Emergent Multiplayer Games

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***Abstract*—In this paper, we introduce a novel video game concept called Emergent Multiplayer Games (EMGs). It aims at providing a platform for large crowds that tune in live game streams. EMGs offer an emergent game experience by empowering a large set of individual players to influence the course of a single, collectively played game. We introduce the general concept of EMGs and present our approach to an EMG prototype. Our implementation is built for audiences of varying numbers and diverse personas. It features a control system based on multiple forms of voting ballots. A preliminary evaluation of the prototype helped to identify EMG designs effective in terms of usability and fun, but also the relationships of our implemented game mechanics and game control system in terms of information flow and balancing.**

***Index Terms*—Interactive live streaming, emergent play, multiplayer games**

I. Introduction

In recent years, video games have evolved into an all-round entertainment that is multidimensional and divided into multiple pieces including viewing, playing, as well as enjoying the latest innovations in hardware. Everything from watching esports and game video content to the ownership of hardware and peripherals is now equally important in the entire spectrum of a game enthusiast—a development in the gaming industry that embraces more diversity in how individuals enjoy video games [1]. Especially live video game streaming on platforms such as Twitch, YouTube and Mixer, which represent the top broadcast services in the western world, connect millions of people each day [2]. Currently, most video game live streams are centered around one individual, the live streamer, oftentimes an entertainer or sometimes even a professional gamer. Streamers broadcast themselves playing solo, multiplayer or competitive video games while narrating and commentating on their gaming experience or performance. Entire communities are built around live streams that bring people together and establish emotional connections between the members of those groups [3]. Even though many people spend a lot of time together in chat-rooms directly or indirectly attached to the live stream, for the majority of viewers it is still a passive viewing experience or merely an interactive experience in terms of verbal exchange but not in terms of play. The companies behind streaming services such as Twitch and Mixer have been investing considerable efforts in making streaming experiences more interactive. For instance, they introduced tools that allow external developers to create interactive experiences by means of Twitch Extensions (TEs) and MixPlay. Additionally, various gamification and engagement features are utilized to support community building and enable social interaction. However, none of the existing platforms have fully delivered a unique gaming experience tailored to players and viewers alike.

While there is rising demand for game streams targeted at spectators who do not want to engage in the actual play [4], there is still a lot of leeway between the role of the solo entertainer who is the only player streaming to hundreds or thousands of spectators and the spectator himself who does not want to be bothered interacting with the game. However, even a spectator might feel the urge to interfere and make his voice heard once in a while. There may also be others, who want to support the course of the game or the game's hero but not bear all the responsibility of successful game progression on their shoulders. The range of personal involvement is as broad as the potential reasons to keep it at a certain level or not.

The concept of emergence offers a solution that potentially fits all. Emergent gameplay captures the idea of delivering complex dynamics through simple mechanics. It is inspired by natural phenomena, where, for instance, birds, fish and insects coordinate their behaviors [5] to form flocks that collectively move, see e.g. [6]. Ant colonies and other social insects, in particular, highlight that a lot of small and simple interconnected interactions or subsystems can result in complex dynamics [7]–[9]. In video games, emergence aims at free and creative play by providing a small set of flexible but interconnected game (sub-)systems that allow players to discover new and unique ways of playing. Giving a player the feeling of authoring one's own experience is sometimes also referred to as emergent narrative [7]. Walsh [10] describes an emergent narrative as a structure or story which emerges as a product of interactions and goals while navigating an experience.

This perspective can be harnessed to create an emergent multiplayer game (EMG) experience for game streaming services by giving each user the opportunity to influence various aspects of the game and let an emergent narrative unfold based on the collective input. Of course, this idea yields a lot of questions such as how the collective input should be consolidated to drive the game, how the interaction mechanics and the feedback infrastructure might look like, how the players would engage to various degrees and at different times, etc. In this paper, we present an EMG prototype in which we systematically address these questions by testing the effectiveness of various solutions. To provide the necessary scientific context for our concept and methodology, Section 2 presents related work and games focusing on interactive experiences on

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live streaming platforms as well as live streaming in general. In Section 3, we outline the concept of EMGs, followed by an overview of the EMG prototype in terms of game design and technological components in Section 4. In Section 5, we present the process of the EMG prototype evaluation and discuss our results. We conclude this paper with a summary and an outlook on the potential of EMGs in the future.

