EMA: AN ANALYTICAL FRAMEWORK FOR THE IDENTIFICATION OF GAME ELEMENTS IN GAMIFIED SCREEN-SCORE WORKS

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ABSTRACT

Gamified compositions – music involving game elements (e.g., avatars and life points) – have been booming in the field of interactive computer music. However, only a few studies have addressed which game elements engender the sense of playfulness in performer-computer interactions in music. This gap may exist because existing analytical frameworks primarily focus on identifying game elements in consumer products rather than musical compositions. To address the lack of analytical frameworks for gamified musical works, this paper proposes the Expanded Motivational Affordances (EMA) model as an analytical framework for identifying game elements in gamified screen-score works. Through an analysis of *Super Colliders* by T. Fukuda and *SQ2* by P. Turowski as case studies, this paper provides a comprehensive list of game elements and discusses what motivational needs for performers these elements satisfy. The EMA model with the resulting list of game elements aims to assist composers in gaining a better understanding of performer-computer interactions in gamified screen-score works. It enables composers to analyze and design such interactions more effectively in their future compositions, enhancing the overall experience for performers.

1. INTRODUCTION

In recent years, the application of gamification, defined as "the use of game design elements in non-game contexts" [1], has gained significant traction in the realm of interactive computer music [1]. The term "gamified" has emerged to describe a specific type of composition that integrates game elements–building blocks that support game mechanics–such as avatars and life points as exemplified by "gamified audiovisual works" [3] and "gamified screen-score" [4]. Noteworthy pieces in this vein include P. Turowski's *Hyperions* (2014), C. Ressi's *Game Over* (2018) and G. Peles' *Score Craft* (2022). Additionally, research projects like "GAPPP: Gamified Audiovisual Performance and Performance Practice" led by M. Ciciliani [2] and the "Digital Score" project spearheaded by C. Vear [3] have contributed to the exploration and development of various gamified works.

The increased interest in gamified compositions stems from their potential to create emergent musical forms through performer-computer interactions. However, despite the growing prominence of these compositions, to the best of our knowledge, only one study has proposed a framework for identifying game elements used in musical compositions and analyzing how these elements contribute to playful performer-computer interactions [4]. This scarcity may be because other analytical frameworks focus primarily on identifying game elements in consumer products rather than musical compositions. This paper aims to address this gap by proposing the Expanded Motivational Affordances (EMA) model as an analytical framework that identifies game elements and examines how the elements support playful performer-computer interactions in gamified screen-score works.

In the following sections, we introduce two crucial analytical frameworks: the Mechanics-Dynamics-Aesthetics model and the Motivational Affordances model. Their comparison underscores the necessity of expanding the Motivational Affordances model, which serves as the cornerstone of our research. Moving forward, we present an overview of the EMA model in the third section. In the subsequent fourth section, we conduct a case study, employing the EMA model to analyze two gamified screen-score works: *Super Colliders* by T. Fukuda and *SQ2* by P. Turowski. This case study yields a comprehensive list of game elements, demonstrating the effectiveness of the EMA framework in this regard. Following this, we delve into discussions regarding implications and limitations in the fifth section, outline potential directions for future research, and conclude by summarizing the validity of the EMA framework for understanding and harnessing the potential of the gamified screen-score works.

2. RELATED WORKS

There have been several frameworks that aid in understanding a game in the field of game design [5, 6, 7]. When it comes to creating engaging interactions between players and computers, one of the most pertinent frameworks is the Motivational Affordances framework.

