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Analytics of Play: Using Information Visualization and Gameplay Practices for Visualizing Video Game Data

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KEYWORDS *Game analytics, game design, game development, game metrics, gameplay, information visualization, play, player, playful visualization, visual analytics*

ABSTRACT Tracking player data in video games has increased in recent years. Data such as click-through-streams and event logs are currently being captured within most major games, while other researchers are prototyping new ways of capturing data from a player's physical body movement or internal brainwaves. The wealth of data produced is beneficial for a wide variety of audiences within the game community: designers, programmers, marketers, executives and players. Visualizing this data is an obvious choice for connecting these audiences to their data by augmenting their ability to cognitively digest the enormous amount of data available to them.

While the principles of information visualization can inform the design of game-related visual analytic systems, such as monitoring player performance over time, video games offer a unique perspective on analytics: analytics that are playful. In this paper we explore the properties that define a playful visualization, one that supports and promotes play. The authors draw on their work building visual game analytic systems for game designers and players, reinforcing their experience with a large number of examples of new visual systems being deployed to analyze game data by both game companies and players. With such a wide variety of game audiences it becomes necessary to explore the avenues between analysis and play in order to provide game audiences with visual experiences that promote gameplay as much as analytics.

PLAY WITH DATA

A child playing with blocks is comparable with a data analyst working with dots. Both manipulate the objects—organizing them into patterns. Both theorize about the object's meaning and project interpretations upon them. Both explore the possibilities of the objects beyond their common representations. One might argue that data analysis is nothing like play—a seemingly unproductive activity. Analysis requires a specific set of skills to understand data comprised of fixed content, context, and relationships from the real world that represent fact and truth. Play is typically associated with creativity and imagination, both traits that benefit an analyst working with new forms of data. In our ever-increasing data-driven culture, a culture that consistently collects, organizes, combines, and interprets new disparate data sets, we can no longer say where data analysis ends and play begins.

Perhaps the most interesting area where the dichotomy between play and analysis disappears is games. Play is often associated with games, as many game designers and theorists define games as *structured play*[1] where rules, goals, and outcomes create that structure. Games, however, also make use of data analysis: players are asked to find patterns, manage resources, and work with incomplete information.[2] Data is a vital part of games. If one subscribes to McLuhan's statement that "the 'content' of any medium is always another medium"[3] games are a medium-filled with data in the form of text, numbers, images, video, sound, etc.

Games as a medium can therefore be described as *play with data* or an activity using an assortment of data in a structured or unstructured playful fashion. It has not been a stretch for other researchers to make similar assumptions and ask how information visualizations, a form of data analysis, can be used to create games, which often heavily rely on visual data representations, as the work of Macklin et al. has investigated.[4] In contrast, our perspective focuses on the number of *visual game analytic systems*[5] which visualize game data but do not necessarily act like games. Instead they offer *playful visualizations* for analyzing game-related data, visualizations that support and promote play. These systems allow for a unique examination of how play alters information visualization, or "InfoVis", allowing different populations of players and game developers to interface with games outside of what is considered normal gameplay.

DATA, PLAY AND GAMES

Play is a notoriously difficult concept to define; it is not our intention to present a concrete definition. Instead, we have chosen two perspectives that present the possible "properties of play" as a way to frame the concept. These two perspectives are separated by nearly fifty years, and, while they share some similarities, arrive at their list of properties differently. First, Caillois in *Man, Play and Games* lays out his properties of play in a sociological pursuit to describe how culture is represented through play and games.[6] Second, in the book *Play* Brown, having studied numerous types of play exhibited both by animals and humans, presents a similar list of play properties, structuring his arguments from a clinical perspective.[7]

FIGURE 1 compares each of their respective property lists identifying their similarities and differences.

Both researchers agree that play is free or voluntary, meaning players are not obligated to participate in the activity, but here is where the major similarities cease. For one example of difference, Brown says play has an inherent attraction because it is a fun activity which causes psychological arousal. Caillios instead states that the attraction of play is due to the activity being free and does not list that attraction as a separate property. Both researchers view play as having an unproductive side but one of Brown's major arguments is that play is vital for learning and living a healthy, happy life.[8] Caillois' list goes on to state that play is uncertain and players create new sets of rules to govern how play commences. Brown, on the other hand, acknowledges the uncertain, improvisational potential found in play but states that rules are not necessary. There are also loose connections between the Caillois' property of make-believe and Brown's properties of diminished consciousness of self and freedom from time. Each point to the alternate reality play creates. Caillois focuses on the second, make-believe reality created; Brown focuses on what the player experiences, a loss of self and time.

