Digital Game Enjoyment: A Literature Review

Owen Schaffer(✉) and Xiaowen Fang

College of Computing and Digital Media, DePaul University,
243 South Wabash Avenue, Chicago, IL 60604, USA
Owen.Schaffer@gmail.com, XFang@cdm.depaul.edu

Abstract. A review of the literature on digital game enjoyment or what makes digital games enjoyable is presented, organized by topic. A literature search resulted in 61 relevant peer-reviewed research articles or papers. No limits were put on the research methods used or date of publication. The reviewed literature spanned from 1980 to 2017. The research was organized into the following topics: Measuring and Understanding Digital Game Enjoyment, Uses and Benefits of Digital Game Enjoyment, Flow, Immersion and Engagement, Challenge and Competition, Player Experience of Need Satisfaction and Self Determination Theory, Motivations to Play Games, Games User Research Methods, Game Design, Game Player Demographics, Game Addiction, and Violence in Games.

Keywords: Enjoyment · Flow · Intrinsic motivation · Digital games · Computer games · Video games · Literature review

1 Introduction

Understanding digital game enjoyment and what leads to that enjoyment is critical for those who want to design interactive experiences for enjoyment, whether for Game Design, Serious Games, or Gamification.

IJsselsteijn et al. [1] presented a literature review and theory paper discussing how digital games are different from productivity applications. Mekler, Bopp, Tuch, and Opwis [2] summarized previous studies on digital game enjoyment, but their search was limited to quantitative studies from 2008 to 2012.

There has yet to be a sufficiently comprehensive summary of the literature on what makes games enjoyable. This paper aims to fill that gap in the literature. A review of the digital game enjoyment literature is presented without constraints on the date of publication or whether the research methods used were quantitative or qualitative.

2 Method

A review of the literature was done by searching Web of Science, Science Direct, ACM's digital library, ABI/Inform ProQuest, PsychArticles, EBSCO's Academic Search Complete, Information Science & Technology Abstracts, Business Source Complete, Education Research Complete, ERIC, Taylor & Francis Online, Sage

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Journals, and Google Scholar using the following keywords and phrases: game enjoyment, game and enjoyment, "Intrinsic motivation" AND games, gamification OR gamified, flow AND "video games", flow AND "computer games", games user research, game user research, "player experience", game AND fun, systematic review computer games, determinants of enjoyment in games. Results with the most number of citations from each search were exported into a spreadsheet.

The first 100 results relevant to the topic of digital game enjoyment or what makes digital games enjoyable were manually selected. The number of citations for each result was checked with Google Scholar on September 1st, 2017 and included in the spreadsheet. 7 results were excluded because they were books or book chapters, not peer-reviewed academic research. Two results were excluded because they were considered duplicates with other articles already included.

From the remaining results, the 61 peer-reviewed journal articles or conference papers with more than 40 citations were reviewed. This cutoff was chosen to focus on the most influential peer reviewed research on the topic. No limits were put on the date of publication, and the reviewed papers spanned from 1980 to 2017.

The 61 articles or papers were summarized and sorted into categories to organize them by topic. What follows is that literature review, organized by topic. Two of the papers were literature reviews, and have been included in the introduction above.

3 Literature Review

Relevant research articles and papers were selected through the process described in the Method section above. This review of the literature has been organized into the following twelve sections: Measuring and Understanding Digital Game Enjoyment, Uses and Benefits of Digital Game Enjoyment, Flow, Immersion and Engagement, Challenge and Competition, Player Experience of Need Satisfaction and Self Determination Theory, Motivations to Play Games, Games User Research Methods, Game Design, Game Player Demographics, Game Addiction, and Violence in Games.

3.1 Measuring and Understanding Digital Game Enjoyment

Developing a Measure of Computer Game Enjoyment with Card Sorting and Factor Analysis. Fang, Chan, Brzezinski, and Nair [3] created a measure of computer game enjoyment. Their questionnaire measure asks participants to report affective, behavioral, and cognitive responses that indicate enjoyment. Their initial items were derived from Nabi and Krcmar's theory of media enjoyment [4]. The items were reviewed by 20 professional game designers and developers for feedback. Sixteen game players participated in an exploratory card sorting procedure, where items were sorted into groups and each group was labeled with a category name. Twenty-three game players then conducted a confirmatory card sort to sort the items into the categories. A follow-up online survey was completed by 508 game players, and factor analysis of the survey data confirmed the construct validity of the measure.

The measure that Fang et al. developed was based on a theory of media enjoyment, not specifically a theory of computer game enjoyment. For that reason, some of the items in their measure may have fit better with enjoyment of a passive viewing experience rather than an active game-playing experience. For example, the Behavior component of their measure focused on talking to oneself, making loud comments, or swearing while playing the game. These behaviors do not necessarily indicate enjoyment. A player speaking to themselves or swearing could be enjoying themselves or could just as easily be frustrated and not enjoying themselves.

Media Enjoyment as Affect, Behavior, and Cognition. Nabi and Krcmar [4] presented a theoretical model of media enjoyment, with Affective Reactions, Cognitive Reactions, and Behavioral Reactions leading to Enjoyment. It seems they took a basic and broad idea from psychology, the ABC's of psychology – Affect, Behavior, and Cognition – and applied it to the inputs and outputs of media enjoyment. So, thoughts, feelings, and behaviors lead to media enjoyment, which in turn have effects on the person's thoughts, feelings, and behaviors. Nabi and Krcmar did not present any research to support their model. Also, their model is too broad to be useful for design, or to help make video games or other media more enjoyable.

Identifying with Video Game Characters. Klimmt, Hefner, and Vorderer [5] presented a conceptual model of identification with video game characters focused on shifting player self-perceptions to take on the positive attributes of the video game characters they are playing in the game. However, they did not present any original research to support their theory.

Feeling Like Your Ideal Self in Games Makes the Games More Fun. Przybylski et al. [6] conducted experiments showing video games were most intrinsically motivating and had the greatest positive emotional impact when players felt their game-self was congruent with their ideal-self.

For their ideal self, participants were asked to think about the type of person they wished, desired, or hoped to be and respond to a personality inventory about that type of person. For their game self, participants played three games and after each game they were asked to think about how they saw themselves when they were playing the game they had just played and respond to the same personality inventory. Hierarchal linear modeling showed that the convergence between game-self and ideal-self characteristics significantly predicted intrinsic motivation and positive affect, and was negatively related to negative affect. Playing digital games can make players feel closer to their desired personality characteristics, more like their ideal self. When it does, this tends to lead to more enjoyment.

