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Ben Medler

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BEN MEDLER

Digital gameplay experiences were once ephemeral. A player would load up *Pac-Man* (Namco 1980), have a wonderful time and walk away with that play session locked in their mind. Yet, the game had amnesia; resetting itself for the next player, no record of what transpired in the previous play session existed, nothing for the game to hold on to. Sure a high score or two may have been saved, but the technology did not allow games to remember the past. Fast forward to today, where most, if not every, game has the ability to lock away gameplay sessions. High scores are ubiquitous and saving a game means players can return to a single play session over and over. Once games moved online, recording achievements, speedruns, trick shots, player ghosts and replays have exploded in the current generation of games. Game developers, and players have never had this level of access, a way to play with the past.

Today games are beginning to be populated by what can be called ludophasmas, or game sprites. Players interact with ludophasmas as player ghosts, cloned players and NPCs that exhibit the behaviors of other living players. These spirits are created by combining artificial intelligence and recorded gameplay, stored historical game traces known as ludivestigums. Player scores, achievements, decisions and communications are now part of these stored ludivestigums as game companies continue to record increasing amounts of information regarding their players and the events that happen inside their games. Developers are continually finding ways to insert their recorded gameplay information back into a player's current game experience known as the player's ludoexhibeo. With these three concepts a cycle is formed from the player's current experience (ludoexhibeo) to the recorded version (ludivestigum) until finally a materialized experience is produced from the recording (ludophasma) and is feed back to the player once more. However, this cycle was not always so well defined. In the past, ludophasmas did not always play among us in our games and very little information about gameplay was recorded into ludivestigums. Ludoexhibeos were relatively history free.

How then has game recording evolved over the generations and how will it affect future generations of players and game developers who have access to the digital past? This article takes a historical look back at the process of recording game information in order to understand where it may head in the future. To do this we must first start at a time before digital games even existed. Game companies recording player actions today are following in the footsteps of the sports statisticians that have been recording sports information for over a century. Next, we must explore how recoding digital gameplay developed from the early pinball machines to the cutting edge online recording systems employed by many game developers and console producers today. Finally, an early glimpse as to where game recording is going is discussed as examples of systems using game analytics and adaptive

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gameplay are explored. These systems will soon allow designers to deliver game content based on each player's personal recorded history and players, in turn, must find their own place in this history-reproducing revolution; acknowledging that their gameplay is being recorded and deciding how they will use their data. Recording the past has taken games to new levels over the generations and there may come a time where games themselves recall more of their past than the players do.

Recording a Past Generation

Pacman, in 1980, only recorded a player's final score as a measurement of the player's success. However, this one number is nothing compared to the hundreds of statistic numbers that were recorded for a single player from a United States of America (USA) Major League Baseball team in 1980. For over a century, various games and sports have been meticulously recorded in such a fashion. The National League of baseball in the USA has records before 1876, as the league was created, and other sports have similar records: the Olympics from 1896, football leagues in the USA from 1922, and basketball leagues in the USA from 1946 (Forman 2007).

Those statistics, which represent ludivestigums, store more than just the final score of a game; baseball records contain player's batting average, strikeouts, stolen bases and all of these figures are available to the public. Of course sports teams themselves make use of this information, they are able to track their own performance and rank themselves against other teams. Yet, it is the sport statisticians who are able to estimate team winning probabilities (Mosteller 1952; McHale and Davies 2007), model the evolution of world records (Kuper and Sterken 2007) and predict player behavior in certain situations (Albert 2007) that add extra value to these extensive records. A remarkable use of sports statistics appears in the article "Winning Isn't Everything: Corruption in Sumo Wrestling" by Mark Duggan and Steven D. Levitt (2002) which analyzes the win/lose records of Japanese Sumo wrestlers. In Sumo wrestling, each wrestler is trying to achieve a winning record (more wins than losses) in order to gain a promotion in the ranks. The authors found that wrestlers may lose a match, intentionally or not, if that loss helps the winning wrestler achieve a winning record and that this happened with increased frequency when the losing wrestler already locked down their winning record (meaning even if they lost they would still advance). Regardless of whether the wrestlers are cheating or sub-consciously allowing their fellow wrestlers to win, having access to the statistical records allowed the anomaly to be found.