The final two properties reveal the major difference between Caillois' and Brown's lists. The property associated with a continuation of desire in Brown's list is another example of what a player experiences while playing. Players wish to keep playing for as long as possible. However, once play ends Caillois' final property of separation is highlighted. Caillois sees play as being separated from real-life

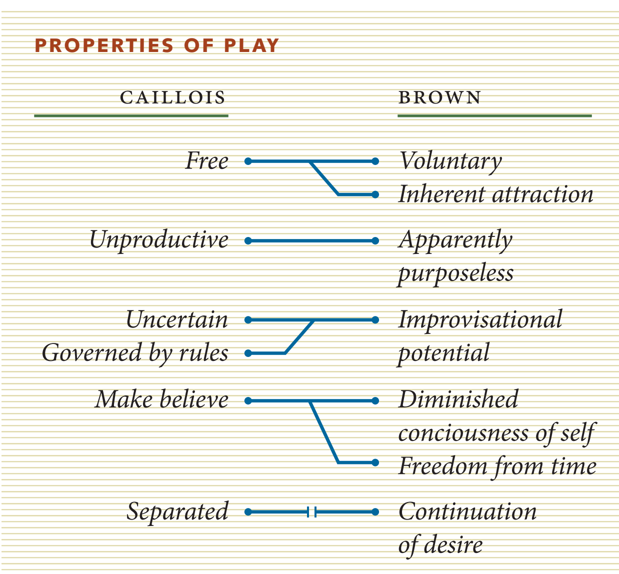

FIGURE 1: *A comparison of Caillois' and Brown's properties of play.*

and if anything disrupts a play session that separation becomes immediately apparent. Children immediately remember they are not pirates or adults remember that they need to make dinner. Brown never states that play must be separated from real-life. People flow in and out of playful activities. The major difference between these last two properties reveal that Caillois' properties describe the form of play and Brown's describe the experience of play. As we move on to investigate the properties of data analysis we can rely on both sets of properties to shed light on how play can affect the form and experience of InfoVis.

THE PLAYFUL AND SERIOUS ANALYST

In his book Now you see it, Few presents a list of personal traits that a good data analyst should exhibit.[9] Some reflect the common, serious tone of data analysis: being skeptical, methodical, analytical, etc. However, Few begins his list with five traits that seem separate from the other serious, utilitarian traits. We separate these traits as representing the "playful" side to data analysis:

PLAYFUL ANALYST TRAITS

- *Interested*
- *Curious*
- *Self-motivated*
- *Open-minded and Flexible*
- *Imaginative*

SERIOUS ANALYST TRAITS

- *Skeptical*
- *Aware of what's worthwhile*
- *Methodical*
- *Capable of spotting patterns*
- *Analytical*
- *Synthetical*
- *Familiar with the data*
- *Skilled in the practices of data analysis*

Each of the playful analyst traits can be matched with the aforementioned properties of play laid out by Caillois and Brown. Traits such as being interested and curious coincide with the inherent attraction of play. An analyst that freely expresses interest in a data set is more likely to be able to play with that data. Self-motivated, open-minded analysts set their own goals or rules creating a situation where they improvise how they analyze a data set. Analysts may even feel motivated to continue their analysis even after they have gained their initial insights from their data. Finally, analysts must be imaginative, creating make-believe scenarios and new ways to illustrate the hidden patterns in a data set.

Where Few's analyst traits and the properties of play do not concur concerns the area of how play must be unproductive and separated. Analysts need a playful and a serious side to their personality according to the listed traits—one informs the other. Imagining a new visual orientation for a data set can be proceeded by further analytical and methodical approaches. These actions certainly do not need to be separated in regard to the "separate" play property Caillois mentions (happening as a natural part of the analysis process). Therefore, data analysis and InfoVis needs to provide both a space for analytic endeavors and a space for play too.

This phenomenon of moving data analysis beyond analytic systems has already begun within the InfoVis community, at least at the fringe. The research of Pousman, Stasko, and Mateas[10] reports a growing trend in InfoVis to provide a wide array of audiences with systems that do not solely focus on analytics. They call these types of systems "Casual Information Visualization" which they define as "the use of computer mediated tools to depict personally meaningful information in visual ways that support everyday users in both everyday work and non-work situations."[11] They separate Casual InfoVis into three categories to correspond to the type of systems they covered. *Ambient InfoVis* are systems found in "peripheral locations and provide abstract depictions of data." *Social InfoVis* systems visualize social networks and allow its users to interact with their social data. Last, *Artistic InfoVis* are systems with the "goal of challenging preconceptions of data and representation."

Casual InfoVis systems are less productive, offer a wider variety of improvised data representations, are used on a more voluntary (i.e. casual) basis, and seem purposeless to other users. Each of these descriptions is also a property used to characterize play. Ambient InfoVis systems, for example, provide displays that may include raw data streams which are less productive to interpret. Whereas a Social InfoVis system may visualize data in an analytically productive way, yet only present data related to a single user. One user may find no purpose in interpreting another person's data, but would be inclined to analyze their own data even if only casually. Finally, Artistic InfoVis systems improvise, or create their own rules for, the form and representations of data that are visualized. These are meant to express an almost make-believe view of what a data set can look like if a normal, utilitarian representation is discarded.

When one compares the types of systems found within Casual InfoVis to the properties of play, Casual InfoVis can be described as an example of how play is being introduced into InfoVis. Seemingly unproductive, uncertain, and voluntary systems match with the form and experience one should have while playing. However, the three categories of Casual InfoVis do not denote play as a specific quality found within those InfoVis systems. Ambient, social, and artistic information visualizations do not necessarily need to be playful. Thus, we argue that an additional category should be added to Casual InfoVis: Playful InfoVis, a category which uses computer mediation to support and promote play through information visualization.