[1] Interactive computer music refers to "a music composition or improvisation where software interprets a live performance to affect music generated or modified by computers" [2]

[2] http://gappp.net

[3] https://digiscore.github.io

2.1 Motivational Affordances

The Motivational Affordances (MA) framework is founded on the MA theory, which postulates that enjoyable human-computer interactions depend on fulfilling users' motivational needs [8, 9]. The term "motivational affordances" refers to the properties of an object that determine whether and how it can support users' motivational needs. Based on the MA theory, Weiser et al. have established a framework that serves as an analytical tool to identify several game elements and how these elements fulfill various motivational needs within gamified products [10]. Their taxonomy of motivational needs encompasses the following six categories:

- Autonomy: The need for the freedom to initiate and regulate one's own behaviour, making choices independently.
- Competence: The need to excel in mastering challenges appropriate for personal growth and development.
- Relatedness: The desire for a sense of belonging and connection to others.
- Achievement: The desire to perform exceptionally well, measured against a standard of excellence, which can involve competing with oneself, others, or specific tasks.
- Affiliation and Intimacy: The need for other people's approval and the inclination toward secure and rewarding relationships, respectively.
- Leadership and Followership: The desire to gain authority and impact, control, and influence others and the desire to support or be subordinate to a leader, respectively.

Weisler et al.'s study introduces the concept of "Mechanics," which are defined as "possible means of interaction between a user and the system" [10]. Engaging interactions are achieved when mechanics are designed to fulfill the user's motivational needs. The six key mechanics are identified:

- Feedback: Providing users with visual and aural information about their actions, optimizing their actions, and increasing motivation.
- User Education: Offering advice to compensate for knowledge gaps and assisting users in achieving their goals.
- Challenges: Presenting difficult tasks or quests that fulfill the desire for competence.
- Rewards: Offering valuable items or incentives in exchange for user accomplishments, satisfying achievement and competence needs.
- Competition and Comparison: Creating situations involving challenges and rivals, addressing the desire for achievement and leadership, often seen in multiplayer settings.
- Cooperation: Facilitating collaborative actions with other players to achieve common goals, addressing the need for affiliation and leader-/followership.

This framework forms the foundation for comprehending how the fulfillment of motivational needs through mechanics can foster the playfulness of performer-computer interactions in gamified environments. Finally, their study defines the term "game elements" as specific tasks or objects that support mechanics, such as quests (for Challenges), points (for Rewards), and leaderboards (for Competition).

2.2 MDA

The Mechanics-Dynamics-Aesthetics (MDA) model is another prominent tool for the analysis of computer games and has been considered in this context because it is a seminal framework for "playcentric" approaches.[6, 7] In other words, focusing on the experience of the player first and foremost "encourages experience-driven (as opposed to feature-driven) design."[11]

The MDA framework offers a comprehensive breakdown of games into three fundamental components:

- Mechanics: The fundamental building blocks of the game encompassing its rules, basic player actions, algorithms, and data representation within the game engine. Mechanics essentially define the core operations and functioning of the game.
- Dynamics: The real-time behaviour of these mechanics when players interact with them. It encompasses how the mechanics respond to player input and how they interact with one another throughout gameplay.
- Aesthetics: The desirable emotional responses elicited in players as they engage with the game.

The MDA framework further provides a taxonomy of aesthetic types that encompass a wide range of player experiences such as the following;

- Sensation: This aesthetic type portrays the game as a source of sensory pleasure, where players delight in memorable audio-visual effects.
- Fantasy: In this category, games offer a realm of make-believe, immersing players in imaginary worlds.
- Narrative: Games take on the role of drama, enticing players with engaging stories that keep them returning for more.
- Challenge: This aesthetic kindles the desire to conquer, presenting games as obstacle courses that fuel the urge to master them and enhance replayability.
- Fellowship: Games act as social frameworks, forming communities where players actively participate. This aesthetic is particularly prevalent in multiplayer games.

- Discovery: Games invite exploration, presenting themselves as uncharted territories that spark players' curiosity to uncover the game world's secrets.

- Expression: This aesthetic encourages self-discovery and creativity, allowing players to express themselves, such as creating characters resembling their own avatars.

- Submission: In this category, games serve as pastimes, fostering a connection to the game as a whole, even within certain constraints.

