Defining Personas in Games Using Metrics

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ABSTRACT
Game metrical data are increasingly being used to enhance game testing and to inform game design. There are different approaches and techniques to gather the metrics data; however there seems to be a lack of frameworks to read and make sense of it. In this paper, the concept of play-persona is applied to game metrics, in the specific case of character-based computer games, where the player controls a single protagonist, around whom the gameplay and –story evolves. A case is presented for *Hitman: Blood Money* (IO Interactive, 2007). Player-controlled game characters can be deconstructed into a range of components and these expressed as monitored game metrics. These metrics can subsequently be utilized to discover patterns of play by building play-personas: Modeled representations of how players interact with the game. This process can also be useful to assist game design, by informing whether the game facilitates the specific play patterns implied by theoretical play-personas.

Categories and Subject Descriptors
K.8 [**Personal computing**]: Games; J.4 [**Social and Behavioral Sciences**]: Psychology.

General Terms
Measurement, Design, Human Factors, Theory.

Keywords
Persona, character, metrics, instrumentation, game design

1. INTRODUCTION
The reasons why people play games are many [1], and therefore the ways that they play are different. Although game design places limits on the way games can be played, it is an increasingly important paradigm that games should be able to be played in many different ways [20]. With the early example of *Deus Ex*, a First-Person Shooter (FPS) which enabled different distinct play-styles throughout, to more modern cases like the "sandbox game" *Grand Theft Auto IV*, multi-player shooters and Massively Multi-player Online Games (MMOGs), a number of very successful titles have been able to cater for different player tastes. In order to reach a wide target audience, it is necessary to create games that accommodate different types of gaming experiences throughout every map or level [12]. This leads to some inherent conflicts between the necessity of the designer to maintain control of the crafted experience – in terms of narrative as well as the ludic/mechanics - versus the diverse interests of the players in interacting with the game space and mechanics. For game designers, it would therefore be an advantage to be able to, during development and after game launch, test and evaluate whether or not a game provides the diversity of possible play-styles and interaction options, in order to facilitate the expression of a range of player desires. Additionally, it is of interest to evaluate how players play the game, i.e. locating emergent play-personas. This kind of game testing and evaluation requires very detailed data about the player behavior. Traditional methods are limited in that researchers can only hand-code so much information, and analysis of screen capture to a high level of detail is incredibly time consuming and not a good solution for the quick and effective game testing process required in the industry [5,17,19]. A potential solution is presented in the automated collection and analysis of game metrical data, i.e. instrumentation data about the user-game interaction. **Metrics** are numerical data obtained from the user-interaction with the game software itself, and can be recorded at different degrees of temporal and spatial resolution [6,21].

Metrics supplement existing methods of games-based user research, e.g. usability testing (measuring ease of operation of the game) and playability testing (exploring if players have a good experience playing the game) by offering insights into how people are actually playing the games under examination.

Metrical (or instrumentation) data are objective (even if the decision about what to measure is not), can be collected in large numbers and can map precisely to a point in a game map or level. Unlike qualitative data and survey-based information, metrics are precise and therefore are helpful in a collaborative environment such as a game development team. In comparison, player-based feedback has less resolution, and contains the inherent problem of bias caused by individual perception, such as preferences for combat vs. exploration. Similarly, the perception of game designers is potentially biased by e.g. infatuation with a particular dialog or scene [20]. Metrics software is however limited in that it can only track player actions, not e.g. the quality of the experience gained from playing the game in question.

In this paper, the potential of using metrics to define **patterns of play**, or more precisely **play-personas** and evaluating whether a game design facilitates these patterns, are discussed in the specific case of character-based games. These are games where the player controls a single avatar or character, the player-character (PC), generally the main protagonist around whom the gameplay and story evolves, i.e. most FPS', RPGs', MMOGs/MMORPGs and adventure games.

The primary research question centers on defining the various components of player-characters and deconstructing these into measureable elements, whose use by a player can be tracked by

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metrical software. Conversely, how these data can be utilized to define patterns of play, or personas. In this paper, the FPS´ *Hitman: Blood Money* is presented as a case study in defining character-bound metrics, and these utilized to discover or plan different play-personas.

2. METRICS: PREVIOUS WORK

In this section presents a few basic properties of metrical data as well as examples of analysis performed on metrics relevant to character-based games.

Automatically logging and analyzing instrumentation data is a well-known procedure within the general HCI field [18], but has only in recent years been widely adapted to digital games, where it has been shown to hold substantial promise to user experience research and game testing. For example, Mellon [15] presented data from automated testing of MMOG development and operations in *The Sims Online. Microsoft Game Labs* performed extensive user testing of *Halo 3*, generating metrics-based analyses of player progression and heatmaps [21]. Goetz [8] considered interface-based metrics in e.g. *Civilization IV.* DeRosa [3] reported on the work of *Bioware* to integrate game metrics in the form of time-spent reports. Similarly, Ducheneaut et al. [4] used logs of player chat in *Star Wars Galaxies* to infer patterns in social behavior. The *PlayOn* project running from the Palo Alto Research Center has explored the social dimension of virtual worlds through data from five *World of Warcraft* servers, investigating subjects such as leveling as a function of class from a top-down perspective. Swain [20] reported metrical data being utilized in a variety of contexts within the game industry to define and measure what play is and conversely how to apply this knowledge to create better games.

