Play-Persona: Modeling Player Behaviour in Computer Games

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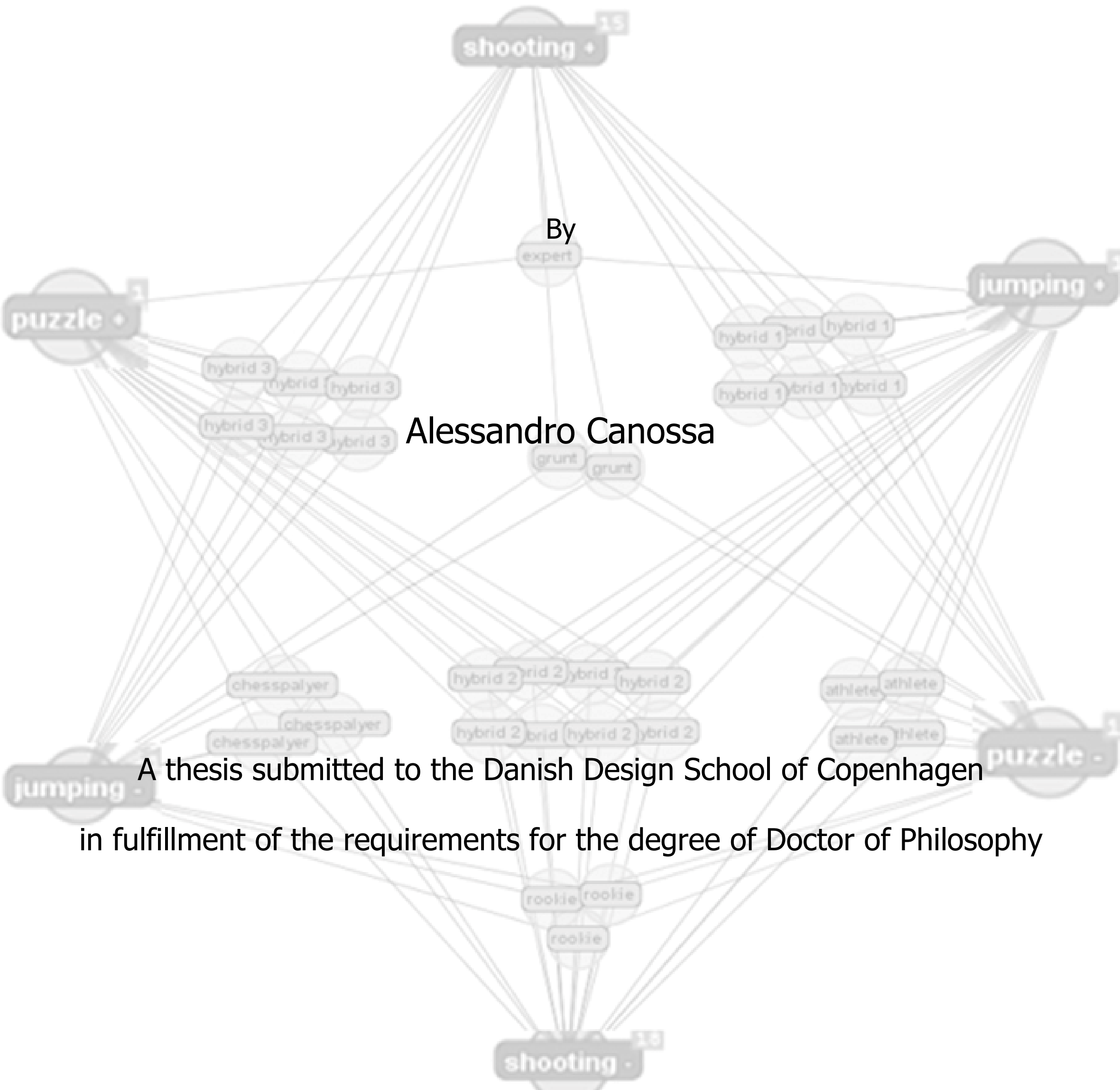

By

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And finally I would like to thank you, my wife and friend, because it is partly your responsibility if I chose to embark for this adventure of discovery.

STATEMENT OF THE CANDIDATE

The work presented here has not been submitted for a higher degree to any other university or institution. Sources of information utilized are indicated in the literature list of the relevant sections of this thesis. This is a thesis by publication and it includes thirteen articles. Eight of them feature co-authors. The candidate is particularly thankful to Dr. Anders Drachen: the collaboration, especially in the last year of the research project, has led both to considerable academic achievements and personal development.

Here is included a clarification of the extent of these contributions and the contact details for the co-authors.

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ABSTRACT

This thesis proposes a framework to sharpen the focus on player experience when designing and evaluating levels for single player action games.

From a developer's point of view, game levels are the confluence of art, code and gameplay. From a player's point of view, levels are a succession of spaces that contain events.

Due to its intrinsic multidisciplinary nature, level design has been historically difficult to define both in terms of scope of the discipline (what is the result of the process) and the skill set required from the level designers. In different game studios it is possible to see how the role of level designer can be covered by artists with a good understanding of space, architects unbound from gravity and materials and even the specific subcategory of programmers called scripters[1]. The core focus of designing game spaces is also often disputed exactly because of the heterogeneous composition of its ranks. Some teams see gameplay as king, and every other decision is secondary; in other contexts it is the story that rules and at times even the code, under the appearance of outstanding technical achievements, can become the compass that orients the design process. Another problem often encountered in level design is the lack of an irrefutable, quantifiable assessment of quality and success ratio. QA departments in leading developer's studios around the world are starting to devote enormous resources to track players' metric data and provide unquestionable answers to issues such as "is this level good enough?" In this setting, the main concern seems to deal with which parameters are necessary to monitor in order to insure a proper feedback on questions regarding the success rate of game levels and how to relate the analysis carried out on the raw data.

This project intends to look for an element that can be the pivot, flexible and solid at the same time, around which all the other fields and disciplines will harmonically dance, structuring the game space and providing it with consistency, focus and variety. The result is not a cumbersome normative procedure, nor a merely descriptive framework, but instead it provides mental and practical tools for level designers. That central pivot is the play-persona concept, initially inspired from the field of Human Computer Interaction as a mean to imply players during the design phase of games.

[1] A scripter's role is to define behaviour of non-playing characters, enemies and events by scripting them in a high level language such as LUA, Python, etc.

1. INTRODUCTION

In the spring of 2006 IO Interactive, the game development studio behind the "Hitman" games, announced a PhD scholarship in "Level Design for single player action games" in cooperation with the Danish Design School. The research project was aimed at analyzing and answering the following question:

"How can attractive gameplay experiences be shaped?"

At the same time it was expected of the candidate to formulate theoretical tools to evaluate said gameplay experiences in titles already at different stages of development. It was an unusual call for a research position. As Hopson pointed out in a much debated and quoted Gamasutra article "the games industry has never shown […] interest in academic work. Every year there are books, journals, and conferences dedicated to studying games and how people play them, but most games professionals never read this work nor attend these conferences" [51]. In this climate of distrust between game industry and academia, not only was IO Interactive co-financing a research project, but the area of interest itself was left as open and vague as possible. Answering the call described above, in my application I recommended to adopt a semio-linguistic approach and look at the behaviour of players in a game as a succession of actions that spell out more or less hidden desires, whishes and beliefs. Somehow it seemed to have been ringing true in the ears of the evaluating panel composed both by game developers and academics, since I was finally awarded the scholarship. Nevertheless I was only beginning to grasp the uniqueness of the position I was in. I had two gods to worship: Hermes, the enterprise, and Athena, academia. Not only they spoke different languages, but the goals themselves were rather different. Whereas academia strives for Truth, it is Purpose that drives each step of enterprise. So it was with this schizophrenic soul that I started my *analysis* of player experience as the one pivotal factor around which to *design* levels for single player action games. And this brings me to the second conundrum: analysis and design, descriptive and normative values, research and practice. These dialectic oppositions not only mirror the stance of the game industry versus academia in general, but also describe the lively debates that are fought within each individual organization. For example I participated to meetings and seminars devoted to finding viable solution to the integration of these two irreconcilable yet complementary aspects both at IO Interactive at the Danish Design School.

There is a clearly marked distance between design and analysis.

Analysis seeks to break down complex situations, identify components and ingredients in order to understand something [30]. Analysis seeks to solve problems through identifying and removing the cause. Analysis rarely fosters progress towards a desired goal, it barely removes impediments. Analysis is all about 'what is', the past and present state of things, and its emphasis is on knowing.

Design involves putting things together in order to deliver some value by constructing and creating solutions [30]. Design is never completely free, it is always bound by constraints and specifications, nevertheless it is trough design that we move forwards towards our desired goals. Design is all about 'what can be', future possibilities and its emphasis is on thinking.

The Danish Design School perfectly embodies this dual soul. A few years ago, the school's leadership devised a four steps research strategy ranging from basic research, applied research, practice-based research and artistic practice, covering the entire spectrum from most abstract research to concrete artistic praxis. Recently, the four layers have been condensed in one integrated container: practice-based research. One way to concretely implement practice-based research is "design" informed but not bound by "analysis". This almost self evident statement was to become the founding pillar of my research and eventually allow me to fit, albeit slightly awkwardly, in radically different environments and communicate effectively with people from opposite ends of the human spectrum. In short, the difficult marriage between analysis and design, promoted ceaselessly by the research leaders in the Danish Design School, guided my curiosity to find areas of overlap between knowledge and thought, between truth and purpose. It was only natural then that my main research question ("How can attractive gameplay experiences be shaped?"), led me to the topic of gameplay metrics[2], since they are objective and actionable records of players' actions in games. Gameplay metrics can in fact provide both empirical grounds for decision-making in the form of prescriptive recommendations and also, by offering a snapshot of the state of the interaction between players and the game, represent a perfect basis to build descriptive statements. It is in the theorizing and sense-making of the metric data, in the interpretative layers used to make sense of the data, that analysis becomes design. Every time we question the data with a hypothesis, every time we approach a problem with expectations towards a desired outcome we re-create reality, moving closer to our desired goals. The play-persona

[2] The term "gameplay metrics" refers to data about players' behaviour in a game (location, use of skills, powers, abilities, interaction with other players, deaths, etc.), automatically recorded during a play session.

construct, central element of this thesis, represents exactly that: the bridge between the analysis of existing data and the design of a desired state.

1.1 Research questions

Level designers are constantly required to simultaneously juggle artistic, technological and design issues and, after several iterations, ultimately produce a meaningful, consistent and engaging level. In a situation with dozens of variables in the air (story, art, gameplay, technology, marketing, etc.) pulling in different directions, it seems necessary to find a unifying construct. In order to insure a coherent, isotopic, compelling and internally consistent design it is required to find a unifying, governing principle to be kept in mind both when planning, designing and producing a level and when evaluating its success rate. In the course of this thesis I will try to individuate such a principle and construct around it a framework that is flexible enough to fit most types of single player action games, at the same time it is important that the creators don't feel that they have to modify radically their workflows to accommodate for it.

Considering the fuzziness of the concept "a*ttractive gameplay"* included in the original mandate of this research, I chose to focus on the centrality of the role of the player. It is the player's role that defines the difference between digital games and other cultural products; hence this research is set on two complementary sides:

- *Do designers think about players when they make games? In which terms? How can designers build better models of players while designing games, even before any player is actually engaged with the game?*
- *How do players think of their play performance and behaviour? How do players organize and make sense of their own play experiences? How can actual player behaviour be used to evaluate the models envisioned by designers?*

Initially, because of my background in Sciences of Communications (I obtained an MA from the University of Turin), instinctively I thought of dealing with the practice of level design as a kind of language and each game level as double-faced act of communication: the practice of designing levels can be seen as a communication act initiated by the designer with the player as a receiver; at the same time the performance of a player experiencing a level of a single player game also is an act of autotelic communication, communication with no receiver or where the receiver is the sender, where players use the game world to express themselves through behaviours, by the ludic mise-en-scene.

Considering games as acts of communication entails treating level design issues as a kind of language. The purpose of a linguistic and semiotic approach is both reading the behaviour of players performing in game worlds and evaluating the practice of designers creating game worlds. The ultimate goal is to eviscerate the rules and habits that make this transaction of communication between designers and players possible.

For both the creative, designer-oriented, side and the performative, player-oriented, side the role of the player becomes central, either as an idealized model of expected behaviour or as a real subject of action. And it is from the pivotal role of the player that my research both started (Article 1: "Towards a Theory of the Player") and ended (Article 13: "Play-Personas in User-Centred Game Development"). It is in fact in the construct of the play-persona that I found that unifying governing principle mentioned earlier.

1.1.1 Game Levels as languages

Language is defined as a vocabulary of elements (dictionary) and a set of rules (syntax) used to combine them into meaningful propositions [62]. Vocabulary and grammar are identified as essential components of language. Entire disciplines, such as architecture, can be seen, and have already been studied, as linguistic processes, where the creator / artist selects elements according to their function and combines them in spaces [5].

Other constituent elements of languages are the ability to perform syntagmatic and paradigmatic operations, the power of each element of the dictionary to have denotative and connotative levels of signification and the use of rhetorical devices.

Dictionary, syntax, connotation, denotation, syntagmatic and paradigmatic operations are essential features of language, but as Hjelmslev points out [50] they are not sufficient: for a semiotic system to be properly considered language it must possess creative economy or in other words it is necessary for it to achieve *second articulation*: the ability to form an infinite number of meaningful combinations using a small number of simple units. In this regard games and game levels cannot be treated as a proper language; there is no finite set of minimal functional non-signifying units such as phonemes or graphemes, almost every single element in a game world is a sign in itself, a complete message, possessing therefore only first articulation. Similarly to what happens in films, the signifier is constrained, motivated, by the signified by the means of iconicity [69].

Nonetheless, linguistic and semiotic tools can be precious for articulating the polysemic nature of games as acts of communication.

1.1.2 Denotation and Connotation

Denotative and Connotative levels refer to the "literal" meaning of an element and the associative values, the symbolic content subject to cultural interpretations. As an example, in architecture, the Greek column's denotative level is their function: to sustain the roof of the temple, while its connotative level conveys the notion of democracy, sharing the weight to carry. Yorda, the girl that accompanies Ico in the homonymous game [53], is dressed in white, the denotative level sees only a garment whose function is to cover the girl's body, but there is an added connotative level since white is often a symbol for innocence and purity, at least in messages codified within our culture. A further connotative level emerges when realizing that the game was produced in Japan, a culture with a very different code where white is often worn at funerals. Here the white garment could be seen as a foreshadowing of events taking place towards the end of the game, where players are led to believe that the girl is in fact dead.

1.1.3 Syntagm and Paradigm

Syntagmatic and paradigmatic operations are easily explained with an example: a player negotiating a swarm of enemies in Gears of War [44].

1. The player selects signs from a paradigm (i.e. sets of possible signs). Each paradigm contains a possible set of pieces from which only one can be chosen. From the "weapons" paradigm (including sniper rifle, shotgun, machinegun), the player selects one. These items share a similar structure, function, and/or other attribute with others in the set: they are related to one another on the basis of similarity, they are all weapons capable in a way or the other to disable enemies.

2. The player then needs to render the choice of weapon operational with a certain movement pattern. A functionally defined classification system or code shapes the connection between a certain selected weapon and a certain way to navigate the environment (i.e., the sniper rifle can be best utilized from a distance, not while charging the enemy), these connections are the more or less conscious or explicit rules. The player's choice of elements within a certain paradigm (weapons) and combination with other paradigms (movement) sends a message through the

ensemble - the syntagm. Selection requires the player to perceive similarity and opposition among signs within the set (the paradigm), classifying them as items having similar function or structure, only one of which the player needs. The player can substitute, or select, a shotgun for the sniper rifle – expressing a different attitude.

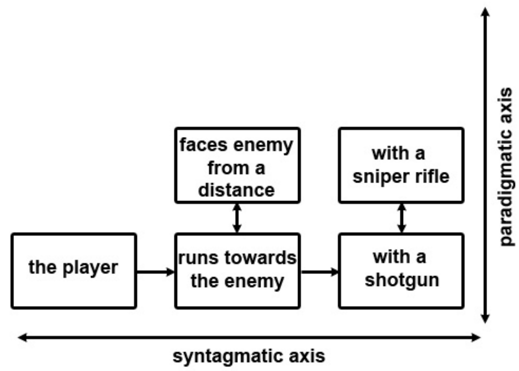


Figure 1: Syntagmatic and paradigmatic operations from the player's point of view

The combination "sniper rifle" + "facing enemies from a distance" (figure 1) requires the player to know the rules by which weapons are optimally utilized. "The combination is, in short, a kind of sentence" [66]. The "shotgun" + "charging the enemies" syntagm conveys a different meaning (sends a different message) if the player has open ground in front or is separated from the enemies by a chasm, this means that awareness of the context and its consequences is fundamental for player's choices. In a game, each of these sentences composed by players is an unconscious act of communication without a receiver.

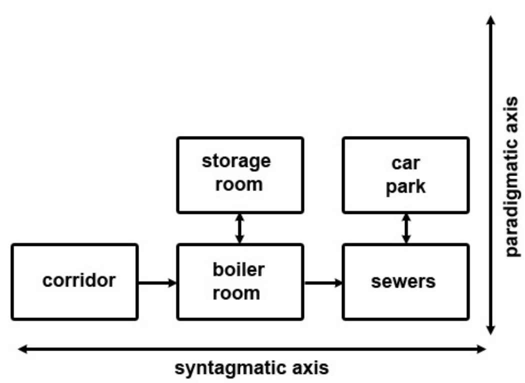


Figure 2: Syntagmatic and paradigmatic operations from the designer's point of view

On the other hand, we could also look at the practice of designing game spaces, as opposed to using them, with the same perspective (figure 2). In a game level, the succession of spaces is the syntagm (i.e. corridor AND boiler room AND sewers), while the paradigm consists of the possible alternatives that could have been used instead (i.e. boiler room OR storage room). From the designer’s point of view the act of communication is the creation of the game spaces and it definitely has a receiver: the player.

1.1.4 Game Levels as meeting grounds between players and designers

Game levels are at the same time the fruit of the designers’ expression and the canvas upon which players can build their experiences. In this thesis I suggest the construct of play-persona[3] as a tool used by designers to envision possible ways that players can use the game whilst it is still being developed, and as a mask used by players to shape their experiences. This double-headed ontological nature of games split between text and practice not only mirrors the split shown initially between design (industry) and analysis (academia) but also foreshadows the often artificially constructed argument that marred the field of game studies from its inception as a separate, independent field of study: ludology versus narratology. The centrality of the experience of play and therefore the necessary presupposition of the player are the two pillars based on which, even while borrowing from literary theory and semiotics, I agree with the scholars that claim complete independence for game studies as an independent field of research.

1.1.5 Modeling players’ behaviour: Play-persona

Play-persona as model of player behaviour has its roots in Human Computer Interaction (HCI) and is inspired by Cooper’s work [26, 27] but achieves the dignity of a separate and independent construct mainly thanks to three factors.

First, the play-persona construct covers both the modelization of ideal players prior to the encounter with the game as such (a-priori metaphor), and the modelization of empirical players after the play experience (a-posteriori lens). This double-headed nature mirrors the creative and performative nature of games as acts of communication that is established around levels or game worlds.

Second, the play-persona attempts to describe behaviours procedurally, beside the traditional narrative model proposed by HCI practitioners. Player’s preferences, choices and desires are

[3] Play-personas, as shown later in the compendium articles, are constructs used to model players’ behaviours.

described in terms of likelihood of choices amongst all the possibilities that the game as a system of rules affords. Due to the intrinsic numeric nature of procedural descriptions, it is immediately possible to compare different play-personas provided that they are scored according to compatible parameters.

Third, I am making use of data gathered by game metrics to inform the creation of performative models, the a-posteriori lens used to describe behaviour of real players. If a model is supposed to indicate a common form shared by separate phenomena, individuating common features and clusters of similarities, then the logical application is to use this model to evaluate the behaviour of players looking for groups of similar performances.

Play-persona limits itself to assumptions/predictions operating on the temporal and spatial fabric of the game: what, where and when; it does not require assumptions that go beyond what can be known.

Play-personas are, at least in embryonic form, present in each of the articles here proposed, but are made fully explicit first in the article 5: "Defining Personas in Games Using Metrics".

1.2 Thesis structure

This PhD thesis is structured as a compendium of articles rather than a monograph. It consists of eleven articles and two extended abstracts previously published in different venues, prefaced by an introduction whose purpose is to provide the reader with a general overview of the work achieved in the three years of the research project. The abstracts, although not very deep, have been kept in the compendium because they show the potential of combining gameplay metrics and biometrics. All the articles are tightly connected by the red thread of player modeling: that is in fact the overarching narrative of the conceptual development. The benefit of this kind of thesis is that it documents the process of research from the very first formulation of the ideas towards a more complete structure of the concepts presented. If this "journeying" format can account for the development of the core ideas, it lends itself, at least potentially, to uncover minor inconsistencies and contradictions. Fortunately, in this case, the later articles do not contradict the earlier ones; they simply strengthen ideas, concepts and logical links that were initially barely drafted.

With hindsight it appears to me that the earlier articles were perhaps too ambitious, maybe exaggerating with eclecticism, skipping a bit too freely from semiotics, to psychology and finally to neurophysiology. The style is also slightly inconsistent, one article is in fact written in a rather informal tone since it was not meant for a scholarly venue but for a popular publishing outlet. Nevertheless these articles have been included because of the unique and pivotal contributions to the corpus of work. I am also painfully aware of the considerable amount of repetitions from article to article: for example the concept of gameplay metrics has been defined, at different levels of detail, in at least six of the articles presented, but this issue is to be expected in a thesis by publications.

The thirteen writings that comprise the compendium appear in chronological order of composition and have not been modified from the original form, except for formatting changes and a short preface. To guide the reader, here is provided an overview of the pieces with a few words contextualizing the works.

1- Towards a theory of the player: designing for experience. In this first article, presented at DIGRA 2007 (peer reviewed). I attempted to understand the processes in action when players are engaged with games. It is clear a preoccupation with the behaviour of the player in the game world and the relation between personality, experience and emotion.

2- Designing levels for enhanced player experience: cognitive tools for game worlds designers. This article, of a marked aesthetic nature, grew out of a lecture presented at Nordic Game 2007 and was eventually published in the international magazine GameFace. The main goal of the article was to apply methods from visual semiotics and disassemble a level from a game, "Hitman: Blood Money", that was considered "open" enough to allow its players to express themselves and, to a certain degree, shape their own experience.

3- Waving experiences: play values, play modes and play personas. This article, accepted at the conference IE 2007 (peer reviewed), intended to abstract and formalize processes that were enacted during the production of the game "Kane & Lynch". These processes showed how designers embedded values in the rules codified by the game and how these rules were used by players to shape their experience. The selection of a rather "closed" game such as "Kane & Lynch" as opposed to "Hitman: Blood Money" was motivated by the fact that if the identified process managed to allow players non trivial choices it would prove the point also for more "open" games.

4- Weaving experiences in virtual worlds: play personas and game metrics. Although the title might recall the previous article, this piece was written specifically for a Danish Design School book: FLUX, published in 2008. This article is the first formalization of an idea that had been growing for the previous year during my collaboration with IO Interactive: models of players' behaviour, play personas, could be expressed procedurally, in numbers, and gathered by records and logs of play time (game metrics).

5- Defining personas in games using metrics. This paper was presented at Futureplay 2008 (peer reviewed) and is a much more complete and formal version of the ideas presented in the previous article. A framework for modeling players' behaviour based on game metrics is presented, but the method is only shown without presenting an actual case study based on concrete examples, in fact the game used as example does not have the capability to gather metrics data from players.

6- Play-personas: behaviours and belief system in user centered game design. This paper, presented at INTERACT 2009 (peer reviewed), presents a complete formulation of the play-persona framework and for the first time is accompanied by a concrete case study where play personas have been built both "a priory", starting from the affordances offered by the game, and "a posteriori" based on the data generated by players using the game "Tomb Raider Underworld".

7- Towards gameplay analysis via gameplay metrics. This article was presented at Mindtrek 2009 (peer reviewed) and it stems from corollary analyses of gameplay data. Two case studies are presented with parallel approaches to analyze level design: location, role at death and cause of death for the multiplayer game "Fragile Alliance"; and deviation from an ideal, perfect path for the single player game "Kane & Lynch".

8- Analyzing spatial user behaviour in computer games using geographic information systems. The article, presented at Mindtrek 2009 (peer reviewed), attempts a complex multivariate analysis to investigate the pattern of deaths using geographic information systems based on data gathered from users playing the game "Tomb Raider Underworld". The result is that such an analysis can potentially lead to precious recommendations for level designers.

9- Player modeling using self-organization in Tomb Raider: Underworld. This article, presented at the IEEE Symposium on Computational Intelligence and Games 2009 (peer reviewed), attempts to utilize emergent self-organizing maps (a type of neural network) to identify clusters of players behaving similarly in the game "Tomb Raider: Underworld".

10- Psychology of personality and play personas: designing for experience. This article, presented at the conference Under the Mask 2009 (peer reviewed), derives principles for drafting play personas from the Five Factor Model, accepted standard in personality theory, and presents a new case study: “Left4Dead”.

11- Game metrics and biometrics: the future of player experience research. This extended abstract refers to a panel presented at Futureplay / GDC Canada 2009 (peer reviewed) where different methods for researching player experience are evaluated.

12- Analyzing user behaviour via gameplay metrics. This extended abstract refers to a full lecture presented at Futureplay / GDC Canada 2009 (peer reviewed) showing how gameplay metrics can be used to model and reproduce user experience.

13- Patterns of play: play-personas in user-centered game development. Article presented at DIGRA 2009 (peer reviewed). It represents a synthesis of the approaches and methods elaborated in the course of the whole PhD project, utilizing “Tomb Raider: Underworld” as a case study.

2. A THEORETICAL FRAMEWORK FOR MODELING PLAYERS

Before unfolding play-personas in detail, it is necessary to chart the environment from which the tool has emerged. This line of research in fact does not only stem from game studies, but has its feet firmly planted both in Human-Computer Interaction and in communication studies.

The study of games from an academic perspective is a fairly recent phenomenon. Being computer games very complex artifacts, perhaps the richest cultural genre yet seen, they lend themselves to a number of approaches and perspectives. Game studies as a discipline is not only multi-disciplinary, showcasing a variety of independent fields of research scrutinizing the phenomenon separately, but also inter-disciplinary since there have been several cases of research projects that successfully crossed boundaries between established academic fields [43, 55]. Yet, because of this multifaceted nature, the necessity for an independent discipline focusing on games is still debated [67]. Independently from the position taken on the subject by different scholars there is one factor that cannot be ignored whatever angle is used to approach the issue: human players. Games are both objects and processes and as such they must be played. In Aarseth's words:

"Playing is integral, not coincidental like the appreciative reader or listener. The creative involvement is a necessary ingredient in the uses of games. The complex nature of simulations is such that a result can't be predicted beforehand; it can vary greatly depending on the player's luck, skill and creativity. In multi-player games, social skills are needed, or must be developed." [2]

2.1 Game studies: contributing disciplines

The role of the human player cannot be ignored if we want to understand how games as processes can take place. It has been argued [19] that the diversity of perspectives adopted to investigate the cultural phenomenon of games could be a result of the indispensability of the human player as an actuator of games as processes. Games are in fact studied by sociologists, psychologists, anthropologists and economists attempting to assess the effects of playing games on people [92, 20, 21, 59, 60, 45].

Cognitive science looks at computer games as fields to experiment and test theories on human consciousness since games represent rich, multi-modal, controllable environments for conducting cognitive experiments [65].

Communication studies, cultural studies, literary theory, media studies, semiotics and linguistics focus on the organization, transmission and interpretation of meanings through different media [63, 70, 1, 9].

From a technological point of view, within the field of computer science, Artificial Intelligence, real-time computer graphics and networking are only few of the disciplines that see in computer games a driving force for technical advancements [71, 88, 25].

Regarding the domain of design, the pivotal question is: "how to make better games" and the largest number of contributions has been made from within - or with applications for - the game industry, by designers eager to improve the practices in use in development studios. [23, 78, 79, 41, 16, 14, 29, 85, 86, 61, 52].

2.1.1 Debates in game studies

Such a rich field, where many disciplines converge each with its own legacy of ideological cornerstones, is bound to give rise to heated debates. From the very beginning, the so-called "narratology versus ludology" controversy had scholars debating whether games should be considered just as extended versions of traditional storytelling, therefore assuming the superfluousness of independent methods and approaches and undermining the necessity of a new discipline; or whether instead the diversity between games and narratives should be acknowledged and their uniqueness treasured. Fortunately that flame seems to have been doused by recognizing that the two terms, narratology and ludology, were not representing separate categories but two poles of the same continuous axis, and no scholar was willing to populate either of the two extremities of the spectrum, if not as an act of provocation.

There have been several other more or less inflamed debates, but particularly pertinent to my research is a recent version of an old fracture that seems to have opened in the already discontinuous fabric of game studies: qualitative (interpretive) versus quantitative (experimental) research methods, or "social sciences" versus "humanities".

According to Boellstorff [18, 105], this issue points to a rather old debate on whether scientific research should be experimental in nature or not, and the recent coalescing of new venues from which to harvest numerical game data, such as game metrics, has exacerbated the altercation. Already in 2005 Williams was warning against "scholars entrenched in comfortable home bases that exclude and denigrate the other camp" [98]. Williams advocated moving beyond terms as “positivism” and “anti-positivism” since, if the goals of games research are to answer important questions rather than using particular toolsets, it would be limiting to circumscribe the discussion on whose methods are better. Williams attempted to quell the debate stating that the discussion does not lie in terms of whether game studies should or should not be borrowing methods from the natural sciences, but rather about the strength of empirical work of all types.

“Data collection—whether in the form of ethnographic field notes or participant observation, or in the form of statistical content analyses, experiments and surveys—is worthwhile” [98].

Summarising the terms of the debate, traditionally, social scientists seem to be asking “What do games do to people?” utilising mostly quantitative methods while humanists seek to find out what meanings are made through game use and what power relationships are reinforced through play, relying more on qualitative methods.

2.2 Positioning play-personas in the field of game studies

Due to my background, my research stands on the threshold between a design-driven approach (how to make better games) and a communication approach (creation and interpretation of meaning). My work is split between understanding games as products to improve, with concrete needs, drives and desired practical outcomes; and as media carrying meanings, attempting to eviscerate the abstract mechanisms that take place when players are engaged with digital games and what meanings emerge from that interaction. This double concern entails a double focus on the game designers as originators of the games as acts of communication and players as receivers.

This double focus drove the definition of play-personas both as tools used by designers to model hypothetical players during the production of games and as mental devices used by players to organize and make sense of their own play experiences.

2.2.1 Bridging the gap: humanistic enquiry with empirical methods

The play-persona framework is an attempt to imbue meaning into the mechanics that designers chose to include in the games they are developing; at the same time it seeks to read meaning in the actions of players interacting with the game. It is an effort that definitely fits under the communication umbrella. As Williams pointed out, communication and humanities are angles that very often resort to qualitative methods.

During the initial phases of the formulation the play-persona framework, I was based at the games development studio IO Interactive, which had recently released the game "Hitman: Blood Money" [49]. During an interview with the game director, game designer and level designers, it was revealed that the team had developed a tool to monitor the player's behaviour: how many shots had been fired and by which weapon, which weapon was most frequently used, level of accuracy, the number of police, security, and civilians killed or injured, and if there were any witnesses. All this information was used at the end of each mission to rate players and award them extra money if the mission was accomplished as cleanly and quietly as possible without drawing any unnecessary attention. Eventually the information was also used to present players with newspapers articles generated procedurally where the mission was summarized and the statistics of player behaviour were presented in narrative form.

This tool was, in embryonic form, an earlier prototype of what was later to become the full blown metric suite developed by the EIDOS Online Development Team, located at IO Interactive. The metrics suite would be later included in several games developed by EIDOS, such as Tomb Raider: Underworld [93], Battlestations: Pacific [15] and Championship Manager 2008 [22] among others.

A metrics suite is an instrumentation system designed to provide game studios with metrics data regarding for example player behaviour. The EIDOS metrics suite has several features in common with instrumentation techniques used in Human-Computer Interaction: users interact with a system that automatically records events of interest in message streams, which are send to a central server for analysis. The EIDOS metrics suite can collect data from game engine software during production as well as following the launch of a product, from installed clients during the live period of the lifetime of a game.

A metric suite seemed the best way to support the play-persona as lens used to describe behaviour of real players, a procedural description of patterns of play. That realization meant that the humanistic angle of my research could greatly benefit from the inclusion of strictly empirical, data-driven approaches, but at the same time they would not suppress the need for qualitative methods, as they together form a complementary, syncretic dyad extremely valuable when studying players. Individuating the axes upon which to build play-personas is in fact a process that entails extensive interviews with game and level designers alike.

The two methods are complimentary. Quantitative analysis is not particularly helpful when looking at experiential phenomena or complex social interactions if approached in any detail. We are miles away from understanding the human mind, let alone devise methods for analyzing its interaction with the game world based solely on numerical data. Quantitative, empirical methods, if properly executed, can give an overview of certain trends or interesting clusters. Qualitative analysis comes in to give a better resolution image of the situation.

2.2.2 A *personal* debt to Human-Computer Interaction

Once the basic functionalities of a metric suite are implemented, there are two main tasks to accomplish when adapting the instrumentation system to any given game: the selection of relevant variables to monitor and the definition of methods for the analysis of the gathered raw data. In both of these areas there is already a considerable corpus of literature generated in the empirical end of the field of Human-Computer interaction (HCI) [i.e. 84, 68]. Initially practices of instrumentation data analysis focused on heuristic evaluation and usability testing by "rating the performance levels of the user" [72, 73]; lately, due to a shifting focus towards how interactions elicit affective user sensations [74, 75, 76] the target of attention has become "monitoring behaviour of the user". There are crucial differences between performance and behaviour: performance entails a score or a rating and a scenario of failure or success while behaviour is not rated and has a great deal of leeway before it can be labeled *right* or *wrong* and it is rarely a matter of *winning* or *loosing*. Performance also assumes choices among few alternatives (constrained affordances) and a single goal, while behaviour is expressed while choosing among a wide variety of available actions and often leads in many different directions even when it is meant to accomplish a task. Play-personas as lenses, tools for evaluation of the player experience, are informed by practices for gathering and analyzing instrumentation data derived from the empirical end of HCI. Play-personas as metaphors, tools to help during the design of a game, have instead their origin in the more humanistic perspective of HCI that includes anthropologic and ethnographic methods [17, 26, 47]. Joining humanistic methods and data-driven descriptions when creating and maintaining personas is a practice that lately seems to have picked up momentum [82, 94, 95, 96, 97]; the innovation introduced by play-personas consists of the application of the tool not only for designing but also for evaluating the experience.

2.3 Aesthetic aspects of play-persona research

The creation and negotiation of play-personas is not only a ludic process enabled by the rules and mechanics of the game, on the contrary, play-personas are also in a considerable part built from the aesthetic affordances of a game. Beyond mere embellishment, the aesthetic aspect of computer games, understood as a sensory-perceptual phenomenon, has already been identified as instrumental in fostering affective, narrative and spatial involvement [19].

Game aesthetics can provide shortcuts and hooks towards deeper involvement by grounding game mechanics, goals, locations and characters into the emotional fabric of players. According to Bachelard's theory of poetic images, the condition for this anchoring to happen is that the aesthetic elements consistently interplay with each other to create "resonance-reverberation doublets" in the mind of players [10].

Resonance is heard in the connotations that an image awakens, it has no causal relation to the image that elicited them, but it is led by "*the outpourings of the mind*". Resonance suggests the possibility of understanding and making connections with other feelings and echoes. Through resonance, we find confirmation of knowledge we already possess, at least in an embryonic manner: the relation of the aesthetic image to "an archetype lying dormant in the depths of the unconscious" [10].

Reverberation is rapture, ecstasy, it "*brings about a change in being*" through a transformation of consciousness and of the deepest aspects of our being. Its effects reach the "*profundities of the soul*". Reverberation challenges our existing knowledge and opens the gate for change.

Resonance and reverberation together can produce identification between the player and the aesthetic image by triggering a subversion of the subject-object duality. This subversion anchors game goals, locations and characters in the personal history of each player.

A visual semiotic approach can be adopted to analyze the devices through which aesthetical elements are used to produce resonant and reverberating meanings. Particular attention must be given to the textual strategies that attempt to close, at least partially, the field of interpretations arising from the aesthetic elements, setting a roof over the problem of unlimited semiosis where the interpretation of a sign becomes a sign for a new interpretation [36, 37].

The interpretation of visual clues to create meaning is neither natural nor simple: it relies heavily on a set of rules and codes that change from culture to culture, from context to context and from time to time. The sense-making process could chase the evanescent chimera of the "one true interpretation", trying to eviscerate what the author intended (intentio auctoris), or it could open completely the process and let users freely look for their own interpretation (intentio lectoris) potentially leading to overinterpretations.

Barthes, in his article "The Death of the Author" [11] clearly negates the value of assigning a single interpretation to a text by hunting for the intentio auctoris because it would impose an artificial limit on that text. Later, Barthes introduced the concepts of "lisible" (readerly) text in which readers are restricted to just reading and "scriptible" (writerly) texts, in which the readers are active in the creative process. This distinction shows great awareness of the fact that some texts, due to their polysemic nature, are more prone to empower the reader [12].

Derrida talks about open borders or margins of texts [31, 32, 33] while Eco reframes the concepts as "open" texts and "closed" texts [34], not as discreet categories but as the two poles of a continuous axis. In order to set a limit to potentially unlimited semiosis and escape excessive subjectivism, in his later work [39, 37] Eco proposes to keep the intention of the work (intentio operis) in mind and to limit the endless series of interpretations by the means of a simple principle: inner textual coherence. If an interpretation cannot be denied by the literal meaning of any part of the text or the cultural frame from which it was produced, then it is considered to be valid.

The research around play-personas analyzes how the visual elements of games can carry the intentio ludi (intention of the work when the work is a game), partly closing the field of interpretation and guiding the implied player towards a set of assumptions that will eventually result in resonant and reverberating meanings. For example in the game Fallout 3 [40] players take the role of a character that leaves the relative security of a shelter to venture in a post-apocalyptic world looking for his/her father. Following the main storyline players eventually wander into the basement of the Jefferson Memorial in Washington D.C. Here, by listening to some holotapes, they discover the rooms where the character was born. As soon as the discovery of the tapes is over, players are presented with a visual cue of an old, red tricycle abandoned on the ground (figure 3). Some of the players might make the connection: *"the character I am representing not only was born here, but spent some of the first years in this environment and used to play with that toy… that was MY trickey"*.

Figure 3: the red tricycle in the game Fallout 3

This connection is not vital to make full sense of the game, the holotapes take care of that; it can also be argued that the placement of the tricycle is purely coincidental, not deliberately planned by designers, considering how many tricycles can be found abandoned in the wasteland. The number of players making that connection is in itself pure conjecture, nevertheless it is legitimate to assume that some players might interpret the facts this way, even more so if they owned a similar toy in their childhood. The interpretation is consistent with the game world independently whether the authors meant it or not and at the same time, through a "resonant" aesthetic device, it creates a poetic effect anchoring narrative and ludic elements both by providing some background information to the relation father-son/daughter and by connotating in a very personal way a location, the Jefferson Memorial, that will play a very crucial role in the end of the game: from here the player's character was born and from here, thanks to Project Purity, a new world order will be born. It is not legitimate to assume that all players can make such connections, but the ones that do are rewarded with a personal involvement in the background story and in the ultimate goal of the game. The game Fallout 3 is dense with this type of aesthetic, resonant devices, and not all of them are necessarily supposed to be decoded by everybody. For example the quest "Stealing Independence" revolves around the Declaration of Independence and is loaded with references and hooks that a non-American audience might not necessarily fathom.

The process of designing the aesthetic side of experiences in games could be seen as the act of accurately disseminating cues and mirrors in the environment to reflect and accentuate the psychological attitudes of players that chose a certain line of actions.

Based on certain elements, such as the position of the player-controlled avatar, it is possible to make legitimate assumptions on recent events, mental processes and plans that the player might have undergone. Whether a player consciously chose to be at a certain place in the game world or just happened to be there is irrelevant, what matters is that the player is there and can be rewarded with aesthetic acknowledgements and visual cues provided by the game stressing the affordances allowed to players that find themselves in that certain place at that certain time. Passengers on board of planes can sometimes catch flashes of light reflecting from the sun on the rooftops of buildings, blinking surreptitiously. Obviously that spectacle has not been deliberately arranged: it is the trajectory of the plane that happens to put people at a certain time and in a certain position, yet passengers witnessing that luminous phenomenon cannot help but feel a certain personal privilege. Distributing aesthetic acknowledgements of players' assumed state based on their game status means pre-figuring possible alternative trajectories that players can follow according to their mental state. Whether a player walks slowly in the shadows and close to the walls, or probing the game's boundaries, or climbing for the highest point to achieve better overview, or openly running into confrontations or eschewing the clash preferring to take the flanks: whenever the game affords a multitude of choices, it is important for designers to monitor what it entails for a player to embody a certain navigation pattern and provide pertinent aesthetic cues if they want to increase the chances of generating resonant effects.

Due to the intrinsic nature of interactive entertainment, designers deliberately leave room for textual openness [24]. It is in the gap of this openness that the competence of model players (or play-personas), actualizing more or less explicit narrative structures [34], reveals the iconic nature of game aesthetics, providing anchors to affective, narrative and spatial elements. And it is still in this balance between textual openness and closeness that players can find resonance and reverberation within the elements of the game world: a completely open text would give birth to unlimited semiosis, a text too close would not permit personal interpretation and the emergence of play-personas, trivializing any effort towards polysemic sense-making.

2.3.1 Games as text: early methods for implying readers (and players)

The post-structuralist paradigm that celebrated the death of the author and the birth of the reader as the source of a plurality of meanings and interpretations also pioneered reader-response theory.

Reader-response theory recognizes the active role of the reader in transforming the unread text into an actualized work, passing from a type to a token, imbuing the text with "real existence". It is the reader that completes the text's meaning through interpretation in a process similar to an actor interpreting a written script. Considerable effort was put by many reader-response theorists to define the different types of archetypical readers.

Eco, after defining literary texts as fields of meaning rather than strings [34], introduces the "*model reader*" as "*one who plays your game*" and accepts the challenge of interpreting complex ideas [38]. Eco comes to these positions through study of language and from semiotics, rather than from psychology or historical analysis as did theorists such as Iser.

Iser [54] lists a number of fictional reader types: the real reader, the ideal reader, the superreader, the informed reader, the intended reader and the implied reader.

The real reader has read and the book and has thoughts about it. The real reader brings to the meeting with the text a certain baggage in terms of personal history, education, gender etc. that must not sacrificed in order not to occur in "the loss of the tension which is a precondition for the processing and for the comprehension that follows it". Real readers are cast into roles by the text at hand but at the same time they maintain their personality, this contrast is what generates interpretation of the text

The ideal reader realized all of the potential meanings of the text allowing maximum coherence. "It is difficult to pinpoint precisely where [the ideal reader] is drawn from, though there is a good deal to be said for the claim that he tends to emerge from the brain of the philologist or critic himself". "An ideal reader is a structural impossibility as far as literary communication is concerned". This reader has to be very close to the author's views in order to understand the literary text in its entirety.

The superreader is a fictitious collective of readers composed by the author, commentators, dictionaries, etc. that "screens for pertinent structures and only pertinent structures" apt at spotting the denser segments of the text that drew most reader response.

The informed reader is someone who is a competent speaker of the language out of which the text is built up; is in full possession of "t*he semantic knowledge that a mature listener brings to his task of comprehension*" and has literary competence. The informed reader is neither an abstraction nor an actual living reader, but a hybrid – a real reader who does everything within his power to make himself informed.

The intended reader is a concept that attempts to recreate the historical audience the author was aiming for when the work was written. The intender reader "can embody not only the concepts and conventions of the contemporary public but also the desire of the author both to link up with these concepts and to work on them".

The implied reader "embodies all those predispositions necessary for a literary work to exercise its effect – predispositions laid down, not by an empirical outside reality, but by the text itself". The implied reader is essentially a component of the structure of a text anticipating the presence of recipients without necessarily defining them. The concept "designates a network of response-inviting structures, which impel the reader to grasp the text". Unlike every other type of reader, the implied reader has to be allowed indetermination. No assumptions about the reader's particular situation, education, or cultural background must be made.

Along the same lines, there have been several attempts in trying to "imply" players or make assumptions on the different kinds of players that may be found engaged with a game.

Following the humanistic tradition that sees the player as a function of the game and not an actual, historical person, Aarseth [1] talks of the "implied player": a role made for the player by the game, a set of expectations that the player must fulfil for the game to "exercise its effect". In later work Aarseth posits that "*the game houses expectations for a player's behaviour, which is supported by an interface, and represented in-game by an avatar. Even more than the implied reader, the implied player has a concrete, material existence, because the game will not be realized unless some mechanism allows player input*" [3]. The implied player is seen as a boundary imposed on the actions of the player by the game; this limit to the freedom of players is enforced both through the game's rules (in games where the avatar lacks the ability to jump, players will never be allowed that option) and the game's aesthetic elements (in dark environments players will not be able to see much further ahead, limiting the navigation possibilities).

A considerable group of game researchers, more oriented towards social sciences, set off investigating players as historical, situated, flesh and blood entities. One of the earliest attempts was conducted by Bartle [13] investigating the motivation of a group of people interacting in a MUD. His method was rather empirical: he studied several hundred bulletin-board postings and his findings are the now famous four classes of players: socializers, explorers, killers and achievers.

Subsequently Yee [100] tightened data samples and methods, shifting even more the focus on motivation and individuated five factors: relationship, immersion, grief, achievement and leadership.

Another attempt to define types of players has been conducted by Bateman and Boon [14]. The 16 types individuated by the Myers-Briggs Type Indicator have been reduced to 4 and adapted to the field of games: Conquerors, Managers, Wanderers and Participants.

A different approach and motivation led Smith to the "Rational Player Model" [89], a tool for understanding the relationship between game goals and the behaviour of players who try to reach these goals. The rational player is one of four player types individuated, the other three are: the susceptible player, the selective player and the active player.

Play-personas are used to imply players both before any play actually happens and to study players' behaviour after the interaction with the game, spanning from the humanistic view of fictional, idealized players, to an approach closer to social sciences focused on empirical players.

Play-personas do not claim to capture universal features of players nor they are deduced from abstract principles, instead they emerge from the aesthetic and ludic structure of each single game.