II. Related Work

One of the more unusual interactive streaming experiences is the "Twitch Plays" phenomenon [11]. In February 2014, this concept was used for the first time, when an Australian programmer streamed a modified version of Pokémon Red (originally released for the Nintendo Game Boy) that was fully controllable by the audience. Viewers would type commands in the live chat which were translated into actual in-game actions using a chatbot. Over 1.16 million people participated and a total of 55 million views were generated during the 16 consecutive days it took the Twitch chat to finish the game [12]. This series has been continued until today with various Pokémon versions and was also adopted for other popular video games such as the real-time strategy (RTS) game StarCraft 2 or the auto battler Teamfight Tactics.

Interactive real-life adventure-like experiences for live streams are another recent trend. During the 2019 Electronic Entertainment Expo (E3), a popular trade event for the video game industry, a company utilized an on-screen interface in some of their live streams which allowed viewers to suggest directions to the broadcaster who then navigated through the real-world venue based on the suggestions. A very familiar setup was used by Porsche to unveil their 2020 Formula E car livery with the help of the Twitch community. This interactive experience was a "Choose Your Own Adventure"-style game where viewers chose options displayed on the screen and solved puzzles together. However, instead of an on-screen interface, viewers had to send numbers to a Twitch chat which represented a voting option mapped to the on-screen actions. One of the downsides of choosing this kind of interaction mechanic is that with an increasing number of participants the chat cannot be used for communication any longer: Rather, when the live stream reached an average of around 30.000 viewers and almost one million viewers in total, it was solely used as a control input interface.

More common are games that allow viewers to influence the gameplay of a streamer during a live stream. Both Dead Cells and Darwin Project are titles that integrate TEs in a way that allows viewers to affect the world of the game and create a more dynamic experience for the player. In Dead Cells, the viewer can vote for perils or perks, increase the number of enemies in a level or help to open special chests through certain commands. In Scavengers Studio's survival game Darwin Project, viewers can vote to close off specific zones of the map, trigger a manhunt on a selected player or even order an airstrike to send contestants scrambling. Mixer provides similar experiences with their MixPlay integration for games such as No Mans Sky or The Walking Dead. The former gives viewers the option to provide a player with additional in-game materials, spawn extra enemies or affect the weather in the game. For the adventure game The Walking Dead, viewers collectively vote on dialog choices to affect the outcome of the game's story. The continuous emergence of new gaming trends and approaches for interactive content on streaming platforms such as the "Twitch Plays" concept or real-life adventure-like experiences indicates two relevant aspects: (1) Means of introducing more interactivity to live streaming are well received and (2) players are rather open-minded in terms of new contents and mechanics.

Most research in the field of live streaming is dedicated to understanding people's motivations to become a streamer or a viewer of live streams. For instance, a study on why people watch others play video games was conducted by Sjöblom and Hamari [13]. They examined five potential types of motivations: Cognitive, affective, personal integrative, social integrative and tension release. By means of an online questionnaire, they found out that hours watched are positively associated with information seeking, tension release, social integrative and affective motivations [13]. In a grounded theory approach, Anderson [14] studied human behavior to analyze the differences between the human aspects on Twitch.tv versus the content being consumed on the platform. His findings suggest that people using the service are there to consume content with others similarly to audiences drawn together to watch movies in cinemas or live sports events at home. In fact, he concludes that the social experience shared with the streamer and the viewing community is more important than the actual contents [14].

Interactive elements turn out to be a welcome addition to the live streaming experience for varying types of viewers [15], for as long as they do not negatively interfere with watching the stream [4], [16]. One specific example is the live-streaming tool Helpstone for the card game Hearthstone, which provides multiple new communication channels for improved interaction between viewer and streamer [17]. Although the authors base their findings on a rather small sample size, they suggest that Helpstone helps to improve communication, gives the audience a feeling of influence, increases their activity level and is additionally appealing to passive viewers.