GAME AND PLAYER TYPES

Differentiating Playful InfoVis from the other Casual InfoVis types requires us to identify interactions, game types, or other examples of play behavior implemented by Playful InfoVis systems to help promote play. This can be achieved by reviewing how other researchers have sought to classify play, games, and players. However, this is a diverse research area with many researchers classifying play related activities through various frames such as motivation, emotion, genres, and other characteristics of play.[12] Some researchers such as Bekker et al, even classify the types of interactions that promote play which includes providing motivating feedback, supporting ad hoc goal formation and creating competitive/collaborative relationships within a system.[13] Having to limit our scope and forced to choose only a few classifications to interpret from this abundant research area we return to Caillois and Brown's research on classifying games and players (see FIGURE 2).

In addition to their properties of play, Caillois and Brown created classifications based on their two perspectives on play. Caillois' analysis of the form of play is followed by his classification of the types of games that exist. Conversely, Brown approached play from the player's experience and created a list of the types of players that exist.

CLASSIFICATION OF GAMES

type of play	CHANCE	COMPETITION	SIMULATION	VERTIGO
UNSTRUCTURED	flipping a coin	play fighting	impersonation	spinning in place
STRUCTURED	casino games	professional boxing	role-playing games	professional skiing

FIGURE 2: *Above, an adapted table of Caillois' classification of games. Below, a list of Brown's player types which list the type of playful activities they enjoy.*

CLASSIFICATION OF PLAYER TYPES

ARTIST/CREATOR building, designing	COLLECTOR archiving, rarity
COMPETITOR challenge, winning	DIRECTOR planning, organizing
EXPLORER new experiences, locations, emotions	KINESTHETE movement, sensation
STORYTELLERS performing, excitement	THE JOKER nonsense, jokes

While neither list is meant to be exhaustive they offer us two different perspectives for interpreting play.

First, Caillois sought to study games by classifying them into four separate groups: chance, competition, simulation, and vertigo.[14] Each category also has an axis that spans from unstructured to structured play (i.e. games). For example, unstructured chance play includes flipping a coin while casino games are highly structured. Competition consists of activities where players meet on, more or less, even odds. One type of unstructured competition is play fighting verses a structured competition like professional boxing. Simulation play is the act of mimicking other activities or objects. Simulations can be unstructured such as when someone impersonates another or structured around rules similar to those found in role-playing games. Finally, vertigo play is where a person seeks to "momentarily destroy the stability of perception." Spinning in place, sky-diving, or professional skiing are examples of vertigo play.

Second, Brown's properties of play focus on the player's experience and therefore his classification present the type of personalities players have while playing.[15] A few relate to Caillois' categories. Competitors can be found in both classifications lists, kinesthete players enjoy vertigo play and storytellers use simulation and mimicry to relive past play experiences. The other player types point out specific activities that the player enjoys: jokers make jokes, explorers hunt for new experiences, directors plan or organize, collectors archive, and artists create.

Through our analysis of visual game analytic systems we show where play manifests itself within InfoVis systems by stating how those systems compare to both Caillois' and Brown's classifications. We use both classifications to reference how Playful InfoVis systems encourage the different categories through various visual data models and interactive capabilities. How is chance, competition, simulation, or even vertigo play depicted in game-related InfoVis and analytic systems? Which player types are catered to within these systems? Understanding how the types of play and players are represented in our example analytic systems helps inform how similar systems can take advantage of play as a companion to analysis.

PLAYFUL INFOVIS

We have divided a number of game-related InfoVis and analytic systems into exemplar categories based on the type of game data displayed and each example's primary function. Examples within each Playful InfoVis category are compared to the game and player types presented in the last section (see FIGURE 3). Some examples work with game data at a larger, more abstract level. This includes players creating maps of game spaces and systems which aggregate data streams from large populations. Other systems are built for promoting competition by comparing players against one another or to create dossier systems which allow players to access their personal data after gameplay has ended. Each of these Playful InfoVis categories represents a different way data analysis is combined with play.

MAPMAKING

Maps are often used in games to orient and direct players within large 2D or 3D spaces. Markers, notifications, or other visual indicators on maps are used to capture the player's attention and push them forward during gameplay. The type of data that is presented on these maps typically stays within the confines of the player's current task. Data regarding the gameplay objects, or other important features of the world, that the player is invited to explore while playing are often omitted from these maps. Once players have explored these areas, however, it becomes beneficial to map important locations not provided by the game map for other players who have yet to explore those regions.

Massively multiplayer online role-playing games (MMORPG) with large 3D game worlds are examples where the in-game mapping system provides less information than players determine as valuable for play. Names of regions are provided but this information does not help inform players of what is available in those regions. For example, fighting monsters is one geographically-determined activity found in MMORPGs such as *World of Warcraft* but the in-game maps do not display the various monsters that exist in an area. This has prompted a number of players to build large, online databases which collect and map the locations of monsters, items, and non-

FIGURE 3: *A comparison visualizing which of Caillois' and Brown's classification categories appear within each Playful Infovis category.*

