*, is composed of two main parts:

- the board, meant primarily to figure out the character pawn position on the game board and convey game information through backlight;
- the avatar, in its prototypal form shaped a box containing several sensors for perceiving as much stimuli/data that are transferred to the AI to be processed as player's action.

Since the exploration of new mechanics relying on the awareness of the environment and the player by the game system was one of the primary goals of the research, we opted for a setting and a theme that could bring such conditions to the extreme, to understand the potential of hybridization and obtain a cohesive game system able to communicate its possibilities (affordances and agency) in a direct, efficient way, the detachment between the actions to perform and the game narrative level has been lessened as much as possible. The horror theme was chosen to explore such potential and develop sensor-based interactions that closely follow the narrative level.

Following and capitalizing on the above described close relation between narrative, mechanics, and interactions, the Avatar (fig. 1) requires to be handled and treated adopting behaviors in line with the occurrences. Therefore, for example, when the character ends up blocked by fear the player is asked to shake the avatar, or when the character is scared because of some narrative

events, its blood freezes and the player must warm up the avatar, just as she would do in a real world situation.

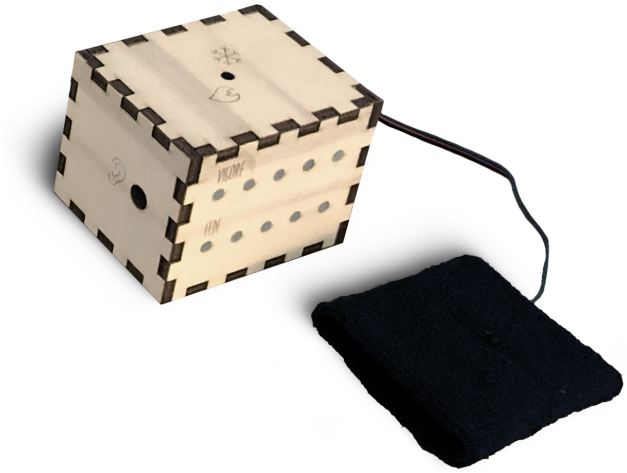

Figure 1. The rough prototype of the Avatar.

Sensors and electronic components embedded allow a considerable variety of possible interactions; moreover, the correspondence between player's action and narrative events enhances the play experience to a level of meaning that could not be reached relying on analog means.

Hiding information to players

To conclude the analysis of the advantages, the last benefit coming from the coexistence of digital and analogue within a board game is the possibility to hide information from the player. Board games, in order to be played, require transparency, as to say that every information, event or game situation has to be described in detail in the rulebook, and players must clearly comprehend it all to properly set a game and apply rules correctly. The knowledge that every turn of the game may require to perform the play activity precludes, or at best hinders, the design of game experiences based on discovery, mystery and surprise. On the contrary, as pointed out by Fischer, the digital medium is, instead, *opaque* [12]. Every information intended for the player must be declared since it has to appear on screen, or else it will remain hidden, yet still present at coding level. The advantage of the digital medium is exactly that the game can be processed by the code without human intervention. Therefore, the game system might possess information strictly necessary for the game to develop, yet not share it with the player. Contrary to analog games where players need to know every detail in order to play, the digital component does not require players to know everything: the game computes and proposes advances even if players are unaware of what is going on. The game designer can take advantage of the opacity of the digital medium by conceiving playing experiences that entail twists of events. Progressive information delivery, combined with the chance of random extraction from a pool of possible events, might also grant and facilitate narrative branching, positively impacting on the replayability of a game [38].

HOW TO ACHIEVE HYBRIDISATION BENEFITS

Parallel and complementary to benefits, operations of tabletop hybridisation with computing capacities might fall into the same problematics addressed in the literature related to smart object design. Such issues, explored in the following, cannot be neglected when designing hybrid games since they might hinder user experience, leading to consistent misunderstandings about what the game allows players to do, both in terms of affordances and agency.

Smart technology dilemma

Different authors delved into the topic of dilemmas caused by smart technology during the design phase [15,22,42]. The first dilemma, arising from embedded interactions [22], is closely related to the concept of *design for commensurability* [15]. Infusing digital and computational capacities into an object might radically alter the very nature of the object itself, by affecting its aspect and behavior, but also the interactions to perform it in order to accomplish the task [4]. The designer should be able to embed digital capacities so that they do not contrast with pre-existing characteristics or entirely reshape how the object has been used so far. While designing the prototype, this matter was closely taken into consideration since both the board and the avatar were going to be used in a way that is augmented if compared to their traditional uses in traditional board games. The solution to this particular aspect has been identified in Tangible User Interfaces (TUIs) [18], interfaces which allow physical manipulation of digital data and the visualization of feedback directly onto the object being handled. Such interfaces take advantage of our ability (and also habit) of manipulating and interacting with objects, providing physical form to digital information. Through TUIs, computational means are able to bring benefits to board games without undermining the physical and tangible experience of playing a tabletop.