The MDA framework, with its categorization of aesthetics and analysis of game components, provides insights into the multifaceted nature of player experiences in computer games. Understanding these components aids in not only game design but also the enhancement of player engagement and enjoyment. The MDA framework stands as a tool for dissecting and comprehending the relationships between mechanics, dynamics, and aesthetics within computer games, contributing to the creation of more immersive and captivating gaming experiences.

2.3 Comparision Between MA and MDA Frameworks

In our pursuit of a comprehensive understanding of gamified screen-score works, we have conducted a comparison between two influential frameworks: the MA framework and the MDA framework. This comparative analysis has unearthed connections between these frameworks, shedding light on how each aesthetic type proposed in the MDA framework can effectively address the motivational needs outlined in the MA framework, as illustrated in Table 1.

For instance, consider the aesthetic type of "Fantasy". This aesthetic type has the capacity to address the need for autonomy because the imaginative immersion in a make-believe world hinges on players' freedom to make decisions within that realm ("1" in Table 1) [12]. Similarly, the aesthetic type "Challenge" can serve as a means to fulfill the desire for competence. The imposition of difficult challenges upon players contributes to the enhancement of their skill levels, aligning with their intrinsic desire for personal growth and proficiency ("5" in Table 1).

Furthermore, during our comparative analysis, we observed an intersection between Zhang's MA theory [9] and the MDA framework. Specifically, the "affect and emotion" category, representing emotional states that occur as reactions to significant stimuli in one's environment, in Zhang's motivational taxonomy is particularly relevant to the "Sensation" aesthetic type in the MDA framework. This association stems from the fact that the sensation aesthetic type often revolves around creating sensory pleasure, which can shape player emotions. In light of this observation, we made a decision to augment the taxonomy of motivational needs initially proposed by Weiser et al [10] by incorporating the "affect and emotion" category.

In the subsequent section, we will introduce our Expanded Motivational Affordances model and elucidate how these refinements augment our understanding of the intricate relationships between aesthetics, mechanics, dynamics, and motivational needs within gamified screen-score works.

3. THE EMA MODEL

3.1 Our Model

The Expanded Motivational Affordances (EMA) model offers an intricate framework designed to comprehensively grasp the dynamics underpinning user engagement in gamified screen-score works. This model recognizes and delves into a diverse array of motivational needs, which users actively seek to fulfill while immersing themselves in these interactive musical compositions. These motivational needs encapsulate a wide spectrum of physiological, psychological, and social desires, collectively constituting the prime motivators that drive user engagement and participation.

In both the MA and MDA frameworks, prioritizing an understanding of the player's experience is pivotal for identifying mechanics that effectively achieve specific outcomes crucial for gamified composition designers. In other words, both frameworks underscore the importance of 'experience-driven design,' prompting a desire to integrate these two models.

3.2 Components of the EMA Model

The EMA model is structured around a taxonomy of motivational needs, each representing a distinct facet of the user's intrinsic drive for engagement. These motivational needs are as follows:

- Autonomy: This fundamental need pertains to the desire for autonomy, empowering users with the freedom to initiate and regulate their behaviour within the gamified screen-score experience. It encompasses the ability to make independent choices and decisions, thereby fostering a sense of agency. Affording autonomy contributes to imaginative immersion (fantasy and narrative), personal expression and emotional maintenance (submission).

- Competence: Users are innately driven by the pursuit of excellence and the desire to master challenges that are optimally suited for their personal growth and development. The competence need fuels the aspiration for continuous improvement. Competence is also related to the process of discovery—i.e., understanding the breadth and scope of the system.

- Relatedness: At its core, the human experience thrives on social connections. The relatedness need encompasses the yearning for social engagement, recognition, and a deep sense of belonging within the community of participants. Integrating fantasy and narrative can help players to relate to their environment, and submission can also be supported by fellowship.