The term "**metric**" denotes a standard unit of measure, e.g. a second or an hour. Metrics are generally organized in systems of measurement, utilized for quantitatively measuring and evaluating processes, events etc. Systems of metrics are generally designed to a specific subject area. Within game development, metrics form measures of engine performance, sales, project progress or user interaction with the game software, the latter category being of interest here. This type of metrics (or User-Initiated Events (UIEs) [10]) can relate to all forms of actions performed by the player in-game, including movement and behavior in a virtual environment, use of character skills and abilities, interaction with objects and other players, etc. In general, metrical data analysis is useful to compare the intent of the designers with the actual behavior of the players and to assist developers with quantifying their vision into elements that can be measured. Importantly, game metrics provide information only regarding actions undertaken in-game by players, it is impossible to assess reasons and motivations behind the action. It does not inform whether the player is male or female, or what the player thinks of the game experience. By including biometrical data feeds [e.g. 14], some measures of player experience, e.g. arousal or emotional state, can be provided, however even with these additional data sources metrics cannot always explain why a player performs a given action. In order to get to the root causes of player behavior, traditional qualitative methods such as playtesting or surveys [5,16,17] generally need to be involved. In essence, metrics analysis can inform how the user is playing the game, where playability testing can inform if the user has a good experience, and usability testing can inform if the user can operate the controls [14].

Metrics in games-based user research can take different forms, from logging of keystrokes to recording specific types of player behavior, e.g. firing a weapon, completing a level etc. Some metrics will be particular to a specific game (e.g. kill methods in *Hitman: Blood Money*), others relevant to an entire game genre (e.g. tracking PC movement as a function of time). At *IO Interactive*, different types of metrics are considered depending on the specific analysis context. In this paper one of these contexts are outlined, which considers metrics relevant to analyzing how players use characters.

Metrical data can generally either be "low level", e.g. the logging of keystrokes, or "high level", related to specific game design features, such as PC movement through the virtual terrain. Metrics can be recorded in different ways; either **continuously** , based on a specific **frequency** (e.g. measurement of PC position every 5 seconds) or **triggered** (e.g. record every time a weapon is fired). With respect to metrics relevant to the analysis of PCs, metrics recorded can include e.g. the **time** of the recording, the **spatial coordinates**, the **originator** of the metric (e.g. the player, a bot), the **camera angle,** and the **content** (the actual event recorded, e.g. a kill or a jump). Which metrics to record and whether to list them, aggregate them into sets etc., depends on the requirements of the specific analysis. Kim et al. [10] suggest recording metrics as event sets, i.e. capturing metrical data as well as the contextual data needed to make sense of the specific event: "*We do not just record a "crash" event every time a player runs into a wall. Instead, we record what car the player was using, the track they were racing on, the difficulty setting […] every time we record the "crash" event"* [10]. These metrical data can be combined with other quantitative or qualitative data, e.g. surveys.

The output from metrics software is typically log files of raw data, transferred to a relational database system and presented using e.g. spreadsheets, data cubes or pivot tables. These files need to be further treated and visualized before they can be used in practice. For example:

00000: (x, y, z), (t), (w°), (λ°, φ°), (m), (i)
00001: (134, 450, 00), (0078), (110°), (110°, 90°), (w5)
00002: (150, 433, 05), (0147), (125°), (120°, 85°), (z)
00003: (189, 400, 10), (0200), (140°), (190°, 120°), (u3)

This output shows the recording of specific set of triggered metrics, providing a unique key for each, and recording the location of the PC, time since recording started; the camera angle and the type of metric recorded (last parenthesis). Recording the spatial component of metrics is necessary in order to adopt visualization techniques from Geographical Information Systems (GIS), where data sets are added as views on top of a map and calculations can be performed along or across layers.

The process of transforming these data to useful reports requires an iterative series of steps. Fry [6] summarized the process from obtaining raw data to their visualization in the following steps: Acquiring the data, parsing data to provide structure and filtering away unwanted data. During analysis, data mining or statistics method are utilized to locate the patterns or calculate the results required. Data are then represented in a visual model, which is refined to improve representation and visual engagement. Finally, the models should ideally be interactive, so that the user can manipulate the data directly in the visual model when interpreting the results of the analysis.

3. PLAYER CHARACTERS

Within digital games the concept of the avatar generally covers the physical representation of the player within the game world, irrespective of the type of embodiment, and irrespective of how graphically simple and static (*Pac-Man*) or complex and customizable it is and how much it evolves during gameplay (e.g. in MMOGs such as *EVE Online* or RPGs such as *Oblivion*) [8]. Klevjer [11] defines avatars as both a functional tool and as a facilitator of the generation of fiction. An avatar can have various features, e.g. appearance, animations showing movement and ways it can interact with objects and entities in the game world (affordances). Klevjer's [11] definition however necessitates a different term to describe avatars with properties that go beyond the visual, auditorial and behavioral. Such a property could be **personality**. For example, in the FPS/action-RPG *Deus Ex*, the player representation has a name, a brother in the game world, a personality, relationships with specific entities controlled by the computer (Non-Player Characters, NPCs), and so forth. These are properties of the player representation that are not physically represented in the avatar, however, they can be viewed as properties that are placed "on top of" avatars to make them more than just physical representations in 2D or 3D gamespaces. Avatars with some or all of these additional properties are here referred to as **characters**, which again is a term that comes with a substantial degree of debate.