Making Video Game Controls Not Work Makes the Game Less Fun. Klimmt et al. [7] conducted an online experiment to test the impact of perceived effectance and control on video game enjoyment. They defined effectance as perceived influence on the game world. Players played three versions of a *Breakout*-style arcade game online. In the reduced effectance version, the controls would not work a third of the time the player pressed the arrow keys. In the reduced control version, the controls worked normally, but the ball moved much faster than in the standard version, making it harder for the players to keep the ball in play and thus to feel in control of the game situation.

Players of the reduced effectance version reported significantly less enjoyment than other groups. Making the controls not work a third of the time may have had unintended consequences they did not measure, such as decreasing the perceived ease of use or usability of the game's controls. Making the ball move faster may have increased task difficulty, which may have increased enjoyment by making it more challenging. There may have been confounding variables impacting player enjoyment and their results.

It appears they did not successfully isolate and manipulate the variables they intended to manipulate. If the design differences they tested had unintended effects beyond effectance and control, all they showed was that making video game controls not work a third of the time players press buttons leads to less player enjoyment.

The Impact of Two Personality Factors (Sensation Seeking and Self-Forgetfulness) on Computer Game Enjoyment. Fang and Zhao [8] investigated the impact of two personality factors, sensation seeking and self-forgetfulness, on computer game enjoyment. Sensation seeking is a need for varied, novel, and complex sensory experiences and being willing to take risks to have those experiences. Self-forgetfulness is a tendency to concentrate so much that one loses all sense of the passage of time and may forget where they are.

Fang and Zhao found that game players who were higher on these two personality traits were significantly more likely to report behavioral reactions indicating enjoyment when they played role-playing games. Game players who were higher on sensation seeking also reported significantly higher behavioral indicators of enjoyment of both action/adventure/shooting/fighting games and sport/racing games, and cognitive indicators of enjoyment of family and simulation games. The results from Fang and Zhao showed that individual differences such as these personality factors can have a systematic impact on computer game enjoyment.

3.2 Uses and Benefits of Digital Game Enjoyment

This section discusses research on the uses and benefits of digital game enjoyment, including for educational games, games to promote health-related behavior change, games as research tools, and games as therapeutic tools.

Benefits of Video Games. Griffiths [9] discussed the many ways that video games can have a positive impact on those who play them. While Griffiths did not present original research, he gave an overview of the benefits of playing digital games and the literature supporting those benefits. Playing games reduces reaction times, improves hand-eye coordination, and raises the self-esteem of players. Video games have been used as research or measurement tools, to teach skills to autistic children or other special needs groups, to teach children with attention deficit disorders to focus their attention using brain-wave biofeedback, and to assist with physical rehabilitation.

Input-Process-Output Game Model for Educational Games. Garris et al. [10] drew on previous research to develop their Input-Process-Outcome Game Model for educational games, and presented experimental research to support their model. This model shows the content to be learned and game characteristics are the inputs into the

process. The process is an iterative, cyclical process of User Judgments, User Behavior, and System Feedback. This cyclical process is the Game Cycle. Then the Debriefing after the Game Cycle leads to Learning as an outcome of reflection on the process.

Garris et al. developed two versions of a navy training simulation of targeting enemy ships from a periscope. A treatment version of the training simulation was designed to incorporate the following game characteristics: Fantasy, Rules/Goals, Sensory Stimuli, Challenge, Mystery, and Control. They made a control version of the training simulation that was designed to provide the same opportunity to target ships but without the game characteristics. The simulation with the game characteristics was rated significantly higher than the control version on each game dimension and it provided significantly more effective training than the control version.

Digital Games as Therapeutic Tools. Griffiths [11] suggested that digital games can be effective therapeutic tools because they motivate patients to succeed at the task, can distract from pain and discomfort, and can help develop social and communication skills among the learning disabled. Griffiths did not present original research on the topic, but provided an overview of the research using digital games as a therapeutic tool. For example, digital games were used along with brainwave biofeedback to help children with attention-deficit disorders learn to focus.

Video Games for Health-Related Behavior Change. Baranowski et al. [12] did a literature review of studies about video games that persuaded players to make health-related behavior changes. They reviewed twenty-seven articles, and found that there were two main ways that these games affected player behavior: goal-setting and story. Some games made the goal of the game the intended behavior change. Others used the story in the game to have characters model the desired behavior, or have the lesson of the story promote the desired behavior change.

Intrinsically Motivating Educational Games. Malone [13] presented research on educational games being used in the classroom. He found that Challenge, Fantasy, and Curiosity were important parts of designing educational computer games that made things fun to learn. Malone asked 65 children in a computer class to rate how much they liked 25 games that their teachers thought were most popular among the students. Malone then rated each game on many different dimensions and analyzed the correlations between these game features and the average ratings the children gave the games. These game features were significantly correlated with game preference: Goal, Computer keeps a score, Audio effects, Randomness involved in game, and Speed of answers counts.

Malone explored why two games are enjoyable using within-subjects experiments by creating multiple different versions of each game. He constructed six versions of the popular game *Breakout* and eight versions of an educational game called *Darts*, varying whether or not certain features were included in the game. Based on this research, Malone developed a framework for intrinsically motivated instruction around three main themes: Challenge, Fantasy, and Curiosity.

Malone emphasized that players should be able to choose their own difficulty level, have multiple levels of goals, be presented with an optimal level of complexity, and that feedback should be both surprising and constructive.

Malone's Heuristics for Designing Educational Computer Games. Malone [14] presented several heuristics for how to make educational computer games fun, or how to make learning fun more broadly. He describes these heuristics as a general taxonomy of intrinsic motivation, organized around Challenge, Fantasy, and Curiosity.

For a game to be challenging, it must provide a goal, and players must be uncertain whether or not they will attain that goal, Malone wrote. Multiple levels of goals allows players of different skill levels to enjoy the same game. For example, having both a basic goal and a meta-goal of reaching the basic goal efficiently. Keeping score and time pressure or speeded responses can help provide multiple levels of goals. Performance feedback must be clear enough to present a challenge but presented in a way that minimizes self-esteem damage.