- Achievement: Individuals aspire to showcase their competence and accomplishments to others. The

		Motivational needs						
		Autonomy	Competence	Relatedness	Achievement	Affiliation and Intimacy	Leadership and Followership	Affect and Emotion
Aesthetic types	Sensation							17
	Fantasy	1		7		13		18
	Narrative	2		8				
	Challenge		5		11		15	
	Fellowship			9		14	16	
	Discovery		6		12			
	Expression	3						
	Submission	4		10				

Table 1. The table shows which motivational needs each aesthetic type may satisfy.

achievement need underscores the motivation to excel and be recognized for one's capabilities and achievements. Rising to a challenge and discovering more of the available possibility space can support a sense of achievement.

- Affiliation and Intimacy: Human connections are nourished by approval, affection, and the cultivation of secure and rewarding relationships. This need encompasses the desire for social approval, as well as the inclination towards forming intimate and meaningful bonds, which can contribute to a sense of immersion.
- Leadership and Followership: Users may seek to exert influence and control over their surroundings, aspiring to shape the physical or social environment in alignment with their vision or plan. Conversely, there is also a desire to support or be subordinate to a leader, reflecting the leadership and followership needs. Effective team management can satisfy the desire to overcome challenge.
- Affect and Emotion: Recognizing the influence of emotions on the user experience, this category emphasizes induced emotional states that arise in response to significant stimuli. It encompasses the emotional responses that play a pivotal role in shaping the overall motivational experience, enriching it with affective dimensions.

The EMA model extends and enriches the foundational concepts of the MA framework. By incorporating the "affect and emotion" category into the taxonomy of motivational needs, the EMA model provides a more comprehensive and nuanced perspective on the factors influencing player-computer engagement in gamified screen-score compositions. This expansion equips researchers, designers, and practitioners with a refined tool for identifying and understanding the game elements that contribute to the multifaceted motivational experiences within this genre of interactive computer music.

The subsequent section of this paper is dedicated to in-depth case studies of existing gamified screen-score works. These case studies employ the EMA model as a lens to comprehensively identify various game elements within two existing gamified screen-score compositions: *Super Colliders* and *SQ2*.

4. CASE STUDIES

4.1 *Super Colliders*

4.1.1 Goals and Rules

Super Colliders (2018) is a composition created for three pitched instruments and an interactive computer system. The primary objective was to craft the piece in such a way that the player's desire to win the game results in an enriching musical performance [4]. Therefore, it can be assumed that the piece aims to satisfy the motivational needs of competence and achievement. The interactive computer system poses challenges as musical symbols, which the players must interact with to perform.

The game consists of four rounds in which players compete against each other. At the end of the game, one player is declared the grand winner based on their success in winning the most rounds. To win each round, players must accumulate 1,080 life points faster than their opponents. These life points are earned by colliding their avatars with continuously moving blobs on the screen-score. Each collision results in the acquisition of one life point. However, if all players miss a collision, all three of them lose a point collectively. Thus, the game has two possible outcomes: either one musician earns the highest number of points and wins the round, or a scenario called "all dead" occurs, signifying that all musicians lose and the computer emerges victorious.

During the performance, the players control their avatars by executing ascending or descending glissandi at varying volumes. The vertical position of the performers' avatars corresponds to the pitch change, while the horizontal position and avatar size are mapped to the loudness of their performance [13].

4.2 Identification of Game Elements

In gamified screen-score compositions, the mechanics that drive performer-system interaction find concrete expression through design components referred to as "elements." These elements, specific to each gamified piece, support and manifest the underlying mechanics, translating abstract concepts into tangible user experiences. While Weiser et al.[10] originally identified seven universal and context-free element categories, this subsection delves into the context-specific instantiation of mechanics as concrete elements with the purpose of discovering new elements specific to gamified screen-score works.

4.2.1 *Feedback*

Feedback mechanisms in this context include:

- Obedient avatars.
- Responsive collision sounds.