3. GAME WORLDS AS FIELDS OF EXPRESSION

Play-personas are communicative strategies within the structure of the game, weaved in the rules, in the mechanics and the aesthetics. Play-personas manifest themselves through players' choices and or preferences. Play-personas are a designer's ways of forecasting models of actualization of a game; mental models of how a game can be played by different players. The non-trivial efforts of the player transform the game from a world of possibility into an actualized game, from type to token. Even the most linear game, with the most limited set of affordances, has more than one ways of transforming the possibility into a reality. It could be the choice of turning left instead of right in Pac-Man [77] or walking while crouching instead of running and jumping in Quake Arena [83].

There is no realized game if the player takes no action. Action means choosing among the affordances provided by the game at any given moment. As already noted by Juul [106], games are more or less "open" according to whether the internal structures of the game foster "emergence" or enforce "progression". The game Grand Theft Auto IV (GTA) [48] has a much more open world than "Hitman: Blood Money" (HBM) [49], players can pick up any vehicle and spend hours exploring the city, while the locations of HBM are rather small and disconnected from each other. Nevertheless HBM is a much more "open" game than GTA, in fact the assassination of various targets throughout the game can be carried out in a variety of ways: from poisoning to explosions, from sniper rifles to causing "accidents", while in GTA, once a player has entered "mission mode" the choices for players to select from are quite narrow. It is in this selection among possible actions that players have the opportunity to express themselves. A game will afford more or less expressivity according to the variety of the palette and the amount of choices presented to players.

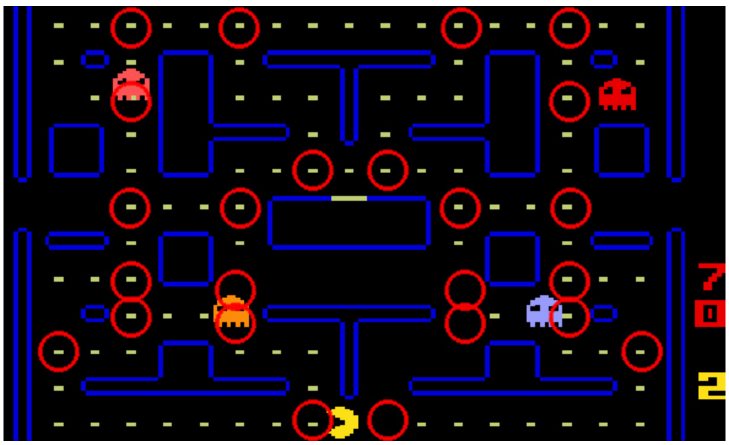


Figure 4: simplified version of Pac Man for Intellivision [77]. Decision points are highlighted with a red ring.

In most games it is not realistic to chart out all the different possibilities for action offered to players. A deterministic model that includes all possibilities offered to players is unrealistic at best, even for a simplified version of Pac Man (figure 4). In that version of the game there are in fact 24 decision points or locations where player has to decide where to go out of two paths; even disregarding the fact that players can change direction at any time, a comprehensive list of all possible behaviours in that game would amount to 2^{24} or 16.777.216. If designers want to envision possible players interacting with the game it makes a lot more sense to group the 16 millions possible behaviours under larger parametric umbrellas such as: players that prefer to linger at the center of the play boards as opposed to players that spend most of the time in the periphery; players who turn the little ghosts edible by eating the "pills" at the beginning of the game as opposed to players that save the "pills" for later in the game; players that maintain a linear trajectory as opposed to players that continuously change direction, etc. Thinking in these terms allows designers to make rather educated assumptions, for example it is legitimate to argue that a player with a fairly linear behaviour might not have mastered the subtle art of "cornering". Such an assumption can be tested utilizing game metrics: if in fact the log of the game shows that, while Pac Man was marching in a straight direction, the player was actually activating the controller in a different direction, then it is admissible to assume that the player was trying to change direction but failed.

This example shows two of the benefits of play-personas. Initially designers can prefigure possible player behaviours by selecting certain game mechanics as parameters to inform the definition of the play-personas describing those behaviours. The game itself should try to provide the right kind of competence necessary for the player to interact with the game successfully. Nevertheless, the selection of the mechanics to be turned into the parameters that will form the structure of the play-personas can greatly benefit from interviews with actual players. Not all possible behaviours will be described by the play-personas, but only those that are deemed interesting or relevant enough, those extreme behaviours that will function as a sort of fence around the game's affordances, limiting the field of experiences. These are the play-personas as metaphors.

Afterwards, certain assumptions can be tested against game metrics, questionnaires or interviews with players. Game metrics are also used to take a new look at the behaviours that actually take place in the game environments, aided by cluster analysis or neural networks it is possible to group behaviours that are similar to each other and extract the values of the parameters used to build play-personas. This a-posteriori approach creates play-personas as lenses.

3.1 Play-personas

Imagine if at every few frames rendered in a game the avatar would leave behind a three-dimensional snapshot of itself, so that the movement of the avatar in the game space would appear as a blurry trail slowly and progressively fading. Imagine also if every time a button is pressed on the controller to perform an action of any kind, the color of the trail would change accordingly to the action performed. The understanding of a player acting in a game world would shift from an entity to a process. No two different players would leave the same trail; therefore, even if the avatar is exactly identical, it would become possible to immediately recognize different performances from player to player.

What would be the parameters that allow a hypothetical viewer to recognize different behaviours? The shape of the trail in space, the spacing between every snapshot and the color of the trail would all be discriminating elements. The shape of the trail would give very precise information on where has the avatar been, the spacing between each snapshot would show when the avatar was in a certain location and finally the color would be an indicator of what action the avatar was engaged with. Those are the tangible, knowable traces left by players in the game world; those are the explicit dimensions of player interaction, which can be objectively measured through game metrics. Where, when and what represent the phenomena that designers can safely use to ground their decision upon.

There are few questions that remain unanswered by this approach: who the player really is (name, gender, age, education, etc.), how does the player like to play (at night, with headphones, surrounded by friends, etc.) and why does the player makes certain choices (because it awakens childhood memories, etc.).

Who, why and how represent the noumena: implicit, sometimes even unconscious, dimensions of the players experience as a whole, that become knowable only with qualitative methods.

Game designers create game spaces and rules hoping to elicit certain emotional responses, confiding that players will have certain motivations for their choices or will play in defined physical situations; but the truth is that through the communication channel of game metrics all designers can hope to know is what a player is doing, where and when. This is where the shortcomings of constructs like the implied or model reader become apparent: it is virtually impossible to find "that ideal reader suffering from an ideal insomnia" required by Joyce [58]. The requirements posited on the ideal reader trespass completely that semiotic gap between the phenomenon and the noumenon, what can be known and what cannot be known through quantitative analysis of player's behaviour. Assessing assumptions on the "unknowable" side of the empirical reader, such as how and by whom should the text be read or the game be played, requires a familiarity and a closeness to the user that is difficult to achieve when the users' count lies at around two million. For example a dog would cause some people to warm up to the memory of a puppy in their childhood but at the same time many others would feel uncomfortable because they were bitten by a dog at some point in their past. Not only it is difficult to make assumptions on subjective emotional states, it might also be dangerous. This is where the play-persona construct steps in; it does not require assumptions that go beyond what can be known: it limits itself to assumptions/predictions operating on the temporal and spatial fabric of the game: what, where and when.

3.2 A communication model for games

In order to cross this semiotic gap it is important to unfold the communication channel established through games. Eco explains the traditional communication model [35] through a rather simple example: a dam with a sensor able to assess the water level and a mechanism that is able to regulate the overflow to prevent catastrophes. The dam is not fully automated: the sensor sends signals to an operator located remotely and the operator eventually takes action increasing or slowing down the flow of water from the dam.

The messages that the operator receives are represented as a set of flashing light bulbs (figure 5).

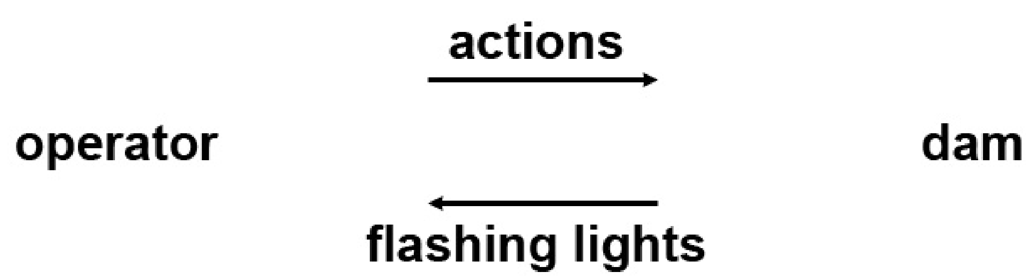


Figure 5: Eco's communication model: the dam.

This simple model originated from the standard communication model: sender, message, addressee [56, 87] where the message is en/decoded on the basis of a code shared by both virtual poles of the chain. But this model is insufficient to describe actual functioning of a communication intercourse. It does not take into consideration the existence of multiple codes and sub codes, noise, contexts and channels. Too many unknowable variables are involved in order to infer correctly any information regarding the implicit aspect of the communication, both from the sender and the addressee's point of view. Eco addressed this problem speaking of the "fallacy of the referent" [35]. At the origin of the theory of signs we find the Peircian triangle: representamen, interpretant object.

"A sign, or representamen, is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. That sign which it creates I call the interpretant of the first sign. The sign stands for something, its object." [80]

It is easy to recognize that there is an obvious connection between the object (the state of the water in the dam) and the sign or representamen (the flashing light bulbs), but if water was the necessary condition for designing the apparatus, it is not sufficient for its semiotic functioning. The operator would interpret/decode the signal in the form of flashing light bulbs and infer a meaning even if the signal was sent by mistake, a faulty electrical wire or deliberate fabrication.
It is useful to adapt to games the traditional communication model in order to understand relationship and flow of information from game designers to players (figure 6):

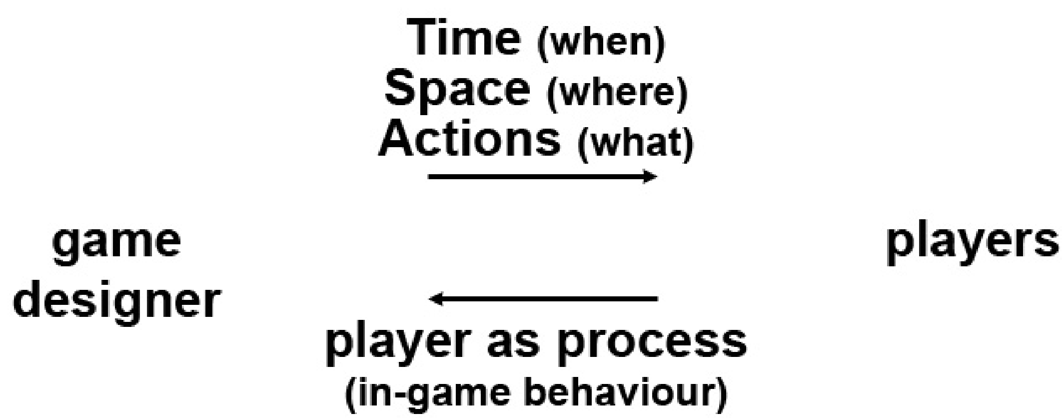


Figure 6: Jakobson's communication model applied to games

Game designers provide temporal and spatial structures embedded into a game to elicit certain actions. Players are not just passive receivers of the act of communication since they are required to make sense and interpret events in the game world and meaning is not extracted or discovered, but constructed. The tangible outcome of players' interpretation is their behaviour in the game.
Speculations on the reasons and the context behind any in-game choice made by the player remain unfathomable unless a closer look is taken with qualitative eyes to the empirical player.

Independently on the identity of each player (who), their reasons (why) and the context (how) behind the choice of using the gun "Desert Eagle" in a game, designers can reasonably expect a certain set of behavioral responses: due to its range, its reload time and scarcity of ammunitions among other factors, the behaviour of players will be dictated in large part by the choice of weapon.

It is exactly through these *inscribed affordances* that designers can realistically imply players and provide them with the tools for expressivity that can be used to paint on the canvas of their experience. Affordances allow a representation of elements not based on the phenomenology of physical properties but on action-based set of properties [81, 74, 75]. For example *"a basketball is not represented by the features round, orange and rubber, but instead is viewed for its throwability, its rollability, or its bounceability"* [101] since, as Gibson maintained, "all necessary information exists in the environment" [46].

Inscription is the process that allows artifacts to embody patterns of use. In this acceptation, artifact can stand for a game object, a rule or a mechanic. It suggests that action is inscribed, grafted or hard-wired into an artifact.

"*Balancing the tight-rope between an objectivistic stance (where artefacts determine the use) and a subjectivistic stance (an artefact is always interpreted and appropriated flexibly), the notion of an inscription may be used to describe how concrete anticipations and restrictions of future patterns of use are involved in the development and use of an artefact.*" [4]

Play-personas are clusters of preferential interaction (what) and navigation (where) attitudes, temporally expressed (when), that coalesce around different kinds of inscribed affordances in the artifacts provided by designers.

The semiotic gap does not allow designers to try and read player-behaviour as a language to infer the motivation behind the choices. There is no code, intended as a local rule of correspondence between two independent worlds, which links players' in-game behaviour with players' inner motivations, emotional states or moods.

Nevertheless Personas, as coherent sets of in-game behaviours and patterns of interaction and navigation, can be probes used to both design game worlds allowing for a higher degree of expressive potential and tools to evaluate level of consistency of the game as a system of rules supported by an appropriate aesthetic canvas.

3.3 Play-persona as a metaphor (a priori)

"*Games are facilitators that structure player behaviour and whose main purpose is enjoyment.*" [3]

In order to structure play behaviour it is necessary to envision it a priori; play-personas can represent tools used to carve attractors of behaviour in the game field without forcing a single line of action (figure 7).

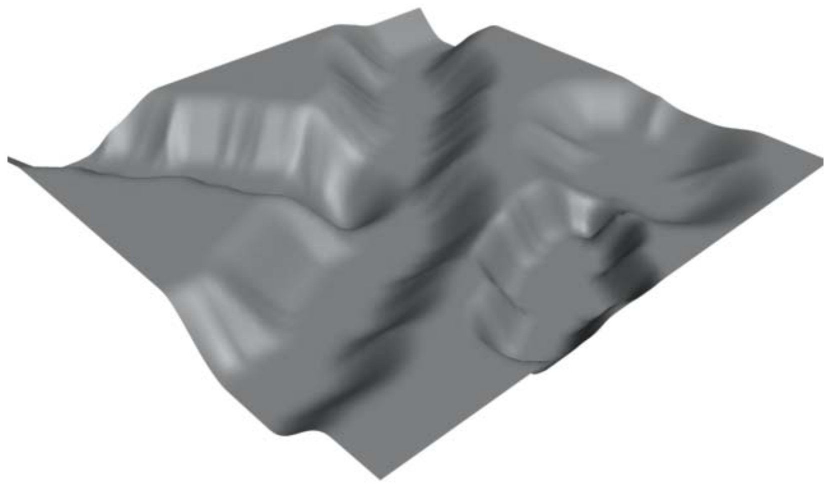


Figure 7: abstract representation of the behaviours a game level can afford; if a hypothetical ball is dropped on the field it will come to rest in lower areas (pits and valleys). This is the concept of attractors of behaviour: inner structural consistencies that guide players' actions without enforcing them.

Players' behaviour is not structured because the designers were able to predict and describe how all the many different (and subjective) kinds of empirical players will behave in-game, but because if the game provides consistent patterns of aesthetic and ludic elements, there is a chance that players will likely decide to behave consistently, donning one of the masks provided by the game.

Certainly there will be players exerting their right to behave subversively, trying to escape the rule of designers; but a large number will abide to the cognitive and evolutionary imperative to make sense of their experience by telling themselves stories about it [99]. In order to cater for a wider array of player preferences, it is ideal to populate the game with a number of these sense-making structures by planning a set of consistent but diverse play-personas that not only inform the selection of the mechanics to include in a game, but also the shape of the game world itself. For example in the game "*Tomb Raider: Underworld*" (TRU) [93] designers decided to sharpen and expand the iconic mechanics of the franchise. Traditionally in fact players were required to develop considerable navigation skills to reach improbable locations and retrieve treasures. Of course gun play was part of the equation and the locations were peppered with environmental puzzles, but the main focus of the brand has always been on navigation. With the latest installment, designers wanted to balance the three components: navigating, shooting and puzzle-solving, therefore the design of the game has expanded to include many more weapons, less linear worlds and more interesting puzzles. Designers attempted to drive both the creation of the world and the coding of game rules along three play-personas: the "athlete", the "chess-player" and the "grunt" [article 6]. This was the triumvirate that presided over the inception of TRU. Athlete, chess-players and grunt are just metaphors used to probe hypothetical player behaviour.

According to recent research [90] it has been shown how variety of player choice and high replayability are two of the most important features for games with a high score in Metacritics, and both of these to goals can be achieved with a multiple cast of play-personas driving design decisions. Initially, play-personas as a priori metaphors are abstract, narrative constructs; but after the game mechanics have chosen, coalesced and settled, play-personas can be expressed numerically as values of parameters whose creation is based on the mechanics of the game.

In psychology, the first and only scientifically accredited tool to gauge personality patterns is the Five Factor Model [28]. In this model, individuals are scored along five parameters: openness to experience, conscientiousness, extraversion, agreeableness and emotional stability (figure 8).

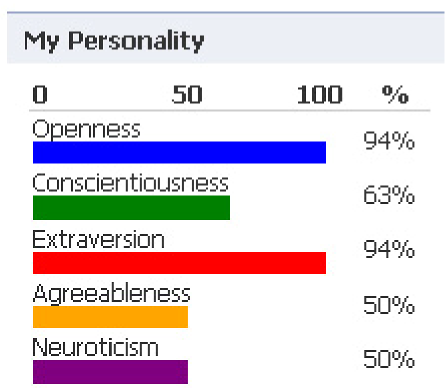


Figure 8: a personality profile scored according to the Five Factor Model

The five parameters have been derived through a lexical hypothesis: *"individual differences that are most salient and socially relevant in people's lives will eventually become encoded into their language, the more important such a difference, the more likely it is to become expressed as a single word"* [57].

A similar approach can be used to sketch play-persona profiles, but it is impossible to use the same dimensions highlighted by the Five Factors Model. The main reason is that the affordances for behaviours in games are a very small subset of the affordances available to people in physical life. In games the possibilities for expressing behaviour are clearly defined and limited by the rules. There are only few ways to move and interact with the virtual world; for example some games don't even allow players to jump. Another reason that prevents identifying universal parameters for building play-persona profiles is that the rules that provide affordances and limit behaviour of players can change radically from game to game.

Nevertheless if, according to the lexical hypothesis, language incorporates the affordances of life, then for games it is in the interaction between players and game that all the affordances can be found; the language through which players express themselves in games is composed of actions facilitated by the specific mechanics inscribed in a certain game. In this regard it is possible to derive specific and localized parameters emanating from the core mechanics, rules and spaces defined by each game and use these parameters to build procedural play-personas ad hoc for each game (figure 9).

	Fugitive	**Grunt**	**Samaritan**	**Doctor**	**Rambo**	**Red Cross**	**Expert**	**Rookie**
Survive	+	-	-	-	+	-	+	-
Kill	-	+	-	-	+	-	+	-
Help	-	-	+	-	-	+	+	-
Heal	-	-	-	+	-	+	+	-

Figure 9: example of parameters derived from the core mechanics of the game Left4Dead [64] the cast of eight play-personas is based on how each profile would perform at each of the skills underlying the parameters.

Play-personas are useful as metaphors during the early phases of game development because they help designers select define and balance the rules of the game even before a prototype exists. After an initial narrative description, play-personas can be expressed numerically in terms of proficiency at accomplishing tasks or likelihood of behaviour. Once the extreme profiles that delimit the possibility field of player behaviour are established, designers can begin weaving aesthetic and ludic affordances and shape the game space.

3.4 Play-persona as a lens (a posteriori)

Once the game spaces and the rules of interaction are defined, play-personas can serve both as a verification of hypothesis on players' behaviour set forth initially, and as a lens to identify play patterns. These two functions are quite diverse in their purposes and methods.

The first function attempts at fitting profiles of real players into the conceptual containers defined by a priori play-personas and provide a statistical overview of the distribution of the player population. Since the metaphor play-personas have been defined as one-sided accentuations, chances are that the large majority of population falls in between the categories.

This is where the second function takes the stage: through traditional clustering methods and dendrograms or with the use of neural networks it is in fact possible to examine the data encoded in gameplay metrics logged by players and detect groups of players with similar behavioural patterns. For example, in the game TRU three play-persona metaphors were selected to drive the design process: "athlete", the "chess-player" and the "grunt". After the game had been launched, both neural networks and dendrograms were used to investigate the usage data generated by 1365 players that completed TRG. Four categories were individuated: veterans, solvers, pacifists and runners (article 9: Player Modelling Using Self-Organization in Tomb Raider: Underworld). Although the clusters of player behaviour discovered in the data do not completely match the three play-personas initially used as metaphors, it is possible to notice strong correspondences between the grunts and the veterans, the chess-players and the solvers and between athletes and runners.

This line of enquiry can be applied as soon as a playable prototype is ready using data derived from play sessions of the designers themselves, testers from the Quality Assurance department or invited external players, as long as these three batches of data are treated separately, considering the bias they contain: designers in fact will tend to play the game as it was intended while QA testers will likely attempt stress tests.

3.5 Grounding Play-personas

There are both cognitive and a psychological grounds for play-personas. Wolpert [99] showed how the compulsion to create a story, to weave drama in people's lives, might actually be biological; it could represent a cognitive imperative, an innate need to have the world organized cognitively.

Wolpert posits that the requirement to establish causality between disconnected events is a necessity for an animal that made tools in order to survive. Tools emerged in fact from the discovery of cause-and-effect relations. Once that discovery was made humans wanted to understand the causes of other things that mattered in their life. The failure to find causes and to explain in causal ways apparently unrelated events creates anxiety and discomfort.

This evolutionary biological imperative to connect the dots and weave stories to make sense of our experiences could explain why, long before the adoption of persona models by HCI practitioners or the abstract user representations utilized in marketing, our past history abounds with attempts at preemptively model behavioral patterns of people.

Transpersonal psychology, psychosynthesis especially, can provide a key to understand the need for a cast of multiple play-personas, as detailed in the first article: "Towards a Theory of the Player".

Psychosynthesis is a psychological approach based on a dynamic understanding of psychic life, which is seen as a struggle among several contrasting and opposing forces. In the middle of this psychic battlefield there is a unifying centre that tries to integrate the forces harmonically and use them for useful and creative purposes. These struggling forces, or "multiplied souls", are called subpersonalities. According to Assagioli [6, 7, 8], the founder of psychosynthesis, personality is not unified, defined, stable and integrated, but it is more like a compound of subpersonalities which, from time to time, gain dominance over each other and negotiate the definition of the self and the motivational/operational aspects of behaviour. Psychosynthesis' ultimate goal is to integrate the potential richness of these multiple subpersonalities in a superior unity.

3.5.1 Origin of subpersonalities

According to Assagioli the factors that come into play during the formation of personality and subpersonalities are: ancestral and familiar heritage (temperament), external influences (environment), self, Eros and Logos (figure 10). Upon this background subpersonalities emerge and thrive. Subpersonalities are the whole repertoire of roles that we decide to play to represent the comedy (and often the drama) of our lives. In psychosynthesis they are not just theoretical constructs or models, but phenomenological realities. Each one has its own motivations and needs, often unconscious, and it tries to avoid frustration. Each one of them moves, in turns, towards the centre of consciousness, staking a claim to the empirical self and saying: "I". Even if they represent only a portion of the whole personality, people can be totally identified with some of them.

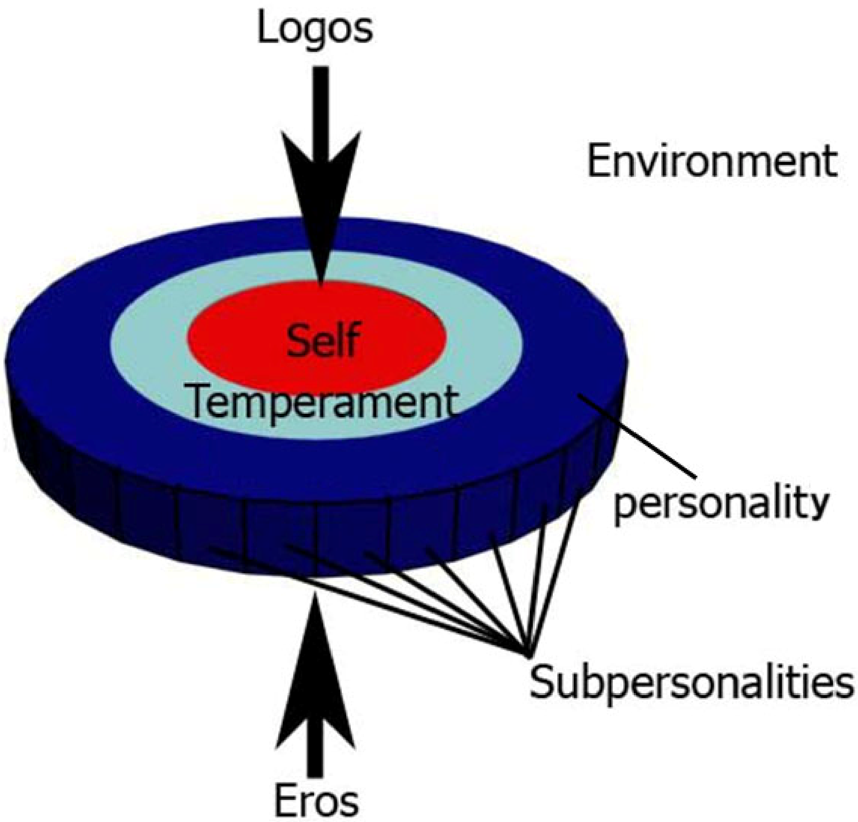


Figure 10: personality and subpersonalities according to psychosynthesis (adapted from [7] and [8]).

In Assagioli's words *"subpersonalities are internal constructs developed through patterns of reactions to experiences of living and frustrated needs/wishes"* [7]. Some psychologists [91] assert that subpersonalities organized themselves around a need within the psyche, often related to Maslow's pyramid of needs. Others [42] suggest that they might arise as primal wounding, yielding a survival value. The development of subpersonalities is not pathological but rather a normal state for all human beings.

3.5.2 Subpersonalities and play-personas

The concept of subpersonalities allows to understand how we shift from one identification to another as we move through life. In a single day we may move through playing "victim", "critic", "couch-potato", "striver", "lover", "frightened child" and so on.

This same shifting mechanism can account for a player facing enemies in a "Rambo" mode and immediately after changing to a "Fugitive" mode.

Each subpersonality contains its own set of values, belief structures, coping mechanisms, motivations, defining emotional sets (preferred or default emotional states), hard coded rational processes, ways of thinking, desires and needs to satisfy.

Subpersonalities can also explain how players' needs, motivations, desires and beliefs change considerably over time during the interaction with a game.

4. CREATING EXPERIENCES

The MDA framework [52] has already attempted to describe how designers embed meaning into their artifacts and how these artifacts express meaning to people, eventually shaping the play experience. The focus of the framework is on the unidirectional channel from designer to player; in fact it moves from "mechanics" (the rules of the game and the code that supports them) to "dynamics" (the processes that are enacted in each session of play) to "aesthetics" (the emotional requirements or the "fun"). The greatest achievement of the framework is to show how important is for designers to choose aesthetic goals (the emotions that the game should elicit) and build mechanics and dynamics that support those goals. Nevertheless the player's input, desires, motivations and background are not kept into consideration since it is the application that brings goals to the user.

From a designer's point of view, creating experiences consists of weaving ludic affordances upon the aesthetic canvas of the game. Ludic affordances provide players with actions to carry out within the aesthetic canvas of the game space. Examining what players chose to do among several alternative actions can shed light on their interaction and navigation attitudes, eventually leading to the inclusion of players' goals into the equation. This biunivocal communication process is unfolded on two layers: the designers' intent of creating entertaining experiences by telling a story through aesthetic and ludic codes, and the players' desire to interact with the game and influence it (explained by figure 11).

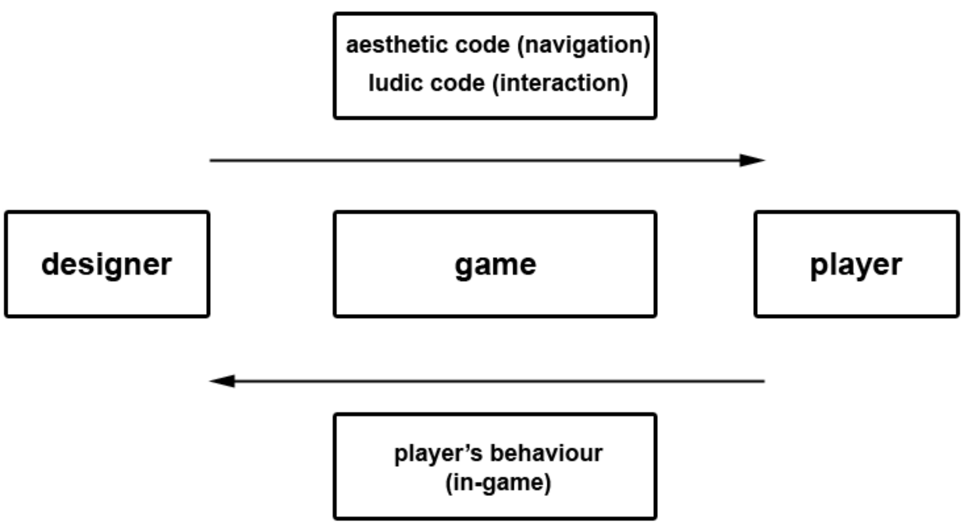


Figure 11: the two layers of communication, from designers to players, through the aesthetic and ludic affordances; and from players to designers through players' behaviour.

Designers provide players with a variety of actions (ludic affordances) to perform in the game space (aesthetic affordances), in return players select among the array of possibilities to express their behavior.

Disregarding the second layer of the communication channel would inevitably lead to solipsistic design.

4.1 Steps of the transaction between designers and players

Analyzing in further detail the negotiation between designers and players (figure 12) and breaking down the previous diagram (figure 11), it is possible to identify certain steps.

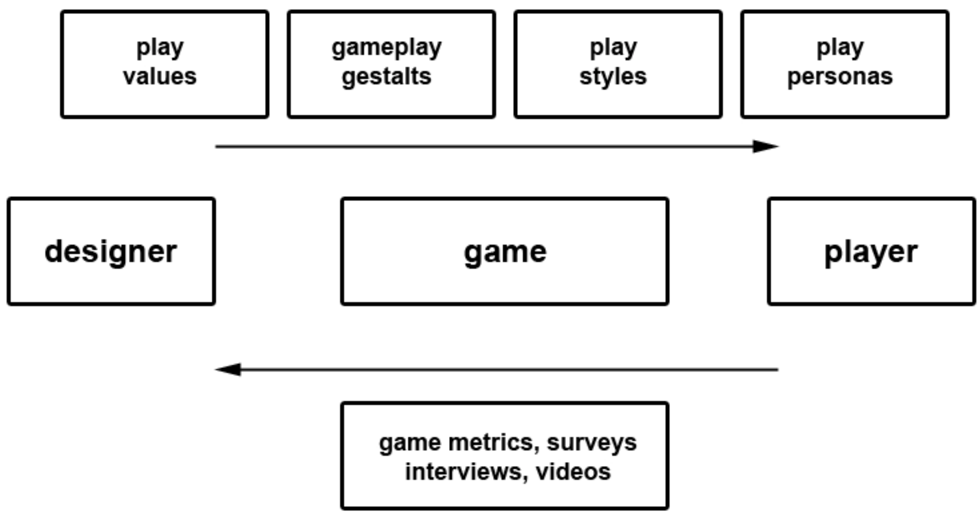


Figure 12: steps of the transaction between designer and player

The conceptual scaffolding that allows designers to facilitate the emergence of personalized experience within the framework of a game unfolds through several steps.

Play values are the abstract principles, both aesthetic and functional, that the game's design should embody [102], not unlike the aesthetics from the MDA framework.

Lindley [65, 103] defines gameplay gestalts as patterns of interaction between player and game and the cognitive structures that underlie and facilitate this interaction. A list of all the gameplay gestalts in a game would cover all possible *navigation* and *interaction* attitudes that players can utilize to negotiate any given situation. Gestalts are the features that motivate, facilitate and constrain player action, offering them methods of operation within the game. They roughly correspond to MDA's mechanics.

Play-styles are sets of isotopic gameplay gestalts which signify, unify or distinguish players from each other. They represent possible ways in which certain subsets of the rules and mechanics provided by the game can be combined. For example a "rush attack" in any real-time strategy game consists of quickly building a large number of the weakest and cheapest units and flooding the opponent with wave after wave of them. Play-styles correspond to MDA's dynamics, how mechanics are used during a game session.

Play-personas are an even bigger and more abstract construct; they allow designers to prefigure possible patterns of behaviour and at the same time allow players to unify their actions and make sense of their behaviour. Play-personas emerge from the various options for actions that players are given. Play-personas provide ways to personalize the playing experience and facilitate players' expression.

The second layer of the communication channel that goes from players to designers should be deconstructed both with quantitative and qualitative tools. Game metrics, being techniques for inferring higher-order concepts from the large quantity of information available when a computer game is played, provide detailed and granular records of players' actions. This allows designers to reconstruct players' in-game behaviour. Of course game metrics can only account for what a player does, where and when, but their merit is also the fact that this information can be harvested remotely even after the game has been released on the market. In order to discover more about players (who), their motivations (why) and the context of play (how), it is necessary to resort to surveys and interviews.

4.2 Unfolding the dialectic "designer-player"

The model utilized insofar clarifies the relation that games build between designers and players (figure 12). Designers provide aesthetic and ludic affordances and they both contribute in shaping and allowing for player expression (figure 13).

4.2.1 Aesthetic affordances

Aesthetic affordances consist of those possibilities for action that emerge from the sensory-perceptual qualities of the world such as navigation patterns and viewing ranges; they describe where the avatar can go and see. The aesthetical elements comprise for example colors, textures, shapes, lights, ambient sounds and music; pretty much anything that invests the senses immediately, purely in the realm of perception as un-mediated, mentally unprocessed, event. Perception is here intended as one of the two meanings of the term experience: a particular sensation that does not build towards a greater whole but is isolated, categorical and pre-rational. Being events that do not prompt cognitive appraisal their effects are mostly unconscious, like the soothing effects of relaxing music; they affect moods more than emotions.

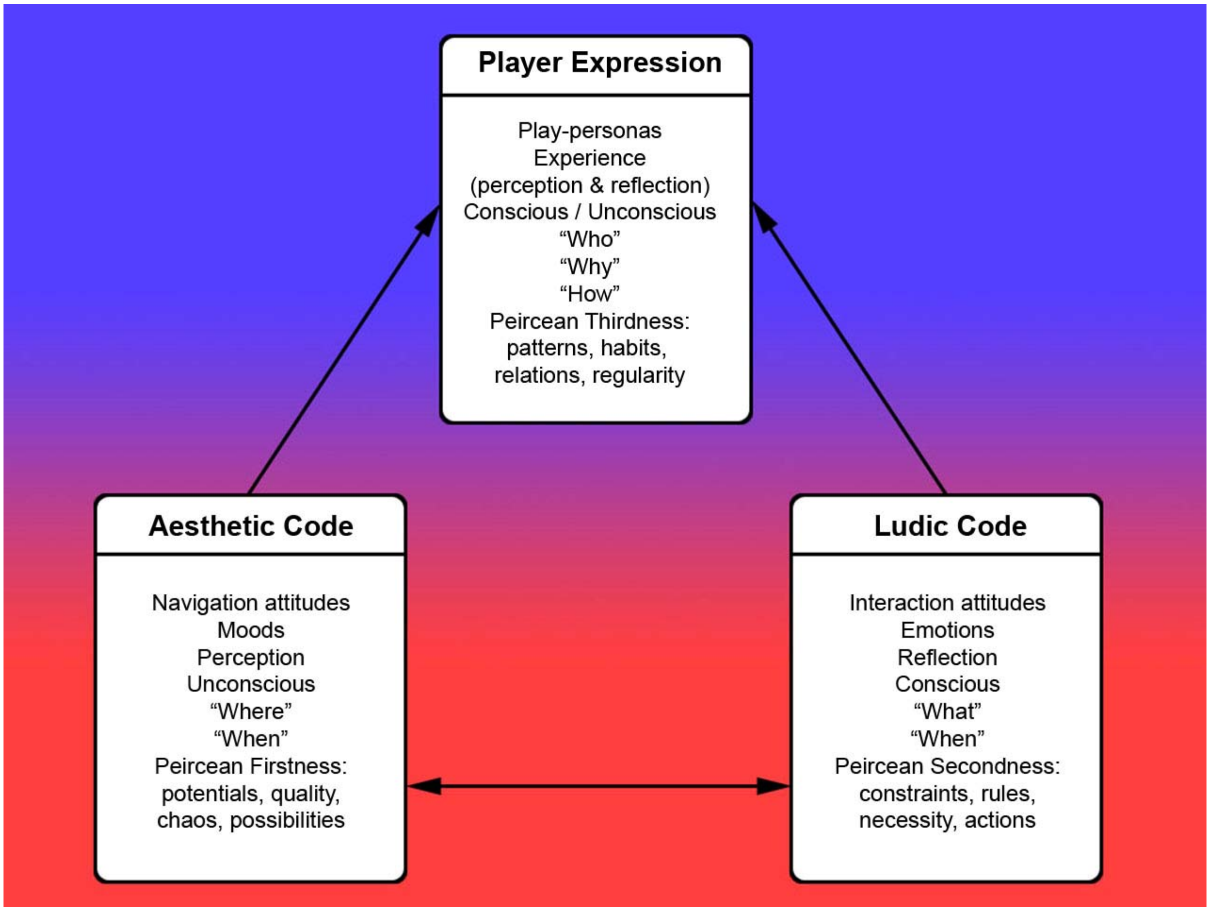


Figure 13: the triad "aesthetic-ludic-player" is strongly reminiscent of Peirce's Trichotomy.

4.2.2 Ludic affordances

Ludic codes afford all the actions that players can undertake such as opening doors, reloading weapons, casting spells, or changing clothes; they define what players can do. It is by acting on these elements that players can express interaction attitudes. Interacting with ludic affordances does require conscious activity and eventually leads to the creation of experience in the second acceptation of the term: wisdom gained in subsequent reflection on events or interpretation of them.

4.2.3 Player expression

Player expression is a phenomenon that involves the whole domain of experience, both perception and reflection, and as such is at the same time a conscious and an unconscious process. Play-personas can help structuring the expression of players in game, but these personas are not always necessarily the same ones inscribed in the game by designers.

4.3 Peirce's Trichotomy

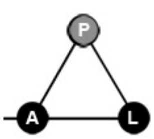
This model bears more than a slight resemblance to Peirce's trichotomic systems [104]. Trichotomy was envisioned as a way to understand how perceptions coalesce into knowledge and eventually founding a possible applied science; this science was introduced by Peirce as the "art of making three-fold divisions". This technique allows triadic analyses-syntheses based on three principles:

- **Firstness** is concerned with ideas, freedom, multiplicity, qualities, feeling, image and possibility. It is closely related to the bodily and sensory apparatus.
- **Secondness** signifies events, brute actions, reactions, existence, facts and causality. It is concerned with rational and verbal realities.
- **Thirdness** brings together firstness in relation to secondness by means of habits, patterns, thoughts, representations, mediation and meaning.

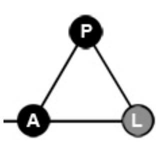
The examination of transactions between designers and players can benefit from this triadic approach because it transcends any debate asserting the supremacy of games-as-systems or games-as-stories. This triadic approach levels the field and shows how both aesthetic and ludic codes are necessary to allow player experiences arise from the tapestry of the game.

4.3.1 Articles tagging system

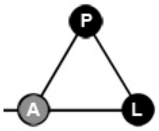
All the articles in this thesis have been tagged with a small symbol in the header to show the angle of the code under investigation.



This symbol identifies articles focused mostly on player experience, patterns of habits and behaviours, sense-making processes.



This symbol identifies articles focused on ludic codes, actions, game rules and mechanics.



This symbol identifies articles focused on the aesthetic codes, the iconic qualities of images evoked and the chaotic, polysemic freedom of interpretations.

Of course there are articles dealing with multiple facets at the same time, they have been appropriately tagged.

4.4 The triadic relation

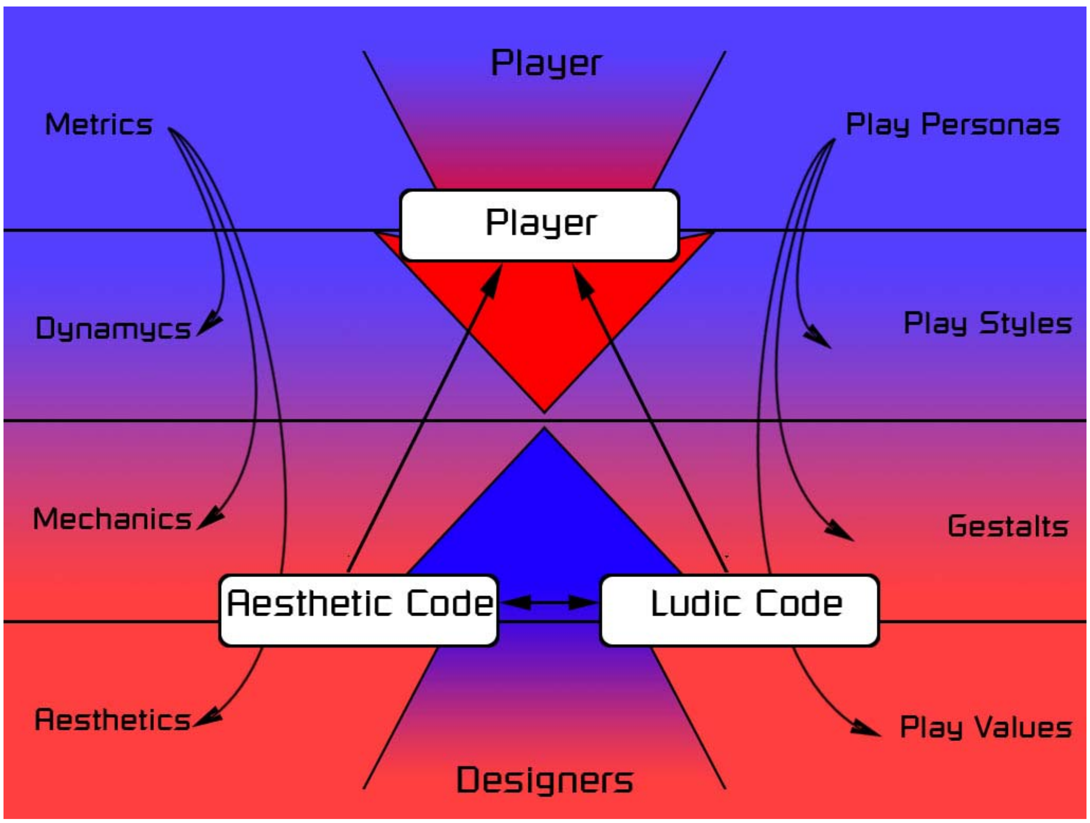


Figure 14: the triadic structure weaved into the process of designing and playing games

From a designer's point of view [52], a game begins with establishing aesthetic goals or play values; these will inform the creation of game mechanics and the gameplay gestalts generated during the interaction with players.
From a player's point of view, preferences towards certain subsets of gameplay gestalts can give rise to play styles in the same way that interacting with the rules of the game (mechanics) moulds the processes (dynamics) enacted in during a play session.

Players will eventually understand the play experience as the kind of role or mask that was worn in the game and this understanding will shed new light and reorganize the perception of play styles, gameplay gestalts and play values alike.

Designers on the other hand can achieve a better understanding of the play experience if during the cyclic, iterative design process they probe with both quantitative and qualitative methods players engaged with the game. This feedback, both in terms of gameplay metrics and interviews, will affect aesthetics, mechanics and dynamics (figure 14).

5. CONCLUSIONS AND FUTURE WORK

This work started out as a project addressing the very general issue of how to shape attractive gameplay experiences. Initially, gameplay experience had been identified as arising from the negotiations that take place between players and designers and this understanding defined two sides of the issue:

- how do designers envision hypothetical players while producing a game
- how do players make sense of their experience while interacting with a game.

Play-personas have been introduced as probes that allow designers to forecast models of actualization of the game and at the same time tools that can shape players' experiences. They are macro metaphors and conglomerates of play styles.

A persona-centric design provides firstly ludic affordances that are at the same time varied and consistent; and secondly aesthetic choices that are pertinent and support the play styles emerging from those affordances.

Several game development studios are already using constructs similar to the metaphoric play-persona to organize design issues. For example at Ubisoft Montreal, while developing Far Cry 2 [107], designers referred to "Sun Tzu", "Rambo" and "Fugitive" to address three different attitudes to deal with hostiles; level designers distributed cover elements in the game world accordingly. "Sun Tzu", preferring a more strategic approach, favors being in areas with plenty of opportunities for cover while the enemies are in open areas. "Rambo" is partial to close combat so he will find himself in the same area of the hostiles, independently if it is densely covered or not. "Fugitive" would rather have freedom of movement while the enemies are encumbered navigating a cluttered space. It does not matter if players wanted to play the "Rambo" persona, the moment they pick up a knife and start walking close up to the enemy, the performance and the behaviour inscribed in the artifact "hunting knife" will shape the way they experience the game space.

In spite of that, Far Cry 2 designers making use of personas seem not to have harnessed the power of gameplay metrics to evaluate whether their hypotheses were confirmed by actual use or not.

Other developers [79] have been utilizing numerical description of player behaviour (lenses) to find clusters of uses, but were not interested in letting concrete hypotheses of player behaviours (metaphors) guide the design of the game.

Combining both of these two approaches allows designers to sharpen game experiences without falling into neo-positivist, data-driven fallacies, nor solipsistic decisions taken by designers too abstracted from players.

The play-persona framework belongs to the same group of research that attempts to find player types, such as Bartle's types [13], Yee's motivations [100] and Bateman's categories [14]. While each of these approaches is structured either top-down (deductively) or bottom-up (inductively), play-personas, with their two-headed nature of metaphors and lenses, succeed in making use of both approaches.