Outside the world of sports a digital game precursor famous for its connection with recording scores is the pinball machine. Pinball's origins often reference the form of billiards called *Bagatelle* (Kent 2001) dating back to the 1700s where players had to sink balls into a number of different holes to score points. During the early 1930s, David Gottlieb created a number of the earliest variations on *Bagatelle* and created what we would call pinball today. Even these first examples of pinball machines had the means of keeping track of points scored. In the 1930s this led to the creation of machines called payouts which combined pinball with gambling by awarding money to customers that achieve a certain amount of points (Kent 2001). Pinball machines were eventually banned throughout most of the USA due to their connection with gambling but fortunately, as new features were added, pinball became a legitimate entertainment option. Features such as the "flappers" allowed pinball to be viewed as a game of skill and gave players more control over how many points they scored. In the mid-1970s, the solid-state, or electronic, pinball machines were introduced allowing for electronic and alphanumeric scoring (BMI Gaming, 2009), not to mention the ability to record complex hit patterns that allowed players to increase their points by hitting certain bumpers or slots.

During the same time, video games and arcade machines had started their trek towards popularity and recording scores was an important feature. The first instance of a high score being recorded in a video game appears in the 1976 game, *Sea Wolf* (Midway 1976). The arcade game had players peer through a submarine periscope to attack enemy ships displayed on the screen. While *Sea Wolf* kept track of the all-time highest score it did not record which player achieved the score. That feature would come in 1979 in the game *Star Fire*, an early arcade shooter where players fire at enemy space ships (Exidy 1979). The game allowed players to enter their initials with their high scores and even had hidden messages for players who entered a specific three letter initials as their signature.

These examples show that the history of recording modern game information goes back for more than a century, well before digital games. Generation after generation of sports statistics have been used to determine game outcomes and player behavior before digital games even existed. When pinball machines and video games were created they were limited to only recording rudimentary values such as high scores. Over the years, however, as digital gaming advanced and new generations of digital games were produced, it became easier to record game information and traces as ludivestigums. The present generation of digital games has surpassed recording high scores and today the act of recording gameplay is a vital part of how digital games function as a whole.

Recording the Present Generation

It is hard to find a digital game today with no ability to record gameplay. Games may begin from a spontaneously created starting point, but as play commences they acquire a history throughout a player's experience. Salen and Zimmermann in their book *Rules of Play* define a game as "a system in which players engage in an artificial conflict, defined by rules, that result in a quantifiable outcome" (2003, p. 96). Resulting in a quantifiable outcome means the artificial conflict occurs over a certain period of time, one where a history is formed. Bernard Suits in his book, *The Grasshopper: Games, Life and Utopia* specifically points out the temporal action that takes place over the course of a game:

> To play a game is to engage in activity directed towards bringing about a specific state of affairs, using only means permitted by rules, where the rules prohibit more efficient in favor of less efficient means, and where such rules are accepted just because they make possible such activity (2005, p.34).

While a simple game like predicting a coin flip does not have any concept of past gameplay, the act of the player "bringing about a specific state of affairs" does. The player's past experience with other coin flips is historically significant to any future coin flip.

Therefore, stored gameplay history is the recording of a player's experiences. Ideally capturing a player's entire experience, there ludoexhibeo, would constitute a true historical record of that player's gameplay but given the technology available today games will only collect a small portion of what each player experiences. For example, a score is one measurement of how a player is performing throughout a single play session and as long as that player continues to play, their score will continually be recorded. Which means recorded gameplay information should not be thought of as just an incomplete experience but as a way of recording gameplay events, which includes player decisions, at various levels of fidelity.

The fidelity of recording player experiences (and game events) has been increasing over the years and it begs the question, how is gameplay history represented in games? Obviously games exist in time and automatically gain a history by their very existence. One can easily bring up many philosophical, narrative or scientific examples of how time flows and relates to history. However, the passage of time is not how history is actually represented in games. Game history is represented in a game's recorded data, in a ludivestigum.

Recording Types

According to Janet Murray (1998) in her book, *Hamlet on the Holodeck,* one attribute of computers as a medium is that they are encyclopedic. Computers allow data to be stored, retrieved, searched and correlated. The same idea Lev Manovich also describes when he claims there are two types of software objects, data structures and algorithms (Manovich 2001). Data structures are used to organize data in "a particular way for efficient search and retrieval" and the "more complex the data structure of a computer program, the simpler the algorithm needs to be," or less work is required to use the stored information (Manovich 2001, p. 223). Digital history, recorded data from the past, can be recalled algorithmically at a moment's notice and stored for later consumption in time. Digital games use the encyclopedic ability by storing game information in variables, arrays and other data structures built into each game. A game's history is represented in that data, storing past gameplay experiences.