Obedient avatars and collision sounds serve as immediate and perceptible feedback to players regarding their performance within the screen-score. This feature inherently caters to the need for self-determination during the performance, thereby affording the motivational need for autonomy. Moreover, the predictability of avatars' reactions to sound effects enhances the performers' sense of control, contributing to a sense of competence, especially when fully immersed in gameplay.

4.2.2 *User Education*

Elements facilitating user education encompass:

- Written instructions.
- Rehearsals.
- Rounds.

These elements bridge the knowledge gap for performers, elucidating the requirements of the performance. They support the competence need by equipping performers with the necessary knowledge and skills to engage effectively. Moreover, if competence leads to success and achievement, user education plays a crucial role in fulfilling the achievement need. Written instructions provide a conceptual framework for the piece and aid in performance preparation. Rehearsals offer valuable opportunities for performers to familiarize themselves with the interactive system, fostering skill development and strategic thinking. The iterative nature of rounds further serves as a learning platform, allowing performers to refine their skills and interpretations as the piece unfolds.

4.2.3 *Challenges*

Challenges are embodied through:

- Moving blobs.

The task of intercepting moving blobs with avatars offers a challenging experience that caters to the competence need. Success in this task demands vigilance, visual acuity, and agility, satisfying performers' desire for mastery. Striking a balance between challenge and frustration is crucial, with blob behaviours serving as the key factor in controlling difficulty levels. These challenges are pivotal in maintaining engagement throughout the piece.

4.2.4 *Rewards*

Reward elements consist of:

- Life points.

Life points serve as a mechanic to reward players for successfully intercepting blobs, aligning with the competence need. Additionally, they fulfill the achievement need by visibly showcasing the player's success. Life points introduce a competitive aspect, where players' health is compared, potentially leading to 'deaths' within the game. This concept fosters both competition and cooperation dynamics among players, making them view each other as rivals and strategic collaborators to avoid 'dying.' Thus, life points satisfy the need for survival, intricately linked to leadership and followership.

Figure 1. The screen-score showing avatars, moving blobs and life point indicators in *Super Colliders*

4.2.5 *Competition*

Competition is epitomized by:

- Leaderboard.

The leaderboard announces round winners and, ultimately, the grand winner at the conclusion of the piece. This element resonates with the relatedness and achievement needs, providing a platform for recognition and social engagement among performers.

4.2.6 *Cooperation*

Cooperation manifests through:

- 'All dead' scenario.

While primarily a competitive setting where only one player can win, the 'all dead' scenario presents an incentive for players to cooperate and prevent missing too many blobs, thus depleting their life points. This element addresses the needs for leadership and followership within the ensemble, emphasizing collaboration among players even in a competitive environment.

4.3 *SQ2*

4.3.1 *Goals and Rules*

SQ2 (2019) may be played by any quartet of performers that are capable of producing sustained pitch with at least a one-octave range and varying degrees of loudness.

In *SQ2*, players take control of four luminescent orbs. When a player makes a sound, their corresponding orb creates circular pulses of energy, which collide with nearby objects and agents. By sustaining pitches, energy pulses can be tuned to resonate with particular targets (see Fig. 2). Players may create energy pulses as long as they have stamina remaining; if a player's stamina is fully depleted, they must wait until it fully recharges before creating another pulse.

Players work together to shape the sounding score and facilitate growth within the virtual environment—e.g. resonating with colored gems (i.e. matching pitch class) to produce tree-like structures. While some elements of the score—e.g. overall form—are prescribed, players are free to decide how lower-level patterns—e.g. rhythm, melody, rate of progression—will develop over time. The game ends when the performers collectively maintain a long period of silence.

SQ2 primarily focuses on collaborative gameplay and therefore aims to satisfy the motivation needs for leadership and followership as well as affiliation and intimacy, emphasizing fellowship among players [14].