5.1 Future work

This research took place at a particular moment where EIDOS was investing resources into the development of a metric suite designed to collect data about player behaviour, therefore it is clearly noticeable how most of the articles possess a bias towards quantitative analyses and interpretations. This happened not because of a belief in the superiority of quantitative methods, but because of the opportunity to use and experiment with a tool that in game development was still rather new. Future work should focus on how to integrate the methods explored during this research with qualitative approaches to observing the human side of players: interviews, self reports, video footage, participant observation, ethnographic and anthropological enquiries, etc.

Another venue worthy of in-depth exploration is investigating how to incorporate biometric data[4] into the definition and use of play-persona profiles.

In this research, Peircian semiotics has been merely scratched, attempting to describe the relation between aesthetic codes, ludic codes and play experiences; but future work could explore the possibility to adapt Peirce's theoretical complexity to account for the emergence of meaning from game worlds. Furthermore a handful of semioticians following the footsteps of Varela and Maturana are working on cybersemiotics: "*a combination of a Peircian-based biosemiotics with system science, cybernetics, autopoiesis theory, second order cybernetics and information science*" [108]. This angle views the interplay of mind and body as a sign and attempts to understand how the prerequisites for human consciousness are laid down in the evolution of the human's bodily system. This could help reading the acts of communication of the avatar as a digital body.

[4] Among all possible biometric variables the most important are: electroencephalograms, heartbeat rate, blood pressure, skin conductance and eye gaze tracking.

5.1.2 Applications of play-personas to other fields

The play-personas framework could successfully be employed during design and evaluation of any product as long as remote collection of metric and/or biometric data is possible. Beta or evaluation versions could be distributed with metric clients that not only log bugs and failures, but also record patterns of use; this data can be used to evaluate goals set in the hypothesised models of expected behaviours. If traditional HCI personas are used in software development as early tools to focus on features and specifications, expanding them as both metaphors and lenses allows early releases of products to become at the same time test beds for the verification of hypotheses of use set forth initially. Traditional HCI personas stop being useful before the end of the production cycle, expanded personas could accompany a product well after its release; the cast of personas itself can actually grow after the release of a product.

Even architecture and urban planning could employ similar approach to design and evaluate spaces by utilising GPS locators to monitor the use of spaces.

Both advertisement and marketing of anything from phones to buildings would find a treasure trove in the persona descriptions as metaphors and lenses, enabling truly personalized communications and yet respecting the need for privacy of users, since it is not necessary to link identities to patterns of use.

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Compendium Articles

ARTICLE 1 - TOWARDS A THEORY OF THE PLAYER: DESIGNING FOR EXPERIENCE

Article presented at DIGRA 2007 in Tokyo, Japan.

Abstract

This article intends to sketch a theory of the player drawing from psychological personality theories (Assagioli's Psychosynthesis), neurophysiologic studies (Damasio and Pert) and previous work on player's theory with the purpose of tracing a functional procedure for designing game worlds. I will make use of the concept of sub-personalities to show how potentially, all player-types coexist within the implied player. Once player types are individuated I intend to show how a "flow" path for each one of them can be planned and included during the design phase of game worlds.

Keywords

Player, experience, emotion, personality, sub-personality, psychosynthesis, player types, flow, level design, game worlds.

1 Introduction

Why is it necessary to investigate player behaviour when the main concern is to draft guidelines for the realization of levels in single player action games?

"If level designers intend to shape game environments with a higher emotional valence that will eventually trigger a defined player experience, they are forced to look at the avatar's behaviour in the game as a direct manifestation of the player's personality."[30]

It becomes apparent how the relationship between personality, experience and emotion assumes a central focus. I am going to give a preliminary definition of these three key concepts, allowing for an eventual later revision.

Personality in type theory is understood as a representation of a particular pattern of basic elements. Special attention is devoted to what the individuals have in common. According to the trait theory, personality is a compendium of traits or characteristic ways of behaving, thinking and feeling. The focus here is on the differences between individuals. These two theories, as the two sides of the same coin, are interchangeable and integrated with each other [26]. For our purpose we can define personality as consisting of certain recognizable and reoccurring patterns. These patterns are of an emotional, rational and behavioural kind. They are seen as responsible for generating actions and responses within game worlds. Later on I will redefine and expand on this concept.

Experience is, according to the philosopher Immanuel Kant, "empirical knowledge or knowledge by means of connected perceptions" [19] and, as we can see from the etymology of the Latin word (experientia) "knowledge gained by repeated trials", in other words the accumulation of knowledge or skill that results from direct participation in events ("a player with experience"). But existence in itself generates experience ("I am experiencing fear"). Since neither English nor Latin render this double meaning of the term I will make use of the terms "erfahrung" and "erlebnis" as defined by the philosopher Walter Benjamin of the Frankfurt school. [6]. Erfahrung is "wisdom gained in subsequent reflection on events or interpretation of them" [36]. It is understanding of life and the world we live in; it is experience as an ongoing, cumulative and critical-cognitive process; "journeyed-through" knowledge, mature reflection on events. Erlebnis is "mentally unprocessed, immediately-perceived event" [36] a one-off encounter, a particular sensation that does not build towards a greater whole; it is isolated, categorical, without cognition, "lived-through" aesthetic/ecstatic perception. It is immediate, pre-reflective and personal. In the following "erfahrung" will be translated into reflective experience or reflection and "erlebnis" into perceptive experience or perception.

Emotion, in psychology, is defined as a complex, subjective experience that is accompanied by biological and behavioural changes [31]. Emotions are responses to certain sorts of events of concern to a subject, triggering bodily changes and typically motivating characteristic behaviour [14]. Nearly all contemporary cognitive theories of emotion recognize four classes of factors:

- instigating stimuli that generate emotions (subjective experience)
- physiological correlates that accompany the emotion
- cognitive appraisal of the situation that triggered the emotion
- motivational properties of emotional arousal (expressive behaviour).

I am adding to the list cognitive appraisal, derived from the work of Nico Frijda on Emotions [16], to the three components of a definition laid out by several theorists as quoted by Leino [23, 19].

I suggest that emotions help transforming and processing perceptive experience in reflective experience in a much faster way than through repeated trials. If strong enough these perceptions (memorable, indexing and iconic) become fastened in the memory and finally these memorable experiences gradually help defining personalities. I will try to prove this statement by analyzing the flow between the player, the avatar, the game world and the arising emotions and reflective experiences.

2 From emotion to reflective experiences (Erfahrung)

As proven by numerous studies [8, 9], emotionally tainted reflective experiences are stored in memory and used as pointers, indexes and prototypes to help define and catalogue emotions in individual ways. These emotionally charged memories are also used to plan courses of action for the future under similar circumstances. Hence, emotionally tagged memories might also play an important role in the definition of personality. It is therefore pivotal to look further into the definition of emotion and how it affects the anchoring of reflective experiences in memory. The most widely accepted view is that emotions occur as a complex sequence of events. The sequence begins when a person encounters an important event or thought (perceptive experience). Some physiological reactions are triggered in the body, then the person interprets the meaning of the encounter (the order of these two steps is much debated), and the interpretation determines the feeling that is likely to follow and the resulting behaviour. For example, someone who encounters an escaped lion (instigating stimulus, perception) would probably interpret the event as dangerous (cognitive appraisal, reflection). The sense of danger would cause the individual to feel fear. Each feeling is followed by or happens simultaneously with a series of physical changes (physiological correlates) and impulses to action (motivational properties, behaviours), which are responses to the experience that started the sequence. Thus, the person who met the lion would probably run away, increasing the person's chance of survival. This definition will help us understand the mutual influences that emotions and reflective experiences have with each other and the role that they both play in the definition of personality. A typical flow to describe how emotions arise while playing and how they fasten experiences can be found in the following occurrence in the game Doom 3 (ID Software, 2005, Activision): the player is surprised/scared by a demon appearing behind the avatar’s back and learns that enemies can spawn out of nothing. Fear helps player internalizing the event, as described in figure 1:

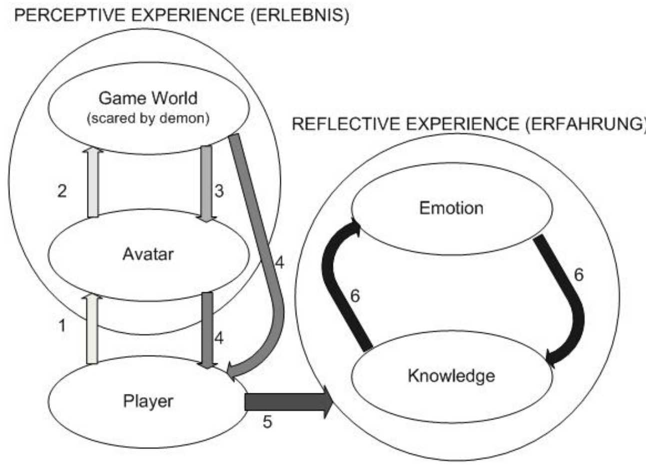

FIGURE 1 Perceptive and Reflective Experience

1. The player controls the avatar. Avatar is here intended as the medium that transfers agency from the player to the world and receives feedbacks from the game world on behalf of the player; as the term's etymology suggests it is the incarnation, in the virtual world, of a deity belonging to reality: the player. A lot more space should be devoted in investigating the relation between player personality and avatar behaviour. The resulting, in-game, behaviour is an emanation of the player's personality. This assumption must be taken carefully since one has to take into consideration the bias operated by the designers who limit the game world. Not all choices are opened to the player for expressing his/her personality but only a certain subset allowed by the designers. This subset often predetermines certain behaviours, so the emanated player's behaviour is a subset, simplified and biased, of the player's personality.

2. The avatar interacts with the game world and its underlying mechanics.

3. The avatar receives feedback from the game world (instigating stimulus). I decided to include avatars as part of this negotiation because as we have seen they clearly represent a filter that can bias game encounters due both to the connotative nature of the avatar itself (its esthetical qualities might foster certain behaviours and frustrate others) and eventual functional constraints embedded by the designer (i.e.: the avatar cannot jump).

4. The player receives feedback both from the avatar and the game world; he/she is aroused by it (physiological correlates).

Steps between 1 and 4 fall into the domain of perceptive experience (erlebnis): the "lived-through" event.

5. This arousal, together with personality traits, is interpreted as an emotion (cognitive appraisal).

6. The player constructs knowledge (reflective experience) with that emotion embedded, it will be remembered and used in the future to plan actions (motivational properties) at the same time emotional categories are redefined (reinforced or negated).

Steps 5 and 6 fall into the domain of reflective experiences (erfahrung): the "journeyed-through" creation of knowledge.

Perceptive experience is elaborated (appraised) by the player and eventually generates reflection. But not all reflections are equivalent, it is necessary to distinguish between trivial and memorable experiences because these two kinds of experiential knowledge affect personality in different ways. As we have seen earlier in the definition of the term, everything seems to generate experience. So trivial perceptive experience requires a certain amount of repetition and, iteration after iteration, eventually it creates knowledge (reflection) and changes behavioural patterns. But some perceptions are memorable in such a way that they become the icons and pointers to precise patterns of emotional activation and behavioural response that engendered them in the first place, without requiring iterations. These are the perceptions that generate "flashbulb memories" individuated by Brown and Kulik [8]. If game designers manage to successfully incorporate memorable perceptions in their games, chances are high that they will also ignite iconic reflections in players increasing the game's impact on the player. I am not advocating the creation of games that are made exclusively of memorable perceptions but merely suggesting that they can represent an effective shortcut and alternative to the repetition needed to convert trivial perception into memorable reflection. For example, there can be two ways for a player to learn a new mechanic of play and therefore create knowledge: repetition of the act (trivial perception) or occurrence of an iconic, indexing event (memorable perception). As a concrete example we can examine a player being taught that right-clicking several times causes the avatar to run. Repetition of perceptive experience: a disembodied aid vocalizes the instructions each time the player walks. Memorable perceptive experience: a NPC is in danger and if the player doesn't reach him in time he'll die. Emotionally charged reflection becomes rooted in memory [8, 9] and is also remembered more often and with more clarity and detail [10, 28, 35, 27, 29].

3 From reflective experience (Erfahrung) to personality

In order to investigate how the emotionally tagged reflection can influence the personality it is necessary to enter the domain of neurosciences.

Candace Pert is the neuroscientist that discovered the opiate receptor in the human brain and initiated the research that eventually found endorphins. Later in her career she set out to study the migrations of amino acid chains in the human body and eventually found herself investigating the interplay between memory and emotions and how this generates memorable, iconic experiences. Her research shows that there is an unequivocal relation between emotions and peptide molecules; furthermore she showed that receptors for this particular neurotransmitter protein are concentrated in the hippocampus area of the brain but are present everywhere in our organism. She also claims that the peptide network holds the key to locate memories and mood states. "Strong emotions are the variable that makes us bother to remember things" [25]. Pert's answer to the mind/body, psychology/physiology debate is that an emotion happens simultaneously in the mind and the body. According to Pert it is through the peptides that emotions can originate both in the head and in body. "Our every move, function and thought is influenced by our emotions because it is the peptides (or information substances) which bring the messages to all our body cells" [24]. Her research went as far as providing proof that emotions exist in a very concrete form; she calls peptide proteins and their receptors "biological correlates" of emotions. These molecules come into contact with our body on a regular basis and can influence its working enormously: according to specific emotional states, moods and feelings, different peptides are released (there are approximately around one hundred types) and different messages are sent throughout the body. "Every second, a massive information exchange is happening in your body. Imagine each of these messenger systems possessing a specific tone, humming a signature tune, rising and falling, waxing and waning, binding and unbinding, and if we could hear this body music with our ears, then the sum of these sounds would be the music that we call the emotion" [24]. Pert's concept of "mobile brain" includes a biological reason as to why different people experience the same event differently. "The term mobile brain is an apt description of the psychosomatic network through which intelligent information travels from one system to another" [24]. It relates to our past experiences and strong, emotionally tagged memories. Basically our past affects the types of peptides and receptors found around the body. We explore the world and receive input through our senses, while the mind unconsciously retrieves tagged memories that are associated with the input information.

This concept of emotionally tagged memories bound to input information introduces us to Damasio's work. Antonio Damasio, neurologist, tries to bridge the dichotomy mind/body regarding emotions by using sensate and mnemonic perception. According to Damasio, emotional processes are sets of rational, bodily, and behavioural responses to the perception (or memory) of an experience. The somatic-marker hypothesis proposes a mechanism by which definite areas in the brain (ventromedial cortices) establish links between a complex situation and the emotions that accompany said situation, resulting in the fact that emotional processes (or emotional memories) can guide (or bias) behaviour, particularly decision-making, by setting bi-univocal indexes from an experience to an emotion to a behaviour. The physical component of an emotion (its biological correlates) provides shortcut to effective decision-making.

"Bodily feelings normally accompany our representations of the anticipated outcomes of options" [12]. In other words, emotions map certain automatic responses to real or simulated decisions. "Somatic markers serve as automatic devices to speed up the process of selecting biologically advantageous options" [33]. Somatic markers allow individuals to wade through immense amount of perceptual/mnemonic data and eventually take action. Although Damasio agrees with Pert on the fact that emotions emerge from the biochemical chatter between mind and body, he challenges the "Mobile Brain" theory by asserting that emotions are not the neuropeptides themselves, but rather the circuit and the patterns that these chemicals activate in the brain. It is important to notice that, even though the somatic markers were set with input from the body, they can be recalled through an exclusively neural process.

In this preliminary paragraph I was interested in grounding emotions and memory as fundamental elements to define memorable playing experience. Candace Pert's work has pointed out how our past shapes the way we experience emotions and how different people experience the same event differently, while Antonio Damasio's somatic markers theory implies that emotions shape behaviours and therefore personality. The next step for me is looking into behaviours and personality both as emanation of emotional states and as results of emotionally charged experiences.

4 Player's personality

Most of the studies and analysis of player behaviours in the past few years have been conducted from a inductive, bottom-up perspective, starting with user tests, player behaviour monitoring, eye-tracking and logging all player's actions. The rough data has then been catalogued, analyzed and eventually synthesized to achieve player's categories. Richard Bartle synthesized his static types starting from hundreds of bulletin-board postings from a pool of 15 expert MUD users [4], while Nick Yee revised Bartle's types [34] using exclusively empirical data. Essentially all empirical research that dealt with categorizing people starts already with a limited sample: expert MUD users or MMORPG players. One of the few game-oriented typology systems that seem to adopt a much broader framework is International Hobo’s Demographic Game Design [5]. Using the widely supported Myers-Briggs Type Indicator, it truly widens the potential types to the whole mass market. International Hobo’s next step has been the translation of the MBTI into a more relevant audience model shrinking the 16 types into 4 types: Conquerors, Managers, Wanderers and Participants. As Bateman points out this is not the only way the patterns could have been reordered: according to the perspective adopted they could have been grouped focusing on play style or skills instead of motivations.

The methodology I propose for this paper is open, deductive, top-bottom: instead of starting with empirical evidence I have combed what Maslow called “the four forces of psychology” [17] looking for a theory of personality that can best accommodate for the dynamic aspects of the emotional, rational and behavioural patterns that contribute creating the personality compound. This change in the approach is not meant to deny the value of empirical methods; on the contrary, it is my intention to capitalize on decades of cognitive and personality studies and back up inductive studies with evidence coming from psychology research conducted on man, the self and behaviours. Subsequently I will try to evaluate whether any of their findings can be applied to study player’s behaviour in a game environment: towards a theory of the player.

4.1 Humanistic psychology

It was co-founded in the 1950s by Abraham Maslow as a reaction to the previous two forces: psychoanalysis and behaviorism. Its focus from the beginning has been man as a whole and not just his pathologies; subjective experiences of persons have been preferred to forced, definitive factors that determine behaviour. Free will and self-determination were its key concepts. Maslow was initially interested in motivation: he noticed how people seemed to be motivated by the same universal needs even though they find very different strategies and behaviours to gratify them. According to Maslow "ends in themselves are far more universal than the roads taken to achieve those ends, for these roads are determined locally in the specific culture. Human beings are more alike than one would think at first" [22].

Maslow individuated five basic, universal needs: bio/physiological needs, safety needs, social needs, ego needs, and the needs to find a purpose and actualize the self. In line with the premises set forth by humanistic psychology he transcended the shortcomings of both psychoanalysis and behaviorism asserting that a comprehensive theory of personality must cover all the aspects of people: their successes as much as their failures; he was convinced that it was natural for men to move towards self-actualizing views and in his last book [21] he focused on people reaching the topmost layer of the pyramid, self-actualizing persons (people fulfilling themselves). These individuals often experience a "peak experience". He defined a peak experience as an "intensification of any experience to the degree that there is a loss or transcendence of self" [21]. A peak experience is one in which an individual perceives an expansion of his or herself, and detects a unity and meaningfulness in life. His last work was centred on behaviours that lead to self actualization.

Mihaly Csikszentmihalyi went even further in his research "Maslow regarded peak experience as a kind of epiphany that happens spontaneously, I wanted to find out how optimal states of being occur and what people can do to bring them about" [11] so, after defining "optimal states of being" as "the flow" he tried to find the rules that would guarantee flow experiences. Here are the nine characteristics of an enjoyable experience:

1 Clear goals,
2 Immediate feedbacks to actions,
3 Balance between challenges and skills,
4 Action and awareness are merged,
5 Distractions are excluded from consciousness
6 No worry of failure
7 Self-consciousness disappears.
8 Sense of time becomes distorted
9 Activity becomes autotelic (rewarding in itself).

Flow theory and its nine characteristics have already been extensively used by game designers and theorists but later on I will focus more on the subject and introduce a couple of emendations.

I have found in Maslow's comprehensiveness the ideal background for a theory of the player that takes into consideration needs, motivations, heights, depths and a drive towards betterment. At the same time, Csikszentmihalyi's work on flow provides a practical approach for how to design game worlds to accommodate for optimal experiences.

4.2 PSYCHOSYNTHESIS

Psychosynthesis, listed by Maslow under the fourth force of psychology, is an approach based on a dynamic understanding of psychic life. Psychic life is seen as a struggle, within man, among several contrasting and opposing forces. In the middle of this psychic battlefield there is a unifying centre that tries to integrate the forces harmonically and use them for useful and creative purposes. In psychosynthesis these struggling forces, or "multiplied souls" [7], are called subpersonalities. According to Roberto Assagioli, the founder of psychosynthesis, personality is not unified, defined, stable and integrated, but it is more like a compound of subpersonalities which, from time to time, gain dominance over each other and negotiate the definition of the self and the motivational/operational aspects of behaviour. An example fitting to describe this situation could be looking at the relation between a male teenager and his Tamagotchi: it is surprising to find in this subject extremely accentuated maternal behavioural patterns, yet the care and responsibility devoted to the virtual pet hint at the presence of a prototypical "mother" subpersonality. If asked, the subject would deny such an occurrence and even feel embarrassed; pointing us towards the fact that the existence and operation of subpersonalities might be an unconscious process. Psychosynthesis' ultimate goal is to integrate the potential richness of these multiple subpersonalities in a superior unity. This synthetic process happens through a series of disidentifications of the self from the subpersonalities (false or partial images of the self) and identifications with a higher, more central unity, a unity that does not negate our inner fauna but integrates it. Psychosynthesis does not claim to wipe the slate clean and start from scratch with a completely original definition of personality; instead it draws on previous accepted contributions. Giovanni Bollea [7] defines personality as "dialectic synthesis of the relationship between the self and the world, between the self and family, society and physical environment"; he implies that personality is our way to be in the world in a given moment. From this definition Assagioli derives that too often the self is confused with conscious personality. The ever-changing contents of our conscience (thoughts, feelings, etc.) are different from the self, the auto-consciousness, which contains and perceives them. "It is the same difference between the screen in a cinema and the images projected on it" [1]. This thought is the foundation of the whole theory of subpersonalities.

4.3 Origin of subpersonalities

According to Assagioli the factors that come into play during the formation of personality and subpersonalities are: ancestral and familiar heritage (temperament), external influences (environment), self, Eros and Logos [13].

Ancestral and familiar heritage include collective unconscious (dreams, fantasies, nightmares), parent formation, genetic heritage, family history, childhood influences and role models. This heritage is the field studied by depth psychology. External influences and the environment's role have been extensively studied by social psychology. The Self is an "a priori individual core" within the bio-psychic apparatus. It is this core that, if not disidentified and not self-aware, gives birth to the "empirical self" that tends to identify itself with the ever-changing contents of consciousness and to definite sets of subpersonalities [3]. This bio-psycho-morphological equipment (heritage, environment, self) consists of what is usually addressed as temperament, types, character traits and constitutional dispositions. The Eros and Logos factors are here mentioned purely for the sake of completion, but since they are tangential at best to the discourse of subpersonalities in players I will not deal with them in this article.

This is the background upon which subpersonalities emerge and thrive. Subpersonalities are the whole repertoire of roles that we decide to play to represent the comedy (and often the drama) of our lives. In psychosynthesis they are not just theoretical constructs or models, but phenomenological realities. Each one has its own motivations and needs, often unconscious, and it tries to avoid frustration. Each one of them moves, in turns, towards the centre of consciousness, staking a claim to the empirical self and saying: "I". Even if they are only a portion of the whole personality, we can be totally identified with some of them. According to several psychosynthetic psychologists, Multiple Personality Disorder would be an exception of human condition only as a matter of degree, meaning that potentially, to a smaller degree, we are all affected by MPD, the difference being that in pathological cases subpersonalities are not aware of each other and of a unifying centre.

In Assagioli's words "subpersonalities are internal constructs developed through patterns of reactions to experiences of living and frustrated needs/wishes". Kenneth Sørensen [32] thought subpersonalities organized themselves around a need within the psyche, often related to Maslow's pyramid of needs. Other psychologists [15] suggest that they might arise as primal wounding, yielding a survival value. Independently of which factor psychologists consider the catalyst for the

emergence of subpersonalities, it is important to stress how their development it is not pathological but rather a normal state for all human beings.
The idea of subpersonalities is a way of conceptualizing how we shift from one identification to another as we move through life. In a single day we may move through playing "victim", "critic", "couch-potato", "striver", "lover", "frightened child" and so on. The kinds of subpersonalities that can exist within any one person can be infinitely variable and any taxonomy of types or psychodynamic mappings can be used to label them. Assagioli himself used several of Jung's archetypes to label subpersonalities, but it is just one of the several psychodynamic mappings that can be used to address behavioural aggregates.
A first attempt to integrate Damasio's somatic markers (or Pert's peptide network) and subpersonalities would lead towards a statement of this kind: subpersonalities emerge as conglomerate entities collecting isotopic and consistent somatic markers. When in the subconscious there are enough "automatic responses" and when these reflexes are consistent enough, they tend to coalesce as subpersonalities, each one of them with a predictable set of behavioural, emotional and rational patterns. Subpersonalities are not a-priori, platonic realities, but Gaussian distributions of somatic markers (or peptide networks) with some degree of consistency and arranged in clusters, that we chose to label in certain ways. At this point the definition of personality individuated in the introduction of this article would not apply to the whole person, but to each and every individual subpersonality. It is important to stress how each subpersonality contains its own set of values, belief structures, coping mechanisms, motivations, defining emotional sets (preferred or default emotional states), hard coded rational processes, ways of thinking, desires and needs to satisfy.
I have chosen to focus on psychosynthesis' theory of personality because it introduces and elaborates deeply the concept of subpersonality, which, as we will see later, is a pivotal concept when planning to design game worlds around a lexicon of player's personalities, furthermore it provides excellent mental tools when describing and comparing different psychodynamic mappings.

5 Unified theory of the player

Synthesizing the arguments set forth during the previous paragraphs I can attempt to sketch a unified draft for a functional model of how the player relates to the game world (see figure 2):
1 - When the player is immersed in the game world one of his/her subpersonalities is triggered and takes action, emanating a behaviour that is consistent and functional both in relation to the

environment and the emanating subpersonality. This behaviour informs the actions that the avatar is allowed to perform.

2 - Through behaviour the player intends to affect the game world, causing certain reactions. Said reactions could have been planned by the designer (scripting) or not (emergent gameplay). Avatar's actions are performed on the game world.

3 - Player's action on the world results in a perception that, once processed, leads to reflection.

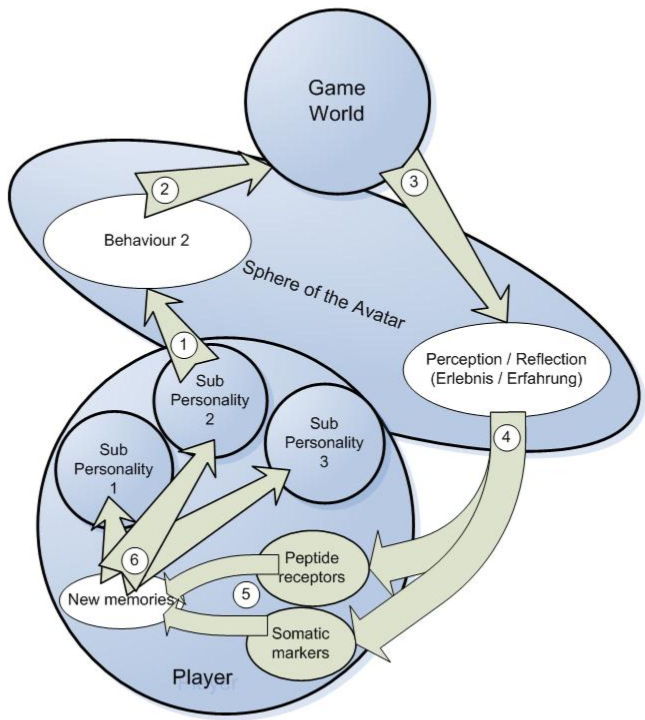

FIGURE 2 Unified theory of the player

4 - If the reflection is sufficiently emotionally charged (a potentially memorable experience) or repeated enough it will result in peptides being produced (Pert's theory) or somatic markers being set or reinforced (Damasio's theory).

5 - Either way both somatic markers and peptide receptors are held responsible for setting new emotional memories or confirming old ones.

6 - These new memories, if consistent with the existing catalogues of reflections, will reinforce the behavioural patters already present in the subpersonalities. If these new memories point instead towards discrepancies within the existing corpus, and if these discrepancies are repeated and reinforced enough, they might generate new subpersonalities. The purpose of this synthesis is to show how, although there is only one real player, there are several implied players. Paraphrasing Gerald Prince, implied player is "the model player that designers hypothetically address during the

conception of a game". These different implied players are manifestations of the subpersonalities that populate the real player. Ultimately the concept of implied player and target audience will need to be redefined in light of the fact that to one real player does not correspond only one consistent behaviour but instead a wealth of very different behavioural pattern can emerge from a single individual.

6 Designing for subpersonalities

Once we understand that the player can be motivated by a collection of varied subpersonalities (or types), it can be interesting to see if this implication can inform decisions regarding the design of game worlds.

6.1 Flow theory

The well-known flow diagram is a tool widely used in the game industry as well as in the research sector to describe successful gameplay or, in other words, how well a game's inner rules meet the player's needs. To achieve optimal experience, a balance is required between the challenges perceived in a given situation and the skills a person brings to that situation. A challenge includes "any opportunity for action that humans are able to respond to" [11]. Any possibility to which a skill corresponds can produce flow. If the perceived challenge is greater than the skills, the person will perceive anxiety or frustration. If however, the skills are greater than the challenge boredom will set in.

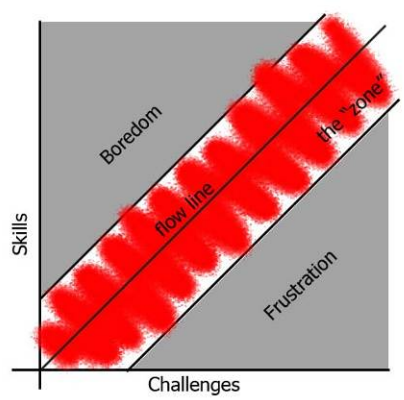

FIGURE 3 The flow diagram [11]

The scheme in figure 3 is derived from the nine characteristics of optimal experience listed earlier and it provides an explanation of what happens when players' needs are not met: if they encounter challenges for which they haven't developed skills they experience frustration and anxiety, while if the skills are excessive to the challenge at hand they experience boredom. To remain in flow (the flow line), one must increase the complexity of the activity by developing new skills to meet new challenges. The "zone" (highlighted in red) is the balance point between skill level and degree of challenge. It is an extremely useful tool to evaluate a-posteriori the experience of individual players but, as many critics have pointed out, players are not all the same, they have different needs, motivations and belief systems, furthermore, as we have just seen, each player embodies different "motivating" instances: the subpersonalities or types, and the power relation among them can change considerably due to the mood or circumstances. This requires the flow theory to be slightly amended.

6.2 Amendments to the flow theory

The first amendment that I'd like to incorporate is a minor but relevant one, instead of channeling the zone between two solid lines I suggest to mark the "zone" (shown as a blurred, fuzzy area of "enjoyable" experience in white color), by containing it at each side by "frustrating" (red) and "boring" (blue) experiences. This minor change (figure 4) takes into consideration the different levels of frustration/boredom that different players are willing to accept and even how the same player at different times is more or less determined to pursue game goals, overcoming more or less frustration and boredom according to which subpersonality has attained a dominant state. Although it is a small change it redefines the two forbidden areas in a fuzzy way, so that there still exist situations that potentially hinder the player's progression in the game, but the wished occurrences are expanded and the fringes can be exploited in a meaningful manner by game designers. To help understanding the following concepts I'd like to introduce the hypothetical subsections of a game level: the player starts in the basement of a hospital and has to make his/her way out through the 1st and 2nd floors, onto the roof and eventually outdoor.

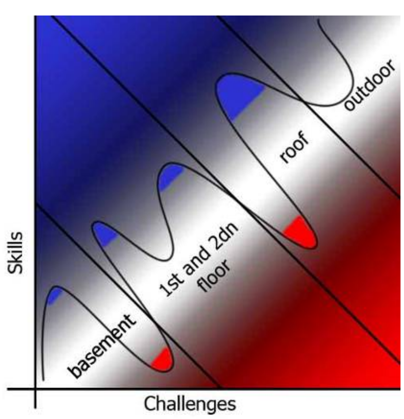

FIGURE 4 Soft edges for the "zone" and variety in the flow line

Following up the "soft edges" modification I'd like to stress the value of moderate levels of boredom and anxiety or frustration by changing the shape of the line describing optimal experience from straight to a curvier outline, incorporating to a certain degree some amount of boredom and frustration. Those moments of boredom and frustration should never be enough to actually enter the forbidden zone (solid colors), but enough to provide a change of pace in the progression along the sub-level spaces (basement, first and second floors, roof and outside a hypothetical hospital that serves as game level). In order to engender in the player memorable perception (erlebnis) it is not enough to enumerate a list of different emotions and try to trigger them because as it has been explained by Pert's work, it is unlikely that in different people the same event causes the same emotion to arise. Besides, as Olli Leino noted [20], it is pointless to pursue emotions per-se since they are often framed by intentionality and temporality. On the other hand, trying to build game worlds based only on player's needs, as suggested by Mark Hassenzahl [18] and the authors of "21st Century Game Design" [5], leaves out what Maslow called "self actualizing instances".

7 Types and Flow

That is why I suggest designing game worlds based on a consistently selected set of subpersonalities (or types), containing behavioural, emotional and rational patterns, motivations, desires and needs, belief systems, defining (default and preferred) emotional states and coping mechanisms. These types need to be fairly consistent with themselves and with the universe of the game. Considering subpersonality theory's openness when it comes to defining type-labels, game designers willing to try this approach will be prompted to select their own type taxonomy: the nine Enneagrams [37], the sixteen MBTI [38] or even the twelve types indicated by the zodiacal signs. As an example I am going to make use of Bartle's types [4]. The core idea is first of all to select among all the possible types some that present consistencies, and then to orchestrate flow curves for each type throughout all the sub-level spaces. In this specific example I chose to work with Bartle's four types, this means that the general assumption is that the same player might enjoy switching among the four different modality of play (killer, achiever, socializer and explorer) even during the same game session. I am aware that few players would switch mode of play so radically as to cover the entire spectrum of a given taxonomy, even more so in the relatively brief span of a single game session, but I feel that some amount of exaggeration and simplification are needed to explain the implication of this design method.

7.1 Explorer's path

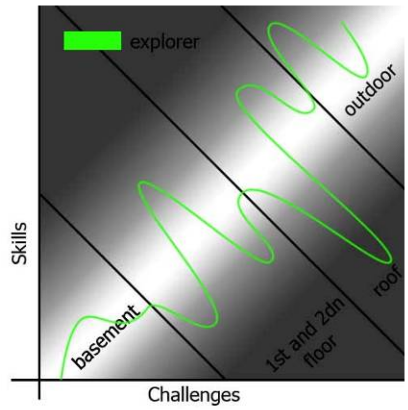

FIGURE 5 Explorer's flow

Planning the flow for the "explorer" (figure 5) subpersonality, the designer might want to start the level by providing the player with means to easily impersonate this type while in the basement. As soon as the player enters the first floor the designer has prepared a mild moment of anxiety followed by a quick change towards boredom between the first and the second floor. The second floor starts with mild frustration only to bring the player again towards a good exploring experience. The roof section becomes impossible to be played as an explorer since there is a moment of exasperated anxiety in the forbidden zone. The closing act of the level sees the player enabled to act again as an explorer, albeit with a certain amount of slow pace. All of this assuming that the player wants to play the level as an explorer espousing the type's behaviour, motivations, desires, needs and belief system.

7.2 Killer's path

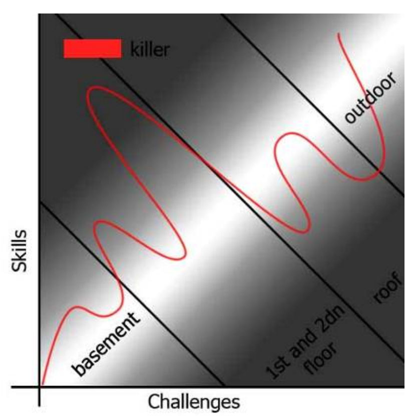

FIGURE 6 Killer's flow

Similarly the designer can prepare a path for the killer (figure 6) profile starting off easily in the basement. In the first and second floor the player will find that it becomes harder and almost impossible to continue pursuing the killing career since the curve describes a moment of boredom beyond the forbidden zone (maybe nobody to kill?). The roof proves to be a good killing ground, although it can be harder at times, closing the level with a perfect in-flow killing spree in the outdoor section.

7.3 Socializer’s path

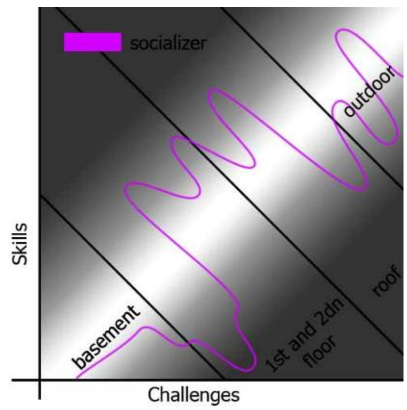

FIGURE 7 Socializer’s flow

Also for the socializer profile (figure 7) the designer prepared an easy start, but it ends soon since already in the first floor the player will be frustrated in his/her attempt to pursue this line of behaviour. Both the roof and the outdoor sections easily allow the player to socialize even if with some swings from very mild boredom to very mild anxiety.

7.4 Achiever’s path

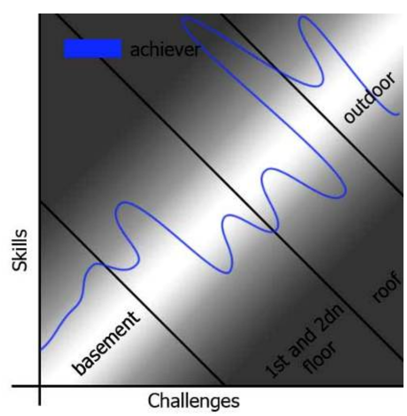

FIGURE 8 Achiever’s flow

For the achiever (figure 8) the designer has prepared a slightly tougher start than for the other types, but the player will be able to follow through in his/her intention to achieve until the end of the roof section, where he/she will find out that it becomes impossible to progress in the game and finish the level unless he/she changes the course of action.

8 Conclusions

The full scope and significance of the planning operated until now becomes visible only when the four type-curves described previously are overlaid (figure 9).

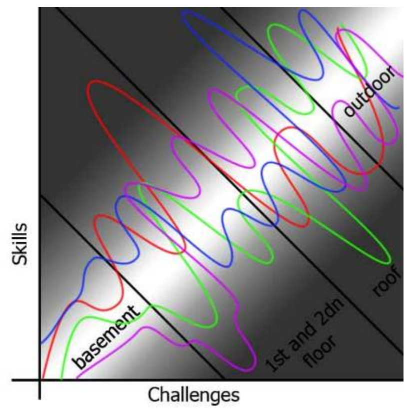

FIGURE 9 Synthetic flow

It is in fact in the movement of the player from one type to the other, playing the same game but in different modes, that the role of the designer becomes clear: he/she is not a mere dealer of rewards and punishments disseminating challenges and skills for a general undistinguished "audience" but a crafter, an orchestrator of experiences, a weaver of playing modes.

The player can in fact choose to play other roles, change mode of play and approach whenever the current line of actions becomes more tedious (or frustrating) than he/she is willing to accept.

I should mention that I exaggerated on purpose the four curves including for each one of them a segment in the forbidden zone; this was just to show the possibility of forcing the player to change to a different type and playing mode. It is not necessary to break the flow in such an abrupt way. This methodology applies independently from the set of past experiences that generated the subpersonalities since its only concern is the end result. The flow diagram is no longer just a tool used to evaluate a posteriori the experience of players, but a precious tool in the design phase and an even sharper, more granular one when comparing goals set in the planning phase and results achieved by the player in terms of enjoyment.

Nevertheless this model can never substitute the iterative process intrinsic to any successful level design as it cannot substitute players testing. I feel it is important to stress how this method does not claim to make accurate predictions on players' behaviour, but it provides more than an inspiration or an error proofing tool: it provides a way to plan and design levels thinking concretely in terms of what kind of experience the players are likely to have and to offer them alternatives consistent with the game world.

The benefit of designing game worlds by interweaving possible experiences becomes apparent thanks to the multifaceted aspect of personality exposed by the psychosynthetic approach and the valence of emotionally tagged reflective experiences.

Further attention will need to be given to a granular categorization of playing modalities according to different parameters: motivations, needs, behaviour, system of values, desires, fears, belief structures, coping mechanisms, defining emotional sets (preferred or default emotional states), hard coded rational processes and ways of thinking.

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ARTICLE 2 - DESIGNING LEVELS FOR ENHANCED PLAYER EXPERIENCE: COGNITIVE TOOLS FOR GAME WORLD DESIGNERS

Article published in GameFace magazine (June/July 2007) and also presented at Cybergames 2007 conference at Manchester Metropolitan University. The paper was also accepted at Futureplay 2007 (ACM conference), but due to a lack of funding I could not participate. Originally the article grew out of a lecture presented at Nordic Game 2007.

Abstract

What is exactly level design? It is juggling 12 balls in the air at the same time, it is solving differential equations with 12 variables, it is trying to realize a vision when everybody is tearing at it. Artists, programmers, marketing PRs, scripters, designers. People from very different backgrounds and with even more varying motivations converge with their vital contributions and it is up to the level designer to manage all of these different issues and create a memorable playing experience. It is not a mystery that the role and tasks of a level designer are the most difficult to describe in a few words. Paraphrasing Elvis Costello "talking about level design is like dancing about architecture". And yet a sentence that I hear confirmed more and more every day is: "Level designers create experiences by providing spaces for players to act." Players act in a space that causes experience to emerge and this experience affects the players, closing the magic circle (see figure 1).

Keywords

Game worlds, level design, aesthetics, ludology, phenomenology, engagement, Flow, Play-modes, Emot-emes, Play-personas.

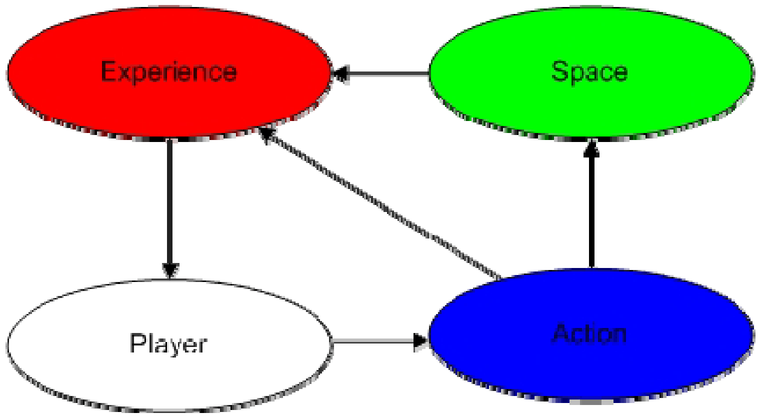

Fig. 1 Player, action, space and experience

1 INTRODUCTION

The sentence "level designers create experiences by providing spaces for players to act" was synthesized starting from the concepts of evocative spaces and acted stories as outlined by Henry Jenkins in his article "Game Design as Narrative Architecture" [2]. Taking into consideration players when designing levels means to a greater extent avoiding the dangers of solipsistic design: games where the designers have most of the fun, where players feel constrained, on rails and in general have difficulty buying into the game world. I will try to read and deconstruct an existing game level using these analytical tools: spaces, actions and experiences.

By spaces I mean every element of the location that can be experienced through the senses: architectural elements, shapes, textures, lights, sounds, even the underlying narrative. As Don Carson says "it is the physical space that does much of the work of conveying the story the designers are trying to tell" [1]. It is the domain of aesthetics, the study of sensori-emotional values.

By actions I mean all the events, game mechanics, possible interactions, Ludo-types. It is the domain of ludology, the study of games in terms of rules, interface, and in terms of the concept of play. "The focus of such study should be on the rules of the game, not on the representational or mimetic elements which are only incidental." [3]

By experiences I mean Emot-emes, play-modes, play-personas, it falls under the wide umbrella of phenomenology, a current in philosophy that takes experience as its starting point and tries to extract its essential features.

2 STRUCTURE OF A GAME LEVEL

The first step in our analysis is to segment a game level and individuate its sub-sections. A sub-section is defined as a contiguous, uninterrupted, isotopic space that shares aesthetic, ludic and phenomenological features. After the level has been divided in subsections it will be easier to apply the three different filters I discussed earlier: aesthetic, ludic and phenomenological. As an example I am going to use the second level ("A vintage year") from the game "Hitman - Blood Money" [5]. A brief introduction to the level: Codename 47 has to get rid of Fernando Delgado, a retired colonel from Pinochet's intelligence service, who is now running a vineyard in Chile. While the vineyard provides him with a decent income it is his cocaine factory that really brings in the cash. In order to make the hit look like an attack on the drug trade, 47 also needs to kill his son Manuel Delgado, cocaine addict and partner in crime. The escape route is provided by a sea plane. The individuated subsections are: "Outdoor open", "Party", "Loading area", "Hacienda", "Wine cellar", "Drug lab" and "Hangar" (see figure 2).

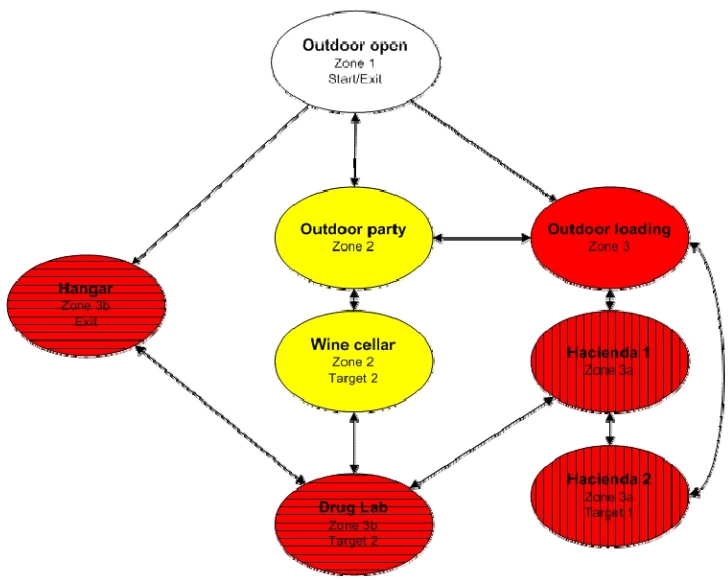

Fig. 2 Sub-sections and relative connections

The analysis of a level is structured in three parts: aesthetic analysis (histograms, symbolical reading and architectural deconstruction), ludic analysis (rules and mechanics, tools for interaction) and phenomenological analysis (play-modes, emot-emes and play-personas).