There are four forms of data recording when digitizing a game's history: concurrent, progressive, longitudinal and external. Concurrent data collection happens at the moment an event occurs. An event is represented by any action or decision that is made by the player or the game itself. For example, when the player dies (most likely due to a failed decision) a game records that event as a loss of one life. The recording of that event is a concurrent recording type because it happens when the event occurs.

Progressive recording is a string of concurrent recordings. Each time a player dies a concurrent record is made and the total amount of player lives over time is the progressive record. A better example is a player's score. While each point a player acquires is a concurrent record, the final, total score is the important record representing a progressive recording across time. These records can literally record a player's progression too. In racing games like *Forza Motorsport 3* (Turn 10 Studios 2009) the player's position on a race track is continuously recorded and players are given the option to rewind their race if they commit an undesirable action like crashing. Other progressive recording examples include: maps showing where the player has explored during their current play session, timing how long a player has been playing and player statistics like health. However, once progressive recordings need to be stored long-term longitudinal recordings are used.

Longitudinal recording are used between game sessions and stores information for later use. In the past when a player wished to end a game they would stop playing. This would obliterate the progressive game record that was created in the game (leaving only the player's own internal history with the game intact) and forced the player to start fresh next time they wished to play. This changed once games began to store data in longitudinal format.

Saving a game is the longitudinal recording of a set of current progressive game records. The values that are stored progressively (scores, lives, levels completed, achievements won, etc.) are recorded in a longitudinal record and are used to initiate game values the next time a player loads the saved game. Players do not have to be the ones who create the saved game and some games save player progress automatically. Older multi-user dungeon games (MUDs) and their cousin, massively multiplayer online games (MMOs) both have made use of longitudinal recording to keep their world's data persistent from day to day without the player having to lift a finger (Bartle 2004). Check-points are another automatic saving example where once a player has passed a certain point, the check-point, they start the game over at the most recent point they passed if anything forces them out of the game (such as their death). These check-points can both represent progressive recording, if they only work while playing a game (but not after leaving the game), or longitudinal recording, if they represent points where the player can save the game in order to return later.

Finally, external records are stored outside the reach of the game where the information is gathered. Online game databases are filled with information about specific games in the form of: walkthroughs, cheat codes, item information, storylines, etc. These databases have taken the place of printed strategy guides, telephone hint lines and personal knowledge passed from player to player (Consalvo 2007). External recorded knowledge is never used by the actual game unlike concurrent, progressive or longitudinal data. The external records represent an emergent behavior of game players and companies who seek to create their own set of longitudinal data that can be referenced outside of a game, whenever players are in need of the information.

Each recording type represents a separate instance of a ludivestigum. Concurrent and progressive records are traces that only exist within a player's current gameplay session, as part of their ludoexhibeo. External records are examples of ludivestigums that are created both through digital means, for example *World of Warcraft* (Blizzard Entertainment 2004) players can use applications to record item information and send it to external databases (Cosmos Patcher 2007), and by a player's own knowledge about a game itself. Walkthroughs are not created by software but by players recording how they traversed a game. Finally, longitudinal data records portions of a player's experience and allows that information to be loaded again at a different time. Each of these recording types create some form of game traces but these records do much more than just knit information together through time, they bind player experiences through space as well.

Time-binding Games

While each of the three data recording methods found in games (if we exclude external data for the moment) are associated with time, only longitudinal recording is time-binding. As part of Harold Innis' theory of the bias that exist in communication, time, or time-binding, is used to refer to media that lasts for long periods of time but do not reach a large audience (for instance, sculptures or oral stories bind people together across time) (Innis 2007, p. 26-27). The second bias Innis uses is space, space-binding, meaning media that covers large distances but does not have the longevity of time-binding media (the telephone or paper). Innis argues that societies have found ways of balancing the bias of time against space (Innis 2007, p. 27), though particularly in the USA space has prevailed over time (Innis 2007, p. 196-197), and others have used Innis' theories to study the bias of games as well (Kline, Dyer-Witheford, and De Peuter, 2003).

For the purposes of representing recorded gameplay, the time-binding property represents data that links games in time together, often in the same location, while space-binding data links games in different locations (e.g. recorded data accessible across the internet). For example, saved games, representing longitudinal records, are time-binding because they link two points in time together for a player. In actual game time there is no progression, as the game begins where the saved game was recorded, only the player witnesses the time in-between saving and loading the saved game. Personal saved games are not space-binding because they do not reach other players, unless those players physically play on the same computer or console.