This definition means that the same avatar can give rise to multiple different characters. Characters range from focusing on appearance and behavior, with personality primarily expressed through the visual design, stance and movements (e.g. *Sonic the Hedgehog*, *Mario, Rayman* and *Crash Bandicoot)*, all the way through to characters with depth: Of personality, background and grounding in the game world (e.g. *Abe*, *April, Ryan* and *Patrick Galloway)*

3.1 Defining player character components

The creation of player characters and the relationship that players have with them is a convoluted subject [e.g. 13]. As with any essentially user-oriented issue, the number of variables involved is staggering (because humans are involved). This is reflected in the massive range of opinions on how player characters should be designed [e.g. 8, 16]. Irrespective, player characters can be designed in different ways and with different properties, depending on the specific requirements of the game in question**.** The character can vary in its constructional complexity across a range of elements, covering the various facets a game character can have, e.g. stats, personality and integration. Within each of these facets, more or less depth can be applied to the character functionality. For example, the character *J. C. Dent* in *Deus Ex* featured a relatively simple character development and item-based upgrading system, but had a relatively well-developed integration into the game world, with e.g. a NPC brother. In the typical RPG, such as *Neverwinter Nights*, characters are usually without detailed personality elements.

What is of interest in the current context, is defining how PC features can be converted to elements that can be tracked using metrical software. An attempt at this is provided here (Table 1),. This model captures not only the actual character traits, but also the physical movement of the character within the game world and how it interacts with objects and entities within it.

Every action the player takes in-game has an effect on the state of the game, therefore it can be recorded by metrics software. This is not to say that recording every single keystroke or event in a game will be useful, rather thorough planning is required in order to define which types of metrics to track, and the level of resolution. For example, the decision about how often to record character position needs to match the purpose of tracking this information. Mechanics and physical behavior are directly related to metrics; however it will be of relevance in some character-based games to track aspects of character personality and game world integration. For example, in RPGs such as *Knights of the Old Republic* it could be relevant to see if players generally prefer to play dark side, neutral or light side Jedi knights.

3.2 Metrics associated with player characters

The potential range of metrics that can be tracked in relation to player-characters is substantial, even in games where the *Personality* and *Game world integration* elements are more or less ignored, e.g. *Unreal Tournament* (Table 1). Metrics related to characters can generally be grouped in four categories. As noted in the above, the actual data recorded for frequency based metrics usually contain a time stamp, coordinates in three dimensions, as well as a code for the actual metric, e.g. "(w)" for "walking", as well as an originator of the metric, e.g. the PC or an NPC.

1) Navigation metrics: Navigation can generally be recorded as frequency metrics, but some are also triggered. For visualization, these can be overlain on a map of a game level (Figures 3,4). A range of navigation metrics can be defined, including movement as a function of time, movement modifiers (different types of movement), speed and direction. Movement can be tracked in three dimensions as a function of time; either continuously or with a given frequency count (sampled every five seconds). Movement modifiers depend on the game in question, for example: "Still", "crouch", "lie down", "run", "walk", "teleport" or "fly" in the MMORPG *World of Warcraft.* Navigation metrics include tracking camera view ($1^{st}/3^{rd}$ person), its angle and direction relative to the character facing. This provides information about what the player is looking at relative to the character. Going back to the example of *Hitman*, the following set of navigation metrics could be defined in an analysis of the physical behavior of player-character:

- The position (x, y, z) and vector ($0<w°<360$, where 0 and 360 represent North) of the PC, recorded in frequencies of 5 seconds (t). In this case the vector of character movement is parallel to the head orientation of the avatar.
- The point of view of the camera: Horizontally ($0<\lambda°<360$; where 0 and 360 represent North) and vertically ($0<\varphi°<180$; where 0 is downwards, looking at the characters feet, and 180 is upwards, looking at zenith).
- The movement modifier (sneak, stand, crouch, walk, run, fall from a height, pilot craft, swim, agility move).