3 AESTHETIC ANALYSIS

3.1 Histograms

For each subsection a 360 deg. panorama is taken. If it is an enclosed area, a panorama picture would not be very representative; instead a screenshot is taken every 5 seconds during a walk of the area. The images are edited together in a strip of fixed size (see figure 3) and analyzed with the histogram tool in Photoshop.

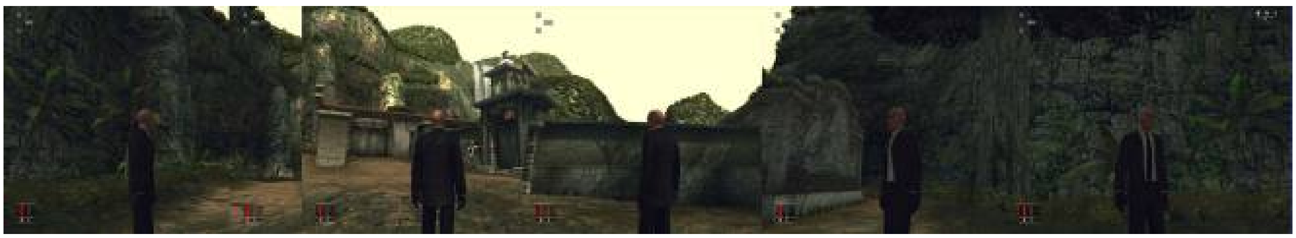

Fig. 3 strip ready for histogram

The histogram tool gives us information about the average luminosity and colour dominance of each subsection (see figure 4).

As expected the outdoor sections are the brightest, but there is a surprise: the loading zone, the most guarded and dangerous subsection is the brightest area, possibly to induce a false sense of security. To underline Fernando's rank the second floor of the hacienda is fairly bright for an indoor scene and the rooms where he is located, with their balconies and open windows, are the brightest of all. Unexpectedly the first floor of the hacienda is even darker than the wine cellar, but this makes it easier to sneak around, enhancing the stealth feeling.

	luminosity	red	green	blue
outdoor open	61,96	61,76	**63,8**	52,54
outdoor party	58,43	**60,11**	59,59	47,63
outdoor loading	65,96	**69,2**	66,73	53,07
hacienda 1	30,31	**34,36**	28,25	30,78
hacienda 2	37,17	**41,35**	35,43	35,63
wine cellar	31,09	**40,1**	27,2	27,41
drug lab	42,87	**48,33**	40,93	38,81
hangar	38,53	37,58	**39,55**	35,5

Fig. 4 Comparative chart of luminosity and color dominance

The generally warm palette (red dominance in 6 out of 8 sections) is motivated by the hot and dusty South American atmosphere and reinforced by the motif permeating the whole level: wine. The green lush exotic forest accounts for the green component of the outdoor open area, while stagnating water, mould and musk explain the hangar.

3.2 Symbolical Reading

The movement between father and son is inevitably a vertical one (see figure 5). The father is located in the highest section of the map, while the son is in the lower areas: the drug lab and the wine cellar. Don Fernando's corruption is so old and inveterate that it becomes almost respectable. Hints are the dusty, neglected environments and at the same time the tasteful décor, the collection of old prints and the old man's hobbies: playing music, collecting butterflies and wine tasting. The son on the other hand dwells in the lower "dungeons" of the farm. He is decadent and depraved, has a strong coke problem and spends his time water-skiing, playing tennis or downloading porn from the internet. His environment is damp, rotten, old and dark. Independently from what hit the player chooses first, there will be a descending or an ascending movement that, even unconsciously, will be registered.

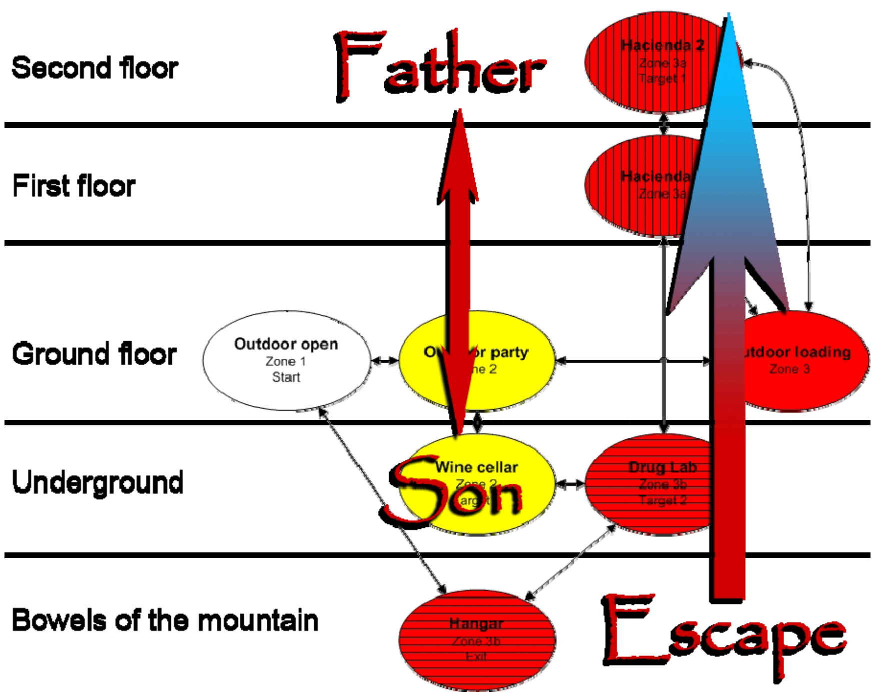

Fig. 5 Symbolical reading

The escape is even more symbolically loaded because it is through a sea plane located in the deepest location of the map, in a dark, moist, damp recess close by the waterfall. The player has to descend even more into the bowels of the farm in order to escape through an air route with the waterfall as a backdrop: an ascending movement accompanied by the subliminally cleansing power of water. The last comment regards the whole mansion: it is built on the very edge of a high cliff top, very dramatic but also very "unstable": the roots of this old family mansion are undermined by the risky business of the drug trade.

4 ARCHITECTURAL ANALYSIS

4.1 Macro Circulation Patterns

Players express themselves by picking a path. Keeping track of the possibilities given to the player to move, holds a wealth of information regarding the ways a level can be played. Examining Macro Circulation Patterns means analyzing all the possible access points to and from each subsection. As an example I am going to look at the "Outdoor open" section. From here the player can chose to crash the party (1), infiltrate the loading zone (2) or sneak into the hangar (3).

1) Crashing the party will inevitably mean mingling with the tourists and partygoers; the player has two routes to enter the party, each with different implications:

- through the main gate; it is the easiest path, it involves good visual feedback, nothing is compromised, no disguise is needed, there is no risk;
- through a service door; it implies a sneaky approach and could lead to the acquisition of a guard or worker disguise; little risk is involved;

Both paths could lead to the wow moment "Utility Box" in the guard house. By breaking some electrical fuses the player can manipulate the light distracting the guards and obtain their disguise, which grants easy access to the loading area.

2) A second choice is to head directly for the loading area where the mansion is clearly visible and obviously pointing towards the fact that our main target is in there:

- through the truck entrance; suicidal, very difficult sneaky approach and nearly impossible frontal assault;
- through a broken wall; suicidal, quite difficult sneaky approach; eventually requires disguise;
- through a crashed truck and hole in the roof; the designer prepared this approach as a preferential entrance; it rewards brains (observation of hole in roof) and brawn (climbing moments); it provides a choice of two disguises (guard or worker) and it incorporates the wow moment "Broken Roof";
- through a service door and then straight over some boxes; fairly easy entry and easy acquisition of worker disguise; good visual feedback in terms of climb animations but hard progression due to the high security area.

3) The third possible path takes us through a steep, winding path down into the hangar, allowing us to access the farm rising from the bowels of the earth:

- exploring the jungle, through a downhill path before the drop-off; definitely rewarding exploration, important sneaking moment passing by a guard in jungle.

The hangar is open for workers and it leads to the wow moment "The Lift", where we have the possibility to ambush and strangle a VIP guard. Acquiring his disguise guarantees access everywhere in the farm.

4.2 Micro Circulation Patterns

A closer exam to "Micro Circulation Patterns" tells us how the player can move within a section (see figure 6). There are four types of constraints or choke points:

- architectonical (walls, doors, gates etc); static choke points
- security zones, the player requires a disguise to move freely into higher security zones: modal choke points
- guards standing in critical positions to block access to certain areas unless disguised; modal choke points
- patrolling guards represent dynamic choke points, meaning that there are no absolutely safe paths, but only dynamic, changing safe paths.

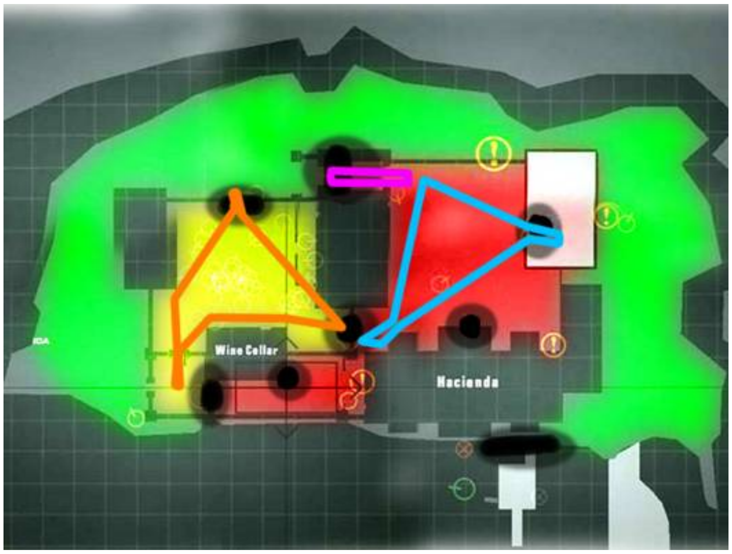

Fig. 6 Micro Circulation Patterns: architectonical choke point (black), security zones (red yellow green), patrolling guards (orange, pink and blue)

4.3 Landmarks

Landmarks are graphical, functional elements or traits that are mostly visible everywhere from within a section of the level and provide a visual/mental backdrop to the action and cues both for physical orientation and planning the next move. For the "Outdoor open" area it is the perimeter wall, constantly providing a blocking challenge to overcome (literally). For the "Party" area it is the cellar entrance, the party revolves around it and the two big doors beckon the player to cross the threshold. For the "Loading" area it is the mansion. Leaning over the yard, it is a symbol of the whole mission: grand, once magnificent and baroque from the outside but decaying from the inside, it reminds us of past glories much alike the father himself, a once respected general but now drug producer. For the "Wine cellar" it is the barrels, they don't exactly point towards an objective but represent the whole duplicity of the cover winemaking operation under which the real business happens. The metaphor becomes real when we notice that a big barrel conceals the secret entrance to the drug lab. In the "Drug lab" the landmark is the big percolator tank, while in the "Hangar" it is the water plane, physical way out and metaphysical symbol of cleansing.

5 LUDIC ANALYSIS

If players express themselves almost unconsciously by navigating the game world, they do it completely openly by choosing how to interact with it. "Hitman – Blood Money" provides plenty of tools to negotiate interactions with the NPCs: distracting, disabling, killing and for each type of interaction there are several ways to accomplish it. Collecting this kind of information and triangulating it with the possible paths chosen by the player will help the designers understand what kind of experiences players are after and what they actually get from playing the game.

5.1 Tools for the player

The designers embodied "play-values" [4] in a system of rules that eventually translated into the set of tools that players can use to express behaviour in the game world.

Security zones: the player cannot walk indiscriminately around the level; some areas allow only certain types of people, creating progressively restricted areas, therefore disguises are rated accordingly to the security they grant.

Disguises: the player can change disguise stealing them from unsuspecting NPCs, drag the bodies of the victims and dispose of them as he/she see fit.

Close combat: the player is given a wide arsenal of moves to negotiate close combat: head butt, punch, disarming, concealing weapon, fiber wiring, elevator ambush, knives (slashing and throwing), narcotic and poison syringes, human shielding and pushing.

Agility moves: the player can jump walls and balconies, climb through windows, walk ledges, climb drainpipes and ladders.

Breaking in: there are many tools to earning access to restricted areas, such as spying from far away with binoculars, observing NPC's patterns of movement in the maps, talking to NPCs to gather info, spying through keyholes, lock-picking, using keycards, shooting locks and hiding in closets.

Distracting: it is also possible to disable NPCs is non-confrontational manner by throwing a coin or manipulating lights.

Bomb: the player has, at all times, access to a small bomb with which can kill NPCs by direct explosion or secondary effect of explosion (accidents such as falling objects or exploiting environment).

5.2 Kill Fernando & Manuel

To see how all the tools can be put to use in the game I am going to list all the locations where our two targets dwell and all the modalities that are available to the player when planning the hit on Fernando Delgado (see figure 7) and Manuel Delgado (see figure 8).

Kill don Fernando Delgado

Location/type	accident (push)	accident (bomb)	accident (sedate&throw)	accident (poisoning)	accident (hostage&throw)	close combat (wire)	close combat (knife)	explosion (bomb)	sniper
second floor piano room			X			X	X	X	X
second floor central sitting room	X			X		X	X	X	X
second floor top of staicase					X				

Fig. 7 Possibilities to kill Fernando Delgado

Kill Manuel Delgado

Location/type	accident (push)	accident (bomb)	accident (sedate&throw)	accident (poisoning)	accident (hostage&throw)	close combat (wire)	close combat (knife)	explosion (bomb)	sniper
under the barrels in the wine cellar		X				X	X	X	
steps leading down the wine cellar	X					X	X	X	
ground level entrance room of the wine cellar			X					X	
central room with desk in wine cellar			X	X		X	X	X	
hallway between central room and steps						X	X	X	
"secret barrel" entrance to drug lab						X	X	X	
hallway between "secret barrel" entrance to drug lab						X	X	X	
courtyard in front of wine cellar entrance				X				X	X

Fig. 8 Possibilities to kill Manuel Delgado

6 PHENOMENOLOGICAL ANALYSIS

6.1 Play-Modes

Looking at the data harvested during the aesthetical and ludic analysis allows us to make assumptions about “play-modes”. Play-modes are preferential attitudes towards navigation of the world and interaction with characters. There are four navigation attitudes emerging:

- BRAWN, physical prowess, climbing, making use of force, always moving
- BRAIN, observation skills, finding holes in the surveillance system, patterning behaviours, waiting
- ROLE PLAYING, dressing up like other characters and acting the part
- HIDING/SNEAKING, keeping the suit, walking in shadows (and closets)

The interaction attitudes are structured according to four binary variables (see figure 9):

- Lethal / non-lethal
- Silent / loud
- Clean / bloody
- Single / multiple effect

Playing modes (interact with NPCs)

Type/attributes	Non Lethal	Lethal	Silent	Loud	Clean	Bloody	Single	Multiple
Distraction (coin, light)	X		X		X			X
Knock Out	X			X		X	X	
Sedative	X		X		X		X	
Accident (push, poison)		X	X		X		X	
Accident (bomb)		X		X		X		X
Close Combat (knife)		X	X			X	X	
Close Combat (wire)		X	X		X		X	
Explosion blast		X		X		X		X
Sniper		X		X	X		X	
Gunshot		X		X		X	X	

Fig. 9 Play-modes

Each one of these playing modes triggers some basic emotional response in the player. Emot-emes, or basic emotions, are emotions that are impossible to deconstruct further. When a player behaves consistently in the game he/she uses only play-modes that share a similar pattern of emot-emes: the player identifies completely with a certain profile.

6.2 Play-Personas

I am going to define these consistent profiles "play-personas". In spite of the fact that players tend to mix play-modes, it is clear that the designers themselves acknowledge the possibility to play out a persona since they reward the "Silent Assassin". Playing as the Silent Assassin means only killing the target and getting out with the suit. All targets should preferably die by "accident". Beside the Silent Assassin, looking at the play-modes shows other possible play-personas emerging:

THE BUTCHER: up, close and personal. Did I mention he likes it bloody?

THE SNIPER: this persona loves to camp and take out the victim from far away.

DIRTY HARRY: a gun-toting extrovert that relates mostly to lead-ridden bodies.

THE PARTY ANIMAL: also known as "the transvestite", he likes nothing more than changing outfits.

THE SHADOW: sticking to stealth movements.

UNABOMBER: not satisfied unless it involves explosions.

IN-AND-OUT: rushing through as fast as possible, the keyword is speed.

SAM FISHER: the main priority is to show off cool animations as much as possible.

THE AESTHETE: inconsistently looking for "interesting" scenarios.

The game designers did not plan the level for them. As I found out comparing internal design documents and walkthroughs on the net, they might not even have been aware of all the play-modes. These personas emerged from the tools that the players were given. Play-personas provide ways to customize the playing experience and allow players to express themselves with no additional cost, requiring no redundancy of assets or expensive adaptive technology.

7 FROM ANALYSIS TO DESIGN

The analytical work operated until now on an existing game level has definitely helped recognizing players' behavioural patterns and has its uses as a tool for evaluating the success of a level by comparing goals set by the designers with the actual experiences that players are having. But the real impact of this method can be fully appreciated if it is applied from the beginning in order to proficiently plan, orchestrate and map out player experiences in the level. Now how can we use the mental tools defined so far to actually help in the design phase of making levels instead of just an evaluation tool? EmSense, a San Francisco-based company, was hired by Epic Games to help fine-tuning the level design for the game "Gears of War". What they did was to turn Csikszentmihalyi's Flow diagram 45 degrees and chart on it the biological feedback of people playing the game. They asked players to wear a head band that can record EEG, skin conductivity response, heart rate and blood pressure. Through their patented algorithms they turned the raw data into an engagement graph so the designers could watch a video of the playing session and spot when the player was exceedingly frustrated or bored and eventually adjust the layout of the level to fix problems (see figure 10).

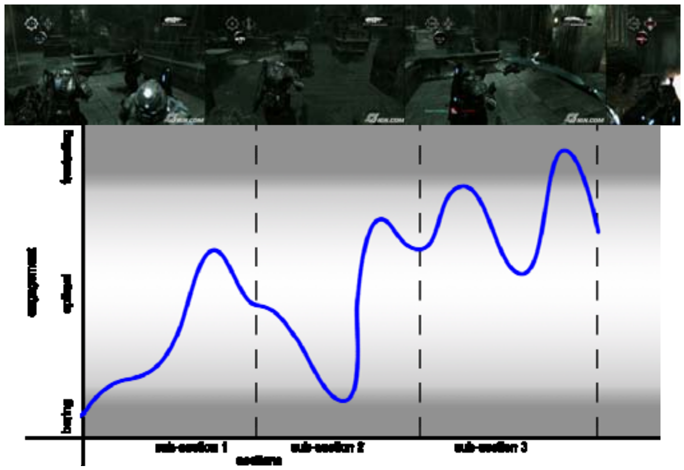

Fig. 10 Emsense's engagement Flow

7.1 Weaving Play-Personas

I suggest reversing this approach and making use of hypothetical engagement curves from the very beginning to chart out the potential player experiences, as shown in figure 11. This has to be done not for just one play-persona, but for all the ones that the designers want to include in the phenomenological set of the game. As an example let's assume that beside the Silent Assassin the designers also chose to reward other play-personas and accommodate for them in the design of the level.

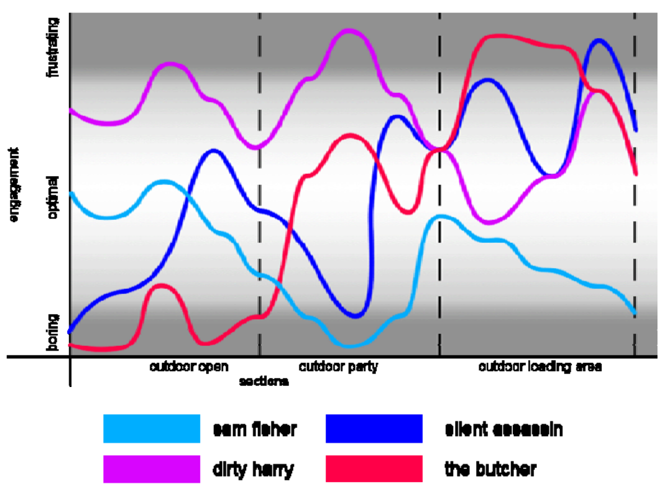

Fig. 11 Pre-emptive Persona paths.

The Butcher persona would have quite a boring experience if he wants to see blood at the beginning of the first section, but as soon as another NPC enters the area there would be something to be butchered. The Party would provide a perfect backdrop for a bloodbath while in the outdoor loading area things will get extremely tricky since the guards clearly overpower the player. The Sam Fisher persona will have a lot of chances to show off his physical prowess in the open, while his gymnastic abilities will not be much used at the party, he will have to wait to enter the loading area for some more occasions to show off.

Players might choose to move from one persona to the other when it gets too difficult or too boring to maintain a profile, or just change for the sake of it.

8 CONCLUSIONS

The role of the designer is no longer limited to dealing rewards and punishments, disseminating challenges and skills for a general undifferentiated audience. The designer is now an orchestrator of experiences, a weaver of play-modes, a pimp of personas.

These tools can help during the preproduction phase of level design by informing the realization of aesthetical and ludic categories and sharpening the production of the level. As a consequence the time spent in different iterations with player testing can be considerably shortened. Nevertheless this model can't substitute the iterative process intrinsic to any successful level design as it cannot substitute play-testing. I feel it is important to stress how this method does not claim to make accurate predictions on players' behaviour, but it represents much more than an inspiration or an error proofing tool: it provides a way to plan and design levels thinking concretely in terms of what kind of experience the players are likely to want and to offer them alternatives consistent with the game world.

9 ACKNOWLEDGMENTS

I would like to thank the gaming community as a whole because I made extensive use of walkthroughs and guides written by very skilled players, much better than me anyway. I have played this level many times but without the help of the gaming community I would not have been able to complete this analysis so thoroughly, although I did manage to kill the party (quite literally) by poisoning a glass of wine. I also am in debt towards IO's designers that allowed me access to internal documentation material and, most importantly, their precious brains.

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ARTICLE 3 - WAVING EXPERIENCES: PLAY VALUES, PLAY MODES AND PLAY PERSONAS

Article accepted by the Australasian conference Interactive Entertainment 2007, due to lack of funding I could not participate.

Abstract

This paper proposes basic procedures and core concepts with the intent of designing single player action games that without necessitating expensive adaptive technologies allow players to express themselves.

The method applied is partly inductive, leaning on empirical observations in the QA department of a game developer studio and partly deductive, deriving concepts, frameworks and core ideas from established research in user-generated content and player-enjoyment.

The purpose of this research is to draft guidelines and possible pre-production pipelines for level designers in order to achieve maximum consistency in scope, production values and artistic expression, and at the same time provide a focused yet diversified players' experience.

The ideas presented here stem from a co-operation between the renowned game development studio, IO Interactive, and the design-oriented research institute, Denmark's School of Design.

Keywords

Game worlds, level design, play-values, play-modes, play-personas, player experience.

1 INTRODUCTION

As Sanders correctly pointed out [10] all efforts aimed at engendering defined experiences are doomed to failure since experiences and emotional responses alike are too individual, subjective and rooted in people's past to be able to scientifically aim at re-producing them. Yet today's tendency towards mass customization, as shown by Bozek [1] cannot be disregarded by game creators. A failure to incorporate means for mass customization could risk alienating the large majority of people that, thanks to the developments introduced by Web 2.0 [14], are becoming more and more acquainted with the practice of expressing themselves at almost every occasion: from Myspace to Wikipedia.

As a possible way out from this impasse, Sanders suggests that "Designers will transform from being designers of "stuff" (e.g., products, communication pieces, etc.) to being the builders of scaffolds for experiencing." [11]. She understands scaffoldings as "temporary and moveable structures for building enormous new things, but also for protecting the surrounding area from the new construction. Scaffolds provide support for the workers and their tools and materials".

Translating this concept to the field of game design, I intend to expand, introduce granularity and flesh out the "scaffolding" by sub-dividing it in four phases and renaming them aptly to fit the process they are meant to describe: the facilitation of player expression within the framework of a game that is not necessarily open-ended.

The four phases I suggest are: play-values, play-modes, play-styles and play-personas (see figure 1).

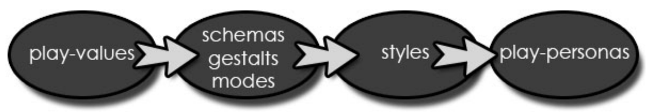

Fig. 1 Play-values, schemas, styles and personas

The starting point in defining the scaffolding is represented by what Zimmerman calls "Play-values": the abstract principles that the game's design, both aesthetic and functional, should embody [13].

These play-values will consequently inform the inception of game play modes, gestalts and schemas. Lindley individuated gestalts and schemas during his quest for interactive storytelling [6, 7]. He understands game play gestalts as patterns of interaction between player and game. He then goes on to define game play schemas as cognitive structures that underlie and facilitate the above mentioned interaction.

Play-modes are the resulting sets of all possible navigation and interaction attitudes that players can utilize to negotiate any given situation. All the game features that motivate, facilitate and constrain player action, offer the players a certain set of methods of operation within the game.

Play-styles are consistent sets of isotopic play-modes which signify, unify or distinguish players from each other. Styles need not to be consistent, implying that players can change style at a whim and select a radically different set of play-modes. If, on the other hand, a player chooses to maintain a certain style, he/she will start identifying with a defined, implied play-persona.

Play-personas are mental constructs that allow the player to identify his/her own behaviour with prototypical profiles. The logic of these play-personas is the same that governs Max Weber's "ideal types" [12]. Personas are constructs that players build to unify their own actions and to make sense of them. It is the player's implied narrative tool. When a player refers his/her own adventures during a game encounter it often reads: "… and then I did this and then this happened", etc… it is clear that this "I" is not the player him/herself but a role that he/she is playing. If players tell themselves these stories, why can't designers plan and create games that accommodate for a (consistent) variety of them?

Summarizing the four-layered structure of the game-scaffolding: play-values, the first layer, inform and inspire the inception of the second layer (gestalts, schemas and modes), the second layer articulates into play-styles (third layer) and, if maintained consistently enough, they eventually coalesce as play-personas (fourth layer). It is my purpose to show how designing around play-personas allows players to express themselves, their individuality and their personality even within the boundaries of fairly linear games, hence negating the necessity of asset redundancy, multiple paths, branching or resource-intensive adaptive technology.

2 PRACTICAL APPLICATIONS

The initial step of the research was to investigate whether the developers at IO Interactive responsible for the game and level design were already making use of the concepts listed above, even unconsciously. Obviously the main goal was to check if these terms (or synonyms of the terms) were playing a significant role in the communication between designers, artists, programmers and level-scripters. In order to gather this kind of information, I utilized written game design documentation, direct interviews (DI), and audio recordings of internal review meetings. Armed with this data, I could make assumptions regarding the overall design of the game as a system, and on a smaller scale, to see if they influenced the functional and artistic development of the game levels.

Secondly it was very interesting for me to try to identify the four layers of the scaffolding in a game currently under development at IOI, independently of whether the designers made conscious use of the terms or not. I reviewed material at very different stages: from the earliest game concept to the finished documentation, from first playable prototypes to the finished game with the purpose of charting the evolution of the scaffolding and its implications for the final product.

The game I chose to investigate was Kane & Lynch [5]; a team-based third person action game with strong narrative elements involving a flawed mercenary and a medicated psychopath. It is going to be released in the fourth quarter of 2007; this implies that the timing for this research is perfect in order to obtain an in-depth snapshot of the production process at all its stages. There is in fact plenty of design and concept material from the inception of the game to the final specifications. Furthermore, the game being in its final stages, means that it is almost fully playable and at the same time I have the chance to observe several review meetings first-hand. Another reason to motivate my choice is that, contrarily to other games developed at IO Interactive, Kane & Lynch is much more linear, focusing on a very strong narrative beside attempting to refresh the squad-based shooter genre. This means that if the "scaffolding" theory proves itself fruitful in this game, it will be even more relevant in less linear games. The last consideration goes to the fact that not being the game completely finalized, some of the details discussed here might be changed at the last moment before release.

3 PLAY-VALUES

As mentioned earlier, play-values are the abstract principles that the game design will embody. For example, the values that Zimmerman mentioned behind his SiSSYFiGHT 2000 [13] are:

- reaching a broad audience;
- not requiring a powerful computer to play;
- a game that is easy to learn and play yet deep and complex;
- mechanics that foster social interplay;
- a smart and ironic look and setting.

When confronted directly, the designers behind Kane & Lynch acknowledged immediately the term play-values, pointing out that the term used in-house was "goals" and informed me that they consciously spent time and resources defining aesthetic, narrative and functional goals for each single level but did not formalize them for the overall arc of the game experience. Nevertheless, reading the background story and the profile of the characters, I immediately recognized the overall goals lurking between the pages describing the flow of the game and the story.

The main character, Kane, is described morally as both light and dark, battle-hardened but with a strong sense of style, ruthless in fending for his life but with strong values of honor and family, physically fit but smoking too much. He has learnt not to trust anybody the hard way and now he's been paired with a partner he strongly dislikes, Lynch, to carry out a mission that he feels is deeply wrong but is unavoidable if he wishes to save his family. It is a character built entirely on contradictions and strong themes, right and wrong are never clearly separated and the story arcs are never fully accomplished. This attempt to dodge more mainstream and Manichean solutions results in the relatively easy task of confirming whether these values are transferred to the successive layers of the scaffolding for experiencing.

The Narrative Play-Values (NPV) identified are:

- NPV1: the revenge of an underdog facing overwhelming odds forced into trusting untrustworthy allies. Importance of the "fragile alliance"[5].
- NPV2: a highly moral man cast by misfortune in a highly immoral environment, trying to do right by doing wrong.
- NPV3: the main hero is a man that loves his daughter, a legendary mercenary and possibly a traitor.

Functional Play-Values (FPV) are:

- FPV1: action, emphasis on fighting rather than opening doors or operating equipment.
- FPV2: simplicity, to support a fast paced game play and to increase the appeal to console gamers commands need to be very simple.
- FPV3: creativity, players should have the freedom to creatively use tactics in varied ways to engage the enemy

As expected, narrative play-values mainly informed the flow of the action and the structure of the tasks and missions of the different levels in the game, while functional play-values dictated the choices made by the designers while defining play-modes, so far confirming the hypotheses laid out in the scaffolding theory.

4 PLAY- MODES, SCHEMAS AND GESTALTS

As mentioned earlier play-modes are each and every one of the rules of the game, all the actions available to the player while playing a game.

Play-schemas are the mental models that players utilize to understand the context and represent their actions. According to Lindley, they are "cognitive structures that link declarative (or factual) and procedural (or performative) knowledge together with other cognitive resources (such as memory, attention, perception, etc.) in patterns that facilitate the manifestation of appropriate actions" [8].

[5] Fragile alliance is a multiplayer mode that sees several players cooperating to pull off a bank heist, with the possibility at any point in time, to betray partners for a bigger share of the stash.

Lindley defines play-gestalts as patterns of interaction between a player and the game, they are usable subsets of all the game rules and features; they represent a possible minimum set of rules that are necessary to successfully support a particular playing style [7] and progress in the game. When presented with these concepts the designers recognized only play-modes and explained that they are addressed internally as “mechanics” or “features”. Reading the game design documents I discovered two distinct groups of play-modes: actions performed by the player on the game world (the avatar, the environment and other NPC) and actions performed by the player on the crew of mercenaries that follow the avatar.

World play-modes:	**Shooting play-modes:**	**Crew play-modes**
Walk	Selecting weapons	Ammo request
Run	Blind fire mode	Shoot at
Sprint	3rd person mode	Go there
Crouch	Single shot	Follow me
Sneak	Full auto	Crew member heal
Climb	Sniping	Crew member select
Rappel	Bare hands combat	
Cover	Push-blade combat	
Pick up	Throwing grenades	
Healing		
Context-sensitive actions		

Observing testers playing, talking to each other and conducting direct interviews allowed me to group these play modes in schemas, here are the individuated schemas for player actions:

- Movement (walk, run, crouch, pick up) design affected by FPV2
- Action movement (climb, sneak, sprint, rappel, cover, context sensitive actions, healing, using equipment) design affected by FPV1
- Basic ranged combat (3rd person mode, single shot, selecting weapons) design affected by FPV2
- Advanced ranged combat (over the shoulder mode, full auto, throwing grenades, variable modal accuracy, sniping, swapping weapons) design affected by FPV1
- Basic close combat (bare hands) heavily influenced by both FPV1 and 2
- Advanced close combat (push-blade) heavily influenced by both FPV1 and 2

Crew actions schemas are:

- Squad command (shoot at, go there, follow me) directly influenced by both FPV2 and 3
- Individual command (ammo request, heal, select, shoot at, go there, follow me) clearly the outcome of NPV1 and FPV3

Schemas, in this game, are layered as "basic" and "advanced", meaning that beginners choosing a low level of difficulty can successfully accomplish the missions making use solely of basic schemas. Once players have acquired a sufficient level of familiarity with the game, they can start experimenting with the different options they are given and eventually develop a favorite set of play-gestalts to face the various game encounters and challenges. Play-gestalts are dynamically defined every time a player selects among play-modes the actions that will guarantee his/her progress in the game, for example:

- hold back the team in a covert position,
- sneak and flank the enemy,
- order a squad attack,
- attack from covert position in "over the shoulder" mode.

5 PLAY-STYLES

If players chose to negotiate game encounters through consistent, isotopic play-gestalts, they start expressing a peculiar play-style. In the physical world the variations available to execute a task or tell a story are nearly countless as shown for example by Queneau in "Zazie dans le metro" or "Hundred Thousand Billion Poems" [9]. On the other hand in the game environment, even accounting for the phenomenon of "emergence", the possible interactions are much more limited because game designers only include very small subsets of all the possible actions. Chomsky acknowledged the importance of "infinite use of finite means" in his works on generative grammar [2] and it shows how the expressive potential of the limited input is vital to gain a glimpse in the player's state of mind. It is possible then to read each action started by the player in the game environment as the semiotic "unintentional sign" defined by Eco: "actions of an emitter, perceived by a receiver as signifying artefacts" [3]. Due to the connotative layer, these signifying artefacts may unconsciously reveal properties of the mental state and behaviour of the emitter. It pays off to understand player's actions as semiotics acts (unintentional signs) because play-styles point towards more than just strategies to successfully complete the game. For example the functional attributes of "bare handed close combat" (basic schema) and "armed close combat" (advanced schema) are nearly identical, but the psychic implications for the players and for the narration are immense. When asked directly, game designers recognized immediately the concept of play-styles, they know exactly what it means and what it implies, yet they do not seem to make use of it during the design phase, it does not appear in other internal communication such as review meeting and it is not mentioned anywhere in the design documentation. Nevertheless observing game testers it was clear that it is perfectly possible to develop personal play-styles. The domain of play-styles still requires a lot of work, but the possible outcome in terms of increased player satisfaction definitely calls for further research. In order to illustrate the impact of play-styles in the playing experience we can examine the very first level of Kane & Lynch: "Bustout" (see the map of the level in fig. 2).

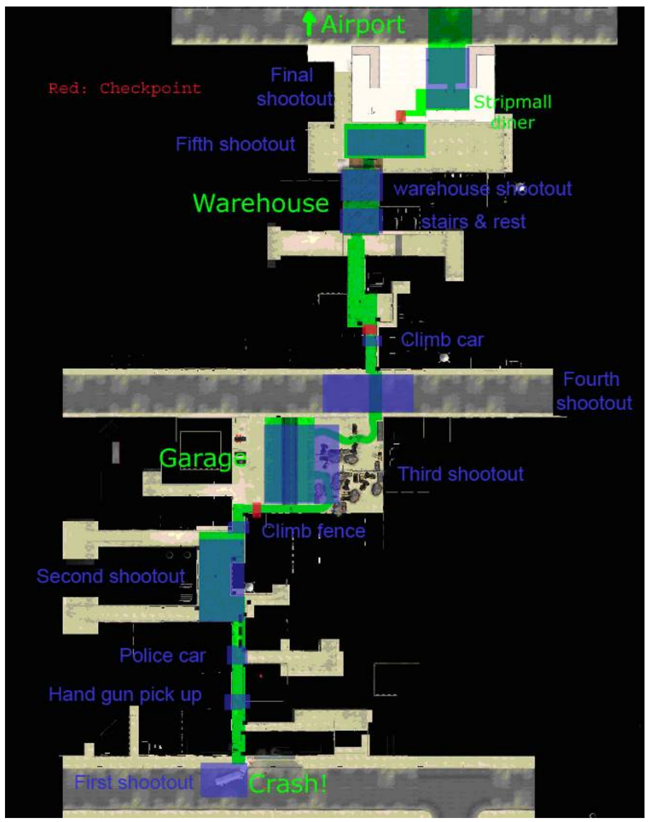

Fig. 2 map of level "Bustout"

In this initial level the player starts at the location denominated "Crash", professional mercenaries ram the prison transportation that was taking Kane to his execution. It is a very emotional experience thanks to a clever use of camera and video-post effects (wavy cam, unclear and hazy vision, bloom and blur effects), although this necessitates for an extremely linear progression where the player does not really have any choice and is "on rails". The player is forced to escape the first shootout without a chance to fend for him/herself; the only refuge is in the alley. The sole choice given until the mark "police car" is the chance to pick up a handgun, which in turn is a way to train the player to pick up objects. We arrive at the second shootout with the possibility to just observe our "saviors" or to take part in the action either with unarmed close combat or with the handgun. After climbing the fence (another play-mode learnt from the "advanced movement" schema) the player gains access to rifles dropped by mercenaries shot by the helicopter that appears in the back lot of the garage. In the garage, which marks the end of the first half of the level, we have the first really big confrontation where the player will have to hold a small army of policemen until a gas tank explodes liberating the way to the fourth shootout. This area can be quickly evaded just by running in the alley where the player learns another way or negotiating obstacles: by jumping over a car it is in fact possible to gain access to the warehouse, the first real breathing room since the beginning. In the lower part of the warehouse another shootout forces the player out and towards a diner, stage for the last gunfight before the escape of the crew. This first level does not allow for crew control and it consists mostly of narrow, corridor-like passages, yet the linearity is concealed with several open areas and a couple of obstacles to overcome in order to proceed along the path. In spite of the limited set of options available to the player and the narrow, linear structure, it is very successful in establishing and reinforcing both narrative and functional play values, furthermore player expression in terms of play style is not only allowed, but deliberately encouraged in many of the shootout sections.

Navigation and interaction attitudes are important looking glasses through which we can study emerging play-styles. Navigation attitudes tell us how players move in the game space:

- physical position of the avatar within the limits of the available space in relation to the vector of hostile NPCs.
- pace of movement (walking, running, staying still, sneaking, sprinting, etc.)
- use of cover, flanking or frontal charges.
- Interaction attitudes inform us on how players chose to negotiate obstacles and NPC:
- preferred weapon
- preferred shooting mode
- use of grenades
- use of advanced teamwork (swap weapon, give ammo, heal, etc.)
- use of individual command or squad command
- whether or not player makes use of aiming modifiers

Studying these variables is the main instrument in order to detect coalescing play-styles.

6 PLAY-PERSONAS

When a player behaves consistently in the game and maintains a defined play-style for longer periods (if not for the whole game altogether) then he/she identifies completely with a certain profile. I am going to call these consistent profiles "playing personas". In spite of the fact that players tend to switch styles extremely easily, it is clear that the designers themselves acknowledge the possibility to play out personas. For example in the game "Hitman: Blood Money" [4] players are given special rewards for completing missions following certain set rules (only killing the assigned targets and getting out with the suit). Those rules restrain the in-game behaviour to a specific style that maintained long enough gives birth to the play-persona called "Silent Assassin". Play-personas are constructs that share many similarities with Weber's ideal types.

"An ideal type is formed by the one-sided accentuation of one or more points of view and by the synthesis of a great many diffuse, discrete, more or less present and occasionally absent concrete individual phenomena, which are arranged according to those one-sidedly emphasized viewpoints into a unified analytical construct". [12].

For Weber the ideal type is a conceptually pure mental construct used to monitor the behaviour of social groups. It is totally theoretic, almost fictitious and generally not empirically found anywhere in reality, but in our case it can prove to be a priceless tool to measure play-behaviours. Ideal types are used as some sort of unit of measure, standards much like "meter", "second" or "kilogram" not really found in nature, but useful to measure it.

Ultimately are those mental models that players refer to when they report "I totally pulled a Rambo there to pass through the blockade" and it is up to the designers to plan and provide diverse, engaging, satisfactory and at the same time consistent play-personas.

7 CONCLUSIONS

Each one of the four stages of the "scaffolding for experiencing" can lead to increased player satisfaction and more focused and consistent design. Although the designers were almost always aware of the concepts and cognizant of their meaning, they were only occasionally found in the documentation or utilized in internal communications. Nevertheless their existence and relevance has been proven during direct interviews with testers.

Clear improvement can be gained just by becoming aware of mechanisms that already are present in the back of the mind of the designers, artists and scripters.

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ARTICLE 4 - WEAVING EXPERIENCES IN VIRTUAL WORLDS: PLAY PERSONAS AND GAME METRICS

Article featured in "FLUX" a Danish Design School publication.

"A game's value proposition is how it makes its players think and feel. Players don't buy games, they buy experiences" [Nicole Lazzaro – XEO Design]

"Designers will transform from being designers of "stuff" to being the builders of scaffolds for experiencing." [Elizabeth Sanders - MakeTools]

"When you can measure what you are speaking about and when you can express it in numbers you know something about it" [Lord Kelvin]

1 Introduction

People leave trails. Books borrowed at the library, websites visited while browsing the net, owning a house, working as a middle manager, vacationing in Southeast Asia. Whether we drive a car, a motorcycle or a rickshaw. Almost any action we take in the public space can represent a syllable of a longer sentence that contributes in composing the narrative of our life. Reading some sort of meaning in our actions is everything but a trivial semiotic effort. Nevertheless the number of messages and products that attempt to take advantage of this disseminated knowledge is increasing drastically: websites aware of our browsing history, spam mails that contain keywords selected according to the content of all the mails that we send and receive, physical advertisement material produced according to our shopping preferences. Yet it is rare that this potential awareness is used for something else, more useful, beside the obvious commercial purposes or blacklisting the courageous few that dare borrowing flying manuals from libraries in the USA, raising all sort of privacy-related concerns. This awareness of people's behaviour could truly shine and show its full potential if utilized to design experiences. One caveat, though: we are all very different people, with different backgrounds and histories; thinking that it is possible to mass-design experiences is not only reductive and naïve, but also potentially harmful. If our products could somehow tap into that knowledge distributed in the trails and reflect it back to its origin, the user, then we could really be on the verge of that brave new world.

2 Computer games and game metrics

Computer games are all about experiences and I was fortunate enough to begin my research on games at a moment where the suits of many game development studios decided that gathering data about the player would have been both an incredibly slick marketing stunt and possibly also a useful tool in the hands of game designers. Gathering player data consists of defining interesting variables in the behaviour of players in game worlds and including in the released game a piece of software that monitors these variables by sending a record of player-activity back to the developers. The content of this record is also addressed as game metrics. As example of an interesting variable we could look at the death of the player (in the game world of course): where does it happen? The resulting outcome of this type of enquiry is a heatmap (fig. 1).

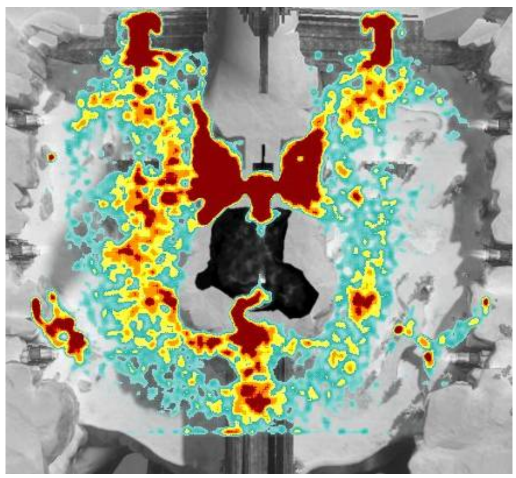

Fig. 1: Heatmap from the game Halo 3 (www.bungie.net /Online/HeatMaps.aspx)

Figure 1 shows a map of the game Halo 3 seen from above, areas tinted in red identify places where players die a lot, yellow a bit less and blue very little. Heatmaps look great on game community websites and are also precious tools in the capable hands of level designers because with few changes they can balance a map and solve potentially critical problems such as players dying several times in the same spot, providing a very frustrating experience. Inebriated by this incredibly successful story, the suits wanted more: who killed the player? With which weapon? When did the player die and what was he/she doing at the time?

What they didn't realize was that the data gathered from players, or game metrics, looked something like this:

```
<X="23455" Y="38449" Z="23586" TS="247" AV="36.6" CV="109.4" CA="49.8"/>
<X="23467" Y="38576" Z="23623" TS="254" MA="3" IW="4" IP="0" IC="1,1"/>
<X="24490" Y="39032" Z="23692" TS="279" IO="3" IC="0" OM="4" CP="0"/>
<X="27575" Y="39468" Z="23748" TS="286" CHi="A+20" CHe="A+10" CD="0" ED="0"/>
```


In order to be able to take action based on this data it is necessary first to present it in ways that humans can understand, and that is the role fulfilled by visualization. Afterwards, it is necessary to apply some semiotic lens capable of making sense of the data as a whole and to synthesize it in a report. The beauty of a heat map is that it both provides an understandable visualization of the data and a lens to extract meaning from it, but in order to turn that knowledge into action it still requires analysis. My contribution to this scenario is a possible way to give meaning to metrics data by grouping similar types of recorded play-behaviours. These groups individuate existing play-patterns, they can be planned and wanted by the designers or emerge accidentally due to the affordances provided by the game. I call these patterns Play-Personas and they constitute the core of a theoretical framework that can both guide designers in the selection of interesting variables to monitor (a priori metaphor) and provide ways to make sense of the gathered metrics (a posteriori lens).

In the domain of Human-Computer Interaction, Alan Cooper defines 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]" and they often take the form of narrative description of user types.

Play-personas are both theoretical models of ideal users and data-driven representations of player behaviours.

3 Persona as metaphor

A metaphor is a rhetorical device that allows to describe something unknown by transferring attributes from a known entity. Metaphors are utilized before the accumulation of experience, in a similar way personas allow designers to "imply" unknown player behavior in the process of creating digital games, i.e. by pre-defining the ideal play-patterns possible in the game in question and design to accommodate these. It is the case in Hitman: Blood Money, where players can choose between different identically optimal strategies to progress in the game. Play-personas as design tools represent an expectance of how players would like to create their experience.