III. Emergent Multiplayer Games - Concept

We designed the EMG concept to deliver an interactive streaming experience for players and viewers alike. With that in mind, we had to ensure that our game concept would (1) support audiences of varying numbers and diverse personas, (2) allow for a variable degree of engagement, and (3) aim for a social gaming experience. Consequently, we decided to provide a control system that allows multiple individual players to collectively influence the game and to implement interfaces that give both players and viewers the information required to understand the current game state and activities. This decision led us to combine EMG specific mechanics (a vote-based control system) with established game systems (Fig. 1). We realized the emergent play by means of the interplay of (1), (2), and (3): Different types of voting mechanics affect the game systems which, in turn, affect the course of the game.

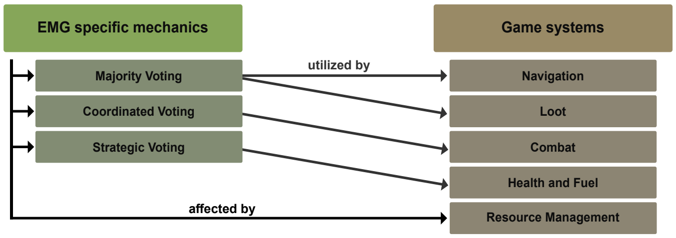

Fig. 1. All EMG specific mechanics and established game systems of the EMG prototype and their basic relationships.

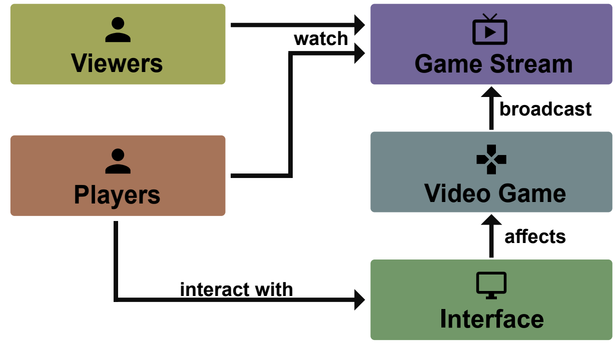

Fig. 3. A single game view is broadcast to all players and viewers and can only be affected by utilizing a separate interface. Each player has his own interface to interact with the game.

A. Emergent Play and Mixed Player Types

Conventional games mostly utilize interfaces to tie individual players to different game elements that feed into different kinds of game mechanics. For a player character, for example, mechanics could be movement-related such as climbing an obstacle or covering behind an object. In the context of a fighting game, it could be the choice between a melee or a ranged attack.

In EMGs, interfaces are used to tie multiple players to specific game elements (Fig. 2). At the same time, the interfaces have to deliver an enjoyable viewing experience, which requires the game's viewing perspective to be setup in a way that multiple players and viewers are able to understand the game's state at all times. Fig. 3 illustrates our approach to incorporate one core perspective for the game, instead of one for each player. It means instead of n players (active or passive) with m individual perspectives, only one perspective is broadcast to n players. However, each player still has access to a separate interface which allows for individual interactions.

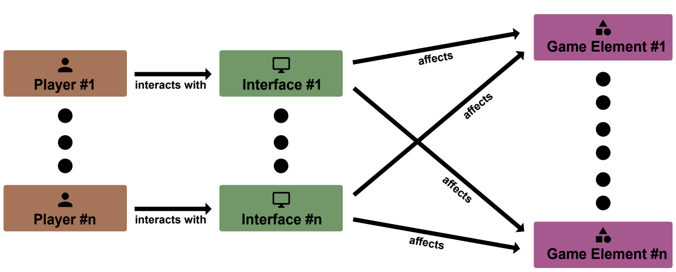

Fig. 2. Game elements can be manipulated by multiple players to execute specific game mechanics and influence the game collectively.

B. Affecting Gameplay in an EMG

RTS games, such as The Settlers or The Age of Empires, demonstrate how players can collectively influence the outcome of a game. In a traditional RTS game, the world mostly consists of landscapes, buildings and units [18]. The player issues commands of movement, military action, harvesting, construction, etc. to selections of units. The world is usually viewed from an isometric perspective and when it comes to gameplay, many different tasks have to be handled to progress in the game. Resource gathering, base building, in-game technological development and indirect control of units are the main focus of many RTS games. Partial autonomy of the units in RTS games in combination with different levels of abstraction and control [19] provide an ideal starting point for designing the play mechanics of EMGs.