Malone defines Fantasy as showing or evoking images of physical objects or social situation that are not actually present. Intrinsic fantasy is where the player's actions and skills to take action are presented within the context of the fantasy world. Malone argued intrinsic fantasies are more interesting and educational than extrinsic fantasies.

Malone defined Curiosity as the motivation to learn. Games evoke curiosity by providing an optimal level of information complexity, so they are novel and surprising, but not completely incomprehensible. Sensory curiosity is a desire to experience changes or patterns of sensory stimuli. Cognitive curiosity is a desire to improve one's knowledge. Malone recommended using incompleteness, inconsistency, or unparsimoniousness to increase curiosity and motivate learners to learn.

A Measure of Enjoyment for Educational Games. Fu, Su, and Yu [15] extended Sweetser and Wyeth's [16] model of flow in games to create a measure of enjoyment for educational games. They added a Knowledge Improvement factor to the model, but dropped the Player Skills factor. To validate their measure, they asked 166 college students to complete their questionnaire after they played one of four educational games. Results showed the measure had adequate construct validity and reliability.

It may have been better if Fu, Su, and Yu had said more about the process they used to develop the model underlying their scale and the rationale for the content validity of their scale. Knowledge Improvement may be a desirable outcome, but it was not made clear why it would lead to enjoyment. It was also unclear why they dropped the Player Skills factor, since it seems distinct from Knowledge Improvement.

Using Computer Games in Psychological Research. Washburn [17] discussed the use of computer games as tools for psychological research. Washburn suggested that many of the cognitive tests that psychologists use are artificial, sterile, and too simple, and that game-like tasks can be more ecologically valid, complex, and enjoyable.

The drawbacks of game-based psychological research include programming demands, introducing unintended complexity, and appearing frivolous or less serious than other types of research. Washburn suggests using the term "game-like tasks" rather than computer games when applying for funding to describe serious cognitive and comparative research tests that use elements of computer games.

Washburn compared a cognitive task called the continuous performance task with the same task described as a star wars game to show that research using computer games leads to more motivation and better performance. Participants had significantly faster response times in the game-like condition than in the non-game condition, about 12% faster, with only 3% less accuracy (97% rather than 99% accuracy).

3.3 Flow

Flow is the psychological experience of overcoming optimally challenging obstacles for the sake of the enjoyment they provide.

User-System-Experience Model of Flow in Games. Cowley et al. [18] adapted Finneran and Zhang's [19] Person-Artefact-Task (PAT) model to understand entertainment and flow in games, proposing a User-System-Experience model. Basically, the User interacts with the System, and what results is the Experience. Cowley et al. did not present any original research to test the model they proposed, but reviewed how the existing literature fit with their proposed theory.

Flow in Media Enjoyment. Sherry [20] suggested that media enjoyment could be understood through flow theory. Sherry suggested that interpreting a movie or TV show could be understood as a task with an optimal level of the difficulty of that interpretation driving enjoyment of the media. However, no evidence was presented to support the idea that people watching passive entertainment experience flow, or that the challenge of interpretation is what makes watching movies or TV enjoyable.

Flow is only one route to enjoyment, but flow is distinct from relaxation because flow requires a high level of concentration on overcoming a series of challenging tasks [21]. Perhaps an expert interpreting a complex experimental film could be an optimally challenging task and therefore a source of flow. But passively watching film or television without trying to achieve a challenging goal is by definition a relaxing experience not a flow experience.

GameFlow Model of Player Enjoyment. Sweetser and Wyeth [16] proposed a model of player enjoyment built on flow theory, made up of 8 elements: concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. They created a list of criteria for each element and used these criteria for expert evaluation of two games, one game with high ratings and one with low ratings from game reviewers.

Because these expert evaluations were conducted only once and by the researchers themselves, no measures of inter-rater agreement could be presented. Sweetser and Wyeth did not empirically validate either these criteria or their model of game enjoyment. Sweetser and Wyeth suggested that because the higher rated game was evaluated more highly on their list of criteria that was a meaningful method to validate their criteria. But since the two games being evaluated were chosen such that one was rated higher than the other by game reviewers, it seems like the researchers knew before they conducted the evaluations which game was rated higher. This lack of a blind evaluation by an independent rater may have biased their results.

As Sweetser and Wyeth pointed out, social interaction is an element of game enjoyment but is not a part of flow theory. They said they included it in their model because "it was highly featured in the literature on user-experience in games." They did not have a sound theoretical or empirical reason to include social interaction in a model of flow in games. It may have been more accurate to call it their model of game enjoyment.

Focus Group Explores Social Processes Leading to Group Flow in Social Gaming. Kaye and Bryce [22] conducted four focus group sessions with four or five people each to understand how playing video games with other people and the social interactions around that lead to group flow. Kaye and Bryce asked the groups about their motivations for playing games, their experience playing games in the presence of other players, and asked probing follow-up questions.

Kaye and Bryce identified several social processes that led to group flow during social gaming: collective competence, collaboration, task-relevant knowledge/skills, complimentary participation, being seen, social connectedness/belonging, social integration, and social networking.

While focus groups are often shunned as research methods that suffer from groupthink and social desirability bias, Kaye and Bryce's study shows that focus groups can be an effective tool for exploratory studies and group brainstorming to identify issues for further research. However, this kind of qualitative research only identifies, discovers, and describes phenomena. Further research is needed that would operationalize and measure the factors they identified and group flow to say with any certainty how these factors relate to group flow.

3.4 Immersion and Engagement

Immersion and Engagement may be thought of as synonymous with Flow, different theories about the same experience, or similar experiences with nuanced differences.

A Grounded Theory Study of Immersion. Brown and Cairns [23] did a grounded theory study of game immersion. They asked seven people who regularly play games to play their favorite game for thirty minutes and then participate in a semi-structured interview. They focused on what immersion and presence mean to the gamers, in their own words.

Brown and Cairns found three levels of immersion: engagement, engrossment, and total immersion. Each level of immersion had different barriers that needed to be overcome to achieve that level of immersion. The barriers to engagement were access to the game, time, effort, and attention. They defined attention as "willingness to concentrate" (p. 1299).

While engagement was about being willing to play the game at all, engrossment was about being emotionally invested in continuing to play the game. The barriers to engrossment were about "game construction", or the quality of the game. Game construction included the visuals, tasks, and plot of the game.