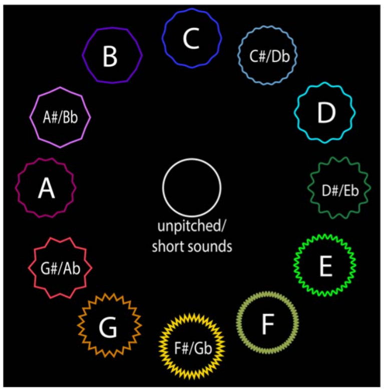

Figure 2. Mapping of shape/color to pitch class in SQ2

4.4 Identification of Game Elements

4.4.1 *Feedback*

Feedback mechanisms in this context include:

- Obedient avatars.
- Electronic sounds as a pitch and rhythmic reference.
- UI meters.

Feedback in *SQ2* is designed to be both 'discernable' and 'integrated', as key aspects of 'meaningful play'[5], which relates to autonomy and competence. Feedback is discernable through immediate visual cues on successful control input in the form of an audio signal. These visual cues are redundant for the sake of greater visibility and accessbility; input is registered in the UI meters at the bottom of screen as well as on the player's avatar, and an extensible line connects the two in later stages to avoid confusion. Furthermore, meters display information about pitch class, available stamina (graphical and numerical), and the time threshold for energy circle creation. (See Fig 3.) At certain points in the progression of the score, the software produces electronic pitches at regular intervals that provide a framework (pitch and rhythm) for improvisation. Feedback is 'integrated' in that "an action a player takes not only has immediate significance in the game, but also affects the play experience at a later point in the game" [5]. This is achieved through the transformation of the environment over the duration of the piece.

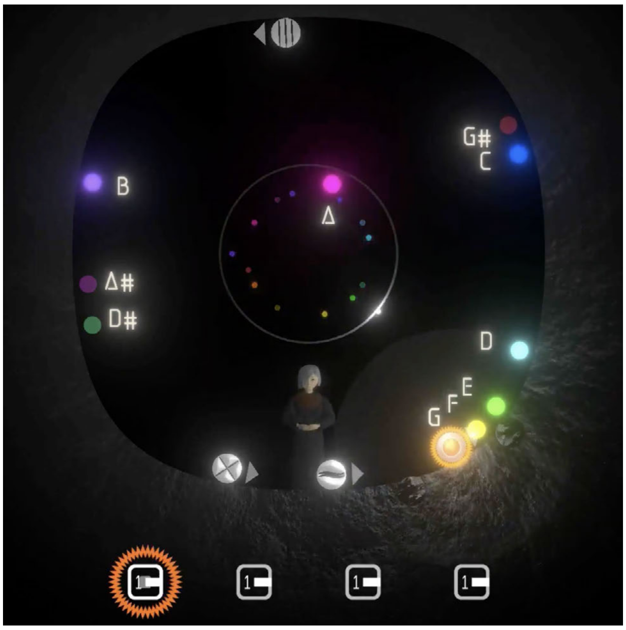

Figure 3. SQ2 user interface

4.4.2 *User Education*

Elements facilitating user education encompass:

- Didactic design.
- Written instructions.
- Instruction video.
- Rehearsal.

The piece requires the completion of basic tasks in the beginning that introduce the players to the mechanics of the game and gradually increase in complexity. Initially, any sound event (a sound that lasts for more than 100ms and terminates in silence) creates an energy pulse that moves the player's avatar forward. (The forward vector is indicated by a small arrow near the avatar.) Energy pulses also release gems from the terrain, and players can resonate with these gems by playing particular pitch classes. Resonating with a gem increments the collective point total, and achieving the target score allow players to progress to the next stage. These basic 'control sound' [15] mechanics are the foundation for more complex mechanics that are revealed later, such as tree growth on the surface of the planet. Defining a 'core mechanism' to achieve a more 'elegant' design [16] serves a didactic purpose and therefore contributes to the motivational need of competence. Education towards a greater sense of competence is further supported by written performance instructions and a tutorial video [17], which should inform the rehearsal process. Given the improvisatory and collaborative nature of the piece, rehearsals are crucial for a proper performance of this piece.