Stepping back to the earliest digital game generation (circa pre-1976) for a moment, games from that era were neither time-binding nor space-binding for players. *PONG* (Atari 1972), for instance, would have no recollection of past gameplay and would fail to bind players together through time or space. Concurrent and progressive data was represented in these games but not longitudinal or external. Each game was a one-time event.

Once games began to record longitudinal variables, like high scores, games started to bind players through time. Arcade machines kept track of the best player performances over the course of the machine's history. Those records would remain until other players came along and beat the previous records, bumping the older scores off the high-score table. High-scores time-bound players together in public arcades as players saw the accomplishments of past players, goading the current players to surpass the ones who came before them.

Players become infamous on high-score tables. Those three letter initials carry a certain stature in the minds of players to come. Future players judge their own performances based on the values lying next to those initials, even though they may never meet the other player. Those records have a certain spiritual quality to them; current players know nothing of where they came from, only the scores remain. The past players have left their essence in the game. A similar phenomenon can be found in many legends and stories, for instance the Lafcadio Hearn (1907) tale *Of a Mirror and a Bell* where a woman's spirit is said to be attached to a particular brass bell which was forged in part with her family's brass mirror. Distraught after allowing her family mirror to be melted down to create the bell, the story ends with the women declaring upon her death that anyone who breaks the bell by ringing it will receive great wealth. Achieving a high score at an arcade is quite similar. By beating or breaking the high score set by the unseen past player the current player may take their place among those immortalized on the high score table. The high score records became ludophasmas and had meaning to the players who witnessed them after they were recorded.

As gaming moved into the home the time-binding spirit of arcade games was taken away from players. Convenience was added to gaming, allowing players to play in the comforts of their own home. Unfortunately, while home consoles or computer games stored longitudinal data that could be recalled at a moment's notice, players were bound only to themselves through time. This changed as more games moved into the home and eventually logged online.

'Time&space-binding' games

Today many games are linked through the internet. Arcades still exist where players congregate, and players are time-bound on local consoles, but online players connect to one another across the entire planet. Game records began to become space-binding with the influx of online connectivity, in addition to being time-binding. This combination of the time and space-binding properties, 'time&space-binding', has been defining the online generation of players and games. It exacerbates everything that came with time-binding media: competition, sharing of achievements, and the mystic in the 'other' player. Space-binding capabilities add to those properties by linking players across great distances and storing recorded gameplay in external locations.

Gaming online is not exactly like playing games at an arcade of the past generation (roughly 1976 to 1995). Online high score tables, for example, not only link players to past performances of other players but a score can be added by a player from any location in the world with access to the online game. Scores from different times and spaces sit side-by-side. A player knows when witnessing a high score table at an arcade that at one time those high scoring players stood in that same spot. With an online high score list players have a weaker connection to the other players, one that is much more distant than the one felt when playing in the same location.

However, this is not to say that the current player generation is antisocial or have disconcerting connections to other players. In fact, while high scores may have lost their power of presence over game players many new 'time&space-binding' features have taken their place. External game data has swept across the internet replacing game manuals and strategy guides. Where once external sources were focused on single players, huge game databases like Thottbot.com or Alakazam.com provide

MMO players with a forum to share game information and their experiences. Players have even built game plug-ins that update those external sources while playing the game they are recording (Cosmos Patcher, 2007) further creating a 'time&space-binding' connection. However, discussing the many examples of external game data will have to be saved for a different article. Instead, the next section will review the recording features that exist inside and apart of today's games. These features have progressed far beyond their high score roots and are allowing players to create their own historical archives which bind time and space.

The Many Faces of Recording

The current game generation allows both developer and player to record game history like never before. Of course high scores are still being recorded but have turned into achievements which players unlock. Saved games are used just as often too but developers are adding some new tricks that will personalize saved games. Finally, players personally record their gameplay as replays and player ghosts. All of these options create player traces, ludivestigums, which can be shared through time and space.

Achievements

Most gaming platforms now offer some form of achievement system. Sony, Microsoft, the Valve Corporation and Blizzard Entertainment each have their own achievement systems (Sony calls them trophies), to name a few. Microsoft defines achievements as "game-defined goals that are stored and displayed in your profile. Achievements can be as simple, complex, or off-the-wall as a game wants" (Achievements with Xbox 360, 2009). Expanding on high scores, achievements record interesting feats or actions that players perform while playing. Anytime one of these goals or feats is met (finding items, exploring levels, etc.) players are awarded the achievement associated with the act, represented by tokens, trophies and/or points. Most of the time more than one player may be awarded a certain achievement but there are variations on how achievements are handled on each system.