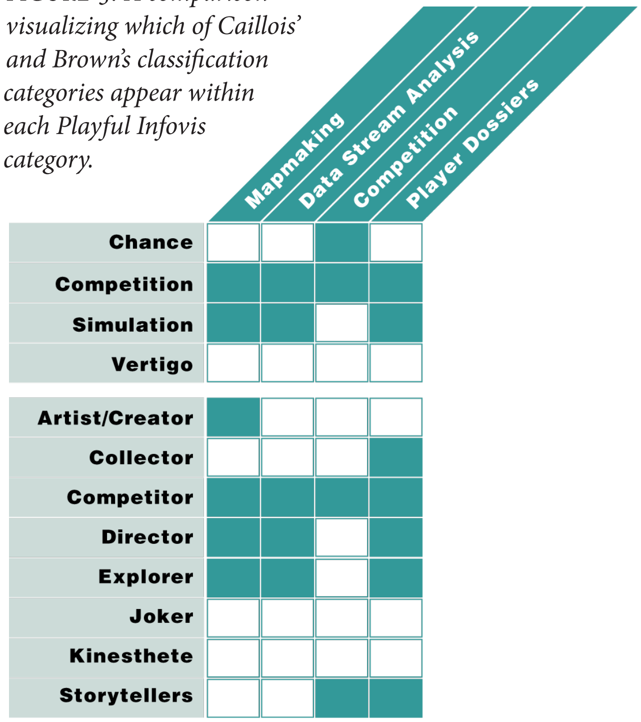

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FIGURE 4A: *Maps are often created outside of their respective games to provide additional data that is unavailable in the provided in-game maps. The above map displays the multiple locations where a particular monster can be found in one area of World of Warcraft.*

player (i.e. computer controlled) characters for referencing that information.[16] The search capabilities provided by these databases makes it easy to finding monsters/items/characters that a player interacts with while playing. In the past a player would have to rely on his or her own experience, or word of mouth, to have access to such information. This search capability provides players with a different interface to their game's world.

Players who enjoy being artistic or engage in the director style of play use cartography as a way to provide other more explorative or competitive players with maps that augment their play experience. A few MMORPGs have dynamic political systems that allow players to join ad hoc groups and control territory within the game. Players of games such as *Darkfall* or EVE *Online* create "political maps" which depicts which player groups own particular territory.[17] Since player groups wax and wane over the years as the game is played these maps continually change and provide players with an up-to-date view of the game world. Mapping game spaces thus becomes a play with simulations, organizing dynamic location-based data that visualize game spaces in new ways that the game's developer does not provide.

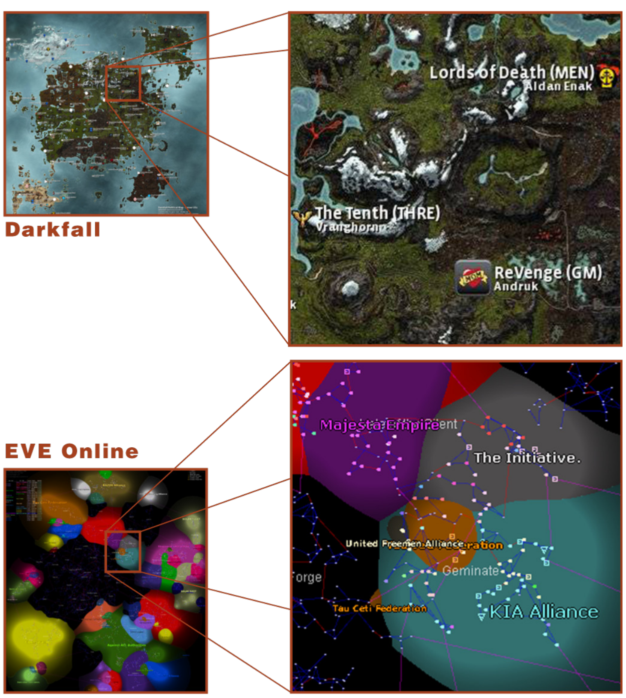


FIGURE 4B & 4C: *Both the Darkfall world map (top) and the* EVE *Online world map (bottom) delineate which player political factions own particular territory within the games.*

DATA STREAM ANALYSIS

Once online capabilities within games became a common technical feature game companies began to track player data on a larger scale.[18] Fast, robust systems have been created by games companies in order to capture player data streams online for analysis by marketers and designers. Game analytic tools are then required in order to make sense of the captured data and many of these tools add elements of play.

Competition is one factor that is added to some of these data analysis tools. *FIFA Earth* was built by Electronic Arts for their game *FIFA 10*, a football simulation game, and was an InfoVis tool meant to be used by players.[19] When a player finished a football, or soccer, game in FIFA 10 the results were uploaded online and added to the total results of the country where that player lived. Each day the world's countries were ranked based on how well their players were fairing in the game. Ecuador would be on top one day and Spain would be on top the next. While the data itself was no more than percentages of wins and losses, aggregating the data of a country's players and comparing their wins created a separate medium through which competition was encouraged.

Another tool, *Skynet*, built by the game developer Bioware, also encourages competition—not amongst players but amongst game developers.[20] The tool logs data regarding player testing and development progress during game production. Normal development data such as bug tracking is visualized through color-coded lists to indicate problems that need to be addressed and make it easier for managers to direct how development proceeds. Skynet keeps track of which team members fix the most bugs or test the most features in the game. Each day team members are ranked against each other and this creates friendly competition amongst the developers.