Each lower level of immersion must be reached before the next can be attempted. The next and final level of immersion Brown and Cairns found was total immersion, which they said was the same as presence. Their participants described total immersion as "being cut off from reality", being so detached from reality that "the game was all that mattered" (p. 1299). The barriers to presence were empathizing with the main character or team in the game and atmosphere, which they defined as having game features that were "relevant to the actions and location of the game characters" (*ibid.*).

Quantitative Experiments on Immersion. Jennett et al. [24] took a more quantitative approach to immersion in digital games. Through three experiments, they found that

immersion could be measured subjectively through questionnaires and objectively through task completion time or eye movements. They also suggested that immersion was not always a positive experience, but could be accompanied by negative emotions as well. The dimensions of their questionnaire measure of immersion were basic attention, temporal dissociation, transportation, challenge, emotional involvement, and enjoyment.

Immersion in Video Game Stories. Qin et al. [25] developed a measure of the factors of computer game narrative that contribute to immersion in the story of the game. Drawing on previous research to generate items, they developed their questionnaire measure through exploratory and then confirmatory factor analysis. The dimensions in the final version of their measure were: Curiosity, Concentration, Challenge and Skills, Control, Comprehension, Empathy, and Familiarity.

While they attempted to sort these factors into antecedents to immersion, experience of immersion, and effects of immersion, it may have been useful for them to separate the factors by whether they are determined by the design of the game (artifact), the personality traits of the person playing the game (person), or the activity that the person is doing in the game (task). In other words, it may have been better if they had applied the Person-Artifact-Task model [19]. This may have made their work more useful for practitioners.

Literature Review on Engagement in Digital Games. Boyle, Connolly, Hainey, and Boyle [26] conducted a literature search on engagement in digital entertainment games. Their initial search captured 19,776 papers, but their review focused on fifty-five papers that were about engagement in digital games. Boyle et al. categorized the papers they reviewed by what aspect of engagement they focused on, such as the subjective experience or motives for playing, and the study design used, such as quasi-experimental, survey, or qualitative approaches.

The Game Engagement Questionnaire. Brockmyer et al. [27] used Rasch analysis to develop a measure how much individuals typically experience engagement when they play video games. This kind of measure uses items that ask whether the statement applies to their experience and allows participants to answer "Yes", "Sort of", or "No". After pilot studies with 17 children and then 213 middle school students to develop the content of the measure, they surveyed 153 junior high school students. The Rasch rating scale analysis they did sorted the items from most to least "difficult", with more difficult meaning participants were less likely to agree with the statements.

In their second study, Brockmyer et al. had 107 male undergraduate students fill out the questionnaire they developed and then play a game. After 25 min of gameplay, they played a recorded voice for 16 s asking three times if they dropped their keys, each time with increasing volume. The researchers videotaped how participants responded to the recording and coded how participants responded. Regression analysis showed that participants whose Game Engagement Questionnaire scores indicated they tend to get more engaged when they play video games were more likely to ignore the first time the recording asked if they dropped their keys than those whose scores indicated they tend to get less engaged when they play games. But these relationships were not found for the second or third time the recording asked if they dropped their keys. They wrote that

how game players respond to hearing an initial statement may be most reflective of engagement. This was an interesting behavioral measure of player engagement, taking as an assumption that the more a person is experiencing engagement, the harder it will be to draw their attention away from the task at hand.

3.5 Challenge and Competition

An optimal level of challenge is one factor that leads to flow. When two players compete against each other, the skill-level of each player becomes the level of challenge for the other player. How do challenge and competition impact enjoyment?

Intrinsically Motivated Players Enjoy Challenges, Extrinsically Motivated Players Enjoy Winning. Abuhamdeh and Csikszentmihalyi [28] used hierarchical linear modeling with survey data from online chess players to show that people who had an intrinsic motivation orientation, meaning they were more motivated by intrinsic motivation, enjoyed more challenging games more than people who were more extrinsically motivated. People who are more extrinsically motivated are more driven by wanting to win the game than by enjoying overcoming challenges, so the easier the game is, the more they enjoyed it. The top quartile of intrinsically motivated people most enjoyed playing against more skilled players, while the bottom quartile on intrinsic motivation most enjoyed playing against less skilled players. Abuhamdeh and Csikszentmihalyi used chess rating as an objective measure of skill at playing chess based on the player's record of previous wins and losses. Relative chess rating was used as an objective measure of challenge or task difficulty, subtracting the player's chess rating from their opponent's chess rating for that game.

Playing Well Against Skilled Opponents Leads to Peak Enjoyment in Online Chess. Abuhamdeh and Csikszentmihalyi [29] studied the effect of optimal challenge on enjoyment in internet chess. Optimal challenge is a level of task difficulty that is not so high that it is overwhelming and not so low that it is boring. By looking at opponents' chess rankings, which are objective records of their past performance, they showed that an optimal level of challenge or task difficulty led to the highest ratings of enjoyment. Specifically, enjoyment was highest when players had a 20% chance of winning based on their opponents' higher chess ranking. They also found that enjoyment was highest when players performed about equally to their opponents. This suggests that playing against more skilled opponents and stretching your abilities to meet the challenge leads to the highest levels of enjoyment. This finding supports flow theory's notion that an optimal level of challenge leads to flow, and enjoyment is a part of the flow experience.

Balancing Outcome Uncertainty with Perceived Competence Maximizes Suspense and Enjoyment in Digital Games. Abuhamdeh, Csikszentmihalyi, and Jalal [30] investigated the impact of suspense and relative score on video game enjoyment. They found an inverted U-shaped relationship between relative score and enjoyment, with enjoyment being highest when participants were ahead of their opponent by 1.5 points. A similar relationship was found between relative score and suspense, with suspense being highest when players were behind their opponent by about 1 point.

Suspense mediated about 36% of the relationship between relative score and enjoyment. A linear relationship was found between relative score and perceived competence. So, a higher score led to higher perceived competence, but scoring higher than one's opponent lowered suspense. Combining these two sources of enjoyment, perceived competence and suspense, accounted for the relationship they found between relative score and enjoyment. Having a slightly higher score than one's opponent makes players feel skilled or competent while maintaining enough uncertainty about the outcome of the game to experience suspense.