4.4.3 Challenges

Challenges are embodied through:

- Time limit (optional).
- Agents.

SQ2 was intended to be an open exploratory experience with a relatively low level of challenge (after the initial learning phase). For example, players can take as long as they want to meet the point-based goals in each stage. (Points and the related stamina system are further discussed in the 'Rewards' section below.) However, an optional time-limit allows for the length of performances to be more strictly regulated and this can increases the level of challenge by giving players an extra task—i.e. to satisfy the point goals before time runs out. Additionally 'agents' or NPCs (non-player characters) roam the terrain and attract players who are making non-pitched sound. Agents can either restrict the player (if they wish to avoid being attracted) or facilitate movement (by changing direction or by 'riding' an agent to a desired location on the map). In either case, players benefit from being aware of agent positions, which can be difficult when focusing on the core tasks of movement and gem resonance. Both elements add challenge to the play experience and thus address the motivational needs of competence and achievement.

4.4.4 Rewards

Reward elements consist of:

- Stamina extension.
- Points.
- World development.

Successful achievement of the primary game goal (i.e. to resonate with colored gems) is rewarded in three ways. Resonating with gems increases the overall point tally, which provides players with a clear and quantifiable sense of collective progression through the piece. Additionally, gem resonance incrementally increases player stamina, which governs how many energy pulses a player can create. In other words, having more stamina allows a player to act (i.e. move and resonate) more continuously rather than having to wait in silence for stamina to replenish. This reward satisfies the motivational need for autonomy. Lastly, progression yields a transition from the 'inner earth' environment to the 'planet surface' environment and subsequently populates the surface with tree-like structures, which modify the traversable terrain and establish the harmonic palette and rhythmic period of the resulting improvisation. All three of these reward types support the motivational need of achievement.

4.4.5 Competition

This piece is designed to avoid competitive gameplay. Players can elect to stifle each other if they wish, but such behaviour would delay/prevent the achievement of the goal to reach the indicated point score, which is shared between all players (see 'Cooperation' below). Players could potentially compete to see who can achieve the highest stamina level, but the mechanics of the game do not explicitly reward such behaviour.

4.4.6 Cooperation

Cooperation manifests through:

- Shared score.
- Player-to-player stamina replenishment.

Resonating with colored gems is rewarded by gaining a point in a collective point system, which regulates the overall progression of the piece and encourages collaborative behaviour to satisfy the motivational needs of relatedness, affiliation and intimacy, and leadership and followership. Additionally, a player is able to help another by creating an energy circle near them, which replenishes their stamina.

5. COMPARISON BETWEEN *SUPER COLLIDERS* AND *SQ2*

The most notable difference between *Super Colliders* and *SQ2* is that the former focuses on a competitive gameplay experience while the latter focuses on collaborative gameplay experience. While both satisfy most of the seven motivational needs to some extent, Competence and Achievement are more primary for *Super Colliders* while Relatedness and Leadership and Followership are more primary for *SQ2*. These motivational differences necessarily result in mechanical differences, such as the different implementations of common game elements like points, agents, and time limits.

6. DISCUSSIONS

The introduction of the Expanded Motivational Affordances (EMA) framework presents an exciting development in the analysis and creation of gamified screen-score compositions within the realm of interactive computer music. In this discussion, we introduce the implications, limitations, and future directions of the EMA framework.

6.1 Implications

The EMA framework offers profound implications for both research and composition in the field of gamified screen-score works.

Firstly, as demonstrated through our case studies of *Super Colliders* and *SQ2*, the EMA framework provides a powerful lens for understanding existing compositions. By dissecting these works into their constituent game elements and linking them to specific motivational needs, we gain insights into the intricate interplay between performers and computer systems. This understanding not only enriches our appreciation of these compositions but also lays the foundation for more informed critique and analysis.