Separating different in-game responsibilities into predefined character classes is a conceivable way to structure the complexity of an RTS game and provide players with a choice to manage only a portion of a game world. The overall goal would revolve around specific missions that the players have to complete or an unconstrained sandbox approach with seemingly endless possibilities to establish and expand an economy. An approach based on different character classes can even utilize different live stream channels and have numerous subgroups of players compete against each other in developing and maintaining a healthy economy. Similarly, it is conceivable to have players take control of individual units or facilities—but finding the right game balance for the individual player striving for simple achievements for the overarching game is a tremendous challenge: Quickly, the player's task might be too trivial to be motivating or engaging or too involved to maintain the link to the overarching game. Another great challenge would be scalability, as the potential variability in numbers of units would have to impact the scope, the required strategy, potentially even the nature, of a given mission challenge.

A mechanic that allows multiple players to control a group of units or individual aspects of a game is much more viable. In The Digital Aquarist, a single-player controls various components of a fish tank [20]. The fundamental concept of this simulator game could be extended to multiple players by introducing predefined responsibilities, similar to the character classes discussed above, that are categorized into different tasks and encourage players to work towards the same goal collectively.

C. Resulting Game Design Challenges

We identified the following challenges arising from the concept of EMGs: (1) The adaptation of the view to different player types, (2) game mechanics that adapt to varying numbers of players, (3) a gaming infrastructure that supports different styles of play, including always-on and intermittent play, (4) means of collaborative control and their technological implementation.

Graphical user interfaces (GUIs) and head-up displays (HUDs) for EMGs need to support mixed player types to make the game state and activities understandable to everyone. Dedicating a specific section of the display to GUI and HUD ensures that interface elements do not interfere with important visuals of the game itself. This is especially crucial in EMGs with only one view for all participating players and spectators.

To support not only mixed player types but also a flexible amount of players, game mechanics need to adjust dynamically according to the number of active players. With that, however, emerges the challenge of finding the right balance for players to enjoy the game in any combination of users. Achieving this ensures that the game experience is not fully dependent on the number of concurrent players while also guaranteeing no major disadvantage even when playing in smaller numbers. Nevertheless, due to the EMG concept aiming for a shared and social gaming experience, it is expected that playing collectively might be more rewarding and fun.

Providing an always-on experience, i.e. letting a gaming stream run constantly, yields several challenges. Players and viewers could join and leave at any moment, which results in a different experience each time, depending on how many players and which ones exactly are playing at the time. Since the state of the game also changes when a player is absent, some form of an event history log that is listing player actions needs to support late joiners. Additionally, players should not fear missing out on important events in the game, which is already handled by multiplayer online games (MMOs). This includes providing challenges that vary in difficulty, length and required numbers of players. Especially larger-scale activities such as dungeons and raids are common types of missions in MMOs that demand a strategic approach to take on powerful enemies and at the same time bring multiple players together. Similarly, for an always-on EMG concept, tasks such as resource gathering, improving player attributes and maintaining the overall in-game economy could be designed as repeatable challenges, while special events being scheduled at predefined times could provide a solution for people not missing out on more unique moments in the game.

Finally, in EMGs, sometimes the players' inputs need to be synchronized. E.g., whenever votes are cast, additional time is needed by some players to make up their minds and communicate their decisions. For instance, a countdown might convey the time left for the players to decide on the destination the collectively controlled hero should travel to. Such waiting times are a basic mechanism to balance the pace of an EMG, which is not only relevant for the actively engaged players but also for the spectators who need to retrace the course of the game and how it came about. Fast decision makers can be rewarded by mini-games and side quests which provide them with a sense of advancement and growth.

IV. EMG Prototype

Based on the deliberations on gameplay, we decided to implement an exploration game as an EMG prototype, with a basic resource management system, combat system and RPG elements. The voting mechanics at the center of our prototype allowed us to tie multiple players to almost any game element and let players advance in the game by making decisions collectively (Figs. 4 and 5). By implementing a single hero and a single viewing perspective, we ensured minimal complexity in terms of mapping the players' input to game elements as well as in terms of the shared view.

Fig. 4. Active destination voting ballot in an open world region.

Fig. 5. Active battle scene with the TE interface opened.