Finally, other visual game analytic tools focus on the exploration aspect of play and attempt to provide accessible environments that attract users to the data analysis process. *Data Cracker* is one such example. Data Cracker was built by the lead author for Visceral Games with the aim of analyzing player data from the game *Dead Space 2*,[21] a horror-themed first-person shooter. The tool was built to be accessible to the entire game team instead of to a select few data analysts. There are two main features that help make the tool more accessible related to play. First, color schemes and artwork from Dead Space 2 are used to brand the tool to the team, this can increase the inherent attraction of the tool as well as information retention.[22] Second, the tool's visualizations are presented in a tiered format which became more detailed the further a user drills down into the data. For example, the types of weapons players use in Dead Space 2 are displayed in tiers that step analysts through a general overview of the player population down to how weapons are used on specific maps, or by specific player groups. This allows team members to become integrated with the tool over time instead of presenting them with an overly complex visualization when they begin. Making data analysis more accessible helps motivate team members to get involve with the analysis process which supports the ability for more people to play with the tool.

Each of these tools represents the more traditional use of InfoVis for data analysis while focusing on specific types of play. Competition is the main game type that Skynet and FIFA Earth exhibit by comparing user data against each other while in the context of data analysis. At the same time the practice of organizing and exploring data is also encouraged, relating to the director and explorer player types. Finally, building these tools to be accessible to wider audiences, whether for players or game developers, increases the attraction of data analysis making it easier for users to voluntarily choose to analyze or play with the data being visualized.

COMPETITION

Comparing players along quantitative measurements is a commonly used method for provoking competition in gameplay. Leaderboards are used in games to compare and rank players using measurements such as how often a player wins or who has the highest score. Many leaderboards are presented as lists of increasing numbers along with the player's name—related to each value. However, games have begun to personalize leaderboards, focusing on comparing friends against each other while visually presenting the information within the context of gameplay.

The *Autolog* system found within *Need For Speed: Hot Pursuit*, a competitive racing game, is one example of this comparison.[23] Each player has their own personal racing statistics consisting of their fasting racing times, experience level, win ratio, etc. Each player value that is recorded can then be compared to that player's friends within the Autolog system. These comparisons are automatically turned into challenge recommendations that are visually displayed within the game environment. Players are asked to beat the score or time of one of their friends and thus receive a reward for completing the recommendation. Challenge recommendations are also displayed while a player is in other game events and players can opt to pursue that recommendation at that time. This creates an improvised playful environment where players choose which goals and competitions to pursue.

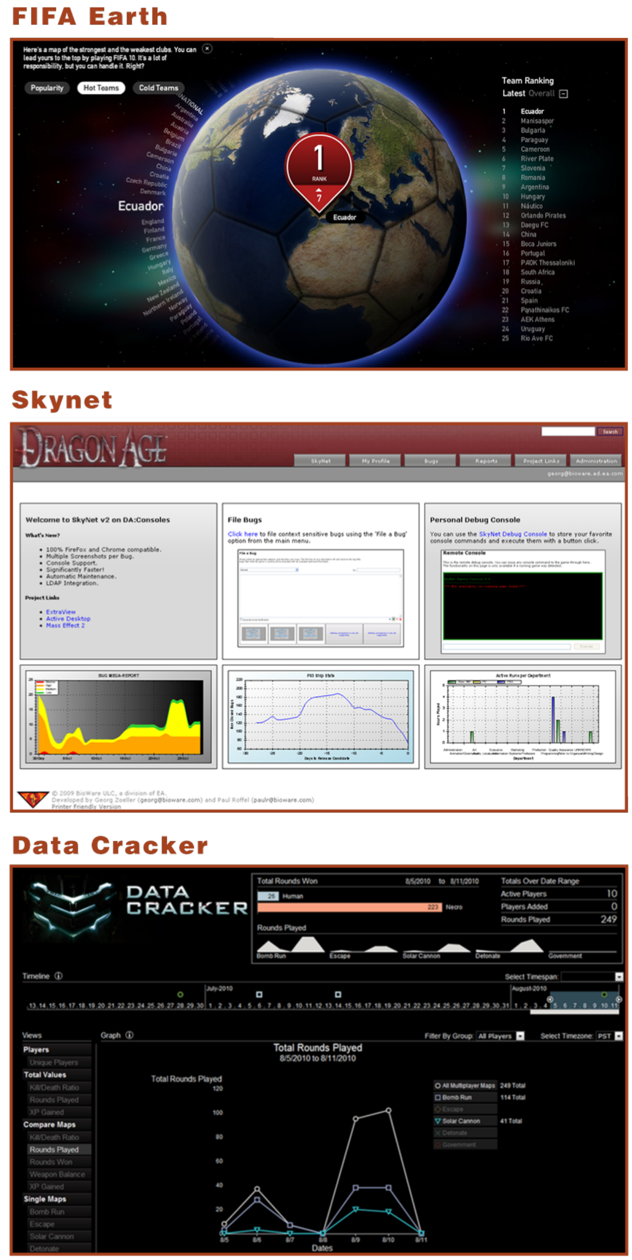
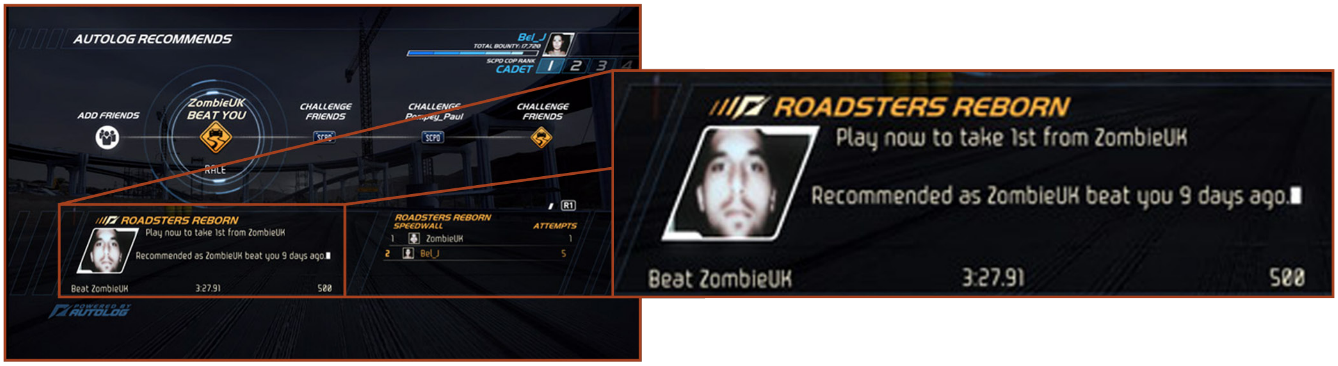