Designers can use personas as categories of behaviors prior to a playable version of the game in order to plan coherent navigation and interaction modes. They are also precious as guides to select which variables are interesting enough to monitor.

4 Persona as lens

Lens is here intended as the choice of a context (umwelt) from which to sense, categorize, measure or codify experience. Lenses are utilized to examine the accumulated experience. Metric data can form the basis of defining data-driven personas during game testing. Personas can be used as tools when evaluating games by comparing the goals set by the designers with those of the players. By comparing designers' and players' goals it is possible to check 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 game 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. It is a sense-making perspective, a code that allows to extract meaning form an otherwise unclear list of numbers.

5 Playstyles

Playstyles, or patterns of play, are possible ways in which certain subsets of the rules and mechanics provided by the game can be combined.
Player that maintains consistent choices of styles eventually identify with personas, for example:

```
brain + stealth + silent + clean + non lethal = silent assassin
```

Personas are aggregate description of possible player behaviour both in theory, as an expectation of the designer (a-priori metaphor) and in practice, as a description of what actual, real players do during a play session (a-posteriori lens).

6 Case study

Taking as a concrete example the game Hitman: Blood Money it becomes easier to see the two sides of the play-persona. During early development, the designers at IO Interactive anticipated that a specific persona (mode of play) would be prevalent, namely the "silent assassin". This persona could be narratively defined as introverted, calm, formal and a loner. He tends to trust no one and 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. After fleshing out this persona-as-metaphor using narrative descriptions, it is necessary to unfold all the navigation and interaction play-modes of the game as possibility fields. A possibility field is the collection of all potentially available choices in any given moment. Finally it will be necessary to locate a subset of the game mechanics that can provide a numerical description that matches the narrative one. The resulting outcome is a procedural description of the patterns of play that best fit the "silent assassin" persona. This concrete and parametric collection of possible play-modes forms the persona hypothesis (fig. 2).

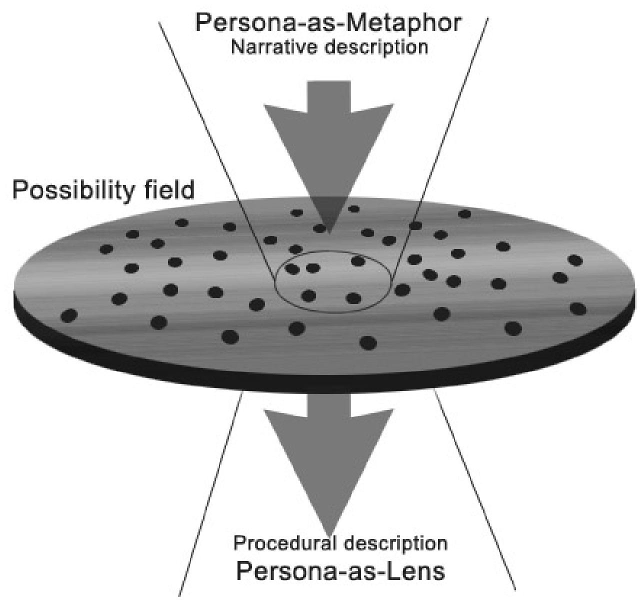

Fig. 2: Two sides of the coin: personas as metaphor and lens

6.1 Navigation possibility field

Players can navigate the game world in four distinct manners. Utilizing a Brawn playstyle implies that 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. If a player chooses a Brain playstyle it means that he/she prefers rational over physical means for negotiating environmental obstacles. Another possibility is to make use of Role-

Play or blending in; it consists of figuring out what is the fitting disguise in order to be granted unconditional access to each zone in the game. The last choice is the Stealth playstyle, where the trademark is the desire to maintain Hitman's identity and wear the black suit without using disguises, relying instead on stealth and sneaking.

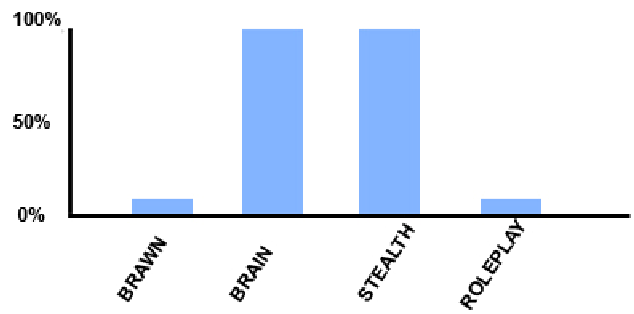

Fig. 3: Hypothesis for the "silent assassin" persona in the navigation possibility field

6.2 Interaction possibility field

The game "affords" a variety of modes for the player to interact with other characters, it is in fact possible to deal with opponents in a Lethal or Non-Lethal way, the weapons used can be Silent or Loud and dispatching an enemy can be a Clean or Bloody affair.

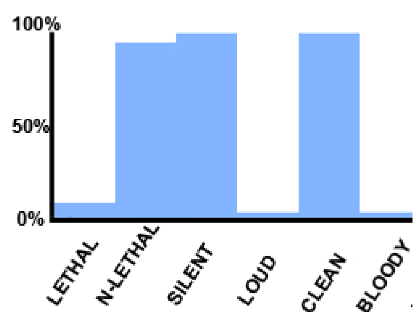

Fig. 4: Hypothesis for the "silent assassin" persona in the interaction possibility field

6.3 Synthesis

At this point it is possible to synthesize our assumptions on the "silent assassin" persona and procedurally describe it making use of the "time-spent" reports shown by figures 2 and 3. The "silent assassin" is an ideal user that spends a considerable amount of time accessing the map, spying through keyholes and picking locks (brain). This player type also spends a lot of time in shadows and closets and prefers to walk slowly or sneak (stealth). He/she also prefers to make use of non lethal, silent, and clean devices to thwart the opposition but, if spotted, won't refrain from killing witnesses.

Navigation attitude		Interaction attitude	
Brawn:	0%	Non-Lethal	90%
Brain:	100%	Lethal	10%
Stealth:	100%	Silent	100%
Role-play:	0%	Loud	0%
		Clean	100%
		Bloody	0%

Fig. 5: Complete hypothesis for the "silent assassin" persona

Now reading and making sense of the collected metrical data becomes an exercise in accounting and statistics. This line:

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<X="23467" Y="38576" Z="23623" TS="254" MA="3" IW="4" IP="0" />
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means that the player was, at a certain time (TimeStamp) in a certain location (X,Y,Z), crouching in the shadows (MovementAttitudes) with the map open (InteractionWorld) and the fiber wire equipped (InteractionPeople). If enough occurrences of this kind happen during one playsession in relation to sessions played by other players, it is statistically sufficient to label this player as a prototypical "silent assassin". After the metrics data is gathered from many players, it is then treated and consolidated in such a way so that it can be modeled according to the persona hypothesis. The tools used for this modellization process are statistical packages such as SPSS and a Geographical Information System such as ARCGIS. Persona hypotheses are checked against the numbers, for example to verify if there is a group of players that play as "the butcher" and how relatively big is this group, it is even possible to discover new clusters of players using the game in ways that no designer had in mind. This kind of information generates knowledge that has both short and long term effects: from modifying a level to achieve better balance, to obtaining a greater insight on the landscape of possible player types and eventually make games that can cater for a broader audience.

7 Conclusions

The play-persona framework aggregates data in a way that binds ludic and narrative aspects of the game. It allows designers to expand their role from mere dealers of rewards and punishments, disseminating challenges and skills for a general undistinguished audience, to become crafters, orchestrators of experiences, weavers of playing modes.

ARTICLE 5 - DEFINING PERSONAS IN GAMES USING METRICS

This article, written in cooperation with Anders Tychsen (ITU), has been presented at Futureplay 2008 and published in the ACM digital library.

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 measurable elements, whose use by a player can be tracked by 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

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. 13], 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 [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 [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.

	Element	Description
Personality	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.
	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.
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 behaviour	Physical Behaviour and 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.
Game World Integration	Association	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]).

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 (1st/3rd 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 ($0<w^{\circ}<360$, 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 ($0<\lambda^{\circ}<360$; where 0 and 360 represent North) and vertically ($0<\varphi^{\circ}<180$; 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 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, etc.

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.

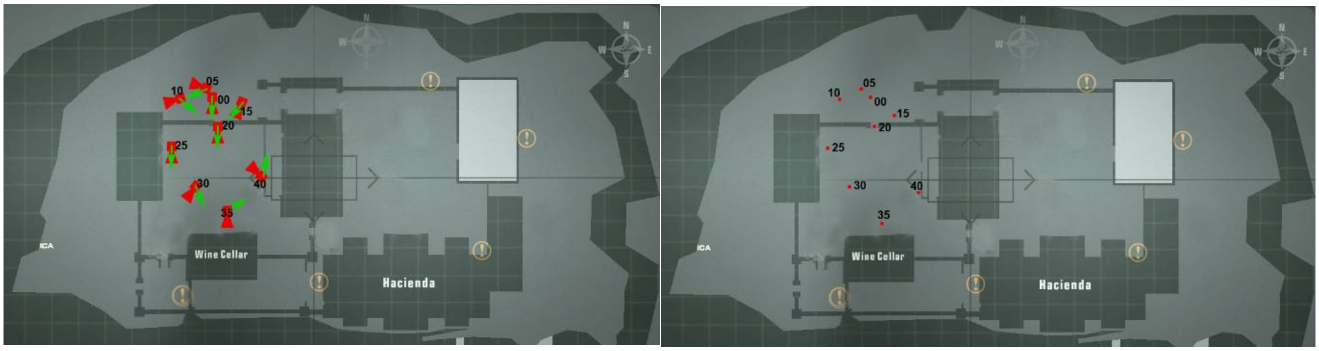


Figure 3: (left): Tracking the movement (X, Y, time) of a character through a section of a map in Hitman: Blood Money. The numbers signify the time in seconds since the character was loaded into the map (at time 00). Data added to a map of the level "A vintage year". (Right) Tracking camera angle in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

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.

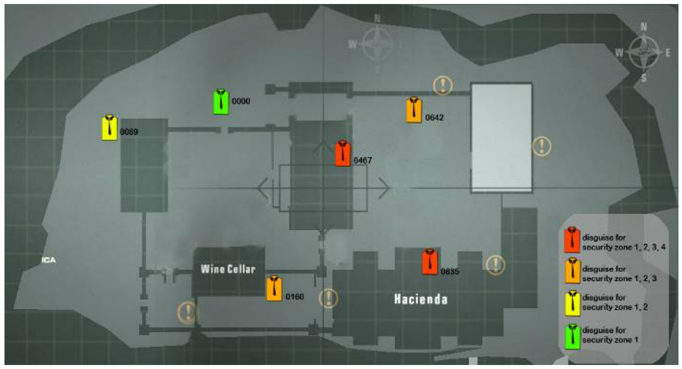


Figure 4: Example of interaction metrics data overlain the level A vintage year from Hitman: Blood Money. Positions of disguise change type of disguise chosen marked with icons that assist in interpretation of the metrics data. Same map as in Figure 3.

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.

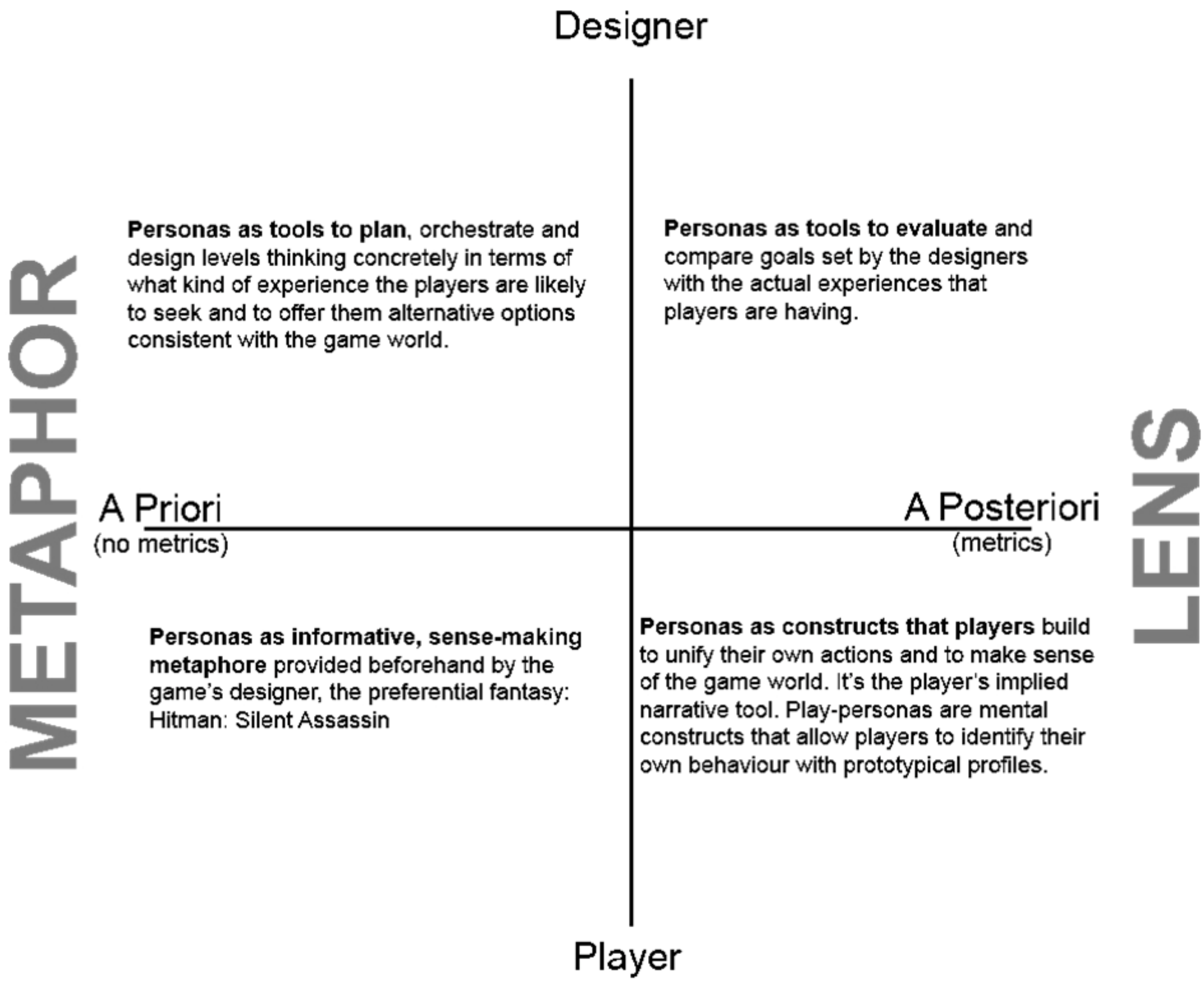
Play mode: The play mode generally refers to the behavior of a player with respect to one or a few discrete metrics, within the same overall group or type of metrics. For example, in Hitman: Blood Money, tracking whether a player uses lethal or non-lethal weapons, recording this single variable but not the means/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: According to whether personas are used by players or designers and 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:



<u>1) Designer hypothetical metaphor:</u> 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 synthetic 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 hypothetical 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 synthetic 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.

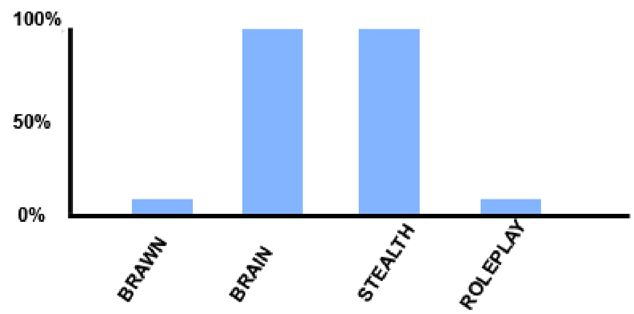


Figure 5: Navigation fingerprint for the persona: "Silent assassin"

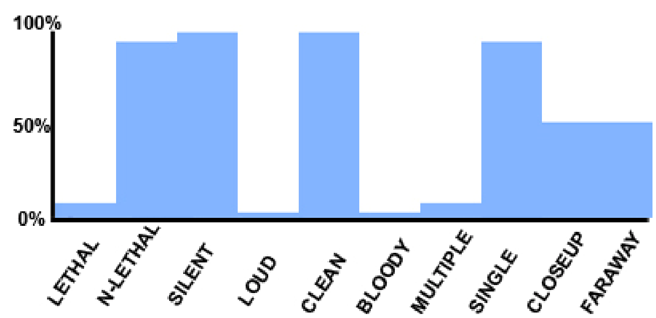


Figure 6: Interaction fingerprint for the persona: "Silent assassin"

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.

7. ACKNOWLEDGEMENTS

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ARTICLE 6 - PLAY-PERSONAS: BEHAVIOURS AND BELIEF SYSTEMS IN USER-CENTRED GAME DESIGN

Alessandro Canossa & Anders Drachen presented at Interact 2009 (published by Springer)

ABSTRACT

Game designers attempt to ignite affective, emotional responses from players via engineering game designs to incite definite user experiences. Theories of emotion state that definite emotional responses are individual, and caused by the individual interaction sequence or history. Engendering desired emotions in the audience of traditional audiovisual media is a considerable challenge; however it is potentially even more difficult to achieve the same goal for the audience of interactive entertainment, because a substantial degree of control rests in the hand of the end user rather than the designer. This paper presents a possible solution to the challenge of integrating the user in the design of interactive entertainment such as computer games by employing the "persona" framework introduced by Alan Cooper. This approach is already in use in interaction design. The method can be improved by complementing the traditional narrative description of personas with quantitative, data-oriented models of predicted patterns of user behaviour for a specific computer game Additionally, persona constructs can be applied both as design-oriented metaphors during the development of games, and as analytical lenses to existing games, e.g. for evaluation of patterns of player behaviour.

Keywords: Play persona, emotion, game design, user centered design, user experience design.

1 INTRODUCTION: USERS AND COMPUTER GAMES

End users of electronic interactive entertainment such as computer games are accustomed to expect a high degree of customization from the products during actual use. They expect sensitivity, awareness and responsiveness, with the standard being set by Web 2.0 [23] compliant applications and services such as Wikipedia, Google Maps and Facebook. The essence of the innovations posed by these applications is how they place the user at the center of the experience, and how they make the user feel: users think they matter, that they can make a difference and it gives them a way to express themselves. For example Nicole Lazzaro recognized the importance of involving players, at least conceptually, when designing games by stating: "A game's value proposition is how it makes its players think and feel. Players don't buy games, they buy experiences" [11]. A failure to incorporate means for mass customization [16] could risk alienating the large majority of people that are becoming more and more acquainted with the practice of expressing themselves at almost every occasion. Furthermore, non-trivial choices and ability to express oneself are seen as determining factors for critical acclaim and are required for adding player choice and broad appeal to computer games [21].

Implementing these innovations in computer games requires both substantial technological advancements and a philosophy of game design that directly incorporates the user needs from the early stages of the design and development process [13, 15, 10, 5, 22]. Technological advancements can include platforms for user generated content, adaptive AI, eventually even biometric feedback [17, 18, 14, 12]. We are only starting to scratch the surface of the many possibilities unleashed by user-aware technology. For example, Left4Dead's [1a] AI Director is a dynamic system that monitors the players' performance and orchestrates accordingly the distribution of enemies, items, visual effects, dynamic music and dialogues between characters. Little Big Planet's [2a] magic relies almost completely on the global exchange of its users' creativity, similarly a big portion of the appeal of games such as Spore [3a] or SingStar [4a] seems to be the possibility of sharing user generated content. All these technology-based innovations require considerable investment of resources. On the other hand, a paradigm shift in game design philosophy appears to be emerging, which can bring about a strong focus on the user and create a set of games that attempt to empower players, all of this requiring minimal technical efforts. Such a game design philosophy mirrors what has already happened in the field of Human Computer Interaction: the introduction of User-centered and Experience design [15, 10]. In order to accelerate this paradigm shift in the field of game design this paper advocates first the adaptation and then the adoption of tools and practices already in use in HCI for modeling users, such as the persona framework [2, 3].

2 DESIGNING USER EXPERIENCE IN GAMES

According to Frijda [7], emotions are complex dynamic processes and arise as states of action-readiness, including affect and arousal, when we interact with people and things in the world. Past experiences are evaluated and remembered and influence the appraisal of future occurrences to inform ensuing behaviour.

Damasio defines emotional processes as sets of rational, bodily, and behavioural responses to the perception (or memory) of an experience [4].

It is possible to see how, as Sanders correctly points out [19], all efforts aimed at engendering defined experiences and emotions are doomed to failure since experiences and emotional responses alike are too individual, subjective and rooted in people's past to be able to scientifically aim at re-producing them.

It is necessary then to utilize a design philosophy that takes into account players and allows them a certain leeway for expressing themselves, but without assuming universal emotional responses to experiences. Such a frame of mind should be accountable for different player's motivations, goals, behaviours and belief-systems.

In the domain of user centred design, such a mental tool exists already. Alan Cooper developed a method called Goal-Directed design [2]. This method makes use of personas - "archetypes that represent distinct groupings of behaviours, attitudes, aptitudes, goals, and motivations" [3] - to help developers understand the end user and to foresee its way of interacting with the product.

2.1 Origin and history of personas

Persona is a Latin word and it indicates the mask that actors put on before becoming their characters, it is a socially agreed convention used to represent certain types. Currently it refers mostly to "social masks" or roles that all humans have to play on the stage of life [8]. Goffman uses the term "fronts" to address the different masks that we have to wear according to the different contexts we are presented with. We must act differently in different settings, as the world is a stage. It is in this sense that Jung listed it as one of the archetypes populating the human unconscious.

Personas or fictional identity-constructs have been recognized as fundamental in many creative practices. In literary theory, Iser [9] introduced the term "implied reader" to address the certain "reader that a given literary work requires". Within the frame and the context imposed by the text, this implied reader makes assumptions, has expectations, defines meanings that are left unstated and adds details to characters and settings through a "wandering viewpoint". For example, by Joyce's own admission, Finnegan's Wake should be read by "that ideal reader suffering from an ideal insomnia". Eco expanded on the concept introducing the "model reader" [6] as "the author's foreshadowing of a reader competent enough to provide the best interpretation of a text". The author tries to prefigure a model reader by imagining what could be the actualization of the text. The author, consciously or not, is concerned with how the text / type becomes interpretation / token.

In social sciences, Max Weber introduced the concept of Idealtyp as: "Formed by one-sided accentuation of one or more points of view and by the synthesis of a great many diffuse, discrete, more or less present and occasionally absent concrete individual phenomena, which are arranged according to those one-sidedly emphasized viewpoints into a unified analytical construct" [20]. The ideal type is a pure mental construct used to assess the behaviour of social groups. It is totally theoretic, almost fictitious and generally not empirically found anywhere in reality, it is not backed by statistical data nor a model personality profile, it is more used as some sort of unit of measure, standards much like "meter", "second" or "kilogram" not really found in nature, but useful to measure it.

In similar ways game designers could benefit greatly by making assumptions on the nature of players using personas to map the extreme boundaries of the field of possibilities afforded by their game.

2.2 Traditional persona modeling

Alan Cooper's [3] goal directed design process starts with the research phase, in which behaviours patterns and modes of use of products are identified. These patterns suggest goals and motivations and in turn these inform the creation of personas. Personas are detailed, composite user archetypes and they serve as main characters in narrative, scenario-based descriptions that iteratively inform the design of a product, so that features emerge directly from the goals.

Typically a persona is a description of behaviour patterns, goals, skills, attitudes, and environment, with a few fictional personal details to make it a realistic character. For each product there should be set of 3 to 12 personas, it is not necessary to design for all of them, but an extensive cast helps articulate the user population, the primary focus for the design will be a limited subset of maximum three personas. Persona description should be precise including as many details as possible, but not necessarily accurate, it does not need to represent a real person. Name, physical appearance, education, and idiosyncrasies should be included.

The main benefits of personas for product development purposes are:

A) It is easier to relate to a personal human face and name instead of abstract customer data.

B) It is possible to infer user needs not openly stated by drawing on personal people-experience.

C) Personas provide a shared, fast and effective language for communication between engineers and designers.

D) Personas states what a user needs and wants so that no stakeholder can reshape the user to their convenience.

E) Personas avoids self-referential designs, where designers might unconsciously project own mental models.

F) Personas also work as reality-checks, helping designers keeping the focus on the limited subset of users that have been deemed "primary".

G) Proposed designs, features and solutions can be evaluated against the needs of individual persona models.

Personas have also been criticized mostly because if they are fictional, they have no clear relationship to real customer data and therefore any data gathered cannot be considered scientific [1]. In any case, in order to apply this design method to computer games some changes are necessary.

3 FROM PERSONA TO PLAY-PERSONA

Play-personas are further defined as clusters of preferential interaction (what) and navigation (where) attitudes, temporally expressed (when), that coalesce around different kinds of inscribed affordances in the artefacts provided by game designers. This means that personas can no longer just be limited to narrative descriptions of motivations, needs and desires distilled in ethnographic interviews.

The persona hypotheses emerge as a relation of parameters from the set of interaction and navigation possibilities that the game-rules and game spaces can afford [22]. Personas can be augmented and strengthened by a quantifiable, parametric, data-driven perspective. Furthermore, if directly coupled with instrumentation data in the form of gameplay metrics gathered from game engine software during play sessions, play-personas can provide a powerful evaluation tool to confirm whether a certain hypothesis also turns out to represent a sizeable slice of players. That is why play-personas are both theoretical models of ideal users (metaphor) and data-driven representations of player behaviours (lens).

3.1 Gameplay metrics

Gameplay metrics are instrumentation data extracted from computer game engines during play. The collection of quantitative data about user-product interaction is an established method within Human-Computer Interaction [24, 25], but has only recently been adapted to user testing in computer game development [10, 22]

The type of game instrumentation data relevant to persona modeling is gameplay metrics, which are measures of game-player interaction. Gameplay metrics can be recorded for any type of user-initiated behavior where interaction takes place in or with the virtual environment; as well as behaviors initiated by agents and systems operating in the virtual environment but which are not controlled by the player, e.g. autonomous agents. Tracked and logged actions can vary from low-level data such as button presses to in-game behavior. For example, tracking the location of a player through the virtual environment, the use of specific character skills, weapons, hit probability etc. Gameplay metrics analysis provides the ability to generate highly detailed, objective and quantitative analyses about player (end user) behavior.

Metrics analysis can be used to evaluate user behavior, and the data type forms a supplement to existing methods for user-oriented research and –testing in the game industry, such as usability testing, playtesting, focus groups and similar qualitative/semi-quantitative approaches. Different methods have different strengths and weaknesses. For example, usability testing focuses on measuring the ease of operation of a game. Playability testing explores if users have a good playing experience. Gameplay metrics analysis offers however detailed insights into how the users are actually playing the games being tested. Furthermore, gameplay metrics can be used to develop data-driven persona models.

3.2 Play-persona as metaphor

A metaphor is a rhetorical device that allows describing something unknown by transferring attributes from a known entity. Metaphors are utilized before the accumulation of experience, in a similar way personas allow designers to “imply” unknown player behaviour in the process of creating digital games, i.e. by pre-defining the ideal play-patterns possible in the game in question and design to accommodate these. It is the case in Tomb Raider Underworld [18], where players can choose between different identically optimal strategies to progress and express preferences for some modes of interaction and navigation instead of others. Play-personas as design tools represent an expectance of how players would like to craft their experience. As metaphors, play-personas are hypotheses that emerge as relations of parameters from the set of possibilities that the game can afford.

Designers can use personas as categories of behaviours prior to a playable version of the game in order to plan coherent navigation and interaction modes. They are also precious as guides to select which variables are interesting enough to monitor as game metrics, which will lead to the creation of play-personas as lens.

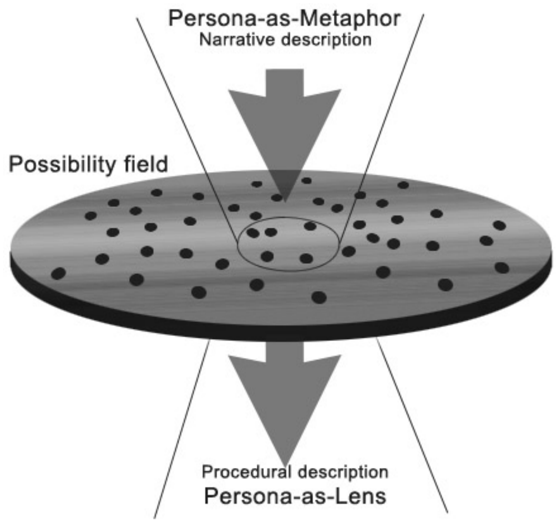

Fig. 1: Two sides of the same coin: persona as metaphor and lens. The black dots on the "possibility-field" plane represent game mechanics; thanks to the a-priori description of the persona-as-metaphor a certain subset is individuated. This persona hypothesis can be checked against metric data gathered from players and inform the creation of persona-as-lens.

3.3 Play-persona as lens

Lens is here intended as the choice of a context (Ümwelt) from which to sense, categorize, measure or codify experience. Lenses are utilized to examine the accumulated experience. Gameplay metrics data can form the basis of defining data-driven personas during game testing. As lenses, play-personas are derived from game metrics gathered from players, after they have been interpreted as clusters of similar behaviours. Personas can be used as tools when evaluating games by comparing the goals set by the designers with those of the players. By comparing designers' and players' goals it is possible to check whether the game design actually supports and facilitates the planned experience in practice, and if any new personas emerge from the user-interaction with the game software. Analyzing game metrical data with multivariate statistical tools can provide a way of discovering patterns in the usage of game 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 assumed as hypotheses. It is a sense-making perspective, a code that allows extracting meaning form an otherwise unclear list of numbers.

Playstyles (or patterns of play) are possible ways in which certain subsets of the rules and mechanics provided by the game can be combined. Player that maintains consistent choices of styles eventually identify with a play-persona.

Personas are aggregate description of possible player behaviour both in theory, as an expectation of the designer – "a priori" metaphor - and in practice, as a description of what actual, real players do during a play session – "a posteriori" lens (Fig. 1).

4 TOMB RAIDER UNDERWORLD: A CASE STUDY

Taking as a concrete example the game Tomb Raider Underworld [5a] it becomes easier to see the two sides of the play-persona. The spaces, rules and mechanics of the game indicate few important skills necessary to identify personas:

- Shooting: Indicated by high or low number of deaths inflicted to enemies & animals (interaction with NPC)
- Jumping: Indicated by high or low number of deaths caused by falling, drowning, being crushed (navigation)
- Puzzle solving: Indicated by high or low requests for help to solve puzzles (interaction with the world)

Player can have "high" or "low" skills for each of the parameters individuated. Keeping these values down to two, although loosing granularity and resolution, simplifies immensely the possibility space. Mapping the possibility space consists of exploding all the combinations of parameters underlying the skills listed before: shooting, jumping and puzzle solving.

Each of the parameters individuates an axe of an n-dimensional space, where n equals the total number of variables worked with in the given situation. In this specific case there are only two possible values that each parameter can assume: plus or minus. Hence the total amount of combinations is the number of values that each parameter can assume, at the power of the number of all the parameters found: Two at the power of three for a total amount of eight combinations. This initial unfolding of gameplay parameters maps the a-priori possibility space within which personas will be found (Fig. 2).

	Expert	Rookie	Grunt	Athlete	Chess-player	Hybrid personas		
Shooting	**+**	**-**	**+**	**-**	**-**	**+**	**-**	**+**
Jumping	**+**	**-**	**-**	**+**	**-**	**+**	**+**	**-**
Puzzles	**+**	**-**	**-**	**-**	**+**	**-**	**+**	**+**

Fig. 2: Table showing how the three parameters unfolded in the two values (+ and -) map the possibility space of the game Tomb Raider Underworld.

At this point it is possible to select which personas-as-metaphors will guide the design process. Play-personas have been defined as extreme cases, one-sided accentuations that delimit the field, statistically most of the players will be identified by one of the hybrid personas, but these exaggerations are helpful both during design, to frame the kind of experience targeted by the game, and during post production, to evaluate how players actually relate to the game. Exaggerating one-sidedly the three parameters individuated lead to three personas: The Athlete, the Grunt and the Chess-player (Fig. 3).

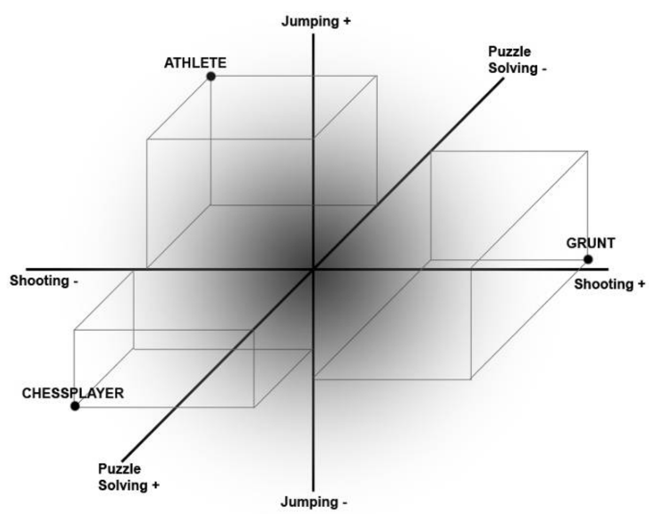

Fig. 3: Possibility space and the three play-personas: Grunt, Athlete and Chess-player. The axes can be defined abstractly such as "+" and "-" prior to a playable version of the game, when personas are used to imply user behavior patterns in the design. However, the axes can also be defined based directly on collected gameplay metrics. For example, the percentage of total puzzles solved. This provides a means for defining detailed quantitative components of the persona models, and even post-launch data-driven analysis of whether these personas emerge in the player behavior.

4.1 Grunt persona

Narrative description: this persona obviously excels at shooting. Grunts particularly enjoy fights and are quite good at them, they are interested in twitch stimulation, taking pride on physical domination, at the same time they might be not so precise with movements, hence the risk of failing at jumps. They might find slightly annoying tight jumping puzzles. Grunts are not interested in spending time figuring out solutions to puzzles, they are more prone to bypass cerebral strain if possible.

Procedural description:

Shooting: +

Jumping: -

Problem solving: -

4.2 Athlete persona:

Narrative description: athletes enjoy exploration of the environment; they will try to avoid fights if at all possible. Considering the amount of skill involved in performing precise jumps we can assume that they are players with experience and are comfortable with navigation controls, this points towards a high proficiency. Taking for granted proficient navigation skills, it is possible to assume a good sense of direction, athletes will rarely loose direction and will display relatively fast completion times, this also reflects on relatively few requests for help for spatial puzzles.

Procedural description:

Shooting: -

Jumping: +

Problem solving: -

4.3 Chess-player persona:

Narrative description: Chess-players get their biggest kicks out of solving puzzles, they will log almost no requests for help, there will be very few deaths caused by mistakes in solving puzzles, they also possesses a good sense of direction that helps a lot in navigating the environments leading to few deaths caused by the environment. At the same time they might not necessarily be good at precise jumps hence they could die several times by falling. They are not expected to show particular skills with a gun. They could resort to asking for hints to solve certain puzzles, but never to complete answers.

Procedural description:

Shooting: -

Jumping: -

Problem solving: +

5 PLAY-PERSONAS AS RELATIONS BETWEEN GAME PARAMETERS

Now that all the possible combinations have been manifested it is possible to plot them as relations between parameters (Fig. 4).

The personas as metaphors, defined as one-sided accentuations, form the hypotheses around which game and level designers plan, produce and test their work. Because of the historical legacy of the Tomb Raider franchise, it could be expected that there will be a bias of players expecting physical and mental challenges in the form of jumping and puzzle solving experiences. Even though the shooting component has always been a part of the Tomb Raider series of games, it has never been the main focus, and players looking for a full fledged shooting experience would probably pick a different title, nevertheless the developers consciously decided to strengthen the combat elements and include a varied array of enemy NPCs for players to express shooting tendencies.

The next step consists of individuating which game mechanics and variables translate as high or low puzzle solving, shooting and jumping skills, and how these can be tracked via gameplay metrics.

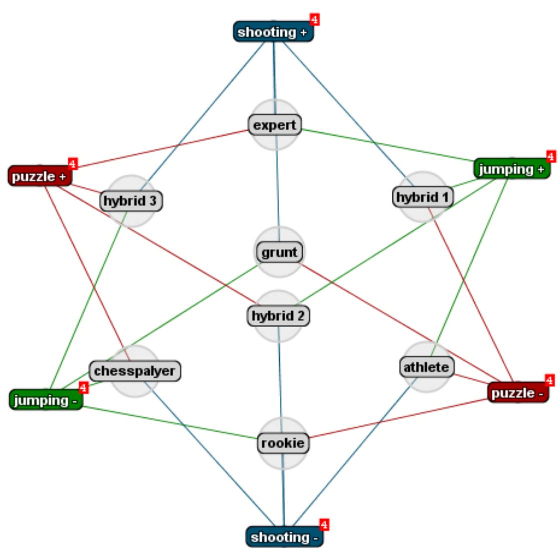

Fig. 4: Persona hypotheses emerge as relations between parameters that have been derived from gameplay mechanics.

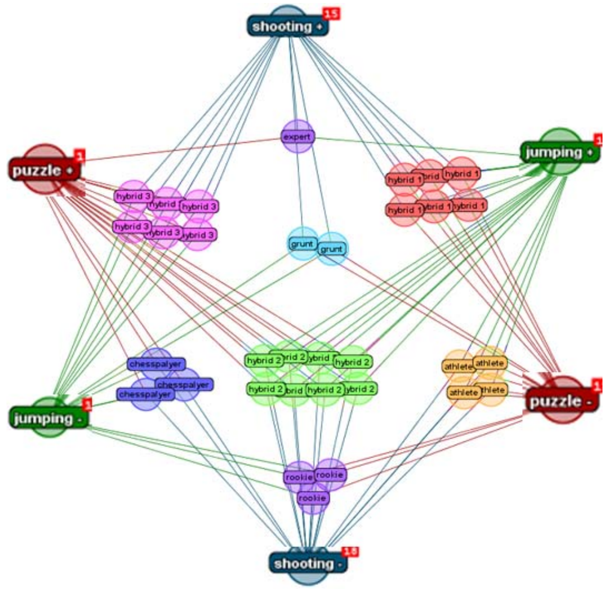

Fig. 5: Personas as lenses show the statistical layering of the population of players condensed into clusters of similar behavior profiles.

For example, players have the possibility to request hints and clues on how to solve puzzles in the game or they can ask directly for the complete answer via the Help On Demand-system. Thanks to the metrics tracking system developed internally at EIDOS [22], it is possible to collect data regarding players' behaviour. The decisions of hundreds of thousands players around the world to ask for help solving puzzles can therefore be collected, analyzed and form the basis for detailed persona models that relate directly to game mechanics. This information helps designers answering straight forward questions such as "where do players get stuck more often?", however, gameplay metrics datasets – depending on the variables tracked – also provide statistical evidence to the subdivision of players in the various persona-defined categories (Fig. 5).

For Tomb Raider: Underworld, data on player progression, level completion times, locations of player death, requests through the Help-on-Demand system, causes of death and a variety of other variables are tracked. Via the application of multivariate statistical methods such as cluster analysis, factor analysis and population statistical methods such as ordination/correspondence analysis, patterns of player behavior in the data can be sought out. Additionally, neural networks, decision three analysis and similar techniques can be used to locate data-driven patterns. This permits game developers to check how and if the pre-defined persona models (as metaphor) actually emerge in the way the end users are playing the game, i.e. as data-driven personas-as-lens [22].

In the case example for Tomb Raider: Underworld, it is apparent that the large majority of players do not fit under the umbrella of the three personas used as hypotheses, but rather is to be found in the profiles of usage defined by the hybrid personas (Fig. 6).

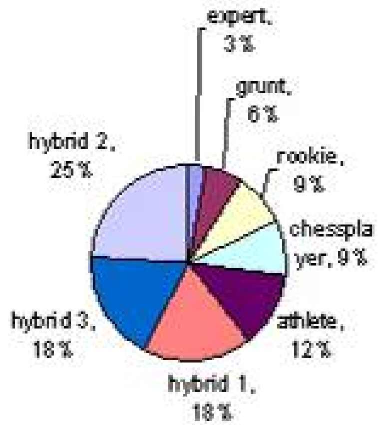

Fig. 6: Distribution of players according Tomb Raider Underworld persona profiles.

It is in this phase that persona hypotheses are checked against the numbers: As expected the Grunt is not very well represented, while the Athlete is the largest "pure" persona. This kind of information generates knowledge that has both short and long term effects: On a concrete level, the information provides valuable feedback to level designers, who can use the input to modify a level to achieve better balance and facilitate the different persona models; to obtaining a greater insight on the landscape of possible player types and eventually make games that can cater for a broader audience.

6 GENERAL APPLICABILITY OF THE METHOD IN EXTREME CASES

The suggested framework could potentially come short of being in any measure exhaustive when applied either to puzzle games with one solution or extremely linear games with very few areas designed for the player to make non-trivial choices. For example, in games such as Braid [6a], where there is only one way to solve the puzzles, it makes no sense to even talk about play-styles let alone personas: the player's sole duty is to second guess the designer's mind and therefore push forward the story. Similarly, in classic point-and-click adventure games, players had to advance the story by collecting and putting together a narrative that the designers exploded and spread around the game world, with no influence on what to do nor how to do it.

Even modern AAA-level games sometimes fail to provide non trivial choices, collapsing all the potential personas into only one profile that players have to conform to in order to proceed. This type of games would not particularly benefit from the application of the method, but it is important to notice how they do not represent the majority of titles on the market, often populating the casual end.

Beside these considerations, the play-persona framework is directly useful in situations where players have more than one way to accomplish a task, any time that the combination of different game-rules in different ways could give rise to something similar to “play style”, every time that players are allowed to express a preference towards a course of action instead of another, even if this only means choosing between killing a NPC with a silenced gun or with poison, as is the case in the Hitman series developed by IO Interactive.

7 CONCLUSIONS

A key design challenge in an increasing number of game development projects is to ensure optimal experience for a variety of player preferences, in order to reach as broad a target audience as possible [11, 15]. In the above, a tool for addressing this requirement has been presented in the form of play-persona frameworks. These function both as models of preliminary hypothesis of in-game behaviour, and a means for categorizing and analyzing character-bound gameplay metrics variables. Play-personas have been shown to be a tool for informing the process of developing and testing a diversity of play behaviours in a computer game.

The play-persona framework aggregates data in a way that binds ludic and narrative aspects of the game. In this paper a case study has been presented that shows how play-personas allow designers to expand their role from mere dealers of rewards and punishments, disseminating challenges and skills for a general undistinguished audience, to become crafters, orchestrators of experiences and weavers of playing modes.

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ARTICLE 7 - TOWARDS GAMEPLAY ANALYSIS VIA GAMEPLAY METRICS

Mindtrek 2009 (ACM conference), Anders Drachen & Alessandro Canossa

ABSTRACT

User-oriented research in the game industry is undergoing a change from relying on informal user-testing methods adapted directly from productivity software development to integrating modern approaches to usability- and user experience testing. Gameplay metrics analysis form one of these techniques, being based on instrumentation methods in HCI. Gameplay metrics are instrumentation data about the user behavior and user-game interaction, and can be collected during testing, production and the live period of the lifetime of a digital game. The use of instrumentation data is relatively new to commercial game development, and remains a relatively unexplored method of user research. In this paper, the focus is on utilizing game metrics for informing the analysis of gameplay during commercial game production as well as in research contexts. A series of case studies are presented, focusing on the major commercial game titles Kane & Lynch and Fragile Alliance.

Keywords: gameplay metrics, game metrics, user experience, user testing, computer games.

1. INTRODUCTION: USER-TESTING IN GAME DEVELOPMENT

The game development industry has within the past decade established itself as a major component of the interactive entertainment industry, rivaling the movie industry in size [1]. Paralleling the dramatic development of the sector, computer games have gone from simple text-based adventures to almost photo-realistic renditions of virtual worlds within a variety of genres, offering a wealth of entertainment opportunities to their users. Contemporaneously with this development, a requirement for user-oriented testing methodologies that take into account the unique nature of digital games has become increasingly prevalent [19,27]. Furthermore, with the increasing complexity of contemporary computer games – in terms of the amount of possible user actions and –behaviors that they afford, as well as the breath of interaction options between the user and the software/hardware – the informal testing methods traditionally utilized in the game industry, which were adopted directly from productivity software testing, have come under pressure [24,27].

Game testing can generally be divided into technical, functional and content testing. Technical testing is focused on issues relating to the game engine itself and associated hardware. Technical testing includes e.g. compliance, compatibility and soaking tests. Functional testing is concerned with bug hunting, stability, integrity of game assets, general problems with the game itself and gameplay or problems with the user interface, game controls etc. Content testing is oriented towards presentation and graphics, level design, the game story and how these elements are communicated to and perceived by the player (user). User-oriented testing (usually residing under Quality Assurance, QA) is essential to game production, because the quality of the product that a game is directly relates to the perceived user experience. Functional and content testing are therefore two areas that receives an increasing amount of attention from academic and industry environments alike [e.g. 13,15,17,18,19,23,24,26,31,32]. The purpose of user-oriented game testing is to see how specific components of, or the entirety of, a game is played by people. It allows game developers to evaluate whether their ideas and work provides the experience they designed for.

User-oriented game testing is normally carried out at different stages of the production cycle of digital games, which are commonly produced using agile methodologies. An organized, methodical approach to QA is vital, as this permits that issues are fixed as they arise rather than at the end of a production cycle. The major period of testing takes place during the alpha-stage, where a playable, full version of the game is (ideally) ready; and furthermore at the following beta-stage. These two periods of testing are usually intensive, with batteries of user-tests and a requirement for very fast turnaround on test results. Bugs and tweaks often need to be integrated within the span of hours or days, so that retesting of solutions can take place [31]. Testing also takes place earlier in the development phases, focusing for example on evaluating concept art and character designs in early phases, and gameplay balancing further into the production cycle. Following game launch, testing of software patches and updates is required, e.g. to insure that imbalances are not created – this is notably crucial to online games with elements of player vs. player competition.

The requirement for improving user-oriented testing methodologies within game development, the increasing complexity of digital games, the variety of aspects of the user interaction that needs to be tested, and the requirement for methods that do not require long turn-around times, has resulted in a variety of approaches from Human-Computer Interaction (HCI) research [13] being adapted user-oriented game testing and –research [6,17,19,24,26,28]. These include different forms of usability testing, ethnographic methods, experience testing etc. All of these have specific strengths and weaknesses, but are generally useful for capturing player feedback and subjective user experiences; and for acquiring in-depth feedback on e.g. gameplay or design problems. However, these approaches are limited in that information is often hand-coded (surveys, analysis of audio-visual recording), meaning that getting highly detailed data about user behavior is either incredibly time consuming or downright impossible.