Secondly, the EMA framework emerges as a potential model for the creation of new gamified screen-score works. Composers can leverage this framework to strategically design and integrate game elements that cater to desired motivational needs. This approach opens up exciting possibilities for the deliberate fusion of musical and gaming elements, fostering innovative and engaging interactive musical experiences.

6.2 Limitations

While the EMA framework holds significant potential, it is essential to acknowledge its limitations.

One notable limitation is the potential contextual dependency of motivational needs. The degree to which specific game elements fulfill these needs may vary across different cultural and contextual settings. Therefore, the framework's universal applicability should be approached with caution. Future research should explore cross-cultural studies to better understand these variations.

Another limitation concerns the need for empirical validation. While the framework is theoretically grounded, empirical studies are necessary to confirm its effectiveness in analyzing and designing gamified screen-score compositions. Such studies could involve performer feedback, audience response analysis, and comparative assessments of compositions that utilize the EMA framework versus those that do not.

We have intentionally limited the scope of this paper to focus primarily on the application of game theories to gamified works and higher level decisions about how creators design mechanics. The relationship between musical criteria and the EMA framework is beyond the scope of this paper and may be the subject of future inquiry.

6.3 Future Work

Future work in this field should prioritize several key directions:

Empirical Validation: Rigorous empirical studies should be conducted to validate the EMA framework. This includes gathering feedback from performers and audiences engaged with gamified screen-score compositions analyzed using the EMA model. This feedback can shed light on the framework's effectiveness and areas for improvement.

Cross-Cultural Studies: To account for potential contextual variations, cross-cultural studies are essential. Investigating how the EMA framework operates in diverse cultural contexts can provide valuable insights into the framework's adaptability and cultural sensitivity.

Interdisciplinary Collaborations: Collaboration between composers, musicians, game designers, psychologists, and human-computer interaction experts can further enrich the EMA framework. Interdisciplinary approaches can foster innovative research and composition methodologies that push the boundaries of gamified screen-score works.

7. CONCLUSIONS

In this paper, we have introduced the Expanded Motivational Affordances (EMA) framework as an analytical tool for the study of gamified screen-score compositions in the field of interactive computer music. The EMA framework expands upon the Motivational Affordances model by incorporating the category of "Affect and Emotion" within a taxonomy of motivational needs. This expansion provides a comprehensive lens through which to identify and understand the game elements that underpin performer-computer interactions in these compositions.

Through case studies of gamified screen-score compositions, specifically *Super Colliders* by T. Fukuda and *SQ2* by P. Turowski, we have exemplified how the EMA framework can be applied to identify and categorize game elements that cater to diverse motivational needs. These elements range from obedient avatars, responsive collision sounds, rounds, and leaderboards to the 'all dead' scenario, showcasing the richness of the game elements interfacing between performer and computer in the interactive system design of these works.

The implications of the EMA framework are twofold. Firstly, it offers a valuable lens for understanding existing gamified compositions, shedding light on the intricate motivations that drive performer engagement. Secondly, it serves as a potent model for the creation of new gamified screen-score works, guiding composers in the strategic incorporation of game elements to enhance the performer's engagement with the gamified computer system.

However, we acknowledge certain limitations of the EMA framework, such as its potential contextual dependencies and the need for further empirical validation through an analysis of more works as samples. As such, future work in this field should focus on empirical studies to refine and expand the framework's applicability.

In conclusion, we believe that the Expanded Motivational Affordances framework represents a significant step forward in understanding and harnessing the potential of gamified screen-score compositions. It offers an analytical lens that emphasizes the fulfillment of motivational needs as a driving force behind the playfulness and engagement that define this evolving genre of interactive computer music. With continued research, refinement, and interdisciplinary collaboration, the EMA framework holds the promise of enriching both the study and creation of gamified screen-score works, paving the way for innovative and captivating compositions within the musical community in the digital age.

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