2) Interaction metrics: Interaction metrics are typically event based, i.e. triggered by a specific PC action. Interaction metrics can be recorded either in concert with a location (X,Y,Z) and time stamp, or as aggregate frequency counts, e.g. recording the number of times a player changes disguise or equips a weapon (Figure 5). Two different types of interaction metrics can be defined, dependent on whether the PC is interacting with *game*

	Element	Description
Mechanics	**Mechanics**	Mechanics covers all the mechanistic traits of characters: Powers, abilities, skills, statistics for physical properties (health/hit points, minimum reaction time, etc.). It is one of the easiest components to monitor with metrics. In RPGs, characters can feature sets of stats and/or skills, which evolve throughout the game, e.g. *Baldur´s Gate*.
Physical behavior	**Physical behavior & movement**	This category includes the specific physical behaviors of game characters, e.g. movement modifiers like running, crouching, special attacks, sneaking and stealth. The physical behavior of a character can enhance the character theme, and project its moods and feelings. Emotes with associated animations are a typical way of providing MMORPG players some control over the physical behavior of their characters.
	Location	The aesthetic aspect of any location provides players with information, and is important to obtain a solid hook into the game world.
Personality	**Psyche**	Psyche defines the core of the character: Psychology, motivations, moral alignment and emotions. It can be non-existent, a blank slate for the player to project onto or relatively complex, forming an interesting template for the player to relate to and possibly even learn from. It can be one of the hardest properties to define in terms of metrics. Psyche can for example be expressed in situations requiring a moral decision.
	Goals	Goals are used to engage the players first hand, similarly to quest systems. Goals can be mechanical or personal, simple or complex: Kill the crime boss; gain control of the guild of thieves; maintain a close relationship with a sister, not letting a phobia control one's life. Goals targeting the psyche are harder to code, therefore comparatively rarer in games than simple goals.
Game world integration	**Associations**	These represent the dynamic social networks (NPCs or other player characters) that a character is connected to. They are one of the primary means of propelling players forward in the game storyline, e.g. via quest- or mission provision.
	Category	The term category should be interpreted in a broad sense, e.g. more than just character classes in RPGs. Classes are not the only way to approach categorization: Games such as *Morrowind* develop stats/skills based on character actions. Categorizations can be used to help develop the vision of the character and anchor it.
	Background	Details of where the character comes from, the events that have brought it to the specific point in its life where the game begins, and the history of the character developed during game time. It can be hard defining background in terms of metrics, as it is usually a given at game start: *Mass Effect, Neverwinter Nights 2*.
	Appearance	Details of the physical/aesthetical aspect of a character. It complements the integration of the character in the world, anchoring it in the overall theme and style of the game world, and it is a vital visual link between the player and the character. Appearance can be modifiable (*World of Warcraft*) or static (*The Longest Journey*).

Table 1: A model of the full range of elements that player-controlled characters can feature in character-based games. Included are examples of the associated game metrics that can be tracked and recorded for each type of feature (character model modified from [22]).

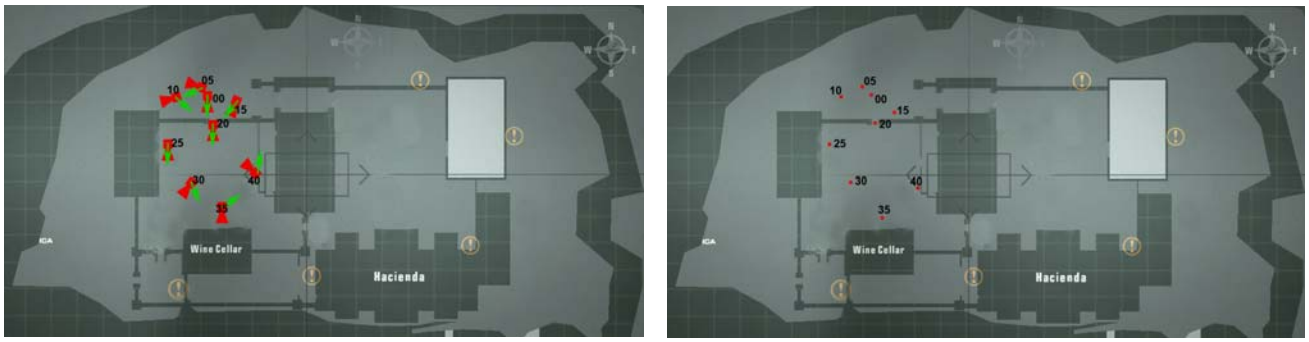

Figure 3: (left): Tracking the movement (X, Y, time) of a character through a section of a map in *Hitman: Blood Money*. The numbers signify the time in seconds since the character was loaded into the map (at time 00). Data added to a map of the level *A vintage year.* (Right) Tracking camera angle in *Hitman: Blood Money.* Green arrows indicate the vector of character movement; red icons indicate camera direction (horizontal plane).

objects/the game world, or with *entities* (e.g. NPCs) inhabiting the game world. Interaction with entities can be further divided into *combat* and *passive* interaction metrics. For example, in *Hitman: Blood Money*, there exist a number of different ways for the PC to interact with the game world, or act within it, e.g.: *Picking up item; Drop/throw item; Change disguise; Equip weapon; Fire weapon (+/- using sniper scope).* Similarly, there exist a set of options for interacting with entities/NPCs, both combat-related and passive: *Talking; Push; Firing a ranged weapon; Using a close combat weapon*

3) Narrative metrics: These will generally be triggered, and deal with the game story and how the player navigates through it, for example in making choices about how to proceed with a given objective, in communicating with NPCs, etc. Examples of metrics in this category include task or quest completion times (also commonly analyzed in traditional usability analysis [17]). For example, in the action-RPG/FPS Deus Ex, players have different choices of dialogue, and sets of missions that can be completed in different ways.