A potential source of supplementary data to accommodate this limitation is the automated collection and analysis of instrumentation data, an approach utilized within the general HCI field [e.g. 24,29], but however only recently adapted to computer game production [19,33]. Different types of instrumentation data can be recorded from player-game interaction. In game development, instrumentation data find uses within e.g. engine performance, sales across different countries or regions, project progress or user interaction with the game software, the latter category being of interest here. Within the context of user-oriented testing, instrumentation data related to player-game interaction are generally termed gameplay metrics [32,35], and serve to provide detailed quantitative information about the player (user) behavior. Gameplay metrics form objective data on the player-game interaction. Any action the player takes while playing can potentially be measured, from low-level data such as button presses to in-game interaction data on movement, behavior etc.

The term "metric" – as it is used here - stems from computer science, and denotes a standard unit of measure, with metrics generally being organized in systems of measurement, utilized in the evaluation and measurement of processes, events, interaction etc. [2,10,21]. Importantly, game metrics are not game heuristics – the latter are design principles that games can be build from, where game metrics are instrumentation data derived from game engines. In general, gameplay metrics can be recorded for any type of user-initiated behavior where interaction takes place in or with the virtual environment; as well as behaviors initiated by agents or systems operating in the virtual environment outside of the control of the player, e.g. autonomous agents [34]. The analysis of user behavior via gameplay metrics act as a supplement to the established methods for user-oriented research in the game industry and –research. For example, usability testing focuses on measuring the ease of operation of a game, while playability testing explores is users have a good playing experience [24]. Gameplay metrics analysis offers however insights into how the users are actually playing the games being tested. This makes this type of data uniquely suited to form the basis for gameplay evaluations.

In this paper, two case studies are presented that showcase novel forms of gameplay analyses that can be performed via the application of gameplay metrics. The case studies showcase new ways to analyze gameplay metrics and take advantage of the spatial dimension of certain metrics in order to target gameplay analysis. They are also indicative of the ability of gameplay metrics analysis to provide detailed data on player behavior, thereby providing a tool for not only game development and –design; but also general user-oriented research in interactive entertainment. While the case studies presented are based on two specific commercial titles, Kane & Lynch and Fragile Alliance (both: 2008, IO Interactive), the two games are examples of the highly popular shooter genre, and represent the two dominating modes of play within this genre: Single-player (Kane & Lynch) and multi-player (Fragile Alliance). The methods described in the case studies are therefore cross-game applicable, directly transferable to other shooter games (e.g. Doom 3, Unreal Tournament, Bioshock and Crysis), as well as other game genres utilizing a central character as the vessel for game-player interaction, i.e. also many role-playing games and adventure games such as Oblivion, Neverwinter Nights and Dreamfall. Additionally, massively-multiplayer online games such as Age of Conan and World of Warcraft and online persistent worlds such as Second Life, as well as other Virtual Environments (VEs), have players taking control of a single 3D character, and therefore also form potential targets for the kinds of analysis presented.

The work presented here is being carried out in collaboration between Danish game developer IO Interactive (a subsidiary of EIDOS Entertainment), and the IT University of Copenhagen.

2. PREVIOUS WORK

The focus of this paper is not to review existing work on gameplay metrics but rather to showcase a series of developed analysis methods for evaluating gameplay. However, a brief overview of the related work is presented here.

The literature on game metrics is minimal, even including the information available from industry sources such as the Game Developers Conference. The handful of published examples of gameplay metrics analysis is restrictive in the amount of information that they provide [e.g. 5,19,17,25,35]. This is in part due to the novelty of the approach, in part because gameplay metrics data would normally be treated as confidential by a company. Furthermore, the few examples of systems developed for capturing game metrics-like data developed outside of the academia are generally targeted at Virtual Environments (VEs) rather than games specifically [e.g. 3,4,5,14]. Additionally, these applications are often targeted at analyzing specific features, such as movement only, or developed for use with specific applications/games [e.g. 14], and therefore not portable across environments.

A substantial part of the current published material about gameplay metrics analysis stems from the work of Microsoft Game Labs, which perform game testing and user-oriented research for the various Microsoft-based game studios. Microsoft Game Labs developed e.g. the TRUE setup to capture gameplay metrics together with survey and video data. The approach has been applied to user testing of e.g. Halo 2 and Shadowrun [19,33]. Among the most recent uses of game metrics in a research context is the work by Williams et al. [36], who examined user data from EverQuest 2 in combination with survey-based information to evaluate player behavior, e.g. in terms of how many hours they spend gaming per week. Other examples include the data presented by Mellon [25] from the massively multiplayer online game (MMOG) The Sims Online; while Goetz [12] presented analysis of interface-based metrics from e.g. Civilization IV. Finally, DeRosa [8] reported from the use of time-spent reports developed at Bioware for their international hit game Mass Effect. Tychsen & Canossa [35] described a model for using gameplay metrics to describe personas of players in game design & -testing. What is apparent from the literature is that there is a need to open up the discussion about how to utilize gameplay metrics analysis in game production and –research, as the relatively limited size of the literature on the topic betrays the increasing amount of attention and use that the automated collection of gameplay metrics has gained within the past five years or so [32]. Notably within massively multi-player online games such as World of Warcraft and Age of Conan is the tracking of at least some basic gameplay metrics today a common practice during the development and live periods of the lifetime of these games [see e.g. 25].

In terms of using gameplay metrics as a user-oriented testing method, this is not without specific challenges. Where methods such as usability-testing and playability-testing focus on establishing whether a player can interact with a game effectively, and if doing so is fun, gameplay metrics-analysis is targeted at clarifying what the player is actually doing, and sometimes why the behavior indicated arises. Importantly, the "why" is hypothesis-based: In order to assess the motivations and reasons behind player behaviors, it is often necessary to combine gameplay metrics-analysis with other user-oriented testing methods. Furthermore, gameplay metrics does not inform about the gender, age or other demographics of the player. As such, the approach supplements existing methods, addressing the key weakness of standard user-oriented game testing methods, namely the lack of detailed and objective data. Finally, it should be noted that order to enable metrics-based analysis, an infrastructure is needed to capture the data, which includes substantial storage needs in the case of large commercial titles such as Kane & Lynch.

In summary, the literature on gameplay metrics and game metrics analysis is largely based on data from in-house testing, with a few MMOG-related examples of data derived from installed clients or game servers such as Williams et al. [36]. Analyses have, with the exception of the work by Microsoft Game Labs, focused on high-level aggregate-counts of metrics. The spatial component of gameplay metrics have not been the focus of published work outside of the heatmaps (game level maps showing the locations of player character death aggregated for a number of players), which have been published for games such as Half Life 2 and Team Fortress 2; and visualizations of player progression as a function of time for Halo 3 [33]. Previous work with metrics has generally included only a single variable at a time, e.g. level completion times, and the potential for performing analysis on the spatial dimension of gameplay metrics (e.g. the position of the player within the virtual environment) limited to handful of industry- and academia-derived applications. There is therefore a substantial room for development of novel approaches towards utilizing gameplay metrics, and this forms the overarching goal of the research presented here.

3. CASE STUDIES

The data used as a basis for the case studies presented here is test data, i.e. data from in-house testing with professional testers or representatives of the target audience for the games in question. A varied amount of game sessions/number of people are used in the datasets for the different case studies, however, it should be noted that essentially the data suffer from a bias because they all stem from in-house testing at IO Interactive, not testing carried out in an independent laboratory. However, the purpose of the case studies is not to present conclusions from experiments performed, but to showcase techniques and methodologies, which can be employed in both an industry and research-oriented context. It should also be noted that the data are derived from tests run on unfinished versions of the games involved, and the data therefore do not represent material from the finished games. This is in the current context not a problem in terms of the quality of the analyses presented, rather it adds strength to the argument of e.g. [19,35] that gameplay metrics form a valuable supplement to other user-oriented research methods during the production phases of computer game development (where testing is carried out iteratively with more and more complete versions of the game/game levels). Due to the confidential nature of the gameplay metrics data, no absolute numbers are presented.

Data for the case study is drawn from the EIDOS metrics suite, developed by the EIDOS Online Development Team at IO Interactive in Denmark. The metrics suite is an instrumentation solution engineered to provide EIDOS studios with metrics data for e.g. user behavior analysis. Logged information is streamed to a central server for extraction and analysis. The metrics suite can collect data from game engine software during production as well as from installed clients during the live period of the lifetime of a game (i.e. following launch and distribution to the customers) [19,35]. In addition to utilizing gameplay metrics in user-oriented testing, IO Interactive and other EIDOS developers potentially involves a battery of methods including audiovisual recording and analysis, survey-based approaches, expert testing, different forms of usability testing, biofeedback, eye tracking etc. [27]. The combination of gameplay metrics analysis with existing methods for user-oriented game testing permits strengthens across-method triangulation of results.

Following transmission from the game engine, the data is transformed through and ETL process (Extract, Transform and Load) and imported to an SQL server. From the server, analysts extract data for analysis and visualization, creating reports for the interested parties (generally QA, designers, producers and marketing). The transformation of raw gameplay metrics data drawn from the EIDOS metrics suite, into reports disseminated to the interested stakeholders requires a series of potentially iterative steps.

When performing analyses of gameplay metrics with a spatial component, data are imported into a geodatabase system from where files are drawn, analyzed and visualized using a Geographical Information System [22], ArcGIS. Some of the gameplay metrics can be quickly visualized using a custom in house-produced tool which adds data on top of level maps. This combination of tools permits both rapid visualization of basic information, as well as in-depth analysis of user-behavior data performed by analysts.

3.1 Case study 1: Level analysis by sub-sector in Fragile Alliance

Fragile Alliance is similar to many other team-based multi-player shooters, e.g. Unreal Tournament and Quake Arena; however, it has a twist: It pitches players as mercenaries trying to accomplish a heist. A game session will typically consist of multiple rounds being placed on the same map (scenario) and/or different maps. The winner of a round is the player who leaves with the most money, irrespective of how these are obtained. At the end of the round, all money stolen is divided among surviving mercenaries. If a mercenary dies, they respawn (are reinstated in the game universe) as police officers, working along with a group of AI-controlled autonomous agents ("bots") playing the same role. This creates a situation where the balance of power initially will typically be on the side of the mercenaries, but shift towards the police. After the second death, the player will typically not respawn, but will have to wait for the game round to end (usually after a few hundred seconds depending on the map). Mercenaries run the risk of being killed by AI-police, as well as police players; however, a substantial threat is other mercenaries: Fragile Alliance allows mercenaries to betray each other. If for example a mercenary player had managed to secure a sum of money from a bank vault, another mercenary could kill the first, and steal his/her money. If a mercenary kills another mercenary he becomes a "traitor" but is allowed to keep all the money collected without sharing (Figure 1).

Figure 1: Screenshot from Fragile Alliance, showing a Traitor clearly marked to the remaining mercenary players.

If a player kills a traitor they receive an instant reward; however, if a police officer kills the traitor that killed him as a mercenary, he will reap a bigger revenge-reward. If a police officer secures an amount of loot money from a mercenary, he keeps a percentage as a finder's fee. The purpose of the mercenaries is to escape with as much money as possible – either by working independently or together.

One of the key design concerns when creating scenario-based levels is ensuring that the right events take place in the right locations. For example, in the current map the mercenaries should at least in some cases reach the exit and complete the mission, rather than being gunned down by the police in the vault area (Figure 2). This question was addressed by analyzing the spatial patterns of player death. This is a powerful tool for analyzing player behavior, as the gameplay metrics data permit plotting of locations of player death – and the causes – with pinpoint accuracy. This allows fine tuning of the design of the game level.

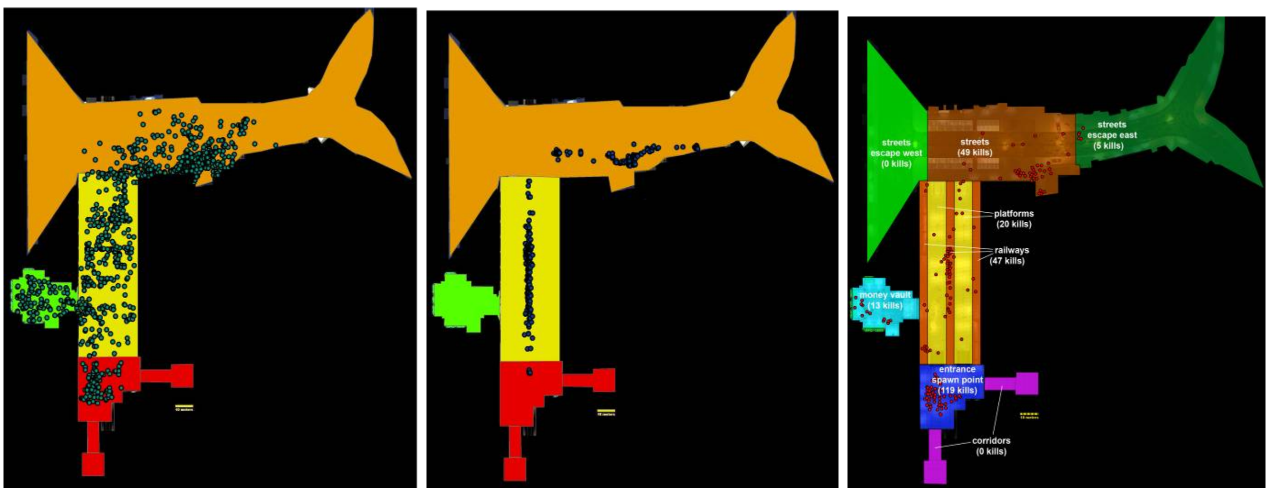
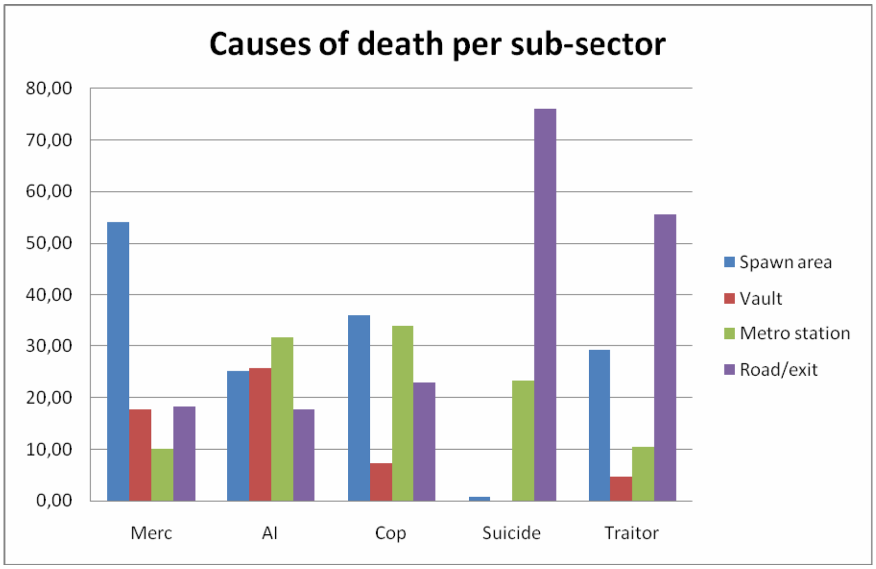


Figure 2: The Fragile Alliance level map divided into four sub-sections: Red = spawning area; Yellow = subway; Green = vault area; Orange = road/exit area. Left: The locations where police officers were the cause of death have been mapped on top of the sub-sector map using overlay analysis in ArcGIS (data from approximately 50 game sessions, 6000 total kills recorded). A broad distribution is apparent indicating that police officers can reach the entire map. Middle: Locations of suicide-caused death events. The events in the yellow sector of the map are caused by players being run over by a subway train while crossing a set of tracks, while the suicides in the orange zone are caused by exploding scenery (e.g. cars that explode after becoming too damaged by weapons fire). Right: An example of feedback to the game designers following metrics analysis of the game level. The map shows the distribution of about 250 player death occurrences overlain the level map, and has added explanations to guide the interpretation of the map. This visualization was produced with ArcGIS. Two layers of data have been added to a map of a level from the game Fragile Alliance produced by IO Interactive. One layer subdivides the game level map into sub-sectors; a second consists of point-based plots of the locations of player character deaths. Using ArcGIS, the number of points in one layer intersecting with the polygons in the other has been calculated.

In the map level selected for this case study, the mercenaries spawn in the bottom of the map, the police AI agents to the top right (Figure 2). The objective of the mercenaries is a vault, located to the left in the map, and thereafter to reach the level exist, in the top right corner, behind the spawning area of the police. The game level consists of four sub-sectors: The spawning area, where the mercenary players enter the game and begin addressing the heist objective (red in Figure 2). The vault area, where the money they need to steal are located (green in Figure 2), a subway station area approximately in the middle between the spawning area of the police (AI and players) and mercenaries (yellow in Figure 2) and finally an area at street level (orange in Figure 2), through the rightmost side of which the mercenary players go if they want to escape the map (i.e. complete the heist or run away).

Dividing the level map into sub-sectors permits an even more detailed analysis of the distribution of the death events (Figure 3). By combining visualization of the spatial behavior of players with statistics of their temporal (and spatial) behavior, a more thorough understanding of the player behavior is gained as it is now possible to compare spatial and temporal behavior. The analysis shows that mercenaries primarily turn traitor in the beginning of the game in the spawn area, but most commonly (55.72%) in the road/exit area – i.e. when the mercenaries are close to getting out with their stolen booty. This pattern of behavior confirms to the designers at IO Interactive that at least in this respect, the behavior of the traitors is as expected from the design of the game level. For the mercenaries, the majority of the kills occur in the spawning area, where mercenaries enter the game. The AI agents are spread across the entire map, indicating that their search & destroy behavior is working excellently. Suicides occur in the vast majority of cases (76.04%) in the road/exit area, where a series of cars are placed which can explode if taking too much damage. A smaller part takes place in the metro station area, where players can be hit by metro trains while crossing the tracks coming from the vault to the exit/road area to the north in the map (Figure 2).

In terms of the roles played by players when they are killed, the pattern is generally as would be expected from the gameplay design. Police officers are typically killed in the road/exit area where they spawn (69.32%), and very few are killed in the spawn and vault areas, where instead the mercenaries are under pressure from the police (44.17%). Interestingly, traitors are typically killed in the spawn area (61.25%), but rarely in the road/exit area (8.81%), which indicates that it is a much more risk-filled endeavor to turn traitor early in the game rather than later (note that spatial analysis shows that mercenaries turning traitor outside of the spawning area rarely move into the spawning area again – by this point the action has moved to the other segments of the map).



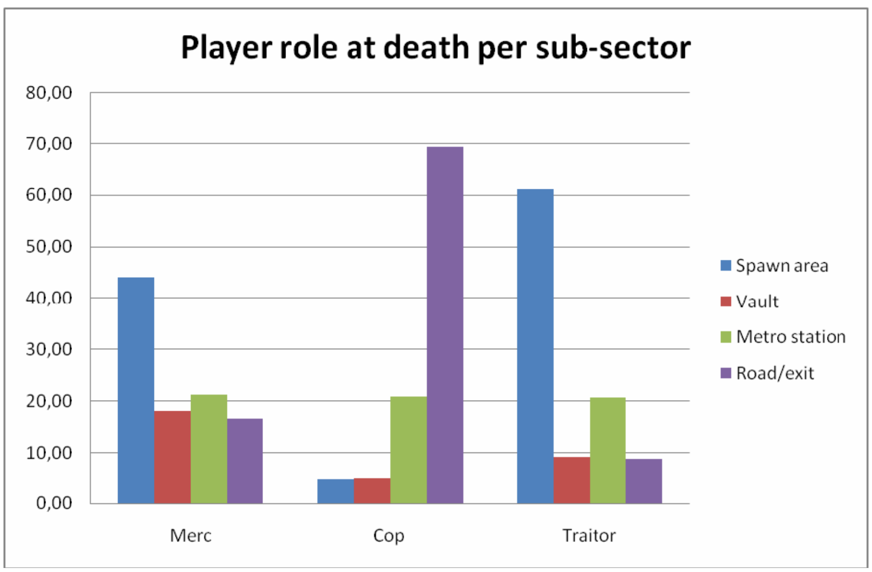


Figure 3 (Top): diagram showing the causes of player death as a function of the Fragile Alliance level map sub-sector. (Bottom): The role of the player at the time of death as a function of the map sub-sector. Same data source as for Figure 2.

In summary, the behavioral patterns of the players in terms of death events in the specific level of Fragile Alliance appear to follow closely the intents of the designers. It should be noted that a somewhat larger amount of death events occur in the spawn area (lowermost part of the map) than is ideal, which could indicate that mercenaries are perhaps a bit too eager to turn traitor early in the game. This may not be a problem to the user experience but rather the opposite. However, gameplay metrics cannot inform about the quality of the user experience on its own, meaning that this question is a subject that should be analyzed in combination with other user-oriented game testing. This example highlights the key limitation of gameplay metrics analysis: It can inform what players are doing, but not always why.

While the causes of death in Fragile Alliance are specific to the game, the basic multi-player shooter game platform is among the more popular among online games. Furthermore, while the players have specific roles unlike in other multi-player shooters such as Unreal Tournament, it is increasingly common to see multi-player shooters employing character classes, i.e. the player chooses a character class with a specific team (assault, sniper, special agent, etc.). This is known from games such as Call of Duty, Team Fortress 2 and the Battlefield-series. The approach is therefore directly transferable to these games. In single-player games (even non-shooters), causes of death will not be other players, but for example different types of computer-controlled enemies or environmental effects. The principle of the analysis remains the same, as to the goal of locating "trouble spots" in game levels/areas where the patterns of death are not as intended by the game design.

3.2 Case study 2: Perfect paths in Kane & Lynch

A key strength of gameplay metrics analysis is the ability to recreate the playing experience of the player in detail. Being able to model the navigation of players through a game environment is of interest to game development for a number of reasons, not the least because it allows designers to observe how their games are being played. Other methods of user-oriented testing of computer games can also locate problems with gameplay, e.g. reporting that a specific encounter is too difficult. However, when integrating gameplay metrics, the second-by-second behavior of the players can be modeled – this enables much more detailed explanations for the observed behaviors. Furthermore, patterns of behavior are much easier to establish (and less time consuming to produce) when based on gameplay metrics as compared to data from play- or usability testing. Gameplay metrics analyses that focus on recreating the player experience generally belongs to the more in-depth types of analysis, where the focus is on capturing and analyzing metrics data in great detail and across a large number of variables, typically from a limited number of users. An example is the analysis of whether and how players move through a game environment varies from the path/-s intended by the designers. In contemporary major game titles where there is a trend towards flexible, open-ended gameplay (e.g. Grand Theft Auto IV), this type of gameplay metrics analysis can be complex.

Kane & Lynch is a shooter-type game where the player takes control of one of a pair of criminals, playing through a series of missions in order to secure the freedom of his family (Figure 4). The game is brutal and the language harsh, depicting the more hard-core element of the criminal/terrorist world with abandon. In terms of gameplay, the game follows previous shooters in that the player controls a single character and mainly has to worry about staying alive, eliminate enemies and solve specific tasks. In certain missions, the player commands a squad of characters, with however the squad operating semi-independently under AI-control.

The focus of this case study is to show how gameplay metrics can be applied to examine player navigation through level maps, and whether the players deviate from the intended path of the level design. Furthermore, if there are any "trouble spots" where the gameplay might be too challenging (i.e. players die/get injured) – i.e. moving beyond the navigation mapping of Chittaro et al. [3,4] to include additional variables on the player state. These are questions relevant to all games and virtual worlds where navigation forms a part of the gameplay, and the player controls a single character/avatar (or small group).

The type of analysis required to address the questions of the designers requires and event-set approach to data collection, where gameplay metrics are recorded in sets associated with specific events. For example, looking not only at where players die, but also where they crouch and cover, the speed of their movement at different intervals through game levels, where they get injured and how much; and so forth. In order to analyze whether players experience the content of the map is a potentially complex analysis, depending on the specific features that are sought investigated. Initially however, content exposure is a matter of placement within the virtual universe – the player has to be there in order to experience the content.

Figure 4: Screenshot from Kane & Lynch, showing the two main characters. The player controls Kane, the character in the front (image © IO Interactive, 2008, used with permission).

For this case study, a section of one of the many level maps from Kane & Lynch was selected. The level features a series of interconnected fights and different locales through which the player (or two players in co-op mode) must navigate and survive. The locales include both near-ranged combat in enclosed spaces, as well as more open environments. The total playtime for an experienced player is about 12-14 minutes.

The first problem addressed was whether the players deviated from the intended path of the designers. This was approached by defining a "perfect path" – the one that players were expected to follow – and calculate the difference between the player paths and the perfect path. The perfect path was defined with the lead designer of the level and a 2 meter wide path defined on top of it using ArcGIS (Figure 5).

Following this, players were asked to play through the level segment, and the following gameplay metrics recorded:

1) Navigation: The path of the players recorded as (X,Y,Z)-coordinates every second. Unlike Chittaro et al. [3,4], it was chosen to use timed coordinates rather than vectors because point data are easier to label and take up less space in the data stream.

2) Health: The (X,Y,Z)-coordinates for the locations where the player is injured, and the degree of injuring. Health is in Kane & Lynch divided into five degrees, depending on the level of injury the player has sustained. These data are tracked as a feature of player location, and can be mapped as

a secondary variable together with the location point data. These types of plots are useful to investigate where players are injured and the causes.
3) Crouch and cover: The (X,Y,Z)-coordinates for the locations where the player crouches or uses the snap-to-cover system that is a hallmark of Kane & Lynch.
4) Speed: The movement modifier of the players, i.e. whether the player was standing still, walking, running etc.

By plotting the navigation coordinates on top of the perfect path, in ArcGIS it is possible to calculate the extent to which players follow this path (Figure 5), i.e. behave as intended by the design. In the example provided here, roughly 85% of the player's path falls within the 2-meter perfect path, i.e. the player is more or less behaving as intended with respect to navigation. The same procedure can be run with data from thousands of players at the same time plotted on top of the perfect path. If such datasets are available, it becomes especially valuable to examine if there are sections where numerous points or clusters of navigation points fall outside the perfect path, as it indicates a deviation by a substantial number of players from the intended path/-s.
In order to address the second question, if there are areas where the player is heavily challenged, the health of the players was added as a color code on top of the navigation point data. The analysis showed that for this segment of the game level, the player went mostly uninjured or lightly injured. However, in two positions the player´s health drops rapidly, and often players would die in these locations. These are locations where considerable opposition is supplied via AI-controlled opponents (Figure 6). This analysis assists in clarifying whether the level is too hard to play (players often dying/getting injured heavily), or too easy. Conversely, if there is a good balance in the level between easy and hard segments (a typical design goal for shooter-type games). The use of crouching and the cover system was also examined, as was the speed with which the player moved through the level. During most of the investigated segment, movement was rapid, which corresponds with the player not being substantially challenged. However, in the two "trouble spots" the player would slow down to a standstill and take cover, navigating between different cover options in order to eliminate the opposition. The analysis showed that for the first "trouble spot", the players generally take little cover; however, cover is also more scarcely available.

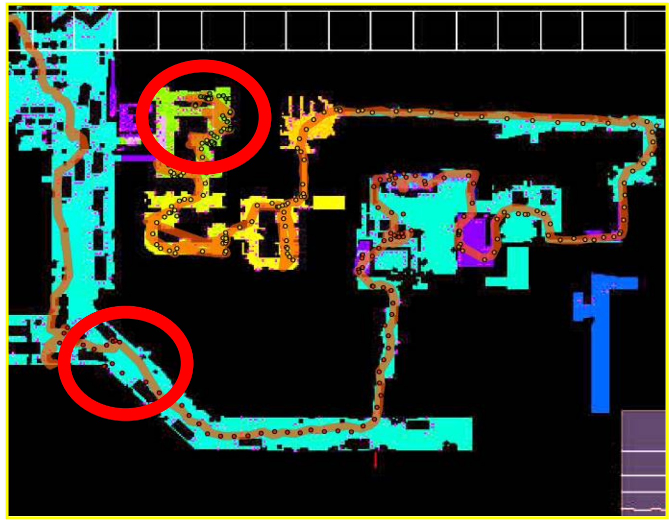


Figure 5: The path of the tester has been overlain the 2-meter wide perfect path. As would be expected from the relatively linear design of Kane & Lynch, the paths almost overlap (85%). However, in a few places the paths diverge (red circles).

Figure 6: Visualizing the health of a single player. The points are spaced one second of playtime apart. Color signifies the health of the players (five categories). Locations of lowest possible health (right before death) have been marked with orange crosses.

This kind of gameplay metrics analysis is useful in recreating the player experience in detail, and evaluating if there are areas of the level design that are problematic – e.g. lack of cover options, encounters that are too challenging or not, and so forth. The kind of feedback provided via gameplay metrics is very precise and detailed - this down to a level where the position of the player can be mapped to the specific corner he or she was covering behind, for how many seconds the player spent at the location and what the player was looking at, etc. Using gameplay metrics in this fashion – ideally in concert with attitudinal data - it is possible to analyze in detail the behavior of players and normally also the causes, for example by considering the spawning points of enemies in concert with player health data and movement patterns. Using ArcGIS, it is possible to plot different variables of player behavior in successions of layers, perform calculations across them, and to dynamically add or remove the individual layers.

4. CONCLUSIONS AND PERSPECTIVES

Gameplay metrics form a novel approach within game development and addresses one of the major challenges to games-oriented user research, namely that of tracking and analyzing user behavior when interacting with the very complex systems that contemporary computer games are. As a user-oriented approach, it complements existing methods utilized in the industry very well, providing detailed and quantitative data to supplement attitudinal and semi-quantitative data from e.g. usability testing and playtesting [19,24,27,30]. In summary, the main benefits of gameplay metrics are as follows:

- Quantitative and highly detailed data on player behavior
- Objective way of visualizing and analyzing play-session data
- Detailed feedback on game design and mechanics
- Supplements existing methods for user experience testing and bug-tracking (data for both purposes can be collected simultaneously)
- Assists the location of game problems: E.g. bugs and faulty patterns of play, and helps with evaluating fixes

Instrumentation data from users form an important contribution to not only user research and – testing during the development phases of game production, but also in monitoring and evaluating user (player) behavior during the extended usage, i.e. during the live periods of games, where given the right tools, data can be obtained directly from the users operating within their natural environments – at home, in internet cafés, LAN-parties etc. This is particularly useful for academic purposes, e.g. where the aim is to examine how people play games in their own environments [e.g. 36]. As shown by e.g. 14, it is possible within an academic context to develop metrics tracking systems. However, in order to take advantage of gameplay metrics, methods need to be developed that can be used to decide which data to track and how to analyze them. Furthermore, because the use of game metrics for gameplay analysis is a relatively recent innovation, it remains uncertain what the limits are for their application and which methods that are cross-game applicable.

The use of gameplay metrics is in itself novel, being hitherto applied in about a dozen different publications, despite the widespread use of instrumentation data within related fields such as application software production and website design. Existing approaches towards gameplay metrics analysis generally focus on single variables and rarely focus on the spatial dimension of the game worlds that players navigate. In this paper, two case studies have been presented which showcases the usefulness of working with multiple variables and within spatial environments, providing an approach for analyzing gameplay and recreating the playing experience. The case studies are based on common features of shooter-type games, navigation and death, and are therefore cross-applicable across games of this genre. Furthermore, the approaches presented are relevant for other kinds of games and VEs where the player controls a single character/avatar. The case studies indicate the usefulness of gameplay metrics in being able to recreate the play experience, as a method for evaluating game design, e.g. figuring out where the challenge level is too high or low, where the player has problems navigating, and if the player does what is intended from in the design, or goes outside it. In games where multiple means of completing the game are possible, using different strategies, such as Deus Ex, the Tomb Raider-series and role-playing games such as Neverwinter Nights, this latter potential is especially promising.

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ARTICLE 8 - ANALYZING SPATIAL USER BEHAVIOR IN COMPUTER GAMES USING GEOGRAPHIC INFORMATION SYSTEMS

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ABSTRACT

An important aspect of the production of digital games is user-oriented testing. A central problem facing practitioners is however the increasing complexity of user-game interaction in modern games, which places challenges on the evaluation of interaction using traditional user-oriented approaches. Gameplay metrics are instrumentation data which detail user behavior within the virtual environment of digital games, forming accurate and detailed datasets about user behavior that supplement existing user-testing methods such as playtesting and usability testing. In this paper existing work on gameplay metrics is reviewed, and spatial analysis of gameplay metrics introduced as a new approach in the toolbox of user-experience testing and –research. Furthermore, Geographic Information Systems (GIS) are introduced as a tool for performing spatial analysis. A case study is presented with Tomb Raider: Underworld, showcasing the merger of GIS with gameplay metrics analysis and its application to game testing and –design.

Keywords: game development, user behavior, metric, gameplay metric, geographic information system

1. INTRODUCTION

User-oriented game testing [12] during production and post-launch has been performed for decades and forms a key aspect of game production [e.g. 16,17,23,25,29-31]. Unlike technical testing (e.g. bug hunting), user-oriented game testing has traditionally been performed using informal methods such as surveys and interviews [23]. Within the last decade, and notably the past few years, a variety of new structured methodologies have been adapted from Human-Computer Interaction research (HCI) and applied to user-oriented game testing or research [16,18], e.g. different forms of playtesting and usability-testing [7,23,26,27].

The methods currently employed for user research in the game industry – e.g. playtesting, usability testing, ethnographic methods and surveys - have different strengths and weaknesses [e.g. 21,26]. Methods such as these are useful for capturing player feedback and subjective experience, as well as for acquiring in-depth information on problems regarding gameplay or design. However, they are limited in that test managers can only hand-code so much information; and analysis of e.g. screen capture to a high level of detail is time consuming and not a good solution for the quick and effective game testing process typically required in the industry. A relatively newly developed potential solution to these shortcomings is presented in the automated collection and analysis of gameplay metrics data, i.e. instrumentation data about the user-game interaction, which supplement other user-oriented methods by providing very detailed quantitative data on the player behavior. Because these data are not recorded manually, they reduce error and save time.

Gameplay metrics form objective data on the interaction between players and games, and potentially any action the player takes while playing can be measured, including which buttons that are pressed, the movement of player-characters within the game world, or which weapons that are used to eliminate opponents. As an analysis tool, gameplay 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.

Despite the relation to instrumentation data in software development, gameplay metrics have only in the past few years begun to see use in game production. There are therefore relative few methods developed for integrating gameplay metrics in game testing and game design/development, and little knowledge as to what metrics that should be tracked, when and how this varies across games [18,33]. Part of the reason is that techniques for the analysis of instrumentation data as they are applied in general HCI do not map directly to the field of game development and –research. First of all, the purpose of games is not usability, but entertainment [26]. Secondly, games take place in virtual environments (whether 2D or 3D) that simulates fictional worlds to a greater or lesser degree. This provides a very different interface and user-actionable environment than in productivity applications. Thirdly, game production can vary substantially from traditional software development processes with an emphasis on rapid iterative development, agile methodologies and needs for extremely rapid testing sessions involving human participants [23,26]. Jointly, these factors mean that the use of gameplay metrics remains largely unexplored, the literature and existing knowledge in the area minimal, and existing techniques rely on basic statistical analysis methods such as bar charts of a single variable showing e.g. level completion times [18,33]. It should be mentioned, that game metrics outside of the gameplay area, notably in terms of monitoring the economies of Massively Multiplayer Online Games (MMOGs) such as World of Warcraft and Age of Conan, or tracking regional sales for marketing purposes, form a stable part of the analysis work done by game companies. However, these metrics are not directly related to gameplay.

Importantly, the analysis of gameplay metrics in relation to the spatial behavior of the player within the actual gaming environment (often 3D virtual worlds), remains largely unexplored. This is however an area of key interest to all games because the experience of the user (player) is directly related to the experience of navigating through, and interacting with, the game world [33]. Currently, the behavior of the user and the resulting interaction experience is primarily measured using usability and playability testing methods, and as mentioned above, these are not well suited towards providing highly detailed accounts of the user behavior, but more focused on evaluating the usability and experience of interacting with the game software [26,27]. The recording of gameplay metrics operating in the spatial environment of game – spatial gameplay metrics - worlds can however provide detailed information about the behavior of the person playing the game. For example, logging the position of the player within the game every second, and recording every action taken by the player, e.g. firing a weapon, picking up objects and interacting with other players.

In summary, what is needed to advance the use of spatial gameplay metrics – indeed any use of gameplay metrics – is flexible tools for analysis that are useful across game productions and game genres, that work both in an industry-context and research-context, and the development of specific analysis methods for different kinds of game metrics.

In this paper, a step is taken in this direction. The purpose is twofold: 1) To review the existing knowledge on gameplay metrics in research and development [e.g. 18,31], focusing on how gameplay metrics supplement existing user-oriented research- and testing methods in game production; 2) To provide a case study of spatial analysis of gameplay metrics from the major commercial game title Tomb Raider: Underworld, showing the potential and benefits towards both game development and research studies of player behavior and user experience; 3) To showcase Geographic Information Systems (GIS) [9,22] as a tool for performing spatial analysis on gameplay metrics, adaptable to any game context, informing user-oriented game testing and –design. A GIS is a computerized data management system used to capture, store, manage, retrieve, analyze, query, interpret and display spatial information in the form of e.g. maps, reports and charts [9,22]. Neither GIS nor spatial analysis of gameplay metrics have formed the subject of previous publications and form the key innovations of this paper.

2. STATE-OF-THE-ART

In the context of game development, the term "metric" denotes a standard unit of measure, e.g. a second or an hour [1,12,21] (in general HCI literature the term is also used to define a calculated number post-analysis, e.g. total number of errors made by users during testing). 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. Gameplay metrics 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, gameplay 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.

Gameplay metrics 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 in FPS´). Some gameplay metrics can be recorded on a continual basis, e.g. movement in the virtual world, or be recorded using specific frequencies, such as the location of the player avatar/-s (virtual representation/-s of the player) every three seconds. Metrics can also register triggered events, e.g. every time an avatar jumps or shoots a weapon, finalizes a quest or completes a level.

Gameplay metrics are inherently objective and quantitative data, which can be collected in large numbers. Metrics allow for incredible detail – data showing for example where a player was positioned in the game environment while firing a specific weapon, with the camera angled in a certain way, and the result of the attack. The level of detail depends on the metrics system in question. Generally, these are custom pieces of software developed in-house, and map data to specific events or points in a gameplaying session. It is common to aggregate the data for easy visualization or for creating overviews or e.g. economies of massively multiplayer online games (MMOGs). In comparison, player-based feedback has much less resolution and is inherently biased due to individual preferences. Gameplay metrics are unbiased, and there is a clear practical outcome to metrics analysis. E.g., in balancing the time players spend performing different in-game actions [10]. Gameplay metrics can be analyzed in different ways. The traditional approach is purely statistical, based on e.g. aggregate counts of variables of user behavior used in time-spent reports, completion times or similar [e.g. 10,18,23].

Gameplay metrics are related to User-Initiated Events (UIEs), which refer to events that occur when a user directly interacts with the game software [18]. UIEs deal specifically with events initiated by the user; however, gameplay metrics also include events taken by the game software, for example the behavior of computer-controlled agents. Using automated tracking of UIEs to better understand user behavior originates within the HCI field, where they have been used for over two decades [e.g. 13,15,28,35]. Logging for example the movement of players in the virtual environment enables analysts to define which sections of the game world that are experienced and which that are not. The major challenge with gameplay metrics analysis is choosing which variables that should be tracked – computer games can form complex systems and the number of potential gameplay metrics is considerable. Furthermore, gameplay metrics datasets are usually very large, and the process transforming, ordering, cleaning, analyzing and visualizing the data can be challenging. Despite these challenges, there are several examples of the successful use of gameplay metrics in production [10,18,24,32]. Within the past few years, gameplay metrics have gained increasing attention as a means for obtaining detailed records of the player-game interaction, being used e.g. by Microsoft, Bioware, Nintendo, EA, and other companies [e.g. 23,31].

It is necessary to differentiate between game metrics and game heuristics [11,19]. Heuristics are design principles upon which games can be build. Game metrics are instrumentation data derived from game engines about e.g. the user's hardware configuration or interaction with the game or game interface.

Gameplay metrics analysis allows user-research professionals to examine player behavior at multiple levels of resolution [18,24,26]. A second core strength of gameplay metrics analysis is the ability to recreate the playing experience of the player in detail. Being able to model the navigation of players through a game environment is of interest to game development for a number of reasons, not the least because it allows designers to observe how their games are being played. Traditional methods of user-testing computer games can locate problems with e.g. gameplay with a fair degree of precision, e.g. reporting that a specific encounter is too difficult. However, when integrating gameplay metrics, the second-by-second behavior of the players can be modeled, enabling much more detailed explanations for the observed behaviors. Furthermore, patterns of behavior are much easier to establish (and less time consuming to produce) when based on gameplay metrics as compared to data from play- or usability testing. Gameplay metrics analyses that focus on recreating the player experience generally belongs to the more in-depth types of analysis, where the focus is on capturing and analyzing metrics data in great detail and across a large number of variables, typically from a limited number of users. An example is the analysis of whether and how players move through a game environment varies from the path/-s intended by the designers. In contemporary major game titles where there is a trend towards flexible, open-ended gameplay (e.g. Grand Theft Auto IV), this type of gameplay metrics analysis can be complex. Using a GIS however assists in facilitating this process.

A distinct advantage of game metrics is that these can be collected off-site, i.e. from client installs - players who have installed the game on their PC/console. Metrics data from client installs are typically referred to as live data within the industry, and the approach is a regular feature of modern online multi-player games, where the ability to provide basic statistics of game sessions is generally appreciated by the players (e.g. level completion time averages). The two most substantial advantages of collecting live data are: 1) The data are unbiased by environmental effects. This is a common problem of laboratory-based research, which remove players from their normal playing environments thus potentially impacting on the way they behave and interact with the games being tested [21,34]; 2) Long-term monitoring in natural environments. Gameplay metrics can be streamed from live users over weeks or months, providing a long-term perspective on trends of use. This form of data collection is also more detailed than what are possible using personal logging methods [21], and is not subjected to the same errors that personal logging over extended periods is.

2.1 Challenges of gameplay metrics analysis

As with any other user-research method, the collection and analysis of gameplay metrics is not without its challenges. First of all, an infrastructure is needed to track and capture the data, and this includes substantial storage for large, commercial productions. Secondly, finding the right metrics to track in order to answer the pertinent questions can be challenging. Thirdly, gameplay metrics inform what players are doing, not always why. Gameplay metrics provide information only regarding actions undertaken in-game by players, it is usually not possible to assess reasons and motivations behind the action, unless additional user data are captured [18]: Gameplay metrics do not inform whether the player is male or female, or what the player thinks of the game experience. In short, gameplay metrics cannot provide any contextual data. For example, whether the player is having fun or not, is male or female or whether another player is watching the screen – a metrics tracking tool can only record information from the specific game software. When an analysis of a set of metrics data point to a specific player behavior, it is often necessary to combine the analysis with traditional game user-research methods such as playtesting, video capture, usability testing or similar.

2.2 Spatial analysis in virtual environments

It is useful to separate between two overall types of gameplay metrics: Non-spatial gameplay metrics are data that do not contain any spatial information, e.g. recording the number of time a player interacts with an NPC but not where. Spatial gameplay metrics are data that come with some sort of spatial reference information attached, e.g. a specific set of X,Y,Z-coordinates, a subsector of a map or similar. For example, the coordinates where a player has interacted with NPCs in a test session of Neverwinter Nights 2. It is entirely possible to analyze spatial metrics without using the associated spatial information. Analysis of spatial metrics requires software that is capable of mapping the data onto maps of the game world, zone or level.

Spatial gameplay metrics are a known resource within game development and –testing, however only utilized to a limited degree due to a general lack of knowledge about how to do so. Therefore, spatial gameplay metrics are usually only used to produce visualizations of single variables, and by far the most well-known example of such visualizations is the heatmap [24]. Heatmaps are density/location-based aggregated visualization of – traditionally - the kill locations of players, combat units or similar. The most commonly known examples are based on FPS´s such as Unreal Tournament and Half-Life 2. However, in principle density-based visualizations can represent any gameplay metric that can be mapped to a specific coordinate set (X,Y,Z) on a map of the game world/level. For example, the locations where players activate a specific player-character power or skill, fires a weapon, interacts with an object etc. In-house developed custom tools are normally used for creating heatmaps. Heatmaps represent the first step of working with gameplay metrics, namely the visualization of the data, and generally only a single variable at a time. Visualizing data is one thing, however, it is another to actually perform analysis in the spatial domain, and this is only rarely done. One of the few published examples of such work is [14], who developed an application (Lithium) for visualizing some basic spatial information from Return to Castle Wolfenstein: Enemy Territory. However, the application developed is largely focused on visualization rather than analysis, and is restricted to the game it was built for. Furthermore, it can only handle the mapping of variables that have been coded into the program. It is therefore not flexible across games or in terms of adding new variables, and cannot adapt to changing demands without the addition of additional code and specialized knowledge. Additionally, it does not permit analysis across layers of variables.

A second example is Börner & Penumarthy [3] who developed an approach towards visualizing the evolution of virtual communities in multi-user online VEs. They utilized the education-oriented ActiveWorlds platform, recording spatial and temporally referenced user interactions, e.g. navigation, object manipulation as well as chatting between users. The logged information was used to visualize e.g. navigation data on top of 2D maps of the VE. Chat data are visualized as 3D data hills, with peaks indicating locations with a high amount of chatting.

A third example stems from Microsoft Game User Research Group, who have developed a setup referred to as TRUE [18], which permits the mapping of basic point-based information and linking this to attitudinal data collected from surveys during gameplay. The ability to perform actual spatial analysis is however limited – at least, such a capacity has not been described in any of the publications or presentations from the group, which have been the forerunners of integrating gameplay metrics directly into the user-oriented research and testing of game development.

Looking outside the games domain, there have in recent years been a number of attempts aimed at visualizing web navigation and interaction between users and software for purposes such as improving usability of the specific applications [e.g. 2,4]. These mainly focus on websites, however a few projects have considered virtual environments (VEs), and the focus is on visualizing information rather than analysis. Chittaro & Ieronutti [5] & Chittaro et al. [6] focus on using post-visit data, i.e. logged records of user movement in VEs. They developed a tool (VU-Flow) engineered towards tracking the movement and orientation of agents operating in VEs, and developed a series of visualizations and basic analyses – e.g. paths follows and areas of maximal and minimal user visitation.