For instances, Microsoft and Sony have collective achievement systems on their platforms; any achievement earned in one game on their platform is combined in their respective achievement (or trophy) system. Flash gaming portals like Newgrounds.com and Kongregate.com provide the same collective achievement systems too, except for online Flash games. Other achievement systems are built for specific games. Blizzard Entertainment has their own internal achievements for their game *World of Warcraft* and the Valve Corporation's game *Team Fortress 2* (Valve Corporation 2007) awards achievements that come with new game abilities or weapons.

Many of these systems link the achievement players are awarded to the player's 'Gamer Tag' or username, which act as a unique recording identifier, and allow players to share their achievement lists with other players. As with other website services like social networks, unique Gamer Tags allow players to build reputations in their gaming community. Instead of the three initials next to the high score of the past generation, the current player generation has complete profiles that connect their gameplay habits, achievements and other media in one place. Players can compare their achievements against one another across not one but thousands of games allowing their gaming accomplishments to reach across space and time.

Significant Saved Games

Most saved games of past and present game generations are game specific. Each save is recorded for one game and is only significant for that game. Players use saved games to a) restart after a failure, b) return to a game at a later time, or c) replay a gaming moment long past. Saved games have been used by players as a way to cheat and gather achievements quickly (Consalvo 2007). They also represent safety nets for the player and Gonzalo Frasca (2000) argues that because saved games act as such games will never achieve meaningful play. Players will always be able to replay or restart if they make poor choices, never having to live with those choices or with the fear of making future wrong ones. While most developers have ignored this argument, or have argued against making games more serious, one game developer is taking a chance on the idea.

Bioware is introducing sequential saved game files for its *Mass Effect* (BioWare 2006) game series. Players will load their saved games into future sequels from previous games in the series. Thus, decisions made in the first game will transfer over to the second game in the series and eventually to the third one as well. Other games have used similar techniques across games before. In one scene in *Metal Gear Solid* the game would scan a player's memory card to find other saved game files in an attempt to shock the player by attempting to show that an in-game villain knew personal information about the player. But few games will have taken it as far as Bioware. The developer is even proposing a related feature in there up-coming *Star Wars: The Old Republic* (BioWare, forthcoming) MMO. Since MMOs do not have a save game feature, Bioware plans to make player decisions in the game have a larger impact than what previous MMOs have attempted in the past.

Significant saved games, as Bioware is building, take away the space-binding property that saved games have today. Saved games will always be time-binding, considering their main purpose is to allow player to return to a game at a later time, but space-binding saves means that any player can use any other player's saved game. Players presently can download saved games online for many digital games, allowing them to skip over a difficult level or play using an optimized character. What significant saved games are trying to do is infuse meaning into each saved game, hoping players will stick with their own saves without needing to load others. There will most likely always be a way to swap saved games but playing with the space-binding property of this recording feature may have its benefits.

Replays and Exquisite Gameplay

Game replays can be defined as gameplay recorded at high fidelity in order to reproduce as much of the recorded gameplay as possible. Generally, this means that a video recording of the gameplay is captured, reproducing the exact audio and video images that the player had seen during the recorded game. For examples, some players record replays of their gameplay and critique their performance later (Taylor 2006). Replays represents another way to record traces or ludivestigums. However, ludophasmas are created when replays record the player's actions and movement of the game entities, which can be called logging by action. *Primrose* (Rohrer 2009), a puzzle game played on a grid, logs the sequence of player moves and is replayed later in the game, instead of capturing a video. *Wii Fit* (Nintendo EAD 2008) records a player's center of balance when performing yoga routines and displays their shifts in balance across time after they complete each yoga position. These recordings are not just data representations (etc. numerical, visual, etc.) like a video but are recreated in the game space itself, producing ludophasmas.

Video recorded replays act the same as regular video recordings, they are passive experiences for the audience. However, if the method of recording actions is used instead of video, e.g. logging by action, that replay can become interactive. These type of replays are replayed within the game itself (meaning the player loads the game first and then views the replay). Once in the game, players become replay spectators and are given spectator control over viewing the replay. If a game occurs in a 3D world (or a world that is larger than a single screen) often the replay will allow players to move the camera around as if they were part of the replay's gameplay. In *Warcraft 3: Reign of Chaos* (Blizzard Entertainment 2003), a real-time strategy game with large maps, replays act similarly to regular games. Spectators may pan the camera around the map, select units and monitor resources that the original players gathered. Logging by action allows replays to stay interactive even if player spectators cannot change the content of the replay itself.