Dynamic Difficulty Adjustment to Maintain Optimal Challenge in Video Games. Hunicke [31] created a dynamic difficulty algorithm to dynamically adjust the difficulty of a shooter game based on player performance. The algorithm looks at player health, expected player health based on a cumulative Gaussian distribution, and enemy damage to calculate how likely players are to die in the game. Then, the algorithm uses this information to adjust the difficulty of the game, such as by changing how much damage enemies do, changing enemy health points, or spawning health packs, ammunition, and weapons players can pick up in the game.

The algorithm Hunicke used attempted to keep player health at a mean of 60 with a standard deviation of 15. About every 3 s, the algorithm would decide whether or not to give players 15 health points. Participants were randomly assigned to play a version of the game with or without this adjustment. In the first 15 min of gameplay, players of the unadjusted version of the game died an average of 6.4 times, while players in the adjusted version died an average of 4 times. Perhaps because there were only had 20 participants, these results were not quite statistically significant ($t = 2.09$; $p = 0.0508$).

Hunicke measured player performance (deaths in the game), but did not measure player enjoyment or flow. It would have been interesting to find out if the dynamic difficulty adjustment version of the game led to higher ratings of player enjoyment.

Optimal Challenge Does Not Mean Medium Difficulty Settings. Klimmt et al. [32] conducted an experiment where participants were randomly assigned to play a First-Person Shooter game on either easy, medium, or very hard difficulty settings. Seventy-four participants played for 10 min and filled out a questionnaire.

Participants who played the game on easier difficulty settings reported significantly more enjoyment. Klimmt et al. claimed that these results were not in line with flow theory and attribution theory, which they interpreted as suggesting a medium level of difficulty would lead to the most enjoyment. However, flow theory does not suggest a medium difficulty setting on a game leads to the most enjoyment. Flow theory suggests that an optimal level of challenge will lead to the most enjoyment, a level of challenge that stretches player skills without overwhelming them. Another way to interpret these results is that participants tended to find the easy mode of this game's three difficulty settings to be closest to their optimal level of difficulty, so as the difficulty increased above that optimal level, their enjoyment decreased. So, their results are fully in line with flow theory's notion of optimal challenge.

In their discussion, Klimmt et al. admit that their results may have been "a mis-interpretation of objective difficulty levels", and that players may have found the easy setting "actually challenging". Optimal challenge is about subjective perceptions of challenge and skill being balanced and high, not objective difficulty. If someone is first

learning to play the game or considers themselves not very skilled, they will find a low challenge level optimally challenging. As perceived skills improve with practice, the optimal difficulty level may increase. This study highlights the difference between optimal challenge in flow theory and a medium difficulty setting on a game.

Competition and Its Impact on Video Game Enjoyment. Vorderer, Hartmann, and Klimmt [33] investigated the impact of competition on video game enjoyment. They defined competition as having an opportunity and necessity to act that affects the subsequent situation. This definition included competing with challenges presented in single-player games and controlled with artificial intelligence. It seems they conflated competition with challenge or task difficulty. In their methods section they called this construct "many possibilities to act and a strong necessity to act (i.e., a challenging/competitive element)" (p. 3).

In a field experiment, one of four hypothetical scenarios were presented to each participant. In the scenarios, the character either had many or few weapons, which manipulated the possibilities to act, and either there were monsters suddenly attacking or no monsters were mentioned, which manipulated the necessity to act. Participants rated the hypothetical situation on a measure of expected enjoyment using Likert scales. Participants rated their expected enjoyment higher when there was a high possibility to act and a necessity to act. However, expected enjoyment of hypothetical scenarios may not generalize at all to actual player experiences and behavior while playing actual video games. Asking about recent past experiences would have been better than asking for speculation about their future expected enjoyment.

3.6 Player Experience of Need Satisfaction and Self Determination Theory

Player Experience of Need Satisfaction (PENS). Ryan, Rigby, and Przybylski [34] developed a model of what motivates people to play digital games and leads to digital game enjoyment based on Deci and Ryan's [35, 36] Self-Determination Theory (SDT). SDT says fulfilling psychological needs for autonomy, competence, and relatedness leads to intrinsic motivation. Autonomy is feeling in control or feeling your actions are freely chosen. Competence is feeling skilled at what you are doing. Relatedness is social belonging and social connectedness.

The Player Experience of Need Satisfaction (PENS) model Ryan et al. proposed includes the three needs of SDT but adds Intuitive Controls and Presence. Intuitive Controls are how user-friendly the controls of the game are, or how easy the controls the player uses to interact with the game are to learn, make sense of, and master. Presence is about feeling like you are actually there in the game, physically, emotionally, and within the narrative of the game.

Ryan et al. presented four studies showing empirical support for the PENS model. The first three studies asked participants to play games from different genres and then fill out a questionnaire. The four study surveyed previous experiences playing massively-multiplayer online games. Results from analyses including repeated measures ANOVA and Hierarchical Linear Modeling supported the PENS model.

Motivational Model of Video Game Engagement. Przybylski et al. [37] described the theory behind the Player Experience of Need Satisfaction (PENS) model. As with Ryan et al. [34], they suggested that fulfilling psychological needs for competence, autonomy, and relatedness motivated people to play video games.

Przybylski et al. discussed research they have conducted suggesting that fulfilling these psychological needs was a better predictor of game enjoyment than violent content. They also discussed their studies distinguishing between having to play versus wanting to play. Their research suggested that people who had their basic psychological needs for autonomy, competence, and relatedness satisfied in their daily life tend to experience more choice about their engagement in video games. They called this distinction between having to play versus wanting to play "harmonious passion" versus "obsessive passion".

Media Enjoyment as Need Satisfaction. Tamborini et al. [38] validated and extended the Player Experience of Need Satisfaction (PENS) model [34]. They conducted a 2×2 between-subjects experiment with a bowling game varying whether players used a traditional controller or a Nintendo Wii motion controller and varying whether they were playing against a human or a computer.

Their proposed model explained 51% of the variance they found in their results. They extended PENS by including Perceived Game Skill as a factor contributing to Autonomy. They argued that players with high game skill would feel more volition in the game, giving them more opportunity to satisfy their autonomy needs. They could have made it more clear how Perceived Game Skill was distinct from Competence, since Competence is basically the experience of feeling skilled.

Experiment Shows Impact of Autonomy and Competence in Exercise Games. Peng et al. [39] conducted a 2×2 experiment manipulating the presence or absence of game features to support autonomy and competence in an exercise game.