This matter of concern is closely followed by a second one: the *invisibility dilemma* [22]. It might happen that computational and electronic means embedded in an object are hidden to the user to avoid the first dilemma. It is otherwise fundamental that an object's potential digital

enhancements are distinguishable by the user for her to identify it as a smart object and use it in a suitable manner. Using fluid yet evident forms of feedback [18] to users input in a TUIs, which are directly provided on the object being manipulated, largely solves this potential design issue. In the prototype developed, the surface of the board is backlit and provides a valuable affordance of its hidden information [27].

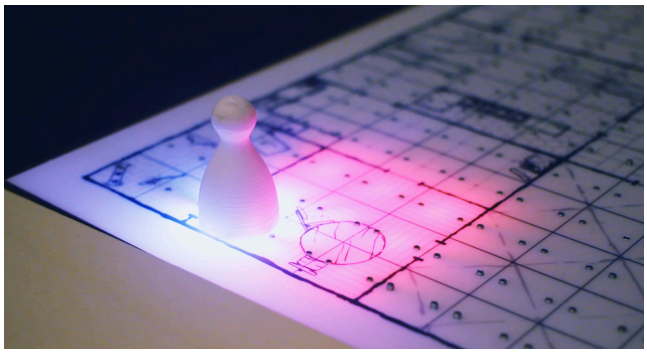

Figure 2. Picture representing the way in which the game information is delivered to the player through backlight.

The third problematic addressed has been called *control dilemma* [42] and it is mainly caused by the increasing automation of smart objects. Designing these objects to act and react autonomously provokes a significant decrease in the overall degree control over them. The risk related to the control dilemma is to cut users out of a flow of events and reactions completely unmanageable on their side. Although paramount, there is no technical solution to this dilemma, which has to be tackled through user research and careful user testing aiming at tailor-made solutions for a flawless experience according the target identified. The hybrid board game mounts an interface that dynamically communicates according to the need. Depending on the specific situation and requirements (gameplay), the computational intelligence that constitutes the board manages its elements and makes them react as a sort of dynamic interface, able to communicate to the user what would otherwise stay hidden. The attempt to integrate smart capacity into a hybrid board game without falling into the aforementioned dilemmas led to accompany the function of interface served by the board, with a screen. The need to tell the ongoing story and its evolution according to the player's action, and the necessity to clearly communicate the implications of the events in progress, enhancing them with narrative meaning, demanded for a clear and complex communication. Despite the presence of a surface that provides visual feedback, the function of showing more complex data and the game narrative is entrusted to an external display.

CONCLUSIONS

Nonetheless, the recent breakthroughs in electronic technology represent a promising opportunity for the hybridisation of the analog medium with the digital one in a tabletop, allowing a new level of interaction between player and game system. While opening ground for the design of new playing experiences impossible before, we are still far from imagining such product on the market, at an affordable price, with meaningful gameplays, and interesting interactions. Even though microprocessors, sensors and other electronic components have gotten smaller, cheaper and more powerful, experimentation in the field are limited in number and obtained not fully satisfying results. First of all, the design and development of a hybrid board game requires a numerous and multidisciplinary team, involving different technical profiles such as game designer, game developer, interaction designer, product designer, computer scientist and electronic engineer. Working on such a complex project with a limited team might hinder the innovation that only a specialist in the field could bring about. On the contrary, working in a small team allows for quick decision-making and project turns based on the issues faced. Moreover, the cost of electronic components, however low, has an important impact on the overall price of a hybrid board game. The resulting is a product not yet ready to compete on the market against fully analog games. In addition, the lack of documentation about similar operations, tackling the hybridisation of a board game from a design point of view, might resolve in a project moving away from standardized territory. While sounding promising, every decision taken has to be carefully tested, since there is no reference to be guided by. Lastly, one of the main issues of designing a hybrid board game as an ecosystem with various smart elements in constant dialogue is the need to have dynamic interfaces able to provide immediate and clear feedback to the user. As argued by Ishii himself when discussing *tangible bits*' limits [18] in favour of his latest concept of *radical atoms* [19], TUIs have the clear advantage of allowing an immediate association between physical representation and digital information. Their limit is the ability to represent change: they cannot adapt and modify their properties during interactions. By contrast, the presence of different components allows to convey information and feedback to the user, combining visual and additional sensory stimuli. This design choice follows

Ishii's recommendation of embedding "malleable" forms of feedback—as audio and video—that are complementary to TUIs tangible and visual feedback. In doing so, it has been applied Ishii's *Double Interaction Loop* [19], an interaction that results into a set of composite feedback. Although this direction adds levels of interpretation, potentially decreasing the immediacy of certain interactions, it also makes the game playable by visual impaired users.

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