Regarding concrete mechanics, the game's navigation system allows players to decide on new destinations collectively (Fig. 4). Combat (Fig. 5) was also designed to rely on voting mechanics such that each players' contribution to defeating an enemy could be retraced. Our first implementation of a combat system involves players to vote for either of two abilities to increase chances of winning in an otherwise automated fight. We incorporated resource management by implementing a simple click-based mining mini-game (Fig. 6) that can be played by everyone individually and rewards the player with an in-game resource called minerals. These are also automatically gathered over time and allow the players to invest in certain attributes of the hero, even health and fuel for traveling or to help them in perilous situations (like spending them on a shield boost during combat).

Fig. 6. Click-based mini-game in the TE interface.

A. *Game Systems*

In this section, we describe all game systems of the EMG prototype in more detail: Navigation, combat, resource management, loot as well as health and fuel. With a heavy focus on voting mechanics, it became especially important to design the game systems in ways that make players experience their influence in the game. In order to achieve this, we closely linked voting and gaming mechanics such that collective efforts could easily be rewarded and lead to social bonding and exchange.

The players control an airship to explore the game world. They set their destinations (different locations within several regions) collectively by voting. The actual journey is automated but takes time depending on the distance traveled. The airship consumes fuel, which has to be refilled using minerals to be able to continue exploring the game world.

Enemy encounters only appear at certain locations unknown to the player. During combat, hero and enemy automatically take turns in attacking each other. Each enemy has a “Limit”-bar that automatically charges over time. When fully charged they perform a critical, more powerful attack. The hero, on the other hand, has a “Limit”-bar and a “Defense”-bar. A fully charged “Limit”-bar also results in a critical attack, while a fully charged “Defense”-bar allows the hero to block the next critical attack. Players have to spend in-game resources in the TE to charge either of the available combat activities. Since the number of players can change during a gaming session, both combat mechanics base their required amount of charges on the current number of active players at the start of the battle. Therefore, the combat is somewhat balanced and manageable with any number of players. The EMG prototype has two different enemy encounters, losing in either of them reduces the hero’s health by 25 percent, while winning is necessary to progress in the game.

Almost all interactions in the game such as voting for new destinations, obtaining health or fuel credits or participating in combat require the player to spend minerals. Users can obtain minerals by just watching the game or, additionally, by playing the click-based mini-game mentioned above. Once launched, the mini-game randomly shows working or broken pick-axes at random spots of a small mini-game screen. The player has to swiftly click the working pick-axes to be rewarded with minerals, whereas a click on a broken one subtracts minerals from his account. Spending minerals on updates may increase the yield, automatize or increase the pace of the process. The players have to prioritize the various spending opportunities in the game in accordance with their own personal goals.

In a basic loot system, we show how collecting and displaying loot can be realized. At certain locations, the players need to answer various simple questions (Fig. 7) to receive loot or lose some, if they answer incorrectly. Currently, available rewards include a powerful sword, health and fuel credits as well as quest items that are required to progress in the game. All available items are displayed in the game’s HUD and are always visible to the players. Other types of items are added to the collective player inventory, for instance, health and fuel credits as well as equipment such as weapons or armor. Upon collection, items are automatically added to their respective inventory and equipped to the hero, if advancing his stats.

Fig. 7. Active voting ballot at a loot location.

It is customary for characters in games to have a health bar that shows the hero’s health status. In our EMG prototype, we decided to implement two separate health bars for the hero—in and out of combat. While the former health bar is always reset after each fight, independent of winning or losing, the latter is only affected when loosing in combat. In this case, 25 percent of the maximum health value is deducted. When the health value reaches zero, the hero has to start the game anew and all players lose some of their collected resources. Additionally, health is reset to the full amount while fuel remains as it was. When health or fuel drop below 50 percent of their maximum values, they recharge automatically, if the necessary 100 minerals are provided by a collective inventory that the players can donate minerals to.

B. *EMG-Specific Mechanics*

Three different types of voting ballots were implemented in the EMG prototype: Majority Voting (MV), Coordinated Voting (CV) and Strategic Voting (SV). Each type has some costs associated per vote and the option to aggregate votes of a single player, or not. Voting ballots are opened upon certain events, starting a 30-second countdown as soon as the first vote is registered. The results are updated each time a new vote is submitted and immediately presented to the players in the game. All votes are accumulated after a vote is closed and the final result is displayed.