The autonomy-supportive features allowed players to customize character appearance, to choose how their character becomes more powerful (hit points, speed, or damage) as they progress through the game, and to choose between a variety of dialog options when speaking with non-player characters. The competence-supportive features included dynamic difficulty adjustment that makes the game easier or harder based on player performance, a heroism meter to give players feedback, and being able to earn achievement badges viewable in an achievement menu.

Each participant played one of the four versions of the game. Participants played the game for 15 min in a lab and then filled out an online questionnaire.

Participant ratings of enjoyment, motivation to play the game in the future, likelihood to recommend the game to others, and their rating of the game were significantly higher when the autonomy-supportive and competence-supportive features were present than when they were absent. They tested these differences with a two-way ANCOVA, controlling for gender and hours of gaming per month.

3.7 Motivations to Play Games

Motivations to Play Online Role-Playing Games. Yee [40] created a model of what motivates people to play online role-playing games. The model had 10 sub-components sorted into 3 main components: Achievement, Social, and Immersion. Achievement was made up of Advancement, Mechanics, and Competition. Social consisted of Socializing, Relationship, and Teamwork. Immersion was made up of Discovery, Role-Playing, Customization, and Escapism.
To develop this model, Yee created a 40-question survey using 5-point Likert-type scales based on Bartle's [41] four player types of achiever, socializer, killer, and explorer. Yee's survey was also based on qualitative information from earlier surveys of online role-playing game players. The results of this 40-item survey were analyzed with exploratory factor analysis using oblique rotation to develop Yee's ten-component model. Running exploratory factor analysis a second time on these ten components was done to group the components together, resulting in the three main components of Achievement, Social, and Immersion.

Bartle's model of player motivations, which he called player types, was generated by dividing up what players do in online games into acting and interacting on other players and the world. Achievers act on the world, socializers interact with other players, etc. This was a purely theoretical construction, not based on research with actual game players. Because Yee started with Bartle's model, and Bartle's model was theoretical and not based on research, Yee's model may be incomplete, lacking in content validity, or not as conceptually comprehensive as it could have been. Yee noted that earlier qualitative surveys influenced the development of this survey, but did not explain how this earlier research influenced survey item generation.

Demographics and Motivations to Play Online Games. Yee [42] used an online survey of 30,000 online game players to explore the demographics, motivations and experience of players of massively-multiplayer online role-playing games (MMORPGs). Yee found a wide range of ages play these games, and that motivation to play was strong across ages (hours of play per week correlated with age at $r = -.04$).

Yee created a questionnaire of motivations to play MMORPGs based on qualitative data from open-ended online survey items, from online forum discussions, and from Bartle's [41] player types. Exploratory Factor Analysis of online survey responses to this questionnaire found eight factors: Relationship, Manipulation, Immersion, Escapism, Achievement, Lead, Learn, and Solo/Group.

As with Yee's [40] other article published the same year, the items that went into this analysis may not have captured the full range of motivations to play games. Bartle's [41] player types were theoretical and not based on research with actual game players. Yee's findings about MMORPGs may not generalize beyond MMORPGs.

Motivations to Play Predict Actual Behavior in World of Warcraft. Billieux et al. [43] surveyed 690 *World of Warcraft* players, focusing on their motivations for playing the game, and then tracked their in-game behavior for 8 months through the game's official database. To measure motivations to play the MMORPG, they used Yee's [40] measure developed for that purpose. Billieux et al. found that several motivations

predicted actual in-game behaviors. For example, the more players were motivated by Advancement, Mechanics, Competition, Escapism, Relationship, or Customization, the more hours per week they played the game, with each showing a statistically significant correlation (r ranging from .18 to .37; $p < 0.00028$).

Understanding Why People Play Online Games with the Theory of Planned Behavior. Lee [44] used structural equation modeling with survey data to compare two competing theories of what makes people want to play online games: the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM). Using multi-group causal analysis, Lee found that the TPB model better explained the data that they collected than the TAM model.

Their results showed that Perceived Usefulness (PU) in the TAM model did not significantly predict Perceived Ease of Use, Attitude, or Intention. This seems like a fairly obvious result, that people do not play online games because playing them is useful.

What was more interesting about this study was how Lee integrated flow theory, enjoyment, usability (which they called Human-Computer Interaction), and the Theory of Planned Behavior to make sense of and predict what makes people want to play online games. To summarize some of the paths in Lee's research model, Human-Computer Interaction and Social Interaction contribute to Flow Experience, which in turn contributes to Attitude and Intention, Attitude contributes to Intention, and Intention contributes to Behavior. Each path in the model was statistically significant.

Motivations to Continue Playing Online Games in Korea. Choi and Kim [45] proposed and tested a model of why people continue to play 16 online games in the Korean market. They proposed that interaction with the system (Personal Interaction) and interaction with other players (Social Interaction) lead to optimal experience or flow, which in turn leads to customer loyalty, or an intention to play the game again in the future. They said three elements of the system design contribute to personal interaction: goal, operation, and feedback. The operation is about the instruments that players can use to help them achieve their goal. Communication Place and Communication Tools contribute to Social Interaction. Communication Place refers to the virtual world where players can gather together. The results of their SEM analysis using LISREL supported their proposed model that Personal and Social Interaction contribute to Optimal Experience or Flow, and that Optimal Experience or Flow in turn contributes to Customer Loyalty.

Motivations to Play Arcade Games in 1985: Mastery and Competition. Morlock, Yando, and Nigolean [46] surveyed 117 university students, asking them about what motivated them to play arcade video games. They found that those who played games frequently were motivated to compete with others and to master the games.

Top 3 Reasons Scottish University Students Play Games: Challenge, Curiosity, and Fantasy. Hainey et al. [47] surveyed 2226 Scottish university students about their computer game playing habits and their reasons for playing games. To assess their reasons for playing games, participants were given descriptions of each part of Malone and Lepper's [48] framework and asked to rate how important each part was for them. The framework included challenge, fantasy, curiosity, control, cooperation,

competition, and recognition. Challenge, Curiosity, and Fantasy were the three most important reasons participants gave for why they played computer games, while Competition and Recognition were least important.

Hainey et al. also asked participants, "If you had the opportunity to use computer games for learning in your programme at University, how would you rate each of the following reasons in terms of importance in learning?" Challenge, curiosity, and cooperation were the most important reasons to play computer games in higher education to those surveyed, while recognition and fantasy were least important.