While the methods of recording replays are important, the content of a replay is typically something I call *exquisite gameplay*. While in recent years there has been a growth in mundane gameplay footage available online, acting as video demos for would-be consumers, there has also been a rise in capturing gameplay that is special to a player or a gaming community. Exquisite gameplay is any recorded gameplay that is recognized for its beautiful, efficient, mystifying, awe-inspiring or humorous qualities. This includes speedruns, trick plays, wacky game errors, and generally anything that a player or community finds worthy enough to share with other players. The barrier to capture video footage of exquisite gameplay is shrinking as programs like *FRAPS* make it easier to record gameplay and websites like Youtube.com make distribution instantaneous. Game developer PopCap Games give players the tools to distribute replays in their game *Peggle* (PopCap Games 2007), a casual game resembling that of playing on a *Pachinko* machine. Players can record replays when special events occur, save them and send the replays to their friends. Replays certainly epitomize 'time&space-binding' games and their high fidelity gameplay reproduction have larger impacts on other players than a high score or an achievement.

Player Ghosts

Replays are not always witnessed from a passive viewpoint and instead can be experienced while playing a game as ludophasmas. When a replay is played alongside the current player these replays are called player ghosts. A player ghost is the representation of a former player inside a shared game space with a player who is currently playing a game. Ghosts are similar to non-player characters (NPCs) which represent an artificial entity in the game world. Though, where NPCs are run by the game's software, simulated as if it were another being playing the game alongside the player, a player ghost is known to be from another player, an embodied recording from a previous game session and not controlled by the game itself (except to replay the recorded information).

Player ghosts often serve as the same function as high scores, they represent a past performance that other players evaluate themselves against. Usually that performance is exquisite gameplay, enough so that a player feels they need to interact with the ghost in order to get better at the game. Racing games make use of ghosts as phantom opponents for players to race against. When racing against live opponents players can run into each other but ghosts allow players to witness another racer in action without the threat of interference (since the current racer will not collide with a player ghost). Player ghosts are time-binding in this respect as they bind two game sessions together in time, for instance when a player saves their own ghost in order to race against it later – like in *Mario Kart 64* (Nintendo 1997). Now player ghosts are space-binding as well; players can trade their ghost data online and race against other player's past performances, like in *Mirror's Edge* (EA Digital Illusions CE 2008).

Other player ghosts can interact with a player's physical game world and even the players themselves. In the game *Cursor*10* (Nekogames 2007) the player must move there mouse cursor through a series of fifteen levels that require them to progress by finding the stairs on each level. Some levels require the player to solve a puzzle before the stairs to the next level are revealed. An example is clicking on a box 99 times before the box disappears, revealing the stairs. This becomes a problem because the player only has twenty seconds before their cursor dies; not long enough for them to complete all of the puzzles in the game. The catch is that every time a cursor dies the player is returned to the starting position and their previous lives are replayed alongside their current life. Every twenty second life is recorded by the game, creating a player ghost, and replays those ghosts while the player is controlling their current cursor. With ten lives, hence *Cursor*10*, by the end of the game there are ten cursors moving around in the game, replaying the actions that the player did in each of the nine other cursor life-spans.

*Cursor*10* allows ghosts to affect the physical space that the player is currently inhabiting but not the player. Games such as *The Misadventures of P.B. Winterbottom* (2K Games 2010) or *Timebot* (Piratejuice 2008) do allow the player to collide with the ghosts who in turn act as obstacles or objects to jump on. The next phase of player ghost interaction may very well build on these notions of physically interaction but ghosts already bind players between time and space.

Recording a Future Generation

The fight for who controls the future of the digital past is already underway. Microsoft, Sony and a number of other smaller groups (Valve Corp., Kongragate.com, and others) are all attempting to build systems that record player information, hoping to monetize the data for player reconsumption. High scores and achievements are their main flagship functionalities for now. The other recording features tend to be game specific like *Peggel*'s replay files or *Mirror's Edge's* player ghosts. Yet, even those records can be swapped easily amongst players. Building recording systems that structure the mélange of recording types into one package is the next task for the future gaming generation.