In MV, a hard decision is made in favor of the majority of votes received. We implemented MV as limited to one vote per user and with costs varying from 50 (loot dialogues) to 200 minerals (destination voting ballots). Generally, MV is utilized in mechanics that allow players to influence the outcome of an action. For the EMG prototype this includes voting for destinations or for dialog options.

In CV, players can vote for an arbitrary number of times. However, the costs increase after each vote. CV is used in combat only and requires players to spend resources to perform a critical attack or make use of a protective shield to block an enemy's critical attack. The idea behind CV is that coordinating actions is rewarded, as the players will maintain a greater resource base, thus being able to achieve better outcomes, together.

SV aims at improving the hero's situation independently of other players and the overall game state. It allows the player to spend resources early (donate to the collective inventory) to benefit later (e.g. by having the hero's health or the airship's fuel recover). To ensure that less affluent players also see the impact of their investment, all players can spend at most 100 minerals on the offered targets.

C. Realisation of the EMG Concept

Fig. 8 presents the three main components of the EMG prototype: The game itself, the TE and the communication protocol. The game component is responsible for all game systems, EMG specific mechanics, the HUD and a Twitch chatbot for handling user activity on a Twitch channel. Data exchange between the game and the TE is managed by a websocket server application, whereas the UI and the mining mini-game are part of the TE.

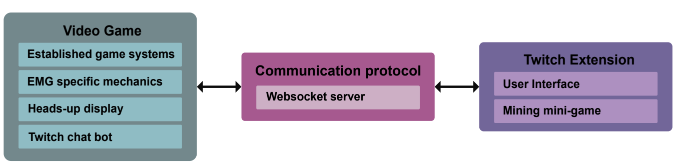

Fig. 8. The three components of the EMG prototype and their sub-components.

A fixed camera angle for all scenes in the game and a dedicated space for all HUD elements provide the players with an overview of the current game state and activities. HUD elements include voting ballot results, health and fuel status as well as inventory contents and a quest log. The airship is the game element for navigation and exploration. It travels across a world map and automatically retrieves the optimal travel path by means of Unity's (the game engine we developed the game in) path-finding sub-engine. The airship and the various locations are wrapped as scenes of the game that are loaded on demand. We bridged to Twitch's streaming API by wrapping the data passed back and forth in an according Twitch chatbot, which requires a Twitch account and a target streaming channel. The chatbot listened to all chat activity to maintain and update a user database used to distribute resources to players and distinguish between active and passive players. The prototype also connected to a dedicated websocket server to listen to and send messages to the TE.

The TE was built using JavaScript, HTML and CSS and visualizes the UI. In contrast to the game, every user has access to their own extension and can navigate it freely. The UI is separated into three views: Inventory, actions and minerals. In the inventory, the players can spend minerals for health and fuel credits, the actions-tab is handling all other vote ballots and in the minerals interface, the user can play the mining mini-game. The mini-game is the only game component that was developed using JavaScript, so the logic of this particular feature is handled by the TE rather than the game itself and is sending regular updates back to the (main) game. Therefore, whenever resources are added or subtracted from a player, the TE communicates with the game to update the mineral's value in the database. Each TE connects to the websocket server when a user activates the interface on a Twitch stream and listens to incoming messages in the same way the game does. Outgoing messages in the case of the TE are always bound to the user's ID and are sent upon every action a player performs that has an impact on the game, such as submitting a vote or winning minerals.

The backend application of the websocket server was written in JavaScript using Node.js and is hosted on the container platform OpenShift. Its functionality is limited to exchange messages in the JSON format which contain simple texts of the desired action and/or associated user ID extracted from the user's Twitch account. Sending and receiving the user ID is necessary to communicate with individual players and map actions accordingly. The system is able to send messages by unicast, anycast and broadcast. Broadcasting messages to all users is important to keep the TE interface updated whenever the game state changes. UI elements are only shown in the TE whenever they are available. For instance, when opening a new vote ballot or loading a new scene, the options in the actions-tab change accordingly. Both, the game itself and the TE connect to the server when they are started and disconnect when the applications are closed.

D. Technological Infrastructure

A detailed illustration of our EMG prototype system architecture can be seen in Fig. 9. Watching a game stream requires spectators to visit the Twitch.tv website or using the Twitch app. Playing the game is only possible using the TE of the prototype which is currently only supported by desktop browsers and the Twitch desktop app. The game itself is responsible for all the in-game rendering and game mechanics and is streamed to Twitch using broadcasting software such as OBS or Twitch's Studio App. The Twitch platform broadcasts the video. The websocket server handles all data exchanges between the video game and the TE interface.