Limiting the reasons for playing games to Malone and Lepper's framework may have limited the range of responses participants were able to express in this study. It may have been better to ask an open-ended question to elicit other reasons participants play games.

The Playful Experience (PLEX) Framework Supported by Interview Data. Korhonen et al. [49] interviewed 13 video game players to develop an initial framework of playful experiences. They drew on previous research to generate a pool of experiences, pleasures, emotions, elements of play, and reasons people play games. Then they interviewed players of three games: *Grand Theft Auto IV, The Sims 2,* and *Spore*. They coded the transcripts from the interviews with their playful experiences framework. They found that all of the categories in their framework were mentioned by players of at least two of the three games that were played. The categories in their framework were: Captivation, Challenge, Competition, Completion, Control, Discovery, Eroticism, Exploration, Expression, Fantasy, Fellowship, Nurture, Relaxation, Sadism, Sensation, Simulation, Subversion, Sympathy, and Thrill.

Korhonen et al. pointed out that their framework is not fully comprehensive and suggested some additional categories they had under consideration: disgust, humor, cuteness, identification, and tragedy. There is some subjectivity in the coding of interview data, and a risk of confirmation bias if the interviewers know the categories. It may have been better if they had used a more bottom-up approach to generate their initial categories and had used more than one coder so they could present inter-rater reliability statistics for the coding of the interview transcripts.

Children's Motivations to Play Video Games. Olson [50] surveyed 1,254 middle school children to evaluate what motivates them to play video games. The top three reasons female students agreed with for why they play electronic games were "it's just fun", "like to compete w/others & win", and "challenge of figuring things out". The top three reasons male students agreed with were "it's just fun", "something to do when bored", and "challenge of figuring things out".

Olson could have said more about how they came up with the reasons they used in their survey. In particular, "it's just fun" does not tell us much about why it is fun. It creates circular logic: it is fun because it is fun.

Motivations to Play First-Person Shooter Games. Jansz and Tanis [51] did an online survey of 751 Dutch people on what motivates them to play First-Person Shooter (FPS) games. Respondents were asked whether or not they were part of an online group that play together, and if they were in an amateur or professional group. Professional players were significantly more likely to be motivated by

Competition and Challenge than the other groups. Players who were a part of a group were significantly more likely to be motivated by Social Interaction than non-group members.

Jansz and Tanis could have said more about how they chose the motivations they measured. In particular, Enjoyment seems too broad to be included as a motivation.

Motivations to Play Social Network Games. Lee, Lee, and Choi [52] surveyed 324 US college students about why they play social network games. Factor analysis of the survey data revealed six motivations: passing time/escapism, entertainment, challenge/competition, self-presentation, fantasy/role playing, and social interaction.

Lee, Lee, and Choi explored the relationship between these motivations and behavioral intentions such as an intention to play social network games, to visit friends to play the games, to send friends gifts in the games, and to purchase virtual goods. Different motives predicted different behavioral intentions. For example, being motivated by Self-Presentation significantly predicted intention to purchase virtual currencies or goods in social networking games.

Hedonic Motivation Systems Model. Lowry et al. [53] proposed a model of hedonic-motivation systems (HMS), systems used for pleasure rather than productivity. The final structural equation model they presented shows Perceived Ease of Use contributing to Perceived Usefulness, Curiosity, Joy, and Control; Perceived Usefulness, Curiosity, and Joy in turn predict Behavioral Intention to Use, while Curiosity, Joy, and Control predict Immersion.

Usefulness is a holdover from the study of productivity applications. This part of the Technology Acceptance Model may not generalize to games for entertainment. The constructs in the HMS model were not specific enough to be useful for design. It is unclear how one would design for usefulness or if usefulness is important to game players. Curiosity was defined as experiences that arouse sensory and cognitive curiosity, but it was not made clear what those experiences were.

3.8 Games User Research Methods

Heuristics to Evaluate the Playability of Games. Desurvire et al. [54] did a heuristic evaluation of a game prototype and a user study of the same prototype with 4 participants, and compared the results from the two methods. They found that the heuristic evaluation found more issues than the user study, but that the issues found in the user study were more specific to the game being studied, its interface, terminology, characters, and wording.

Desurvire et al. suggested that heuristic evaluation may be most useful in the early stages of game development before the prototype allows much interactivity. They suggested heuristic evaluation be used along with rather than instead of user testing.

Playtest Method for Assessing Player Perceptions. Davis, Steury, and Pagulayan [55] introduced the playtest method for assessing player perceptions of digital games as a formative research method to improve game designs. The playtest method combines surveys with playing the game in a controlled lab environment. Participants play the

first hour of the game and then fill out a questionnaire to rate the overall fun, graphics, controls, sound, story (if the game has a story), and other elements of the game. These questionnaires include not only Likert-type rating scales, but also open-ended questions to understand the reasons participants have for the ratings they gave.

They recommend 25–35 participants for the playtest method. This sample size was based on a power analysis of the statistical tests used in their previous research. Having a larger sample size than typical usability tests allows for comparisons between groups, such as between different versions of the same game or between their game and a similar game from a competing company. Playtests allow for statistically significant comparisons of player perceptions across groups, perceptions informed by the first-hand experience of playing the game in a controlled lab environment.

Intrinsic Skill Atoms as a Lens for Gameful Design. Deterding [56] presented a method for gameful design or gamification he called the lens of intrinsic skill atoms. This involves identifying the inherent, skill-based challenges of the activity, removing extraneous challenges through automation or improving usability, and then restructuring the remaining inherent challenges into nested, interlinked feedback loops of goals, actions, objects, rules, and feedback that create motivating experiences.

The skill atom is a feedback loop between user and system that users engage in to overcome a challenge using their skills. Deterding defined the rules of the system to mean the actions that users can take and how those actions affect the system state.

Deterding then presented these steps for gameful design: (1) strategy, (2) research, (3) synthesis, (4) ideation, and (5) iterative prototyping. Deterding described two case studies applying the lens of intrinsic skill atoms method. For each case study, Deterding described how each of the five steps of gameful design were done. The first case study was a project for a European online dating platform focused more on ideation, and the second was for an online social network that focused more on evaluation.