The problem right now is none of these recording systems talk to one another, which is why there is a second battle brewing amongst those who seek to combine each recording system under one roof. GamerDNA.com and GiantBomb.com are now leading the charge, aggregating player records in one location by combining achievements across multiple systems. Other game communication platforms, Raptr.com and Xfire, allow players to swap their gameplaying experiences such as saved games and replays too. These services are not limited to single platforms or a select list of games. As long as the first tier recording services, provided by systems managed by Microsoft and Sony, continue to provide these second tier aggregators access, in the future those aggregators will be able to provide a clearer picture of the world's collective gaming experiences.

Although, building an "all-in-one recording packages" will not be enough. Utilizing the recorded information will be another goal for the future gaming generation. Systems built to analyze recordings and adapt gameplay based on recorded information are the next technological areas to be colonized in the war over remembering the past. Perhaps a new level of gaming experience will be reached as these future technologies combine recorded gameplay with current gaming experiences; one that may be more metaphysical than technological.

Game Analytics

Game analytics, the practice of analyzing recorded game information to facilitate future design decisions, is still in its infancy as a practice. However, web analytics has been around for quite some time and by mimicking the best practices from other web analytic systems, game developers get a head start as they build their own analytic systems to analysis gameplay recordings. The goals of both analytical forms will most likely be the same given that the general goal of web analytics can be stated as "understanding the online experience such that it can be improved" (Peterson 2004). Thus, game analytics can be seen as a process to understand the gaming experience in hopes of improving it (which may mean improving usability, playability or some other facet of a game).

Microsoft and Sony currently can track players using their recording systems, having their own internal analytic tools, and other companies are providing analytic capabilities directly to game developers. Mochibot.com and Nonoba.com are the two leading providers of analytic tools for developers of Flash games. Game developers use application programming interfaces (APIs) to hook into Mochibot's or Nanoba's online analytic system and send recorded information back to the analytic servers owned by the companies, without having to build any specific recoding functionality themselves. Instead, the companies maintain the online servers that house the recorded game information where thousands of different games send their information.

Once an initial set of recorded data is received, game developers analyzes their recordings using the analytic tools that Mochibot.com and Nonoba.com provides. Visual reports are generated and it is the developer's job to interpret and draw conclusions from the records that have been captured. Currently the level of detail that these Flash analytic tools provide are not as extensive as the level of detail that larger MMO developers capture with their recording systems (Ludwig 2007; Williams 2008). Records such as how many times the game is loaded or which check-points players reached during a game are common, along with other non-game information such as how often an in-game advertising is clicked (most Flash developers rely on in-game advertising to some capacity (Riley 2008)). But these analytic systems are making it easier for any Flash game developer to begin recording game information and make design decisions based on their own analysis of that information.

What is easy for developers will hopefully filter down and become easier for players. It is one thing for developers to have access to the analytic process and quite another to allow players to view those records too. Valve's online *Steam* service provides a macro-level look at recorded information they gather daily and display their collected data on their website. Players can view analytic graphs of how many players get online throughout the day, or how often a certain weapon is used in one game or another, but these are superficial displays given that players have no direct access to the records themselves. Maxis, on the other hand, built their own API which connects to the recorded information that the company is tracking in their game *Spore*. Allowing outsiders access to their data, Maxis has allowed a larger community to join the analyzing process, using the information in ways beyond the scope that Maxis would likely pursue (Developer Corner 2008; Twardos 2009). Allowing players to analyze their own game recordings will be vitally important for the next generation player and game developer, aiding in community building and expansion of a game's usefulness.

Game Adaption

If game analytics is the process of analyzing recorded game information then game adaption is the process of automatically reacting to that information. Instead of having a human intermediary, one that analyzes and interprets the data, adaptive systems analyze recorded information computationally and acts upon that analysis. Real-time analysis, or close to it, creates a situation where recorded information can be put to use almost immediately.

Xbox Live has a system called *Trueskill* (Trueskill™ 2007), a system that calculates a player's skill level over a period of time based on their performance in-game. *Trueskill* uses historical data to produce models for how the player will perform in the future and those models are checked against other players (Medler 2009). Whenever a player wishes to play a new game the system checks their skill level and matches them with other players at the similar level. This is done under the assumption, based on flow theory (Csikszentmihalyi 1991), that players with similar skill levels will have an exciting game rather than a boring game if their skill levels are too different.

The *Trueskill* system is an adaptive system because it records player information, analyzes it automatically, makes predictions as to the skill level of each player and decides which players to match together. GamerDNA.com already has a system that can pair-up players based on their gameplaying habits, which is similar to other research using identity classification schemas to determine player types (Yee 2006). Other academic AI research projects are attempting to create actual adaptive learning agents for games; ones that can use a player's past decisions to make predictions about what the player will do in the future. Current attempts to make such systems are used to solve a wide number of problems including creating game quests (Thue, et al. 2007), telling dramatic stories (Magerko and Laird 2003), and building adaptive race tracks (Togelius, et al. 2007). These systems will ultimately produce AI agents that can model a player's decision making process and operate alongside players as adaptive agents.