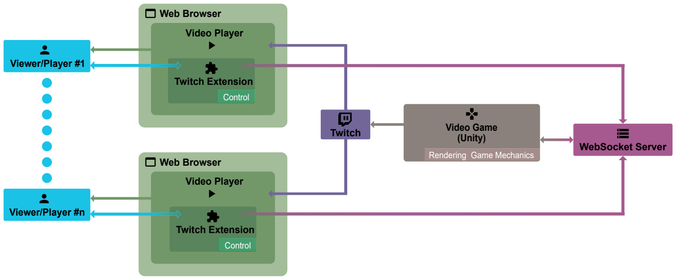

Fig. 9. Conceptual model of the EMG prototype, describing the structure and relationship between different components of the system.

V. Experiment & Results

We conducted a playtest to primarily identify EMG designs effective in terms of usability and enjoyment. We determined how our game design choices were perceived by our participants and analyzed the relationships of the implemented game mechanics and game control system in terms of information flow and balancing.

20 participants were acquired for the playtest, of which 17 were male and three female. Their age ranged from 23 to 32 with an average age of 27.1 years (σ = 2.67). According to our demographic questionnaire, 13 subjects play video games for over seven hours a week. Popular game genres among the participants included online first-person shooters, action-adventure and role-playing games. All 20 subjects indicated that they play games for fun, while 12 like to be challenged by a game and eight stated they played games to dissociate from everyday routine or used games to socialize with friends or people they meet online. Weekly Twitch viewing hours ranged from zero to three hours for 10 participants, between four and 10 hours for 8 participants and two subjects consume more than 10 hours of Twitch content a week. The category "entertainment based on games owned" was the most frequently given reason for watching Twitch with 12 entries, whereas "entertainment for games I do not own" was a reason to watch Twitch for five participants and four stated that they consumed Twitch content that classifies as "entertainment based on Twitch streamers performance". 14 subjects simply watch a stream without interacting with the chat and also do not pursue any other activities at the same time. Nine participants play games themselves while watching Twitch content and four said they don't watch Twitch at all. All but one participant had heard of TEs before the experiment and, of those, 16 had used TEs for themselves.

The System Usability Scale (SUS) [21] questionnaire helped to ensure that the game interface itself does not interfere with the play experience. The Core Elements of the Gaming Experience (CEGE) [22] questionnaire measured how various game aspects affect the overall game experience as well as enjoyment and frustration. Additionally, the game state and action logs of each participant were monitored. The 20 subjects we acquired were split into two groups, with group one containing eight and group two 12 participants. Besides the sessions taking place on two different days, the overall process was kept the same. The playtest was setup in a way that players could watch the game stream online on Twitch which allowed them to stay at home in their usual environment and experience the game in a way they would typically consume content on Twitch (if they did). A simple objective was given by the game in the form of a quest, however, the participants were free to explore the world as they desired.

The overall usability of our EMG prototype scored 74.125 out of 100 points which is above the average of 68 points, according to the SUS. Fig. 10 shows the percentage of the maximum scores of the total CEGE value and its sub-scales. Judging by the enjoyment value, the participants had fun playing the game while frustration during the game session was rather low. The puppetry value is above average and covers the experience with the overall interaction of the player with the video game. The video game category is focused on how the game is perceived in terms of forming experience and it also shows a positive outcome.

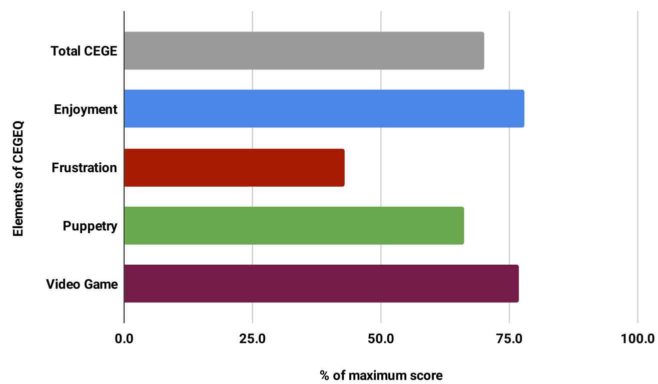

Fig. 10. Total CEGE score and values of the sub-scales enjoyment, frustration, puppetry and video game in percentage of their maximum score.