FIGURE 5: *Screenshots from game analytic systems which visualize large populations in order from top to bottom: FIFA Earth (EA), Skynet (Bioware), Data Cracker (EA).*

AutoLog



Web Battle

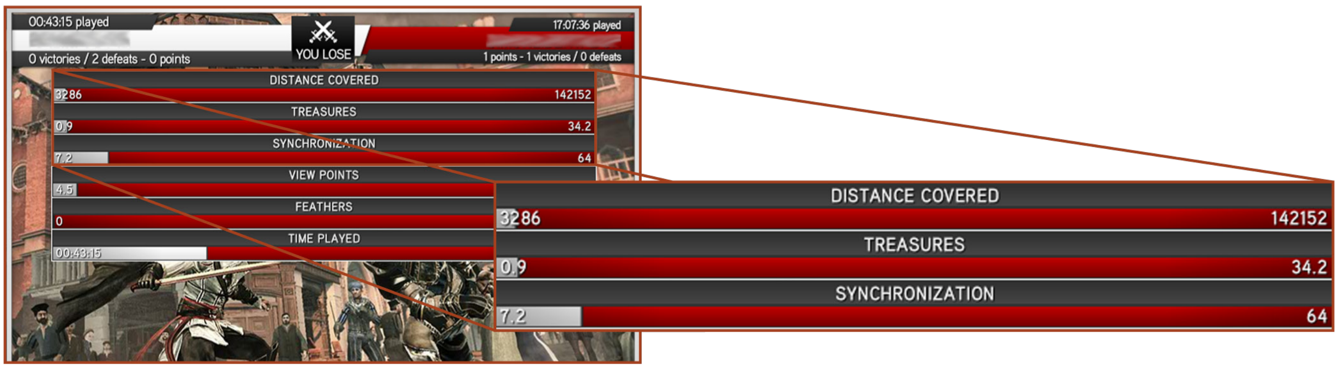


FIGURE 6: *The Autolog system on the left displays recommended challenges for players to pursue based on data collected from each player. On the right, Assassin's Creed 2 provides players with a "Web Battle" service for comparing their game statistics, captured by the game, against each other. Their statistics include details about how far they have traveled, treasures they have found, etc.*

A similar system is used as part of the game *Assassin's Creed 2* (AC2), an action-adventure game which has the player participating in street fights and traversing large cityscapes. The *Web Battle* system allows two AC2 players to compare their game statistics against each other.[24] In contrast to Autolog's racing statistics, alternative game statistics from AC2 are used that relate to fighting and navigating the game's world. During a "web battle" comparison, the player who defeated the most enemies, found the most hidden locations, or ran the furthest distance is rewarded with points or extra game-related content. Offering these types of rewards encourages collector players who seek unique items. There is also an element of chance surrounding each web battle because player statistics are hidden until one player decides to compare their statistics against another.

Compared to the systems present in the Data Stream Analysis section, both the Autolog and Web Battle systems offer a similar type of competition play. Each system compares player data to create a sense of competition but compare players one-to-one instead of against a group. The storytelling player type is encouraged through this form of competition too, because it generates exciting experiences related to individual friends. This yields experiences that players can later recount to their friends. Chance also factors into these exciting experiences. Out of the total possible challenges that exist only a select number of comparisons are shown to each player at any time. Collectors then benefit from winning rewards for these unique challenges while storytellers are continually served novel scenarios to experience and relive later.

PLAYER DOSSIERS

Certain visual game analytic systems are built to record player progress and statistics over long stretches of time. For players who play a single game or play on a gaming platform regularly those records create a player dossier. Each dossier contains a player's progress within a game or on a particular platform. Game developers and third-party companies then provide additional services outside of normal gameplay that visualize each player's dossier reports. These visualizations simulate a player's personal game history and prompt players to explore each other's data, keeping them further engaged with the game's content.