In summary, the work with instrumentation data outside the field of games is a source of inspiration for the work with games-specific data, however, the amount of development of metrics-based methods within the games area itself remains limited and the applicability in the context of game production and broader research is limited: Hoobler et al. [14] and Börner & Penumarthy [3] focus on specific online multiuser VEs. The strongest feature is the visualization and limited analysis of group behaviors and the handling of application-specific events, during runtime. They are inherently inflexible and not portable across environments. Similarly, while the VU-Flow tool of Chittaro et al. [6] is cross-VE compatible, it remain a specialized tool designed for the research purposes of navigational data only.

In a game production context, testing and data analysis needs to be carried out effectively, and therefore using a series of custom applications is not feasible. A GIS offers the advantage of being able to encompass virtually any spatial analysis – and if an analysis method is not already present in the myriad GIS systems or additional analysis modules available, it can be programmed in-house or via consultants using the built-in scripting languages. GIS offers a unified framework for spatial analysis, whether in 2D or 3D. Unlike most academia-developed systems, which are too inflexible for general analytic/testing work in the industry (or academia), GIS have been developed within a range of industries and is therefore engineered towards being flexible towards different uses. This makes it adaptable to spatial analysis in games research and –production. Importantly, GIS software is designed with the purpose of providing flexible exporting of visualizations and analysis results to a variety of stakeholders, e.g. marketing, design and management, which is a core requirement for adoption by the game industry.

2.3 Geographic Information Systems

In a GIS, a map links map features with attribute information. When working with a GIS, spatial gameplay metrics are generally referred to as geospatial metrics. This signifies that the data have both a spatial (coordinates or topological relationship signifying location) and a thematic component (the variables or attributes that are under study) that is being visualized/analyzed.

This correlates with the properties of spatial gameplay metrics, which contain spatial information as well as thematic (see above). The spatial information provides the type of feature to be mapped (for example a point, line or area), and the thematic information the attributes of the metric (for example, that a player character was killed at the given coordinate set). In a GIS, gameplay metrics can be plotted on e.g. level maps, and the data analyzed and visualized. Plotting for example the progression of one or more playtesters in the form of points registering the location (X,Y,Z) of the player every five seconds, with a color grading provides an instant visualization of progression which can subsequently be analyzed to evaluate whether the playtester is moving through the map as intended and if any problems are encountered and where [see also 32]. In this example, the map is treated as a traditional paper map, i.e. it is not interactive. In a GIS, it is possible to tag map features with detailed information in the form of attributes: For example, the level map could be divided into sub-sections and each section be named individually and contain various attributes such as degree of lighting, number of enemies, expected completion time etc. When mapping gameplay metrics on top of maps that themselves contain detailed feature information, a high degree of flexibility in the gameplay metrics analysis is gained, for example in calculating the number of kills occurring in "inside" type environments vs. "outside" type environments in an FPS – as well as specific numbers for each map feature. Conceptually, a GIS is reminiscent of the architecture of computer game systems that feature virtual environments linked with objects and entities whose attributes are stored in databases [9,22]. The difference is that a GIS is specifically engineered towards analysis of the featured data and their underlying attributes in a spatial environment (although analysis can also happen outside of the mapping environment, for example in building models or querying the underlying attribute databases). In practice, gameplay metrics are added in the form of layers on top of a level or zone map (Figure 1). GIS allows the placement of several layers and performing calculations along and across the associated multiple variables and their attributes.

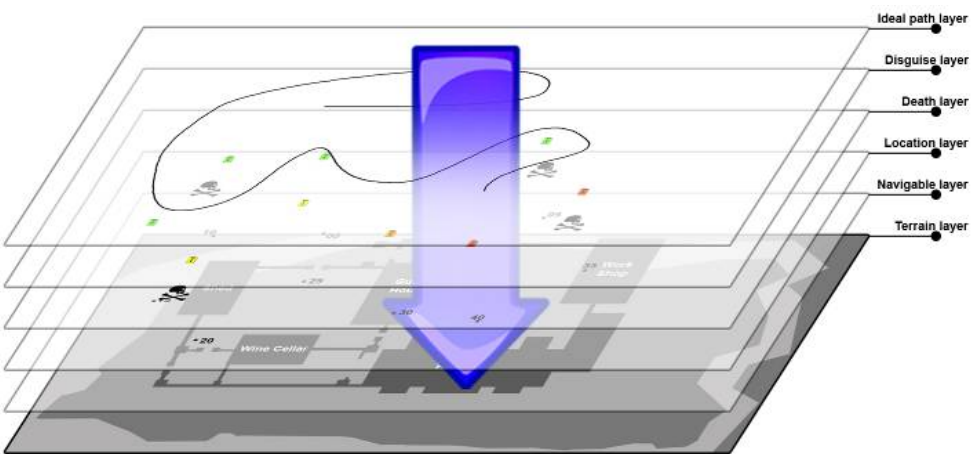

Figure 1: A GIS represent different data sets as layers on top of a game level map

2.4 The EIDOS Metrics Suite

The data for the case studies presented here are derived from the game Tomb Raider: Underworld (Crystal Dynamics, 2008). The data have been logged via the EIDOS Metrics Suite (Figure 2), an instrumentation system is designed to be able to interact with the existing user-oriented research and testing at the EIDOS studios and development houses; during production as well as in the live period, in addition to providing gameplay metrics data. It is constructed so as to facilitate the collection of data from any EIDOS-produced game, and to deliver these data directly to a variety of analysis software, e.g. the native GIS. The user research conducted at within EIDOS, e.g. at IO Interactive usually involves an array of methods, recordings and analyses [e.g. 16,25,33]. These varied data input are generally utilized together (e.g. attitudinal data, screen capture and gameplay metrics), as the various user research testing methods come with inherent strengths and weaknesses, requiring method triangulation to produce viable results.

The EIDOS metrics suite has several features in common with instrumentation techniques used in the general HCI-field, e.g. that users interact with a system that automatically record application events of interest in message streams, which are send to a central server for analysis. The metrics suite was developed by and is maintained by the EIDOS Online Development Team, located at IO Interactive in Denmark. The team is responsible for maintaining the metrics suite and assist EIDOS developers in enabling and tracking metrics.

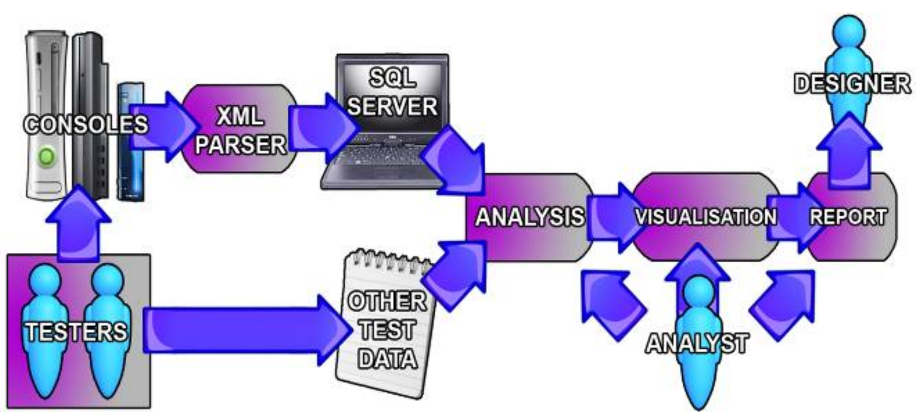

Figure 2: General framework for the gameplay metrics capture and analysis process at IO Interactive. Data are captured from testers (players) to a central EIDOS SQL server, from where they are drawn into different software analysis packages such as SPSS or ArcGIS for cleaning, evaluation and analysis. The data are then exported to visualization software), and a report developed for the target user (e.g. designer, QA).

3. TOMB RAIDER: A CASE STUDY

To showcase the potential of spatial analysis of gameplay metrics, three case studies are presented which also serve to highlight the functionality of GIS. At IO Interactive, the GIS software utilized is ArcGIS (produced by Esri Corp.). ArcGIS forms one of a handful of analysis packages utilized in conjunction with the game metrics collected from EIDOS games thanks to the work of the EIDOS Online Development Team. These include in-house tools developed for specific purposes, such as the easy visualization of key gameplay metrics such as kill locations and player movement trails. The overall research problem addressed by this paper is to evaluate the usefulness of spatial gameplay metrics analysis.

While the case studies are limited to the game Tomb Raider: Underworld [TRU], it focuses on analyzing gameplay features that are common to not only First-Person and Third-Person shooters but also Adventure Games as well as Massively Multi-Player Online Games (MMOGs) and similar genres where the player interacts with the game world via a central character.

The gameplay metrics data utilized are live data, i.e. data from players in their natural environment, captured using the EIDOS Metrics Suite. Due to the confidential nature of metrics data from commercial game titles, some facts about the underlying dataset cannot be revealed. For example, the precise dates that the data were generated, and the absolute numbers represented. The dataset consists of logs from roughly 28,000 players playing the game once in the fall 2008 after the game was released.

One of key gameplay aspects to be tested via user-oriented methods in First-Person or Third-Person perspective games, where the players control a single character (or avatar), considers the level of challenge – are there any areas where the level of challenge is too high? Too low? Etc. one way to get an initial grasp of this key research question is to consider the locations and causes of player death in a game – in essence, areas where players die consistently and repeatedly are potentially imbalanced in terms of the challenge posed by the areas. This kind of design/research problem can be targeted from a non-spatial and a spatial angle. Using non-spatial gameplay metrics, analyses can only be performed on the causes of death (e.g. enemies, falling) and their relative frequencies (Figure 3). Such an analysis however does not inform whether there are specific areas that pose problems. Via spatial analysis it is possible to pinpoint exactly where problematic areas of the game world are located.

TRU is a 3D game focusing on the player controlling Lara Croft, an internationally rather well-known game character who forms a cross between an action heroine and Indiana Jones. The game is played in Third-Person perspective with a flexible camera system and forms an advanced platform game, where the player has to apply 3D-movement and jumping to solve a series of puzzles and navigate exotic environments such as Thailand and Jan Van Mayan Island. Apart from the ever-present risk of falling from the precarious heights that Lara Croft needs to navigate, the player regularly encounters different kinds of enemies, such as mercenaries or animals. Finally, the environment itself can pose a hazard to the player, such as fire.

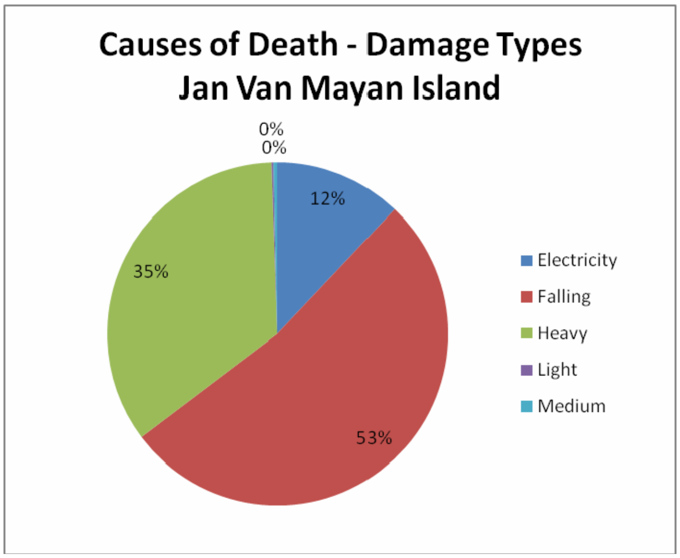

Figure 3: A pie chart showing the distribution of causes of death in the form of specific damage types, in the Jan Van Mayan Island level of Tomb Raider: Underworld. Live data from Xbox Live during a period in the fall 2008.

The game consists of seven main levels plus a prologue. Each game level is comprised of multiple "map units", for which the EIDOS Metrics Suite collects gameplay metrics data. One of these is the Valaskjalf map unit, occurring about two-thirds through the game. It is one of the more complex puzzle/trap locations in the game, featuring multiple different challenges to the players' skill. The map unit was subjected to a thorough challenge analysis during the early work with TRU gameplay metrics. In analyzing the patterns of death in the Valaskjalf map unit, the first step was to produce a heatmap based on locations of player death (X,Y,Z-coordinates) using ArcGIS (with the Spatial Analyst extension loaded (Figure 4). Heatmaps can be produced in different ways, e.g. using density functions or simply summing the number of deaths occurring within grid cells.

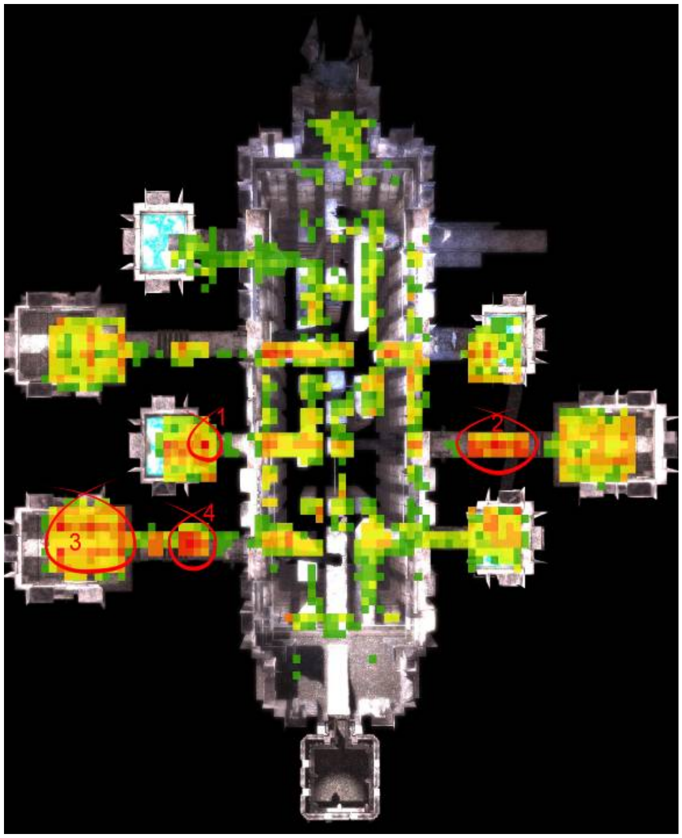

Figure 4: Grid-based heatmap of the locations of player death in the Valaskjalf map unit of Tomb Raider: Underworld. Scale ranges from light green (low numbers of death) to red (high numbers of death). Locations with no color have zero deaths. Dark red corresponds to 3050 deaths occurring within a single grid cell. Heatmap created in ArcGIS. Four of the most lethal areas are marked with red circles.

The heatmap is excellent for informing about the lethality of different game areas. However, it is unspecific as to the nature of the deaths. In order to evaluate where different causes of death such as falling, different kinds of environmental dangers and computer-controlled enemies occurred (and if they occurred as intended by the game's design!), a series of visualizations was produced using ArcGIS, showing the areas where players died of different causes (Figure 5).

Both above examples form visualizations of gameplay metrics data rather than analysis. Apart from the ability to rapidly create visualization of key data, ArcGIS facilitates spatial analysis. In the current case, the question posed calls for an evaluation of which areas of the Valskjalf map that represent areas of not only high lethality, but also where multiple different causes of death occur. Such areas represent sites of high challenge to the players and therefore form targets for evaluation about whether their challenge level is too high. Answering this kind of question requires spatial analysis. In the current case overlaying several layers, each containing the distribution of one cause of death, and performing a count across these layers. A total of eight causes of death were included (including death by falling, via contact with enemies and environment causes, such as traps) (Figure 6).

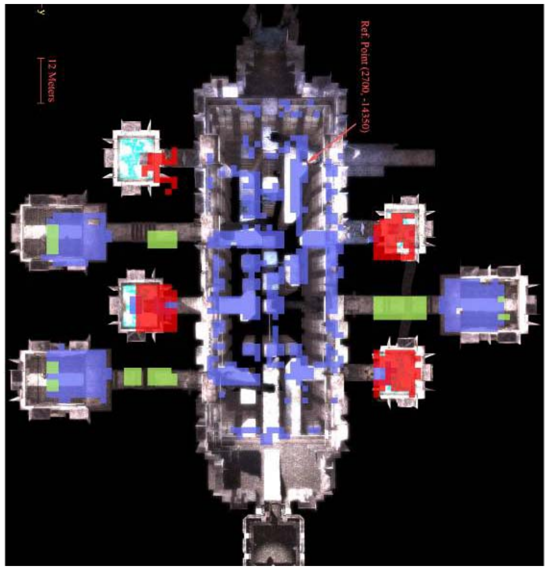

Figure 5: The Valaskjalf map unit level map has been overlain with three layers showing the extent of three separate causes of death: Falling (light blue), traps (green) and water volume [players drowning by being submerged in rising waters] (red).

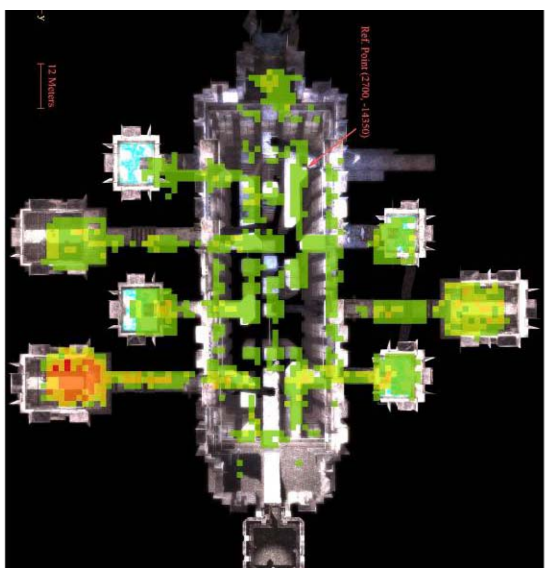

Figure 6: Overlay analysis using ArcGIS. The analysis shows the areas of the map where the highest number of different causes of death occur, on a scale from light green (one cause of death) to red (six causes of death). The area with the most causes of death is also one of the areas with the highest overall death count (Fig. 4).

The result of the overlay analysis shows that most areas of the map unit have one to two causes of death. Four areas (Figure 4) have been marked for closer analysis (Figure 7).

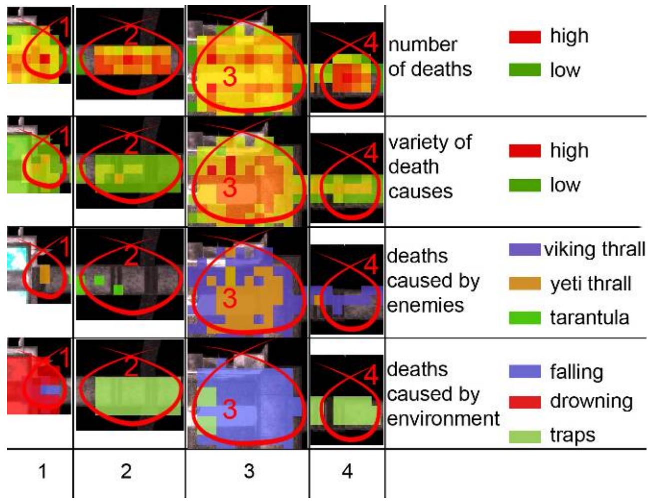

Figure 7: Detail of the overlay analysis with a breakdown of the four targeted areas with multiple causes of death. Four ArcGIS-derived layers included: Aggregated death count, aggregated causes of death (top two rows) and deaths specifically caused by enemies or environment effects (bottom two rows).

For Area 1, a high number of deaths occur in one specific grid cell (about 5*5 meters), being caused by a low variety of causes, namely the attack of a Thrall (an AI-enemy, third row in Figure 7) combined with a tricky jump (death by falling, fourth row in Figure 7). If the number of deaths occurring in this area is deemed to high (i.e. prevents or diminishes player enjoyment), the analysis suggests two ways of solving the problem, e.g. making the jump easier or eliminating the Thrall enemy. Area 2 (second column, Figure 7) also shows a high number of deaths and even though there are only two different causes, tarantulas (third row) and traps (fourth row), the distribution of tarantula kills on the Valaskjalf map is not spread enough to justify all the deaths displayed, meaning that most of the deaths are caused by the traps. This could suggest that the traps should be more lenient. The third area displays a high number of deaths, however it is motivated by a varied array of causes: Enemies, environment effects and falling – this is the climax of the level and clearly the toughest part to get through without dying. As with Area 1, a revision of the challenge level might be useful here. Area 4 displays very similar characteristics to Area 2 with similar implications in terms of the play experience.

The spatial analysis has thus identified potential trouble spots in the Valaskjalf map design, which subsequently can be analyzed in further detail, for example by comparing with user-satisfaction feedback from the level, to evaluate whether there is a problem or not. Additionally, this kind of spatial analysis provides valuable knowledge for future designs of Tomb Raider-style game levels.

ArcGIS permits different layers to be turned off and on flexibly, and even permits specific layers to be given different weights in the analysis – if e.g. players dying of electrocution is an unwanted occurrence in the game design, this can be given a greater weight and thus show up stronger in the analysis. Additionally, maps can be exported using the ArcPublisher extension as dynamic reports, which permit the user to add or remove layers dynamically, forming the perfect reporting tool for giving feedback to e.g. designers.

4. SIGNIFICANCE AND DISCUSSION

One of the major challenges to user research and –testing in commercial game development is the increasing complexity of interaction between players and game software, due in part to the sheer variety of interaction options. With the uptake in complexity, instrumentation data such as gameplay metrics form an increasingly more important tool for analysis of player-game interaction. The analysis of instrumentation data forms an important contribution to the user research and –testing performed during game development; as well as in the monitoring and continued evaluation of games during the live period. Furthermore, gameplay metrics form an excellent supplement to the existing user-oriented methods utilized within the game industry by providing detailed quantitative data about player behavior.

The EIDOS Metrics Suite, a system that permits the tracking, capturing, storage and reporting of game metrics, customized to the different games produced at the EIDOS studios; was developed by IO Interactive and is maintained by the EIDOS Online Development Team, as a response to the requirement of understanding the details of interaction between players and game, and to be able to monitor and analyze player behavior over extended periods of time. It is only recently that the game development industry has begun utilizing instrumentation data on a regular basis [18,31]. The use is often limited to aggregate counts of specific metrics – limited efforts have been directed at more complex analyses of user behavior (e.g. locating patterns of play [33]), as well as to the spatial behavior of player of computer games. The latter is crucial, because the vast majority of contemporary games are set in 3D virtual worlds. It therefore is imperative to be able to analyze and visualize gameplay metrics spatially. In essence, it is not enough to know that X% of player spent too long completing the level. In order to find out why, spatial analysis provides a venue for pinpointing exactly where players experience problems with progression. Visualizing and analyzing data in a Geographic Information System [9,22], which is specifically engineered towards handling data with a spatial component, provides a powerful tool and a plethora of new opportunities for user research experts in game development - as well as those working with other forms of virtual environments - to study how their users interact with and behave in these environments. Importantly, GIS´ are developed for multiple target industries and research fields and therefore flexible – they can handle a variety of needs as opposed to the systems developed by e.g. [3,5,6,14] which are focused on specific types of data/visualization.

The case study presented here is based on the major commercial title Tomb Raider: Underworld, eighth game in the Tomb Raider-series and one of the biggest franchises in the industry. While the case study is specific to TRU, it is focused on occurrences of player death, a phenomenon common in all games and the approach is directly applicable to any game or virtual environment (VE) where players control a single character. Spatial analysis of gameplay metrics has also been applied to Real-Time Strategy games, and forms the focus of future publications. The case study highlights the benefits of using spatial analysis of gameplay metrics data, not only as a testing tool but also in terms of user experience research – using gameplay metrics in combination with attitudinal data [18], it is possible to pinpoint exactly where players have good or bad experiences in the games, and which game features that cause them. Additionally, spatial analysis form sources of feedback to the players. Heatmap visualizations already form part of the community feedback from a variety of games such as World in Conflict, Half-Life 2 and Team Fortress 2, however, actual spatial analysis provide the potential to expand on community feedback.

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ARTICLE 9 - PLAYER MODELING USING SELF-ORGANIZATION IN TOMB RAIDER: UNDERWORLD

IEEE Symposium on Computational Intelligence and Games 2009. Anders Drachen, Alessandro Canossa and Georgios N. Yannakakis

ABSTRACT

We present a study focused on constructing models of players for the major commercial title Tomb Raider: Underworld (TRU). Emergent self-organizing maps are trained on high-level playing behavior data obtained from 1365 players that completed the TRU game. The unsupervised learning approach utilized reveals four types of players which are analyzed within the context of the game. The proposed approach automates, in part, the traditional user and play testing procedures followed in the game industry since it can inform game developers, in detail, if the players play the game as intended by the game design. Subsequently, player models can assist the tailoring of game mechanics in real-time for the needs of the player type identified.

Keywords: Player modeling, unsupervised learning, emergent self-organizing maps, Tomb Raider: Underworld

1. INTRODUCTION

Being able to evaluate how people play a game is a crucial component of the user-oriented testing process in the game development industry. During the development phases, games are iteratively improved and modified towards the final gold master version, which is published. Representatives of the target audience as well as internal professional testers spend hundreds of hours testing the games and evaluating the quality of the gaming experience [1]. Moreover, one of the key components of user-oriented testing both during production, as well as after game launch, is to evaluate if people play the game as intended — and if not, to find out why there is a difference between the intended and actual playing behavior, and whether this has an impact on their playing experience [1], [2]. Given that nonlinear game design becomes increasingly popular — massively multilayer on-line games being a good example of the increased popularity of nonlinear sandbox-type games — the need of more reliable and detailed user-testing is growing.

Within the last five years, instrumentation data — or game metrics as they are referred to in game development — has gained increasing attention in the game industry as a source of detailed information about player behavior in computer games [2]. Gameplay metrics are detailed numerical data extracted from the interaction of the player with the game using specialized monitoring software [3]. The application of machine learning on such data and the inference of playing patterns from the data can provide an alternative quantitative approach to and supplement traditional qualitative approaches to user and playability testing [4].

In this paper, we investigate dissimilar patterns of playing behavior in the popular commercial game title Tomb Raider: Underworld (TRU) using the principles of self-organization.

The experiments presented are based on a data set derived from 1365 players, which completed the entire TRU game during November 2008. Data was collected via the EIDOS Metrics Suite (a game metrics logging system utilized by EIDOS).

The data collection process is completely unobtrusive since data was gathered directly from the game engines of subjects playing TRU in their natural habitat (via the Xbox Live! web service) rather than in a laboratory setup.

Six statistical features that correspond to high-level playing behaviors are extracted from the data. Information about game completion time, number of deaths, causes of death and help on demand actions is used for feature extraction.

An initial analysis via k-means and Ward's hierarchical clustering methods provides some first insight into the inner structure of the features. Then unsupervised learning via Emergent Self-Organizing Maps (ESOMs) [5] — an efficient visualization tool for large-scale self-organizing maps (SOMs) [6] — is used to identify dissimilar clusters (types) of playing behavior. The highest-performing ESOM network which is built on the six individual features of play projects four clusters of behavior, covering the vast majority of the sampled players. The four groups of behavior identified by self-organization are subsequently labeled in terms of the game mechanics and game design. This process ensures that the outcome of the analysis is in a form and terminology that is usable by the game designers evaluating if the players interact with the game in the way intended (given the specific input playing features) and deciding on whether and how to change the design in order to alter the behavior of the players.

Unsupervised learning has been utilized for modeling player behavior in games (e.g. [7]); however, to the best of the authors' knowledge, SOMs have not been applied for modeling high-level behaviors of players trained on data of completed games. Results showcase the effectiveness of unsupervised learning in capturing dissimilar high-level playing behaviors (e.g. completion time) in the TRU game. Such behavior clusters can form the basis of further investigation in lower-levels of playing behavior (e.g. shooting accuracy in a specific level of the game).

Because this study is based on large-scale data collection (1365 players) obtained from a major commercial game and via an industrial logging system, the findings of this study directly address the requirements for player behavior modeling in the game industry. Very few studies of academic game AI investigate actual commercial-standard games due to lack of source-code accessibility and even fewer examine the game as a whole. This often generates challenges with respect to generalization of the main findings to a real game production and with respect to directly addressing the needs of the game industry.

2. PLAYER MODELING

User modeling is a broad field of research with numerous applications. In this section we will concentrate on user modeling approaches to games, namely player modeling [8], [9]. Among the few player modeling studies existent in the literature, quantitative models of players have been built to assist the learning of basic non-player character (NPC) behaviors (e.g. moving, shooting) in Quake II [10], [7], [11].

In those studies self-organizing maps [7], bayesian networks [11] and neural gas [10] approaches are utilized for clustering game-playing samples. Similarly, self-organizing maps have been used for clustering the trails (player waypoints) of users playing a simple level exploration game [12]. Viewing player modeling as an intermediate process of adaptive learning in games, Yannakakis and Maragoudakis [13] trained naïve bayesian models of Pac-Man players which infer values for parameters of an on-line neuro-evolutionary learning mechanism. The on-line learning mechanism was designed to maximize the entertainment value of the game by adjusting NPC behavior during play. Within the field of interactive narrative and AI in games, quantitative models of players — partially built on theoretical qualitative models — have been used to dynamically select the content of an interactive story [14].

Self-organizing maps — as a tool for player modeling — have been primarily used to generate a low-dimensional data map to assist training of NPC behaviors. For instance, the trained SOM can generate the desired outputs of a supervised learning approach [7] or form the action-state space of a reinforcement learning approach [15]. On that basis, Thurau et al. [7] utilize SOMs to lower the dimensionality of input data for training multi layered perceptrons that perform simple playing behaviors in Quake II while White and Brogan [15] use SOMs to generate the state space of a temporal difference learning mechanism which learns to play RoboCup simulated soccer.

All the aforementioned studies focus on constructing models of playing behavior based on small-scale player data collection experiments held in laboratories. Also, the vast majority of approaches concentrate on a few specific scenarios (e.g. imitate human movement in a particular level of a game) while the game environments investigated are in-house instrumented test-bed games or simplified versions of commercial games. This results to the simplification of the learning task which acts in favor of the learning approach; however, the scalability of the obtained performance is often questionable. This paper differentiates in that high-level behaviors of players that completed a game are modeled; data is gathered in a natural setup via an industrial logging system and a commercial web service; the data collection experiment consists of over 1300 players making it large-scale and representative; and the test-bed game used is a published game from one of the major franchises in the industry. Deriving models of playing behavior under these conditions appears to minimize any limitations of scalability and commercial-game practicality and contributes toward bridging the existing gap between academic and industrial game AI.

Fig. 1. Screenshot from Tomb Raider: Underworld.

3. TOMB RAIDER: UNDERWORLD

The popularity of the Tomb Raider series is mainly due to the game protagonist, whom the player controls: Lara Croft. She is a combination between an action heroine and Indiana Jones, who travels to exotic locations and enters forgotten tombs and lairs, solving puzzles and finding ancient treasures at the same time. The Tomb Raider game environments have been 3D from the beginning, and Tomb Raider: Underworld (TRU) is no exception. The game features exceptional graphics and takes full advantage of the graphics processors of game consoles.

The game is played in third-person perspective with a flexible camera system. TRU is in essence an advanced platform game, where the player has to apply strategic thinking in planning the 3D-movements of Lara Croft, in order to solve a series of puzzles and navigate through complicated levels (see Fig. 1). Apart from the continuous risk of falling from the heightened platforms that Lara Croft needs to jump at (and from) and navigate through, the player regularly encounters different enemy types, notably animals, various kinds of monsters and mercenaries. An additional threat to the player is the environment itself. Falling into a trap, catching fire or drowning into water are the three of the typical dangers the player is facing which are caused by the game environment.

4. DATA COLLECTION

The gameplay data, namely game metrics, utilized in this study were recorded using the EIDOS Metrics Suite software embedded to the TRU game. The suite is an instrumentation system which is designed to record game metrics from EIDOS games in production and post-launch, transmitting the logged data to an SQL-server via an ETL process. Game metrics are normally logged as sequences of events — with multiple types of data captured for each event — each carrying its own time stamp as well as any other pertinent contextual information. From the server, data can be extracted for analysis and visualization, creating reports for the interested parties within the game development process (e.g. quality assurance, game design, production and marketing departments). Data from the TRU game were extracted from the SQL server system and preprocessed. The dataset used for the experiments reported in this paper contains live data, i.e. data from people playing the finished, published version of TRU in their natural habitats. This unobtrusive way of user data collection provides with data free from bias induced by using a laboratory setup, i.e. avoids modifying the habitat of the participant [16]. The dataset used was collected during November 2008, and includes entries from 25240 players.

Note that at the moment of writing there are over 1 million recorded gameplay sessions of TRU which will form the basis for future research. The 1365 of those 25240 players that completed the game – i.e. played through all levels of the game — were isolated and used in the experiments presented in this paper. TRU consists of seven main levels plus a prologue. Each game level is sub-divided into map units, of which there are 100. The EIDOS Metrics Suite stores data for all these map units and levels individually; however data is aggregated at the level of a complete game in this initial study.

A variety of different playing characteristics (game metrics) are collected for an internal analysis work carried out by Crystal Dynamics. For each player, several gameplay features are logged, such as the completion time for each game level, the number of times the player died, as well as the 3D coordinates of the player. For the current study, initially the focus is on defining the primary playing features — among those collected — that relate to the core mechanics of the game and, furthermore, may have an impact on the playing behavior. For instance, the ability of players to perform jump actions without dying is of key interest for classifying different playing styles, as jumping is a key TRU game mechanic.

5. EXTRACTED FEATURES

In total, six gameplay features are extracted from the data collected and are further investigated in this paper. All features are calculated on the basis of a completed TRU game in this initial study. The selection of these particular features is based on the core game design of the TRU game and their potential impact to the process of distinguishing among dissimilar patterns of play.

1, 2, 3) Causes of death: TRU features a variety of ways in which players can die, which can be grouped into three overall categories that encompass all possible ways players can die. The total number of times a player died for each of the three following categories and the corresponding percentages over the total number of deaths is calculated:

1 – Opponent; the percent of total number of deaths caused by any computer-controlled opponent existent in the game over the total number of deaths, D_o. Dying from opponents comprises 28.9% of the total number of deaths across the 1365 data samples. The best player died only 6.32% of the times from opponents, while 60.86% is the maximum value observed for D_o.

2 – Environment; the percent of total number of deaths caused by the environment over the total number of deaths, D_e. Environment-related causes of death include player drowning, being consumed by fire, or killed in a trap, comprising 13.7% of the total number of deaths across all players. The best player died 2.43% of her total number of deaths from environment-related effects, while the highest recorded value of D_e is 45.31%.

3 – Falling; the percent of total number of deaths caused by a failed jump over the total number of deaths, D_f. Dying from falling comprises 57.2% of all death events making it the dominating cause of death in TRU. This is expected since the core of the gameplay consists of jumping, climbing and navigating in 3D environments. The minimum and maximum values of D_f are 27.19% and 83.33% respectively.

4) Total number of deaths: The total number of deaths of each player, D. A total of 190936 deaths were recorded, giving a mean value of approximately 140 per player, with the best and worst player dying 16 and 458 times, respectively.

5) Completion time: The time (in minutes) required from each player to compete the game, C. A total of 521.6 days of playtime were recorded. The average completion time of the game in the sampled data is 550.8 minutes, with certain levels generally taking longer to complete than others as they are bigger in extent and/or contain harder-to-solve puzzles. The C value varies from 2 hours and 51 minutes to 28 hours and 58 minutes, showing considerable variance which, in part, showcases the variation in the experience level, skill and play-style of the players.

Fig. 2. Example of a puzzle in Tomb Raider: Underworld. Several gear wheels fit together in a specific way and the player must figure out how to manipulate them.

6) Help-on-Demand: The number of times help was requested, H. A key feature of TRU is the focus on puzzle solving. A typical puzzle could be a door which requires specific switches to be pressed in order to open. There are more than 200 registered puzzles in the game, which the players have to solve in order to progress through the game narrative (see Fig. 2). The game features a native Help-on-Demand (HoD) system which players can consult in order to get help with solving the puzzles. The player can either request a hint about how to solve the puzzle or a straight answer. The H value incorporates the total number of times that each player requested either a hint or an answer. The data from the 1365 players reveal that players generally either request both hints and answers from the HoD-system, or no help at all, for specific puzzles. It was therefore decided to combine the hint and answer requests into the H aggregated value. The H value ranges from 0 to 148, with an average of 29.4 per player.

6. EMERGENT SELF-ORGANIZING MAPS

The self-organizing map (SOM) [6] or (Kohonen map) iteratively adjusts a low dimensional projection of the input space via vector quantization [17]. A SOM consists of neurons organized in a low (2 or 3) dimensional grid. Each neuron in the grid (map) is connected to the input vector through a d-dimensional connection weight vector $m = \{m_1; : : : ;m_d\}$ where d is the size of the input vector, x. The connection weight vector is also named prototype or codebook vector. In addition to the input vector, the neurons are connected to neighbor neurons of the map through neighborhood interconnections which generate the structure of the map: rectangular and hexagonal lattices organized in 2-dimensional sheet or 3-dimensional toroid shapes are some of the most popular topologies used. SOM training can be viewed as a vector quantization algorithm which resembles k-means [17]; however, what differentiates SOM is the update of the topological neighbors of the best-matching neuron: the whole neuron neighborhood is stretched towards the presented input vector. The outcome of SOM training is that neighboring neurons have similar weight vectors which can be used for projecting the input data to the two dimensional space. SOMs can be used for clustering of data (unsupervised learning) for the aforementioned properties. For a more detailed description of SOMs, the reader is referred to [6].

The power of self-organization — which generates emergence of structure in the data — is disused when small SOMs are utilized. The topology preservation of the SOM projection is of little use and the advantage of neighbor neuron relation is neglected which makes a small SOM almost identical to a k-means clustering algorithm. Using large SOMs — called Emergent Self-Organizing Maps

(ESOM) [5] to emphasize the distinction — and reliable visualization techniques help in identifying clusters in the low-dimensional projection of the data.

The topology size of an artificial neural network (ANN) is related to performance. A too small ANN may generate low approximation of the underlined function while a too large ANN may overfit the data when using supervised learning (e.g. multi layered ANN backpropagation training).

Unlike supervised learning, ESOM size does not affect the model's performance in the same way because the neurons are restricted by the topology preservation of the map. The use of more neurons (larger maps) results to an increase of the map resolution deriving from the projection of the input space into 2 dimensions. However, there is a balance between resolution and computational effort that the ESOM designer should keep in mind.

We use the batch algorithm for training the ESOM. The databionic ESOM software tool [19] is used for training and visualizing the ESOM. Batch training searches the map for finding the neuron (namely, the best-match) with a corresponding connection weight vector that matches each input vector. A best-match neuron is a neuron for which there exists at least one input vector for which the Euclidean distance to the weight vector of this neuron is minimal. In ESOM batch training, similarly to batch back propagation, all input samples are presented to the network before the weight update if performed. The toroid topology is used to avoid border effects that are generated by clusters existent in the border of 2D sheet maps. Neurons are interconnected within the map in a rectangular grid (i.e. each neuron has four immediate neighbors). The hexagonal grid (i.e. six immediate neighbor neurons per neuron) is not preferred since recent studies indicate that the shape of the map has a greater impact to SOM performance than the number of immediate neighbors [18].

There are numerous measures proposed in the literature used to evaluate the performance of a clustering approach. Even though all measures provide dissimilar indications for the properties of the generated clusters, no measure can guarantee approximation of the performance with high accuracy. In this study we choose the average quantization error and the topographic error [6] as measures of ESOM training performance. In the case of ESOM, the average quantization error equals 1/N $\|x - m_c\|$ across all N data samples, where mc is the weight vector of the best-matching neuron. Topographic error measures topology preservation of the map and is calculated as the proportion of all input data vectors for which the first and second best-matching neurons are not adjacent [6].

7. RESULTS

This section presents the main findings of the clustering approaches applied to the data. A pre-processing analysis of the data is complementary to and followed by the design of ESOM approach for unsupervised learning of the data and the identification of the different player styles.

7.1 Pre-processing and Initial Cluster Analysis

All six features extracted are uniformly normalized into [0; 1] before any clustering analysis is followed. Note that the cause of death features (D_o, D_e and D_f) are already normalized in [0; 1] being percentages of the total number of deaths.

To get some first insight of the possible number of data clusters existent in the data, we apply the k-means clustering algorithm to the normalized data for all k values less than or equal to 20. The number of player observations (6- dimensional vector samples) and the sum of the Euclidean distances between each player instance and its corresponding cluster centroid (quantization error) are calculated for all 20 trials of the k-means algorithm. The analysis shows that the percent decrease of the mean quantization error due to the increase of k is notably high when k = 3 and k = 4. For k = 3 and k = 4 this value equals 19.06% and 13.11% respectively while it lies between 7% and 2% for k > 4. Thus, the k-means clustering analysis provides the first indication of the existence of 3 or 4 main clusters within the data.

An alternative approach to k-means for cluster analysis is through hierarchical clustering. This approach seeks to build a hierarchy of clusters existent in the data. The squared Euclidian distance is used as a measure of dissimilarity between data vector pairs and Ward's clustering method [20] is utilized to specify the clusters in the data; the resulting dendrogram is depicted in Fig 3. (A dendrogram is a treelike diagram that illustrates the merging of data sets into clusters. It consists of many U-shaped lines connecting the clusters while the height of each U represents the squared Euclidian distance between the two clusters being connected.)

Depending on where the designer sets the squared Euclidian distance threshold, T, a dissimilar number of clusters can be observed. For instance, 3, 4 and 5 clusters of data can be identified if 6:56 > T > 4:72, 4:72 > T > 4:25 and 4:25 > T > 3:74, respectively.

Both clustering approaches demonstrate that the 1365 players' feature vector can be clustered in a low number of different player types. k-means statistics provide indications for 3 or 4 clusters while the Ward's dendrogram shows the existence of 2 populated and 2 smaller clusters, respectively, in the middle and at the edges of the illustration resulting to four clusters. By further splitting the populated middle-left cluster (Fig. 3), a number of six clusters can be obtained within a small difference of the squared Euclidian distance: the difference between the minimum T for obtaining 4 clusters and the maximum T for obtaining 6 clusters equals 0.52. This initial cluster analysis provides the first insights into the spatial structure of the data, which reveals the existence of a small number of clusters in the dataset. The procedure followed through k-means and Ward's clustering is viewed as necessary data pre-processing before learning from data via self-organization.

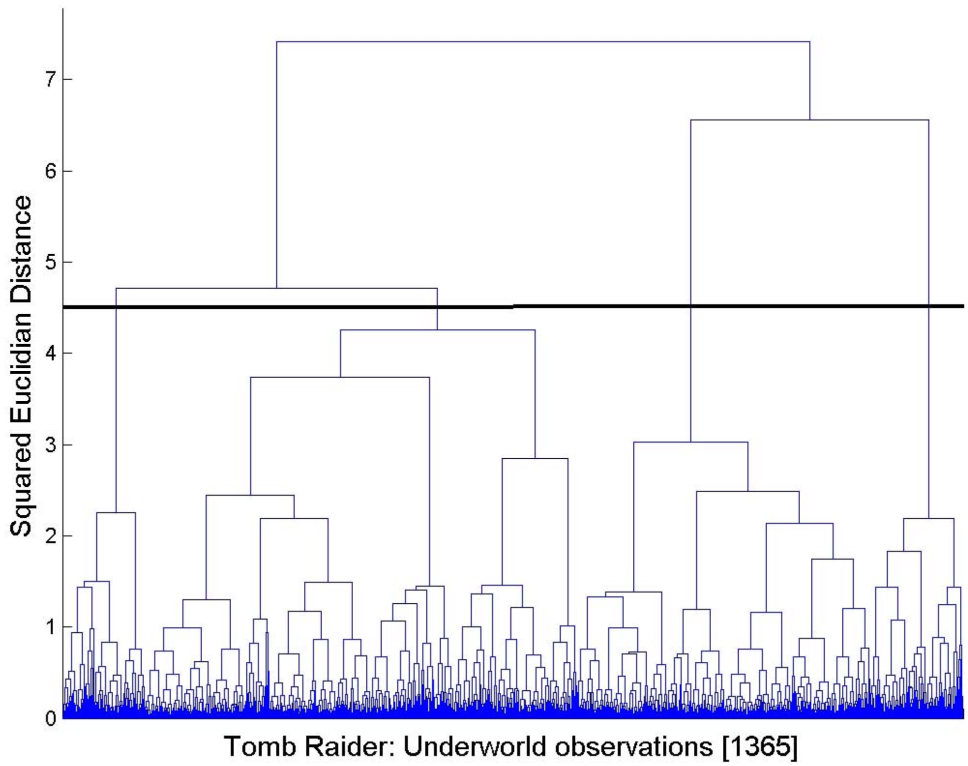


Fig. 3. Clustering of data using the Ward dendrogram method. A T value of 4.5 (illustrated with a horizontal black line) reveals 4 clusters.

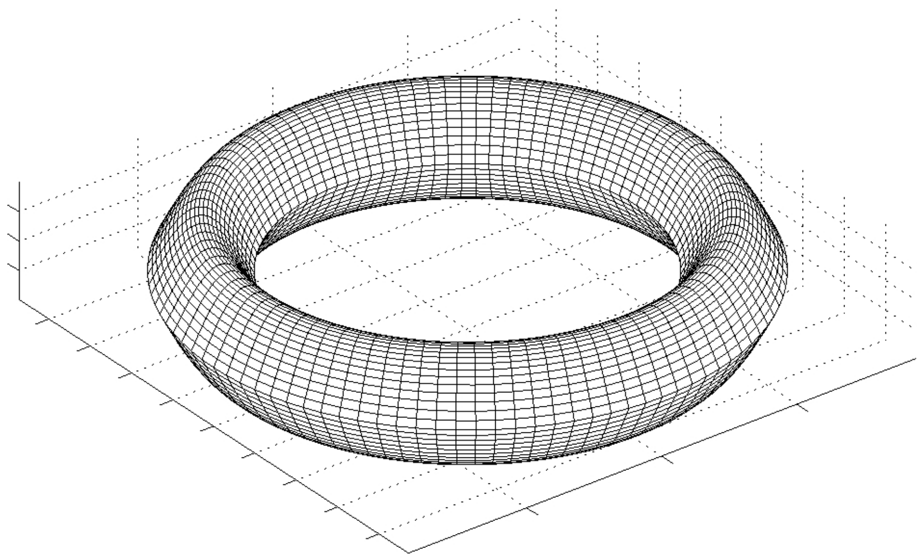


Fig. 4. Rectangular lattice map organized in a toroid shape; SOM size: 50 X 100 neurons.