3.9 Game Design

The Mechanics, Dynamics, and Aesthetics (MDA) Framework. Hunicke, LeBlanc, and Zubek [57] presented a conceptual framework for understanding games they called the MDA framework, standing for Mechanics, Dynamics, and Aesthetics.
Mechanics are all actions players can take within the game and all components of the game, such as algorithms and data. The Mechanics along with the content of the game such as the levels and assets support gameplay Dynamics. The Dynamics are how the Mechanics respond to player actions and other events over time. The Aesthetics are the desirable emotional responses players have when interacting with the game. Hunicke et al. presented the following taxonomy of 8 game aesthetics: Sensation, Fantasy, Narrative, Challenge, Fellowship, Discovery, Expression, and Submission. They emphasized that Aesthetics includes but is not limited to this taxonomy.

MDA is a conceptual model to bridge the gap between the mechanics and interactive systems of games and the emotional experience of players. Hunicke et al. did not present empirical research to support this model. Instead, they gave an example of how the MDA model could be applied to game design. They discussed three iterations of a

game design, each with different target audiences. For each iteration, they described the Aesthetics, Dynamics, and Mechanics they would consider.

3.10 Game Player Demographics

Griffiths et al. [58], Williams et al. [59], and Griffiths and Hunt [60] surveyed game players, and found that people who play games are diverse along dimensions such as age and gender. Williams et al. found a median average age of 31 years-old compared to a median age of 35.4 years-old among the general population. 42% of those Griffiths and Hunt surveyed were female. The Entertainment Software Association releases annual reports showing a similar trend towards diversity among players [61].

3.11 Game Addiction

Wanting to Play Versus Having to Play Video Games. Przybylski et al. [62] integrated Self-Determination Theory and a two-factor model of passion. The two-factor model of passion distinguishes between harmonious passion, which is wanting to play the game, and obsessive passion, which is feeling like you have to play. Participants were surveyed about a favorite video game they had played for at least one month. Hierarchical regression modeling of the survey data showed that trait need satisfaction – people feeling that their basic psychological needs for autonomy, competence, and relatedness were met – was positively associated with harmonious passion, and negatively associated with obsessive passion. So, players whose basic psychological needs were already met were more likely to play games because they wanted to rather than because they felt that they had to or were compelled to play.

Harmonious passion was associated with enjoyment, but not hours per week of play. Obsessive passion was associated with more hours per week of play, higher tension, and less game enjoyment. This study demonstrated that video game enjoyment driven by intrinsic motivation and wanting to play is a distinct phenomenon from compulsive or disordered video game play driven by feeling like one has to play.

Designing Digital Gambling Machines to Maximize Profit. Schull [63] describes an ethnographic study in Las Vegas of people playing digital gambling machines, and the designers of those games. Schull discussed how changes in the design of these games has led to more rapid extraction of money from players and led to players feeling a deeper sense of immersion or flow. For example, changing from a pull-handle to push-button machines allows players to rest their hand on the button, doubling the rate of play from 300 to 600 games per hour. The core of what makes gambling machines effective are random number generators that determine wins and losses, using a pattern B.F. Skinner called a variable intermittent ratio reinforcement schedule.

Several elements of digital gambling machines get players “in the zone”: being alone, not being interrupted, speed, choice, and tempo. Schull used quotes from player interviews as evidence for each of these elements.

It would have been better if Schull had differentiated between gambling and gameplay. Perhaps having money at stake makes the game more addictive, while an engaging game design leads to flow and enjoyment even without gambling money.

User-Experience Design Factors That Predict Addiction to MMORPGs. Hsu, Wen, and Wu [64] developed a questionnaire measure of user-experience design factors they hypothesized would predict addiction to MMORPGs. 418 Taiwanese college students responded to the measure online along with a previously-validated questionnaire measure of game addiction. Regression analysis showed that Role-Playing, Belonging, Reward, Obligation, and Curiosity predicted addiction to MMORPGs.

3.12 Violence in Games

Autonomy and Competence Predict Enjoyment Better than Violent Content. Przybylski et al. [65] conducted an online survey and two lab studies. Multiple linear regression analysis of the survey data showed that how much the games fulfilled players' psychological needs for autonomy and competence explained more of the variance in enjoyment, presence, interest in playing a sequel to the game, and recommending the game to others than how violent the games were.
In their third study, participants were randomly assigned to play either a violent or non-violent game for twenty minutes and fill out a questionnaire. In-game autonomy and competence explained much of the variance in enjoyment, presence, and desire to play the game in the future. Players with high trait aggression who played the violent game were more likely to want to play the game again in the future.

The Impact of Moral Disengagement Cues on the Emotional Experience of Violent Video Gameplay. Hartmann and Vorderer [66] conducted experiments on how moral justification and consequences impact the emotional experience of playing a first-person shooter game. In the morally justified condition, players were UN soldiers attacking a torture camp to restore humanity, while in the morally unjustified condition players were paramilitary forces in the torture camp continuing to torture and defend the torture camp. When players shot opponents in the consequences condition, blood was shed and dying characters screamed and fell to the ground. In the lack-of-consequences condition, a "ping" sound played and characters vanished.

Fighting for a just cause led to significantly less guilt and negative affect, but not significantly more enjoyment, than fighting for a morally unjustified cause. Enjoyment was higher when consequences were shown in the just condition, but higher when consequences were not shown in the unjust condition. Players who thought it was "just a game" reported significantly less guilt.

Technological Advancement in Video Games Increases Player Involvement, Arousal, and Presence. Ivory and Kalyanaraman [67] conducted a an experiment on the impact of technological advancement and violent content on physiological arousal and questionnaire measures of arousal, presence, involvement, and aggression. Playing newer games resulted in more presence, involvement, physiological arousal, and excitement than playing older games. No significant differences were found between the experience of players of the violent and non-violent games.

4 Conclusion

For those who wish to design interactive systems for user enjoyment and intrinsic motivation, the literature reviewed above is a good starting point. More empirical research must be done on the sources, uses, and benefits of digital game enjoyment.

Qualitative research is needed to discover design differences and other factors that lead to enjoyment. For example, a recent card sorting study identified 32 sources of enjoyment in digital games [68]. Quantitative research is needed to understand how these factors influence and relate to each other. Controlled experiments are needed to operationalize the sources of enjoyment into concrete design differences and to establish causal links between factors. For example, controlled experiments can test the causal links between sources of enjoyment and enjoyment, and between enjoyment and the benefits of enjoyment or the desired outcomes associated with serious games such as learning, persuasion, or behavioral outcomes.

There is much research to be done to build a science of digital game enjoyment that can be used to reliably engineer enjoyable experiences.

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