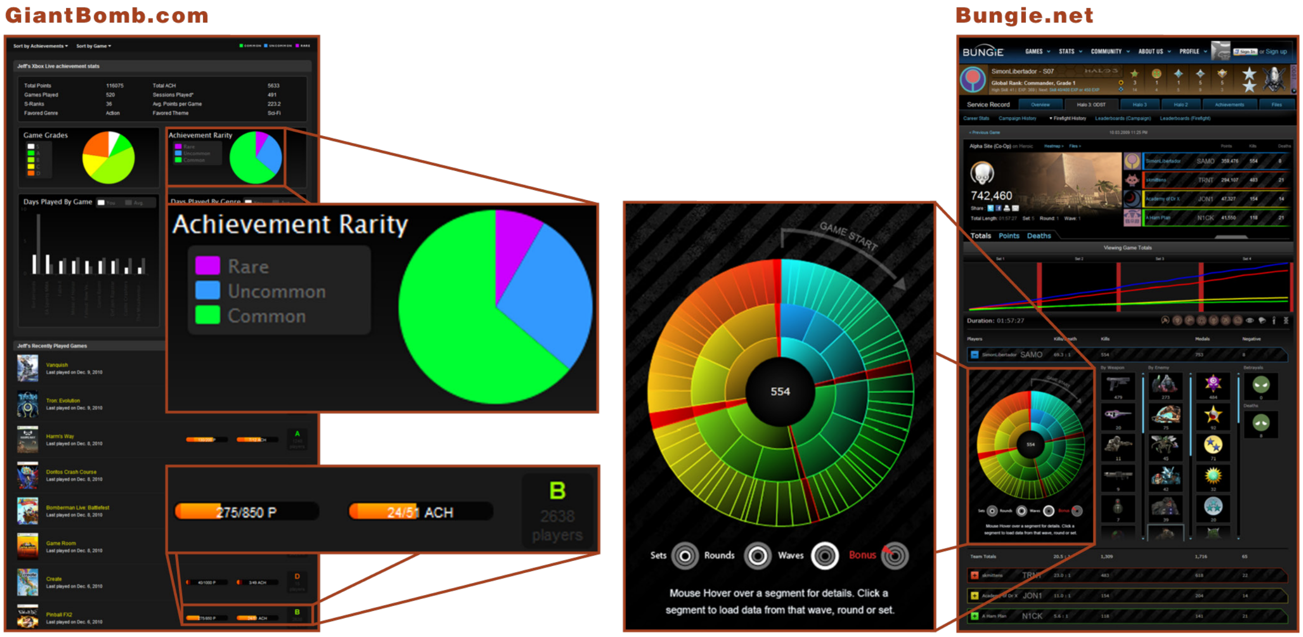


FIGURE 7: *GiantBomb.com, on the left, aggregates their user's achievements from multiple game platforms. The website is also able to determine other factors about achievements, such as their rarity amongst their users. On the right, Bungie.net visualizes player data from multiple games in the Halo series. Players can analyze their past gameplay through a number of visualizations including sunburst graphs used to portray different segments of a single battle from the game Halo: ODST.*

In addition to the previously discussed leaderboards, achievements are another aspect of games that have grown since online gaming become possible. Achievements are merit badges, rewards for accomplishing specific tasks within a game. Most games offer some form of achievements but are often tied to a particular game platform. For example, playing games on an Xbox 360 will earn the player Xbox achievements, while players on a Playstation 3 earn Playstation trophies. Fortunately, outside companies are granted the ability to aggregate a player's achievements across the multiple gaming platforms. Websites like GiantBomb.com aggregate and visualize a player's past achievements from the Xbox 360 achievement system, the Steam platform, and the game *World of Warcraft*.[25] As an aggregator, Giant Bomb's system can also determine other achievement statistics such as the rarity of achievements and creates a new level of collector play where players hunt for the rarest achievement. Players therefore enjoy exploring their data while being encouraged to collect new achievements and compete with other players.

Beyond achievements, there are player dossier systems which collect hundreds of player variables over multiple play sessions—in some cases across an entire game series. These systems are regularly associated with games that rely on skill and strategy such as games within the first-person shooter or real-time strategy genres. Players who enjoy those genres wish to track their performance over time to monitor how effective they are performing. *Heroes of Newerth* (HoN) is a real-time strategy game where players battle individually, or in teams, attempting to destroy the other team's army. Within each individual battle, statistics such as kill/death ratios, experience points awarded and how much damage the player inflicted on enemy forces are recorded. Battle statistics are uploaded to HoN's website[26] where players can explore the data from their past battles. Players can use the system to gauge how well their team, or they personally performed, during certain battles and reflect on their gameplay over time.

Bungie.net offers a similar dossier system compared to HoN, tracking player data across four separate games from the *Halo* game series.[27] Even though each Halo game is from the first-person shooter genre, instead of real-time strategy, the same amount of data is collected for similar reasons as HoN. Every kill made, point earned, and objective completed is recorded during each battle. Player data is visualized using a number of visual forms including: line graphs for point progression over time, heat maps for detailing where on a game map events occur, and sunburst graphs detailing when events occurred during separate sections of particular game. These visualizations are only offered within the online system and most player data cannot be accessed through the game. Limiting the access to data to Bungie.net creates a type of trophy room interface to each player's data. Awards and gameplay are put on display to explore outside of the game.