Additional Game Related Questions	Mean (σ)
(1) Voting was an integral part of the game	4.35 (0.75)
(2) I enjoyed using votes	4.20 (0.83)
(3) I was playing a new type of game	4.45 (0.83)
(4) I enjoyed watching the game	3.70 (0.92)
(5) Chatting with others had a positive effect on the gaming experience	4.45 (1.05)
(6) Playing the game felt like a shared experience	4.40 (0.94)
(7) I had nothing to do most of the time	1.60 (0.94)
(8) I perceived the presence of my co-players on Twitch	3.95 (1.05)
(9) The presence of my co-players felt like a part of the game dynamic	4.00 (1.12)
(10) I enjoyed the battle mechanics	2.40 (1.27)
(11) I enjoyed the looting mechanics	3.30 (0.92)
(12) I enjoyed the healing / refueling mechanics	3.10 (1.12)
(13) I enjoyed the mineral mining mini game	3.70 (1.26)

Fig. 11. Specific EMG-related questions answered on a 5-point Likert scale.

Additional game specific questions (Fig. 11) were evaluated individually and are all in relation to a maximum scale value of five. Participants enjoyed voting *(*1) and perceived it as an integral part of the game *(*2). According to the questionnaire scores, the EMG prototype is considered a new type of game *(*3). In regards to social aspects, players felt like chatting had a positive effect on the gaming experience *(*5), co-players were perceived as present on Twitch *(*8) and as part of the game dynamic (9) while playing the game, in general, felt like a shared experience (6). Feelings towards the game mechanics of looting (11), healing and refueling (12) and mineral mining (13) were above average, whereas the battle mechanics (10) scored rather modest.

Examining the action log data revealed that users had the TE open for the majority of the time, which can be explained by the fact that it was necessary to play the mining mini-game to advance in the (main) game. Although most people enjoyed playing the mini-game, which is a positive outcome in itself, it is not deniable that it took a lot of attention away from the main activities which should be considered when furthering the design of this and other EMG prototypes and games. Aside from the player data, logs were also saved for each triggered vote ballot. 10 vote ballots happened during session one with an average of 6.2 participants out of eight active users (σ = 1.75). Session two had nine vote ballots with an average of 6.67 participants out of 12 active users (σ = 2.65). Across both sessions, more than 50 percent of participation was recorded.

VI. Discussion & Conclusion

Derived from the need of various player types and the means of current streaming-based gaming technologies, we conceptualized EMGs and designed, implemented and evaluated an EMG prototype. It delivered an interactive streaming experience on Twitch with a game concept that uses interfaces and mechanics to tie multiple players to numerous game elements. Emergent play was achieved by means of a vote-based control system. We were able to confirm that players are open to new contents and mechanics on streaming platforms. No major usability issues hindered the testers to play the game and, most importantly, they had an overall positive experience according to the CEGE questionnaire, understood the collective activities and appreciated the resulting social experience.

Our concept of combining EMG-specific and established game systems worked well, even though some of the game systems need to be improved. The players frequently asked for more and clearer feedback on the game's state and whether game progression emerges from collective or individual efforts. This could be achieved by means of more consistent HUD, UI and logs, especially during combat. More diversity in the types of mini-games and social game elements set such as highscores and ranking lists based on mini-games would address suggestions by the players that aim at competitive play.

Based on their current potential and the continued rising interest, we expect that streaming services such as Twitch, YouTube, Mixer and Facebook Gaming will continue to facilitate the design, development and deployment of EMGs and other social game experiences. But we believe that EMGs are not only the result of an emerging technological infrastructure but that they provide an attractive social medium for large numbers of players/spectators, bringing together traditional TV-like entertainment and interactive play. In our study, we have only just begun investigating the interplay of input, interaction and view mechanics of EMGs. More complex mechanics of simulation games and emergent play, more diverse and elaborate voting/contribution mechanics and effective visualisations in combination with systematic user studies should be researched in order to strengthen the design of EMGs and also to anticipate their potential social impact.

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