Game adaption will be available to future generations of players but, like game analytics, players must let their voices be heard has developers create these automatic systems that monitor and react to game behaviors. Classifying individuals into groups is not an exact science (Baker 2008) and there is always room for error. Current adaptive systems, like the ones discussed, tend to focus on one aspect of gameplay: pairing skillful players, classifying player type, telling a dramatic story, etc. Yet, if players do not wish those exact features to be self-selected for them there should be ways for players to opt-out of adaptive systems. A balance will have to be reached between player and developer to deliver features that players wish to control for themselves and those done automatically.

Consciousness-binding games

All of this talk about recording the past, representing history and the information stored by games, is talking about how we explore game experiences. We use media as a way to record these experiences so that we may share them with others and remember them ourselves. This is what Harold Innis meant with time-binding and space-binding media, the properties that allow media to share experiences across space and time (Innis 2007). Game analytics and game adaption are concepts that will help build systems that future generations of players and developers will use to interact with recorded experiences. However, to end on a slightly more metaphysical note than the technological perspective this paper has presented, the future gaming generation may surpass the presented examples of sharing experiences across time and space and explore how we can produce new experiences based on the recorded past.

In future gaming generations, time-binding and space-binding games will be joined by consciousness-binding games, ones that bind the consciousness of an individual to a game itself and create conscious ludophasmas. The internet allows all forms of media to become time and space binding (photos, text, video, audio) but games will allow the consciousness of an individual to inhabit their spaces, creating new experiences beyond the original recordings. Ludophasmas, like player ghosts, and adaptive systems, like Microsoft's *Trueskill* system, are currently using recorded player experiences to affect other player's games. If player ghosts gain the ability to mimic the actual decisions processes of their human counterparts they become actual ghosts, imprints of humans that have been left behind. The *Trueskill* system and other programs could then match players not only with living players but with ludophasmas too.

Current AI research is already looking at ways to capture player ludoexhibeos through ludivestigums to produce aware ludophasmas. *The Restaurant Project* (Orkin and Roy 2009), headed by Jeff Orkin, is attempting to use recorded gameplay experiences to produce his own ludophasmas. The project places players into a virtual restaurant simulation. Each player acts as if they are at a restaurant: conversing with NPCs, eating food, etc. Every game session is recorded and combined to create social models of how to act at a restaurant. NPCs will eventually use these models to simulate human behavior in a restaurant environment without the need for a game designer to create those behaviors. The models will produce ludophasmas that simulate the combined consciousness of thousands of players and has thus already begun to produce consciousness-binding media.

Once consciousness-binding media has been realized we will truly have living ghosts. Just like in the novel *Ubik* 'half-life' beings will populate our digital media, imprints of the former living (Dick 1991). We will be able to interact with them in real time, not just a recording that has been made of their likeness. This will open up whole new experiences for games. Top players could be kept around for years. Players could make copies of themselves to play with and ludophasmas could populate entire game worlds without the development burden of creating each one individually (or creating multiple 'dumb' NPCs). These are all blue-sky and utopian ideas for where game recording could be going but as shown, recording gameplay will only increase in fidelity as we move in the next gaming generation.

Conclusion

As we have traversed the history of recording history in games we reach an interesting cross-road. In the future, games will rely much more on their past than they have in previous generations and the way recording gameplay is handle will likely change. High-scores and saved games were generally used during the earlier generations of digital gaming but have expanded into other areas: achievements, significant saved games, replays and player ghosts. Only today has digital game recording begun to rival the level of statistical sport recording that has been used for decades. With the first analytic and adaptive systems being used and built as this article is written the future generations of players and developers will enter into a historically aware gaming environment.

Today's game studies literature tends to focus on the procedurality of games and how games model operations or systems in real-time. The next step will be to focus on the encyclopedic aspects of gaming as this article has covered. Structuring recording formats, covering the breadth of data to be recorded, learning to analyze records, and using recordings for gameplay will all need to be pursued in the coming years has access to the digital past becomes easier. We may even reach a point where we play with conscious recordings of players as AI researchers continue their attempts to use historical data to build game agents. If we should learn anything from the history of recording digital game information it is that remembering the past has, and will have, a huge impact on the future.

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