4) Interface metrics: Depending on the viewpoint, these could be viewed as unrelated to the use of player-characters. The category covers the use of the graphical user interface, its menus and basic functionality. For example, tracking the navigation of players when leveling a character in a MMORPG.

These four classes of metrics can be referred to as **character-bound metrics**, because they are associated with the PC and how the player utilizes it when playing the game. The PC is however not the only entity active in the game world and this necessitates the definition of a class of metrics unbound to PCs: **Event metrics:** These can be of any type, and cover e.g. the actions of NPCs, changes in the game world state due to actions of player or game software, e.g. the number of shots fired by a bot. Based on the four categories of character-bound metrics, different classifications of player behavior can be defined for each category or a subset of metrics within or across categories. For example, navigation metrics could be aimed at tracking whether a player prefers staying in the open, staying in the shadows or inside buildings (as is the case of *Hitman: Blood Money*). Similarly, an interaction metric covering elimination of opponent entities could be divided into close-up/midrange/faraway, i.e. tracking the methods with which players' eliminate opponents. Individually, these would prove the play attitude towards one form of navigation, while combining the data would provide a set of nine combinations which can be used to define simple play-styles.

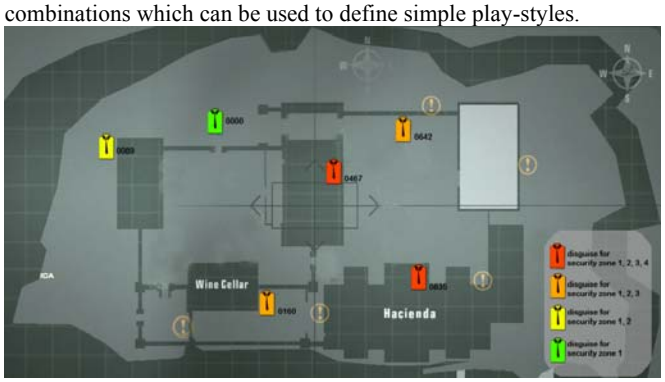

Figure 4: Example of interaction metrics data overlain the level *A vintage year* from *Hitman: Blood Money*. Positions of disguise change type of disguise chosen marked with icons that assist in interpretation of the metrics data. Same map as in Figure 3.

Character element	***Hitman: Blood Money* examples of character metrics**
Mechanics	Frequency and place of player character death; time spent holding different weapon types; frequency of acquiring and donning disguises
Physical behavior & movement	Choice of map entry point, use of character-specific movement (e.g. running, walking, sneaking, charging); time spent in different types of environments; movement patterns as a function of time and level/map design (context); angle of camera (screen angle vs. character orientation)
Location	X,Y,Z coordinates tracked as a function of time, location of the character in the context of other characters or objects, e.g. placement with relation to objects; time spent in different types of security-labeled areas
Psyche	Psyche virtually non-existent in *Hitman: Blood Money* apart from what is expressed in behavior/appearance; method of opponent elimination; number of unnecessary killings
Goals	Time spent completing missions; mission completed with or without the suit (the game awards bonus points for this)
Associations	NPCs are static and scripted, players cannot freely modify associations. In e.g. *Mass Effect* players can develop their relationships with NPCs, and these could be tracked, e.g.: Registering if contact has been made between player and NPC; Recording type of interaction with entities/NPCs (attacking, talking to). In *Hitman: Blood Money*, there are some NPCs which players can listen to, ignore or kill. The player choice in this regard can also be tracked
Category	Choice of weapon to start a mission with; level of notoriety
Background	*Hitman: Blood Money* feature background histories of the player-characters, however, players cannot affect these backgrounds, nor develop them during play. Therefore there are no metrics associated with this character element. In comparison, games such as *Neverwinter Nights 2*, allow players to actively choose between different backgrounds.
Appearance	*Hitman: Blood Money* feature relatively static PC appearances, with the exception of disguises. However, appearance is a highly customizable and changeable feature in many RPGs and MMOGs, where relevant metrics to track could include: A) Choice of appearance during character creation; B) Appearance changes and when the player initiates these changes; C) Selection of equipment, tools and apparel as a function of time or in specific contexts.

Table 2: Character elements and examples of associated metrics in *Hitman: Blood Money*. Some metrics can be used with respect to different character component categories.

4. MODE, STYLE AND PERSONA

When dealing with PC-based metrics, it is necessary to be able to operate at different levels of data aggregation, dependent on the specific requirements of the analysis. There are different ways this problem could be approached. In order to assist with the exploration of play-personas, a three-tiered structure of data aggregation is suggested here, containing the elements: Play mode, play-style and play-personas.