Player dossier systems use simulation play to reconstruct a player's gameplay history while providing players with ways of comparing statistics to encourage competition. Both competitor and director player types can use dossier systems to determine the effectiveness of their gameplay strategies. Explorer and storytelling player types are supported through these systems by giving them rich data sets of virtually every major game statistic to sift through. Dossier systems moreover act as trophy rooms, which aid the collector player type, displaying data that would otherwise not be available within the game itself.

CONSOLIDATING ANALYTICS AND PLAY

Through our analysis of game-related Playful InfoVis systems we have argued that the practices of analytics and play certainly fit together. Even though play may seem at odds with analytics it is important for analysts to approach data analysis from both perspectives. Using games as a frame for examining how analytics and play fit together offers a unique look at how InfoVis can support and promote play. Nonetheless, how might others build interactive InfoVis systems, game-related or not, that promote play? What are the actual interactions that are used by Playful InfoVis systems that caused play to occur?

Along with his list of data analyst traits, Few also lists a number of analytical interactions that occur in visual data analysis: comparing, sorting, adding variables, filtering, highlighting, aggregating, re-expressing, re-visualizing, zooming and panning, re-scaling, accessing details on demand, annotating, and bookmarking.[28] From an analytic prospect these interactions help us cognitively make sense of visualized data. Additionally, many of these interactions are used by the Playful InfoVis systems as well. We can now see which interactions are used by Playful InfoVis systems to promote play in relation to the types of games and player from Caillois' and Brown's lists (see FIGURE 8).

Beginning with Caillois' game types, competition is heightened when friend's data is *compared* against each other as was seen in many systems: Need for Speed's Autolog feature being one of them. The Skynet system also sorted and highlighted performance measurements between developers to increase competition. *Filtering* data or *accessing details on demand* is used to add chance to a system, such as hiding each player's statistics within Assassin's Creed 2's online Web Battles until they are compared. Other Playful InfoVis systems create simulations

	Adding variables	Aggregating	Annotating	Bookmarking	Comparing	Details on demand	Filtering	Highlighting	Re-expressing	Re-scaling	Re-visualizing	Sorting	Zooming and panning
Chance					■	■	■						
Competition	■	■	■		■			■				■	
Simulation	■	■	■	■	■					■	■		
Vertigo	■								■	■	■		■
Artist/Creator	■		■						■	■	■		
Collector	■	■		■	■			■			■		
Competitor	■	■	■		■			■				■	
Director		■	■		■	■	■	■				■	■
Explorer				■		■	■			■		■	■
Joker			■	■				■			■		
Kinesthete				■							■	■	■
Storytellers	■		■	■				■	■		■		

FIGURE 8: *A comparison detailing which of Few's data analysis interactions relate to Caillois' and Brown's classifications of games and player types, respectively.*

of gameplay by *re-visualizing* maps with new *annotations* not found within the game or *aggregating* player battle statistics for *comparison* across multiple play sessions. Only vertigo play is left out of these Playful InfoVis systems amongst Caillois' type of games. This is not to say that vertigo is not a common feature in games, however.[29] Perhaps a vertigo-based Playful InfoVis would have to bombard players with *re-expressions* of data using methods such as *zooming* or *panning* to alter their perceptions of the data.

Reviewing Brown's play types, services such as GiantBomb.com *aggregate* and *re-visualize* player achievement data, *adding variables* like achievement rarity which benefits collectors and competitors. Dossier systems allow director players to *sort, filter,* and *compare* their gameplay statistics over time. Storytellers can *bookmark* and *highlight* specific content that they found interesting in the data streams or dossiers they analyze. While the artist player type can *add new variables* to game maps *annotating* them in ways that other explorer players may find helpful. Finally, while the last two player types, jokers and kinesthete players, were not discussed amongst the Playful InfoVis examples they certainly can engage in these systems. Jokers can *re-visualize* maps or *highlight* peculiar data points in a data set in order to make jokes relating to the game or another player. Kinesthete players can find enjoyment from Playful InfoVis systems that involve alternate reality game or motion control games found on all of the major consoles.[30] Macklin et al.'s, research, for example, had players *sorting* location nodes on a map and *re-visualizing* their layout while physically traversing a city.[31]

Framing these typical "analytical interactions" to show how they can benefit players helps consolidate analytics and play. Instead of focusing on the visually efficient, utilitarian aspects of those interactions more imaginative or playful facets of InfoVis can be realized. Even something as simple as visually comparing two data sets together can cause competitive situations while highlighting data can create storytelling opportunities. This is how play can inform the way InfoVis systems structure data and interact with users. Furthermore, we present Playful InfoVis as a category of Casual InfoVis but example systems such as Skynet show very serious InfoVis tools can incorporate play without diminishing their serious analytic side. Playful visualizations should be an addition not a hindrance to analytics. It is our hope that by fostering both the practices of playful and serious data analysis InfoVis systems can be created to not only cognitively enhance but entertain as well.

BIOGRAPHIES

Ben Medler is a third year PhD student at Georgia Tech. His dissertation work focuses on game analytics and how it is used to connect players to their gameplay. This work has included building game analytic tools for game designers at Electronic Arts (EA) to research player behavior.

Dr. Brian Magerko is the head of the Adaptive Digital Media (ADAM) Lab at Georgia Tech. His research explores artificial intelligence and cognitive modeling approaches to story management, synthetic characters, and logical representations of story for interactive narratives.

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