Play mode: The play mode generally refers to the behavior of a player with respect to one or a few discrete metrics, within the same overall group or type of metrics. For example, in *Hitman: Blood Money*, tracking whether a player uses lethal or non-lethal weapons, recording this single variable but not themeans/methods (i.e. not which type of weapon or the effect, ammunition used etc.). Another example could be recording the time and location of players using the sniper scope. The choice of the player in terms of how they interact with their opponent can be tracked and recorded as metrical data, because the actions of the player is recorded by the game software and in turn provides a result. A piece of metrics tracking software could for example be asked to monitor how players eliminate opponents and the various options categorized as noted above. Play modes would in this case refer to the specific group of metrics related to interaction, and a set of "interaction modes" could be defined based on these. Similar attitudes could be defined for metrics associated with navigation, interaction with friendly NPCs, etc.

Play-style: Play-style is here defined as a set of composite play-modes [see also 1]. Play-styles form a compound of different

playmodes, and are unlike these constructed from several different tracked player behavior variables (metrics) relevant to the specific play-style, for example all elements of interaction and navigation. Play-style characterizes the **momentary style** of play a person chooses to negotiate a given situation, for example close combat versus ranged combat. Thus a play-style can - but does not need to - change over the course of gameplay, and players can choose between different sets of play-styles for different situations. For example, the *tank rush* in the real-time strategy game *Red Alert* is a play-style, bearing comparison with the *zerg rush* in *StarCraft*. *Ninja looting* is a play-style observed in MMORPGs, *bull rushing* and *grenade jumping* typical of multi-player FPS'. Play-styles are, unlike play modes, constructed from the full range of tracked player behavior variables relevant to the specific play-style, i.e. all elements of interaction and navigation. For example, a *bull rush* in a FPS defines a behavior where the player-character runs directly at the opponent with guns blazing. In order to describe a *bull rush* in terms of metrical data, both navigational (direction, speed, potentially even eye tracking data), positional (X,Y and Z coordinates) and interaction (e.g. weapon used, number of shots fired, result from shots fired) metrics need to be involved. Different play-styles require different metrics to be tracked. From this leads the requirement to track a variety of metrics when exploring what play-styles people utilize in a specific game (emergent play-styles). This is dependent on the specific requirement of the analysis in question. E.g. if looking at play-styles related to combat in a FPS, tracking how players interact with NPCs may not be relevant to include in the analysis.

Play-persona: Play-personas are larger-order patterns that can be defined when a player uses one or more play-styles consistently throughout the game play session. Players can change play-styles, or other aspects of their behavior during the game, while still maintaining the same persona. For example, in *Hitman: Blood Money* dispatching the targets "close up", using silent and clean methods or from "far away" using a sniper rifle, does not affect the definition of the "silent assassin" persona; as long as the behavioral requirements for that specific persona is met: Using stealth, staying in the shadows and killing only the designated targets. Play personas are just like the play-styles that they are comprised of, defined on multiple PC-metrics. The concept is modified from Cooper [2], who defined personas as: *"Detailed, composite user archetypes that represent distinct groupings of behaviors, attitudes, aptitudes, goals and motivations observed and identified during the research phase [of product design]."*

As suggested above, player-controlled game characters can be deconstructed into a range of properties that can be tracked and recorded using metrical tracking software. For example the use of weapons, interaction with objects or Non-Player Characters (NPCs), use of skills or abilities, or interaction with other players. These can be combined with navigational and other data to provide a well-rounded image of the behavior of the player. It is here argued that the concept of play-personas can form a framework for grouping these patterns of player behavior in-game, as well as the experience people gain from playing the game. For example, two personas may both prefer short-range combat, but one aim at melee, the other at ranged assassination. These are just examples, the specific metrics tracked can vary as a function of game design and as a function of the requirements of the analysis in question. Furthermore, because player-characters come in a variety of forms and designs, they impact on the possible play-styles and play-personas when playing the game by setting specific limits on the affordances of players.

Play-personas can be developed for a variety of reasons related to game development, and are as a concept are here used as the term for both mentally constructed models of user behavior, defined using PC-bound metrics as the core variables, or alternatively data-driven representations of player behavior. In the system presented here, play-personas are defined under four different conditions: 1) According to whether personas are used by players or designers; 2) According to whether the concept is utilized *a priori (metaphor)*, i.e. before a playable demo/prototype exists, or *a posteriori (lens),* i.e. after a playable prototype has been developed that data can be gathered from:

1) *Designer metaphor:* Personas allow designers to "imply" player behavior in the process of creating digital games, i.e. by pre-defining the play-patterns possible in the game in question and design to accommodate these, as is the case in e.g. *Hitman: Blood Money*, where players can choose between different identically optimal strategies to progress in the game. In this case, play-personas represent a design tool, an expectance of how players would like to behave in the game environment and approach the game goals. Designers can use these categories of behaviors as a guide during design. This prior to a playable version of the game (e.g. before the beta-stage) in order to design for coherent navigation and interaction modes, distinguishing between different ways of playing the game and expected experiences.

2) *Designer lens:* Alternatively, metrics can form the basis of defining data-driven personas during game testing. Personas based on PC-metrics can be used as tools when evaluating demos or prototypes (i.e. conducting user-research), or even post-launch (especially important to MMOGs and other online/persistent games), comparing the goals set by the designers with those of the players. That is, answering the question about whether the game design actually supports and facilitates the planned personas in practice, and if any new personas emerge from the user-interaction with the game software. Game metrical data can form a way of discovering patterns in the usage of PC elements and features, thus enabling the building of personas of how players interact with the game, and whether the game design facilitates the specific play patterns of the personas.

3) *Player metaphor:* Similarly, personas can be released to players (e.g. in the form of narrative descriptions) or even created by players based on their expectations of the game, as models for the expected experience of playing (e.g. as indicated by the title *Hitman: Silent Assassin*). If games are about realizing fantasy, this type of persona is the preferential fantasy that a game is sold upon.

4) Player lens: When playing the game or afterwards, during reflection on the experience of play, players can form mental constructs (consciously or not), which players can build to unify their own actions and to make sense of the game world and the experience of interacting with it. In this context personas are the implied narrative tool of player. Irrespective of whether personas are developed prior to a testable prototype, or after players actually get to play the game; and irrespective of whether personas are developed by players or designers, they can be defined based on variables expressed as metrics, even if actual metrical data cannot be gathered until after a testable prototype is complete. The definition and grouping of specific sets of player behaviors via metrics are generally strengthened by other sources of quantitative as well as qualitative data [10,16], or alternatively as mentally derived constructs.

5. USING PERSONAS: *Hitman: Blood Money*

As a brief example on how to build personas, it will be considered how designers can develop personas of player behavior during the early phases of game design, based on character-based interaction and navigation metrics. The case study is *Hitman: Blood Money*, which includes an embryonic version of the metric system currently in use at *IO Interactive*.

Personas developed for use in early-phase game design are not limited to narrative description of modalities of use, but take the form of coherent patterns of play, deconstructed in terms of specific metrics and expressed quantitatively. During early development, the designers at *IO Interactive* anticipated that a specific persona (mode of play) would be prevalent in *Hitman: Blood Money*, namely the "silent assassin". This persona could be narratively defined as introverted, calm, formal and a loner. He tends to trust no one, is extremely professional, killing only his designated targets in the most silent and surgical manner, preferring to set up his hits as if they were accidents. The highest priority remains for him to maintain his identity a secret; hence he is willing to dispatch even innocent bystanders if they have seen him in action. The game rewards this unobtrusive, silent and sober behaviour profile with additional cash at the end of each mission; however, as it is increasingly important for the success of games to support multiple different modes of play, the designers needed to define additional play personas, anticipating variances in player behaviour to accommodate for different ways through which players can express themselves. These initial persona hypotheses can be fleshed out using narrative descriptions of the character animated by different players [2]. Additionally, all the navigation and interaction play modes of the game can be mapped out as possibility fields. Subsets of these can be selected to procedurally describe the patterns of play that best fit the different personas. This concrete and parametric collection of possible play modes forms the **persona hypotheses.**

Navigation possibility field: A possibility field is the collection of all potentially available choices in any given moment. There are four classes of play-styles that can be used to structure the navigation possibility field. Play-styles can be categorized by monitoring navigation metrics, based on play modes (comprised of individual/few metrics tracked), for example:

Brawn play-style: The player is obviously interested in showing off and testing the limits of the character's physical prowess by climbing everywhere, making use of force whenever possible and always being on-the-move.
Play modes: Running, climbing, falling from heights, close combat moves (e.g. head butt, punch, disarm, knife, hammer).
Key navigation metrics: Percent of time spent running, vector of movement towards opponents. Frequency of climbing and falling. Frequency of lock shooting as opposed to lock-picking/key use.

Brain play-style: Player shows preference towards rational over physical means for negotiating environmental obstacles. Focuses on observation skills, finding holes in the surveillance system and to individuate patterns in the behaviour of NPCs.
Play modes: Standing, crouching, walking, accessing map, disposing/dragging bodies, special moves (e.g. spy through keyholes, keycards, coin distraction, recovering surveillance tapes.
Key navigation metrics: Frequency and time spent accessing the map function, frequency and time spent e.g. spying through keyholes, frequency of opening doors using keycards.

Role-play play-style: The player's highest priority is to blend in, to figure out what is the fitting disguise in order to be granted unconditional access to each zone in the game; hence it is paramount dressing up like different characters and acting like them.
Play modes: Walking, standing, changing disguise appropriately to security zones, interacting with NPCs to gain intelligence.
Key navigation metrics: Frequency of disguise change, pertinence of disguise to current zone, frequency of interaction with NPCs.

Stealth play-style: The trademark of players preferring this style is the desire to maintain wearing the trademark black suit and not using disguises, relying instead on stealth.
Play modes: Standing, crouching, sneaking, close combat (e.g. fiber wiring, syringes, poison), using shadows, hiding in closets
Key metrics: Time spent walking in shadows and in closets, time spent sneaking, frequency of silent/close combat moves.

It is possible to combine play-styles in coherent clusters and observe what kind of personas that could potentially emerge. The "*silent assassin*" persona is a combination of *stealth* and *brain* play-styles, in the *role-play* and *brain* quadrant a persona can be identified which could be titled "*James Bond*", maintaining a rational approach but often working undercover, while *role-play* and *brawn* engenders more a ""*Starsky & Hutch* "-persona, defined by working undercover and a physically violent approach. Lastly, in the *stealth* and *brawn* quadrant a persona exists that could be called the "*Sam Fisher*"-persona, concerned with keeping his identity secret and infiltrating the environment, thanks to superior physical skills.

Interaction possibility field: There are at least three different pairs of play-styles structuring this possibility field. Each one of them is individuated by the preferential use of certain play modes, which are monitored by the relevant metrics, for example:
Non-lethal: Close combat moves (head butt, punch, disarm, anesthetic), coin distraction, light manipulation.
Lethal: Fiber wiring, knives, hammers, poison, human shield, gunfire, pushing, bomb (second degree).
Silent: Fiber wiring, sniper rifle, poison, anesthetic, pushing, knife, hammer, head butt, punch, elevator ambush, lock pick.
Loud: Disarming, bomb (first and second degree, shotgun, assault rifle machinegun, human shield, shooting locks.
Clean: Head butt, punch, fiber wire, ambush, poison, anesthetic, push, lock pick, ambush, sniper rifle.
Bloody: Rifles, machineguns, shotguns, knives, hammer.

Furthermore, it is relevant to investigate whether players choose to interact with a single or multiple targets, if they prefer bare-handed or tool-aided interaction, as well as the range of interaction: Close-up, mid-range or far-away (e.g. using a knife, a pistol or a sniper rifle). From the translation of descriptive principles into metrics of player behavior, it is possible to procedurally quantify play personas numerically through the navigation and interaction metrics. E.g., based on navigation and interaction play modes, the "silent assassin" persona could be defined as having a specific profile (Figures 5,6). These templates are of direct use during design: Ensuring that the "silent assassin" always has a means of eliminating targets silently and preferably in a non-lethal fashion. The same principles apply to the other personas defined for *Hitman: Blood Money*, and this verification process can help redesigning and focusing elements ranging from game mechanics to game worlds. During playtesting, the persona hypotheses can be checked and verified against metrics data gathered by tracking player behavior in

game. It can be tested if pre-defined personas exist in player behavior, and if they are supported by the game design; however, personas can also emerge from player behavior in unanticipated ways: Players could begin to play a game in an unanticipated fashion, and it must then be decided whether to facilitate this play mode, play-style or play persona. In *Hitman: Blood Money*, players are via the integrated embryonic metrics system, provided scores in terms of e.g. "noise" and "violence". The game also provide players a status according to their positioning on a stealth-aggression axis and other in-game behaviorally triggered scores, with status titles ranging from "*mass murderer", "silent assassin", "mad butcher"* to "*the cleaner*". The titles relate closely to the personas implied by the designers.

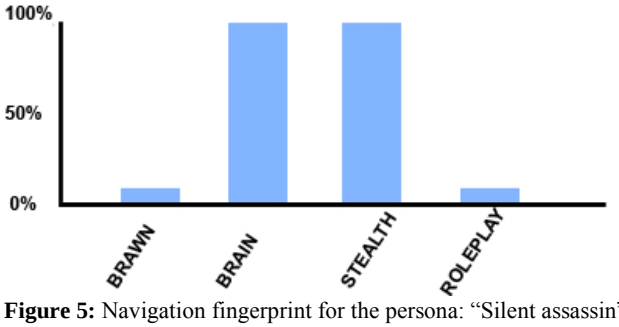

Figure 5: Navigation fingerprint for the persona: "Silent assassin"

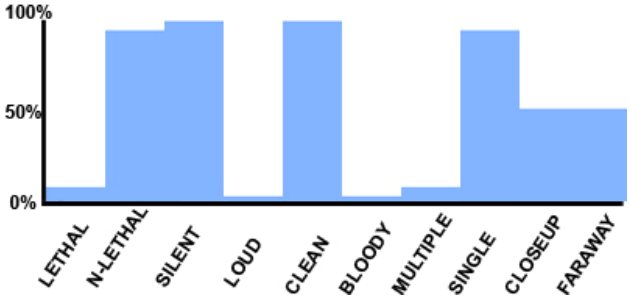

Figure 6: Interaction fingerprint for the persona: "Silent assassin"

6. CONCLUSIONS

A key design challenge in game development is to ensure optimal experience for a variety of player preferences. In the above, it has been attempted to argue for the use of persona constructs as a means for categorizing and analyzing character-bound metrics, as a tool for informing the process of developing and testing a diversity of play behaviors in a computer game. In addition to personas, play-style and play mode have been defined as two different methods for utilizing metrical data to define player behavior. Due to space constraints, it has not been possible discuss how best to analyze character-bound metrical data in practice or present them in reports; this is a topic for future work. The use of instrumentation data are a highly useful approach towards integrating user behavior in game design- and development. As a HCI method applied to game development, metrics form a valuable addition to existing user-testing methods, providing precise data about player behavior extending outside the data range of e.g. usability methods. Metrics data combined with on-going persona classification form an interesting perspective with regards to procedurally generated content and flow maintenance, with respect to play-styles/difficulty, i.e. adaptation to the player behavior in real-time.

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