7.2 ESOM

As previously mentioned in Section 5, a toroid-shaped ESOM structured in a sheet grid is utilized to identify classes of playing behavior in TRU. Fig. 4 depicts the 50^{100} neuron structure used in the experiments presented in this paper. The number of 5000 neurons is chosen to provide a good compromise between training performance, computational effort and resolution detail of the map. The toroid shape of the map is selected due to border effects observed in training attempts with 2-dimensional sheet maps.

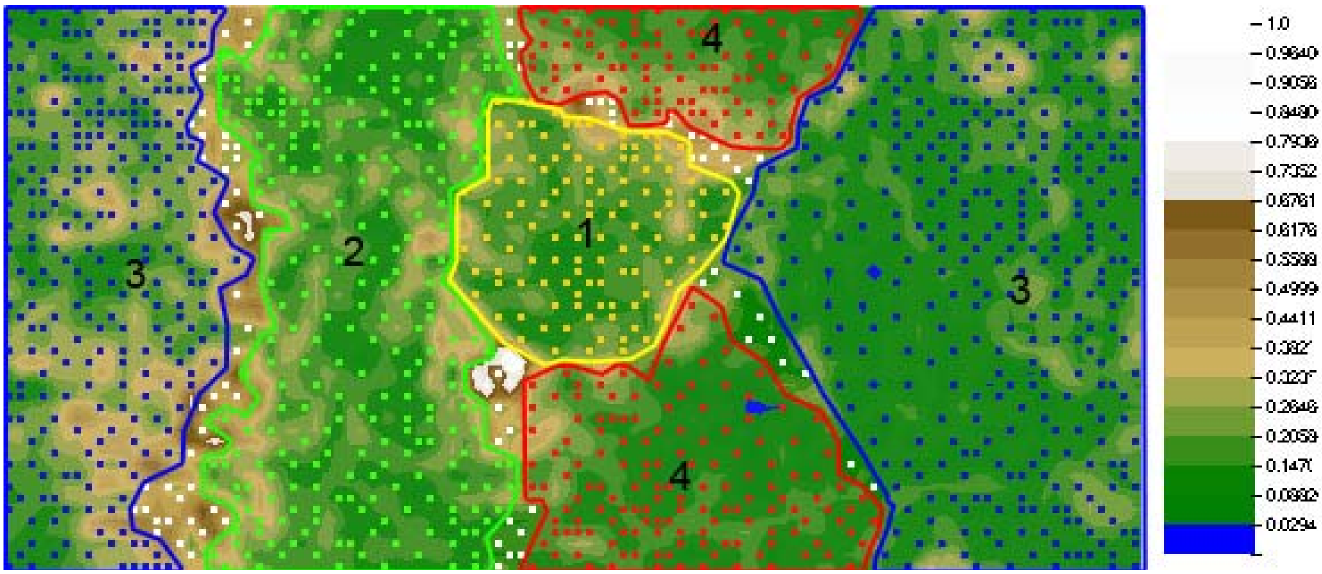
1) ESOM training: The weight vector of the ESOM is randomly initialized using a Gaussian distribution; the mean and standard deviation of the distribution are set to the respective values of the corresponding input feature. The initial neighborhood size is set to 25 which linearly drops to 1 while the weighting neighbor function, h, used is the Gaussian kernel. The learning rate is set to 0.7 but is decreased linearly during training reaching the value of 0.1 at the end of the 100 training epochs used. The training samples are presented in a randomly permuted order at each epoch of the algorithm. In order to minimize the effect of non-deterministic selection of initial

weight values we repeat the training 20 times — using dissimilar initial weight vectors — and select the ESOM with the smallest average quantization error (see Section VI). The highest-performing ESOM that is examined in the remained of this paper has a quantization error of 0.038 and a corresponding topographic error of 0.005. As a baseline performance to compare against, the mean quantization and topographic error for 10 randomly generated ESOMs equals 0.1744 and 0.9983 respectively.

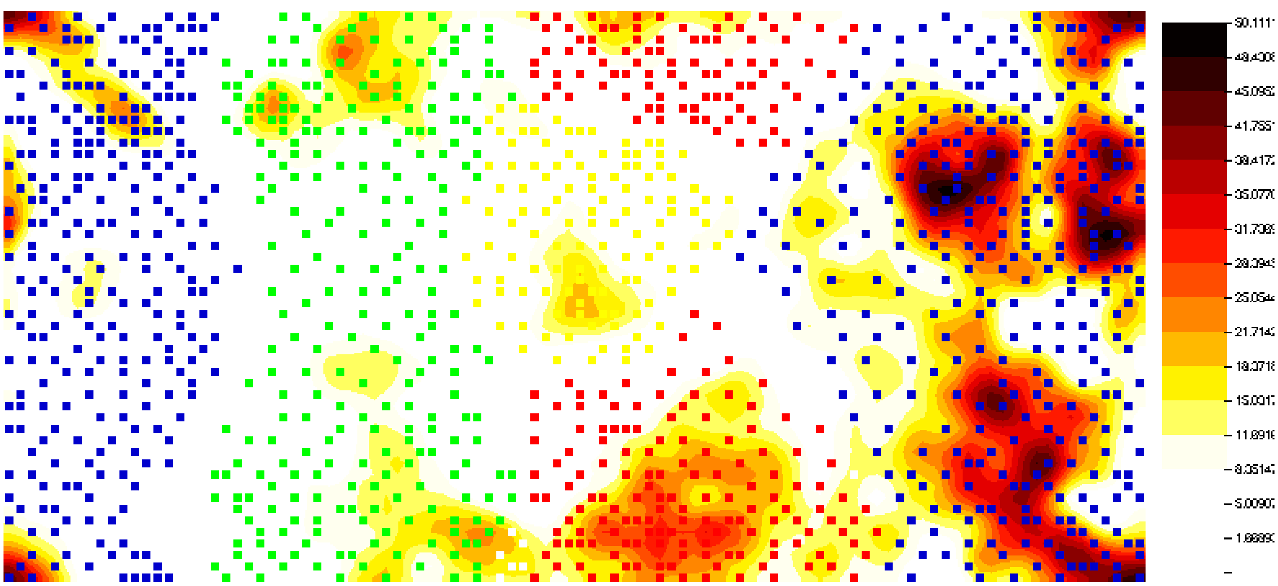
2) ESOM visualization: The training data can be clustered by observation of the best performing ESOM. The U-matrix depicted in Fig. 5(a) is a visualization of the local distance structure in the data placed onto the two-dimensional map. The average distance value between each neuron's weight vector and the weight vectors of its immediate neighbors corresponds to the height of that neuron in the U-matrix (positioned at the map coordinates of the neuron). Thus, Umatrix values are large in areas where no or few data points reside, creating mountain ranges for cluster boundaries. On the other hand, visualized valleys indicate clusters of data since small U-matrix values are observed in areas where the data space distances of neurons are small. Distance based map visualizations (e.g. U-matrix) usually work well for clearly separated clusters; however, problems may occur with overlapping clusters. Density-based SOM visualizations display the density of the data onto the map space via the best-matching neurons. The P-matrix (see Fig. 5(b)) displays the local density measures with Pareto Density Estimation [21]. Neurons with large P-matrix values are located in dense regions of the input vector space and, therefore, areas with height P-matrix values indicate clusters in the data.

3) Player Types: The two map visualizations are complementary and used for cluster identification within the TRU data. Four main classes (player types) can be identified as depicted in Fig. 5(a) and Fig. 5(b). The best-matching neurons for all 1365 input vector samples are also represented with small squares of varying color — different colors correspond to different clusters of the best matching neurons. On the same basis, Table I presents the number of observations (i.e. players completed TRU) and percent of neurons belonging to each of the four clusters. Note that 87 (6.37% of the sample) players were not assigned to any cluster since their best matching neurons are placed in cluster borders of the ESOM (see Fig. 5).

Fig. 6 illustrates the corresponding component planes of the ESOM. A component plane projects the relative distribution of one input data vector component (i.e. input vector dimension) to the ESOM. In the grayscale illustration of those values, white areas represent relatively small values while dark areas represent relatively large values. By matching the component planes with the U-matrix of Fig. 5(a) we can infer characteristics (i.e. playing behavior features) for each cluster identified.



(a) U-matrix



(b) P-matrix

Fig. 5. Visualization maps of the highest-performing ESOM obtained and the 4 clusters identified. The 1365 best-matching neurons are drawn as squares on top of the maps. The maps illustrated are border-less since the map grid is organized in a toroid shape.

TABLE I

THE FOUR PLAYING BEHAVIOR CLUSTERS IDENTIFIED USING ESOM

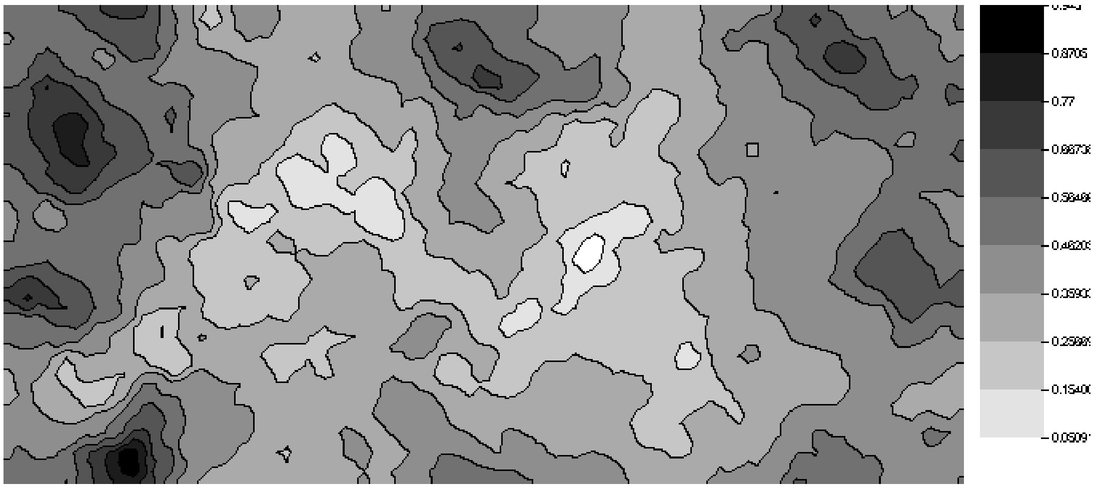
Class	Observations	Neurons on map space (%)
1	122	8.68
2	270	22.12
3	641	46.18
4	245	16.56
N/A	87	6.46

Cluster number 1 corresponds to players that die very few times; their death is caused mainly by the environment and they complete TRU very fast. These players' HOD requests vary from low to average and they are labeled as Veterans as they are the most well performing group of players despite the high number of environment-related deaths.

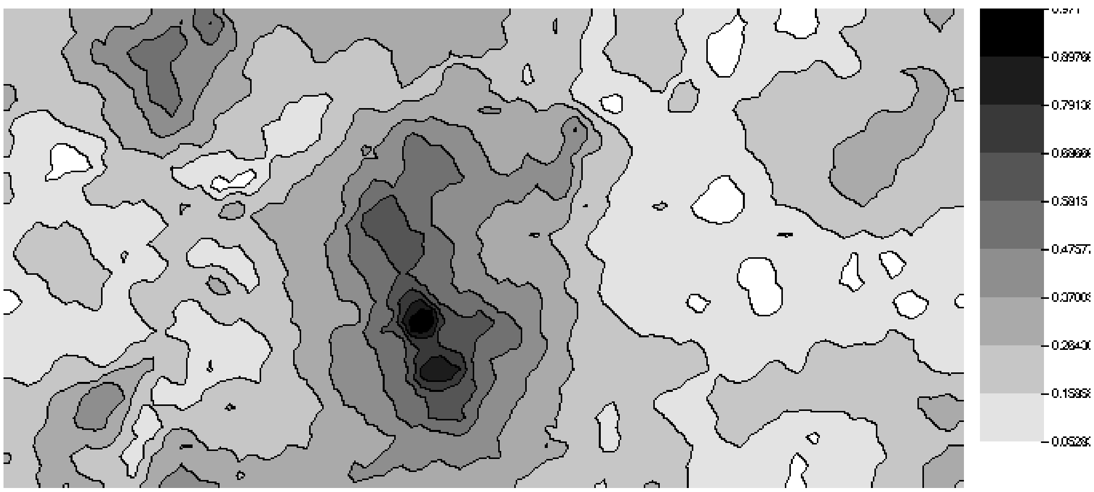
Likewise, cluster number 2 corresponds to players that die quite often mainly due to falling; it takes them quite a long time to complete the game; and they do not appear to ask for puzzle hints or answers. Players of this cluster are labeled as Solvers, because they are adept at solving the puzzles of TRU. Their long completion times, low number of deaths by enemies or environment effects indicates a slow-moving, careful style of play with the number one cause of death being falling (jumping).

Players of cluster number 3, form the largest group and are labeled as Pacifists as they die primarily from active opponents. The total number of their deaths varies a lot but their completion times are below average and their help requests are minimal indicating a certain amount of skill at playing the game.

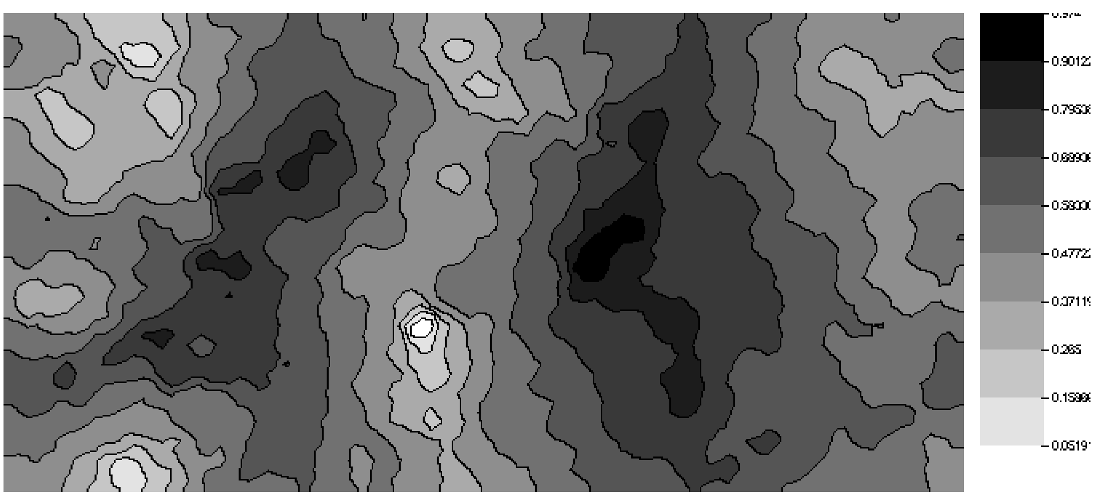
Finally, group of players corresponding to cluster number 4, namely the Runners, is characterized by players that die quite often and mainly by opponents and the environment. These players are very fast in completing the game (similar to the Veterans), while having a varying number of help requests which cover the majority of the H value range.



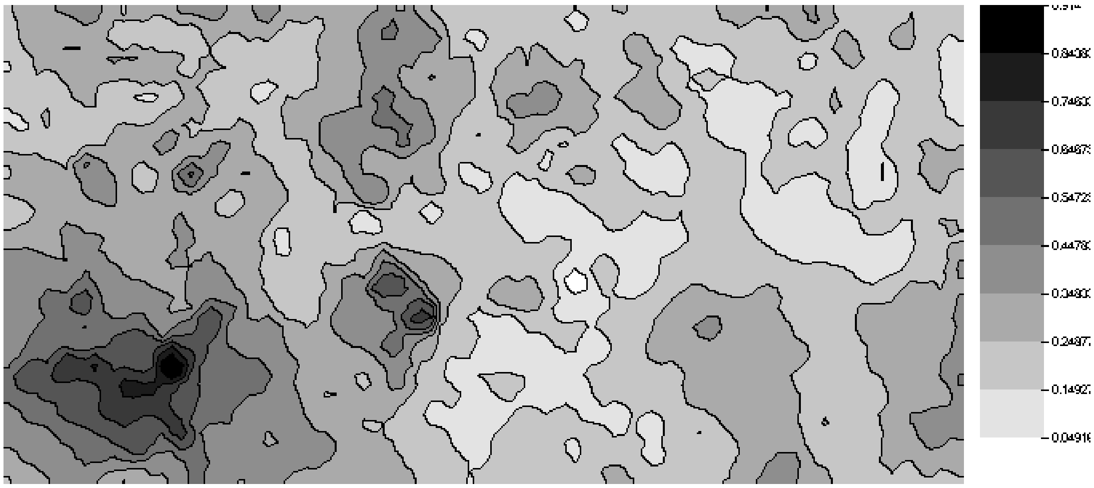
(a) Cause of Death: Opponent, D_o



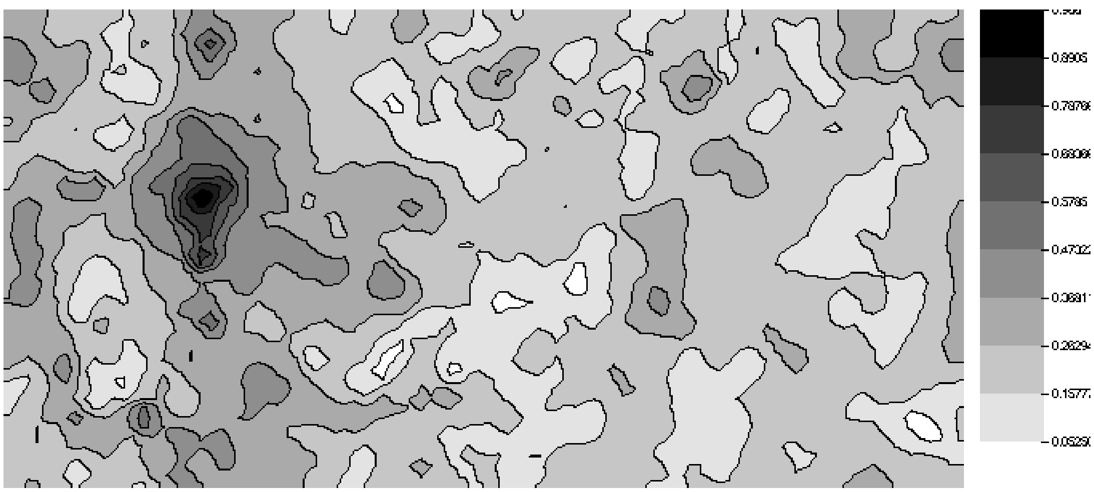
(b) Cause of Death: Environment, D_e



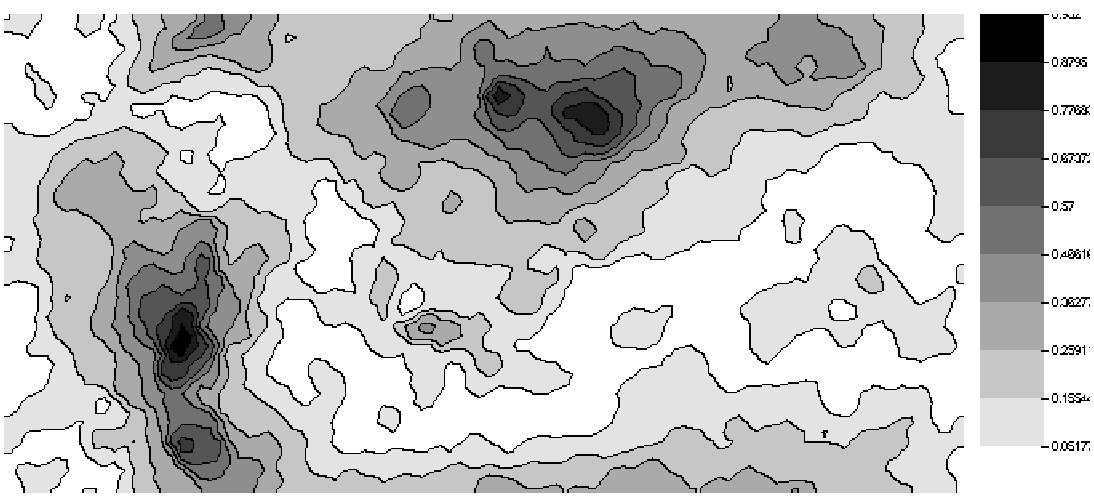
(c) Cause of Death: Falling, D_f



(d) Number of Deaths, D



(e) Completion Time, C



(f) Help on Demand, H

Fig. 6. The six component plane representations of the highest performing ESOM. The darker the area the higher the value of the component (feature).

8. DISCUSSION & CONCLUSIONS

This paper provides an initial study on identifying different player types in a major commercial computer game via unsupervised learning. A large set of data obtained from 1365 players that completed the game Tomb Raider: Underworld is used for this purpose. Six statistical features corresponding to high-level playing characteristics of the core game mechanics are used as the inputs of an emergent self-organizing map.

The input (feature) vector used consists of: 1) the game completion time; 2) the total number of deaths; 3) the total number of Help-on-Demand actions; and the proportion of deaths caused by the different causes of death in the game, categorized as 4) death by falling, 5) death due to the action of computer-controlled opponents, and 6) death due to hazards in the virtual environment.

The highest performing toroid-shaped ESOM trained on the data reveals four clusters of playing behavior — labeled as Veterans, Solvers, Pacifists and Runners — which are characterized by specific patterns of play, after the analysis of the Umatrix and its corresponding component planes.

Importantly, the existence of four clusters of behavior, even in a fairly linear and restricted game like TRU, shows that players utilize the affordance space and flexibility offered by the design of the game, rather than simply using one specific strategy to get through the game. For example, the Pacifists are experts in terms of navigation and move rapidly through the virtual environment, but also respond badly to threats that are moveable or unexpected; whereas Solvers are excellent at solving puzzles, respond readily to moveable threats but die often from falling and are slow to complete the game.

When evaluating if the players of a game play as intended, or if unwanted or surprising (but unproblematic) behaviors occur, the type of results presented here are immediately useful. Importantly, the translation of player behaviors from raw data output to descriptions that take their basis in the game design and associated terminology is crucial in order for the information to be useful to the industry-based game designers.

The obvious step that will take the modeling of TRU players further is to extract additional features from the data available (e.g. use of different weapons and spatial/navigational behavior) and insert them in the input vector of the ESOM.

Given a large feature set, automatic feature selection methods will most likely be employed to choose the most suitable feature subset that yields the highest performing ESOM.

In addition to the high-level features, more data features corresponding to lower-level behaviors (e.g. number of times a weapon is fired in a specific level or sub-section of a game level, HoD-requests for specific in-game puzzles) will be extracted. The player types identified by the ESOM can then assist a machine learner trained on sequences of player actions over the various levels of the game using hidden Markov models or recurrent artificial neural networks.

The proposed approach of player modeling through self-organization appears generic to any type of game genre, especially those featuring a central player character, as long as reliable playing behavior data is available; however, it should be noted that the features suitable for the investigation will vary between games. For example, shooting accuracy with different weapons appears as a suitable input feature of a shooter-type game. In general, the features chosen will depend on the core mechanics of the game as well as the overall purpose of the analysis in question.

The methodology can be used for automating, in part, the traditional exhaustive user and player testing procedures used in the games industry [2] by providing detailed, quantitative feedback on player behavior. This is plausible since the proposed approach provides the opportunity to evaluate in detail if a game design works as intended, by recognizing the patterns in how the game is played, and comparing this with the intentions of the design. Optimization of game design features — i.e. making sure that no feature of the game is under-used or misused — and phenomenological debugging — i.e. debugging of playing experience and game balancing — can also benefit from player behavior modeling.

Furthermore, information about the different player types can be used during play to dynamically alter in-game controllable parameters (e.g. help on demand accessibility, difficulty of jumps) to adjust to the needs and skills of the player type identified in real-time and ensure variation in gameplay.

ACKNOWLEDGMENTS

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ARTICLE 10 - PSYCHOLOGY OF PERSONALITY AND PLAY PERSONAS: DESIGNING FOR EXPERIENCE

Alessandro Canossa, Under the Mask conference, University of Bedfordshire, 2009

ABSTRACT

This article attempts to draft a method, inspired by trait-based theories of personality, to model and profile players' behaviour within the boundaries of computer games. These player's models can both provide developers with tools to evaluate, sharpen and improve the player's experience and provide game researchers with insights regarding the landscape of players' behaviour.

1. INTRODUCTION

People leave trails. Books borrowed at the library, websites visited while browsing the net, owning a house, working as a middle manager, vacationing in South-east Asia. In a virtual game world every action undertaken by players becomes a syllable of a longer sentence that contributes in composing the narrative of play; every action undertaken can be seen as the visible outcome of somebody's personality.

If game designers could easily read the stories spelled by players through their behaviours in game worlds, then they would empower players and allow them to live out their fantasies in more meaningful experiences.

It really is a challenge to find a design philosophy that can afford to craft experiences accommodating dreams, goals and fantasies of a multitude of players; it is not just a matter of level of expertise or skills, it actually involves the whole of a person's history, the circuit between memories and emotions, even the genetic background.

2. Experience

The main challenge in creating game experiences manifests itself in the double nature of the meaning of the word itself: experience refers both to the knowledge arising from reflection ("he's a man of experience") and the immediate sensory perception of an event ("he was experiencing fear"). The German terms "erfahrung" and "erlebnis" will be used to refer to the two sides of experience. The philosopher Walter Benjamin defines erfahrung as "wisdom gained in subsequent reflection on events or interpretation of them" [3]. It is understanding of life and the world we live in; it is experience as an ongoing, cumulative and critical-cognitive process; "journeyed-through" knowledge, mature reflection on events. Erfahrung is elaborated after an encounter with a game; it selects the memorable moments and builds preconceptions and expectations for the next game encounter. Erlebnis is "mentally unprocessed, immediately-perceived event" [3] a one-off encounter, a particular sensation that does not build towards a greater whole; it is isolated, categorical, without cognition, "lived-through" aesthetic/ecstatic perception. It is immediate, pre-reflective and personal. Erlebnis is found while a player is engaged with a game, while she hasn't had the time to reflect or express judgments. In the following "erfahrung" will be translated into reflective experience or reflection and "erlebnis" into perceptive experience or perception.

2.1 Experience design and personality

It is unrealistic to design experiences expecting to take into consideration the history, the reflective experience, of each single player; but the perceptive experiences, the here-and-now experiences, can easily be accounted for through the use of gameplay metrics. The term refers to numerical data derived from the interaction of players with game recording the behaviour of the player (i.e. location, use of skills, powers, abilities, etc.) [26].

Furthermore, several efforts have been made to categorize players' types in order to precisely tailor games to their audience. Methodologies and approaches to investigate and catalogue game experience have been taken from communication and media theory [14, 27], cognitive science [16, 17], neurobiology [25], physiology [7, 18-20, 21, 22], behavior [9], human-computer interaction [4, 5, 11, 12, 24], brain-computer interfacing [8, 23] and other areas. Particularly interesting are the studies that attempted to compile a taxonomy of player types. Bartle's study pioneered the concept of analyzing players' behaviour in MUDs and resulted in the known four types [1]. Yee worked further in that direction uncovering three factors that motivate players [28]. Bateman & Boon deduced four different player types starting from the MBTI [2].

In general it appears that the taxonomies of players have some common features:

- they are inspired by type-based personality theories as opposed to trait-based;
- they claim to be universal and applicable across a wide variety of games.

Personality is described as recognizable and reoccurring patterns of a rational, emotional and behavioural kind. Personality theories, strive to understand and predict human behaviour by observations of persons across various situations.

Type-based theories attempt to classify people into a number of categories, for example the 16 types indicated by the MBTI, while trait theories describe personality according to scores for certain dimensions. Trait theories do not attempt in fitting profiles in pre existing boxes, they attempt instead to describe a profile by scoring it according to certain parameters.

3. IN-GAME TRAIT-BASED PERSONALITY DESCRIPTOR: PLAY PERSONA

This paper argues for the benefits of a model of player's behaviour that is inspired by trait-based personality theories and whose dimensions are deeply rooted in the fabric of the game in question.

The reason behind the preference of trait-based classification is to be found in all major trait-based personality theories move initially from the lexical hypothesis: "individual differences that are most salient and socially relevant in people's lives will eventually become encoded into their language, the more important such a difference, the more likely it is to become expressed as a single word" [13]. This initial hypothesis led to a comprehensive collection of adjectives, the list has been subsequently reduced and formed the starting point for research on general personality traits.

One of the results of this line of enquiry is the Five Factors Model, whose dimensions of personality are Openness to experiences (or Intellect / Imagination), Conscientiousness, Extraversion, Agreeableness and Neuroticism (or emotional stability) [10]. Although it is possible to utilize the five factors to hypothesize personality profiles (fig. 1), this approach cannot be applied to computer games without modifications.

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Einstein	**+**	**-**	**+ / -**	**-**	**+**
Mussolini	**-**	**+**	**-**	**-**	**+**
Jesus	**+**	**+**	**+**	**+**	**-**

Fig. 1 Examples of hypothetical a priori personality profiles described with the five Factor Model

It is impossible to use the same dimensions highlighted by the Five Factors Model mainly because the affordances for behaviours in games are a very small subset of the affordances available to people in the physical world. In games the possibilities for expressing behaviour are clearly defined.

There are only few ways to move and interact with the virtual world for example some games don't even allow players to jump.
It is also impossible to adopt a similar lexical hypothesis because the language through which players express themselves in games is composed of actions and is expressed through the specific game mechanics inscribed in a certain game and they can change radically from game to game.
If, according to the lexical hypothesis, language incorporates the affordances of life, then for games it is in the interaction between players and game that all the affordances can be found. Game metrics provide a tool to record these interactions as long as this data reflects the granularity of the possibilities offered to players by the game mechanics.
Because of the impossibility of using the existing five dimensions and the lack of a game language from which to stat distilling new dimensions, it is necessary to individuate new dimensions used to describe play behaviour in alternative ways. The game's core mechanics need to directly inform the identification of the dimensions. Describing and categorizing players by keeping an account of what they do when they play a certain game must be done according to dimensions defined ad hoc for each game.
By patterning player's behaviour along dimensions inherently bound to a game's core mechanics, it becomes possible to predict patterns of behaviour by aggregating large numbers of observations, as already seen in the work by Tychsen and Canossa [26, 6]. Adopting a play persona approach it is possible to deduce in-game personality dimensions from any game's core mechanics and use these dimensions to describe the behaviour of players and inform the generation of archetypical player's profiles.

4. CASE STUDY: LEFT4DEAD

Play personas allow to aggregate large number of game variables along dimensions defined by core game mechanics to establish a form of "in-game" personality profile. As a case study the game Left4Dead [15] has been selected. The game is a first-person, cooperative shooter with a survival horror theme. Players are asked to survive hordes of infected enemies and escape the location to a safer area. The core mechanics are:

Inputs:	Outputs:
Primary attack (ranged) Secondary attack (melee) Crouch Jump Reload 180 deg. spin Use (context sensitive) Walk Run Inventory (flashlight, first aid kit, pain pills, molotov, pipe bomb) Change weapons (pistol, dual pistol, sub machinegun, pump shotgun, auto shotgun, assault rifle, hunting rifle)	Damage to self / enemy / team mate (direct or indirect) Death to self / enemy / team mate (direct or indirect) Headshot to self / enemy / team mate Heal self / team mate Revive team mate Being revived by team mate Hand out first aid / pills Receive first aid / pills Partial / full reload Crouch-shooting (more precise)

The list of core mechanics seems to point towards four main parameters of behaviour:

- <u>Surviving:</u> measured by counting the times that players heal themselves, the damage taken, the total number of times incapacitated and number of deaths. Surviving points towards a selfish skill set aimed only at self preservation.
- <u>Killing:</u> measured by counting the headshots inflicted, the accuracy, the total number of kills and the ratio of pipe bombs and molotovs used versus the amount of infected killed with their use. The killing skill polarizes players according to their ability to dispatch enemies.
- <u>Helping:</u> measured by counting the times players kill infected and special infected that are dealing damage to team mates and reviving team mates. The "helping" dimension shows players' attentiveness to each other.
- <u>Healing:</u> measured by counting the times players heal and give health packs / pills to team mates. The "healing" dimension reveals players that are willing to sacrifice their own survival for the good of others.

These four parameters form the axes of a 4th dimensional space that contains all the possible players' behaviours in the game (fig. 2). At the same time they allow developers to select which game variables should be monitored in order to gather usable game metrics data for profiling players' behaviour.

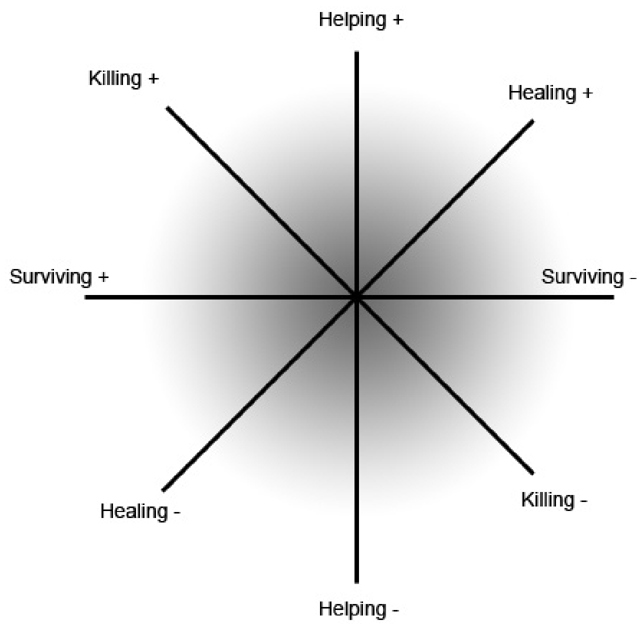

Fig.2 4th dimensional possibility field

Let's postulate that players can be scored in each dimension only in two ways: positive and negative. Exploding the possibility field is a matter of elevating 2 (the possible values) at the power of 4 (the dimensions) obtaining a total of 16 possible profiles (fig. 3). Amongst those profiles there are only few that become interesting because they are so extreme that delimit the possibility field of player behaviour.

	Fugitive	Grunt	Samaritan	Doctor	Rambo	Red Cross	Expert	Rookie	H 1	H 2	H 3	H 4	H 5	H 6	H 7	H 8
Survive	+	-	-	-	+	-	+	-	+	-	+	-	+	+	+	-
Kill	-	+	-	-	+	-	+	-	-	+	-	+	+	+	-	+
Help	-	-	+	-	-	+	+	-	-	+	+	-	+	-	+	+
Heal	-	-	-	+	-	+	+	-	+	-	-	+	-	+	+	+

Fig. 3 Example: A player that dies more times than the average but kills more zombies than the average, while not helping or healing team mates will be classified as a "Grunt".

Due to the fact that each game metric message includes location data in the form of X,Y and Z coordinates, it is possible to perform an evaluation of the performance of the player at different scales:

Single sector: within a certain level it is possible to score the performance of a player in different sub-sections of that level.

Whole level: aggregating the scores for each sub-sector, a player can be scored for his/her performance across the whole level.

Whole game: aggregating the scores obtained for each level, it is possible to show a compounded score, an average, of the player's behaviour in the whole game.

This framework enables researchers to score the players interacting with the game in question in a manner that aggregates several variables and compare the profiles.

5. Conclusions

Play personas can be built with the same methods used to profile people's personality, namely the Five Factor Model, and they can be useful both as an a priori metaphor during pre-production and as a posteriori lens to evaluate behaviour of players [6, 26].

The initial hypothesis, the persona-as-metaphor has a prescriptive nature: after individuating the dimensions emerging from the core mechanics it is possible to define personas as guiding beacons during the design phase. The final analysis, the persona-as-lens is of a descriptive nature: it allows to observe the clustering and the subdivisions of players' behaviours. The main uses for these aggregate constructs are:

- phenomenological debugging (balancing of experiences), some levels are "open" in terms of defining what kinds of experience can emerge from the player-game interaction, some others are "closed"
- envisioning possible ways the game can be played; some levels will show the not-so-invisible hand of the designer forcing the players behaviour in a bottleneck, limiting possibility for expression and therefore the depth of the experience
- verification of hypotheses set forth during design phase (designers imagined a certain way their game could be used, play patterns can verify that or not)
- insuring variation and change in gameplay by providing quantifiable proof for variety of play
- optimization of features and resources (making sure that no feature in the game is underused or wasted).

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ARTICLE 11 - GAME METRICS AND BIOMETRICS: THE FUTURE OF PLAYER EXPERIENCE RESEARCH (EXTENDED ABSTRACT)

Futureplay 2009 (ACM conference) panel with Lennart Nacke (Department of Interaction and System Design, Blekinge Institute of Technology), Mike Ambinder (Valve Corporation), Alessandro Canossa (IO Interactive), Anders Drachen (Center for Computer Games Research, IT University of Copenhagen), Regan Mandryk (Department of Computer Science, University of Saskatchewan), David Pinelle (Institute of Information Technology, National Research Council)

ABSTRACT

There is a call in industry and research for objective evaluation of player experience in games. With recent technological advancements, it is possible to automatically log numerical information on in-game player behavior and put this into temporal, spatial, and psychophysiological context. The latter is done using biometric evaluation techniques, like electromyography (EMG), electroencephalography (EEG), and eye tracking. Therefore, it is necessary to discuss experimental results in academia and best practices in industry. This panel brings together experts from both worlds sharing their knowledge using conventional and experimental, qualitative and quantitative methods of player experience in games.

Categories and Subject Descriptors

K.8.0 [General]: Games|Personal Computing;

D.2.8 [Soft- ware Engineering]: Metrics|complexity measures, performance measures;

H.5.1 [Multimedia Information Sys- tems]: Evaluation/methodology|Information Interfaces And Presentation

General Terms: Measurement, Performance, Design, Experimentation, Human Factors, Standardization

Keywords: games, metrics, biometrics, player, user experience, funology

1. INTRODUCTION

In the past, user-centered game testing [16, 22] has largely borrowed methods from the human-computer interaction [17, 3] and the user experience community [6, 18, 19], which uses principally qualitative measures, like think-aloud protocol, interviews and surveys or a combination of them [8].

While these methods provide great insights into individual user experiences and allow developers to get an estimation of how their game is perceived by their players, they lack the empirical power of quantification. Previous panels and workshops explored for example differences between user research methods for games and productivity software [9], untapped video game genres [7], user experience measurement in games [1] and evaluation of the player experience in games [2]. This panel will take this discussion one step further by looking at the status quo of game metrics evaluation and the future of player evaluation. It will consider how new types of data, including psychophysiological instrumentation (e.g electroencephalography (EEG), electromyography (EMG), and eye tracking) or problem reports can be incorporated into the existing game evaluation process. Recently, there has been a change in many game companies toward using quantitative data in game evaluation [21]. This move comes together with research efforts into biometric evaluation of play [4, 5, 10, 11, 12, 13, 14, 15]. There is, however, a need to discuss the benefits and limitations of these evaluative methods and to compare them to classic qualitative evaluation methods.

Tychsen and Canossa [21, 20] provided a distinction of game metrics in (1) navigation metrics, (2) interaction metrics, (3) narrative metrics, and (4) interface metrics. We will extend this definition to include biometric player data and seek to explore and establish a more precise taxonomy, usable application methods, and research and industry practices. The panel has the goal to provide a platform for industry and academia to discuss the current challenges in game metrics and biometric research and practice. This can only be done by comparing benefits and limitations of qualitative and quantitative methods.

2. PRESENTERS

2.1 Lennart Nacke

Lennart Nacke has a computer engineer's degree (Dipl.Ing.) in Computational Visualistics from Otto-von-Guericke University, and is currently a Ph.D. candidate in Digital Game Development at the Blekinge Institute of Technology.

His research interests are biometric/psychophysiological evaluation of game experience, playability metrics and innovative interaction design for digital games. He moderates the panel.

2.2 Mike Ambinder

Dr. Mike Ambinder has a Ph.D. in Experimental Psychology (with a focus on visual cognition) from the University of Illinois and a B.A. in Computer Science and Psychology from Yale University. At Valve, he works on the application of knowledge and methodologies from psychology to game design.

2.3 Alessandro Canossa

Alessandro Canossa has a M.A. in Science of Communication, from the University of Turin. During the late nineties he was Art Director in advertisement and found his vocation/obsession in game development (LEGO, Tabula Rasa Games). Since 2006 he has worked at IO Interactive on his Ph.D.

2.4 Anders Drachen

Dr. Anders Drachen is a post doctoral research fellow at the IT University of Copenhagen. His research focuses on user experience and games-based user-oriented research using gameplay metrics.

2.5 Regan Mandryk

Dr. Regan Mandryk is an Assistant Professor in Computer Science at the University of Saskatchewan. Among her degrees are a M.Sc. in Kinesiology (2000), and a Ph.D. in Computing Science, both from Simon Fraser University (2005). Her current research interests are on sensing and modeling user state, designing interaction techniques and games for emerging devices and to encourage healthy living.

2.6 David Pinelle

Dr. David Pinelle has a Ph.D. in Computer Science from the University of Saskatchewan and a B.Sc. in Occupational Therapy from Texas Tech University. He is working as a Research Officer with the Institute of Information Technology at the National Research Council, where he focuses on understanding and classifying game usability problems.

3. POINTS OF INTERACTIVITY

Each panelist will introduce themselves in a fast-paced, vibrant, 30-seconds ash entrance. The panel moderator will subsequently put controversial statements about game metrics up for discussion by the panelists. A main point of discussion will be the integration of qualitative and quantitative game evaluation methods. This part of the panel is a moderated, interactive discussion between experts from academia and industry about current issues in metrical game evaluation.

The discussion will be guided to provoke thoughts about best practices in research and industry for using game metrics.

The last 10 minutes of the panel are reserved for questions from the audience.

4. TAKE-HOME MESSAGE

Participants will have a clear understanding of the current state of the art in biometrics and game metrics methods as well as suggestion on how to incorporate these into existing processes for evaluating player experience.

5. REFERENCES

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ARTICLE 12 - ANALYZING USER BEHAVIOR VIA GAMEPLAY METRICS (EXTENDED ABSTRACT)

Alessandro Canossa, Anders Drachen full paper presentation at Futureplay 2009 (ACM conference)

ABSTRACT

User-oriented research in the game industry is undergoing a change from relying on informal user-testing methods adapted directly from productivity software development to integrating modern approaches to usability- and user experience testing. Gameplay metrics analysis form one of these techniques, being based on instrumentation methods in HCI. Gameplay metrics are instrumentation data about the user behavior and user-game interaction, and can be collected during testing, production and the live period of the lifetime of a digital game. The use of instrumentation data is relatively new to commercial game development, offering a powerful supplement to existing user-oriented testing methods. This presentation will introduce a metrics solution and a series of case studies of games from major Danish game developer IO Interactive of EIDOS.

General Terms: Measurement, Documentation, Performance, Human Factors.

Keywords: Gameplay metrics, game metrics, user experience, user testing, computer games.

1. INTRODUCTION

The game development industry has within the past decade established itself as a major component of the interactive entertainment industry, rivaling the movie industry in size [1].
Paralleling the dramatic development of the sector, computer games have gone from simple text-based adventures to almost photorealistic renditions of virtual worlds within a variety of genres, offering a wealth of entertainment opportunities to their users.
Contemporaneously with this development, a requirement for user-oriented testing methodologies that take into account the unique nature of digital games has become increasingly prevalent [9,12].
Furthermore, with the increasing complexity of contemporary computer games – in terms of the amount of possible user actions and –behaviors that they afford, as well as the breath of

interaction options between the user and the software/hardware – the informal testing methods traditionally utilized in the game industry, which were adopted directly from productivity software testing, have come under pressure [11,13].

Game testing can generally be divided into technical, functional and content testing, the latter two categories involving user-oriented approaches. User-oriented testing is essential to game production, because the quality of the product that a game is directly relates to the perceived user experience. Functional and content testing are therefore two areas that receives an increasing amount of attention from academic and industry environments alike [e.g. 5,6,7,8,9,11,12,15,16]. The purpose of user-oriented game testing is to see how specific components of, or the entirety of, a game is played by people. It allows game developers to evaluate whether their ideas and work provides the experience they designed for.

User-oriented game testing is normally carried out at different stages of the production cycle of digital games, which are commonly produced using agile methodologies. An organized, methodical approach to this work is vital, as this permits that issues are fixed as they arise rather than at the end of a production cycle. The requirement for improving user-oriented testing methodologies within game development, the increasing complexity of digital games, the variety of aspects of the user interaction that needs to be tested, and the requirement for methods that do not require long turn-around times, has resulted in a variety of approaches from Human-Computer Interaction (HCI) research being adapted user-oriented game testing and –research [2,7,9,11,13,14]. These include different forms of usability testing, ethnographic methods, experience testing etc. All of these have specific strengths and weaknesses, but are generally useful for capturing player feedback and subjective user experiences; and for acquiring in-depth feedback on e.g. gameplay or design problems. However, these approaches are limited in that information is often hand-coded (surveys, analysis of audio-visual recording), meaning that getting highly detailed data about user behavior is either incredibly time consuming or downright impossible.

A potential source of supplementary data to accommodate this limitation is the automated collection and analysis of instrumentation data, an approach utilized within the general HCI field [e.g. 11,15], but however only recently adapted to computer game production [9,16]. Different types of instrumentation data can be recorded from player-game interaction. In game development, instrumentation data find uses within e.g. engine performance, sales across different countries or regions, project progress or user interaction with the game software, the latter category being of interest here. Within the context of user-oriented testing, instrumentation data related to player-game interaction are generally termed gameplay metrics [16,17], and serve to provide detailed quantitative information about the player (user) behavior. Gameplay metrics form objective data on the player-game interaction. Any action the player takes while playing can potentially be measured, from low-level data such as button presses to in-game interaction data on movement, behavior etc.

The term "metric" – as it is used here - stems from computer science, and denotes a standard unit of measure, with metrics generally being organized in systems of measurement, utilized in the evaluation and measurement of processes, events, interaction etc. [4,10]. In general, gameplay metrics can be recorded for any type of user-initiated behavior where interaction takes place in or with the virtual environment; as well as behaviors initiated by agents or systems operating in the virtual environment outside of the control of the player, e.g. autonomous agents. The analysis of user behavior via gameplay metrics act as a supplement to the established methods for user-oriented research in the game industry and –research. For example, usability testing focuses on measuring the ease of operation of a game, while playability testing explores is users have a good playing experience [11]. Gameplay metrics analysis offers however insights into how the users are actually playing the games being tested.

In this presentation, an instrumentation-based solution to the challenge of locating methods for acquiring and analyzing detailed data about user behavior in computer games is presented. The approach has been formed in collaboration between Danish game developer IO Interactive (a subsidiary of EIDOS Entertainment), and the IT University of Copenhagen. The solution is presented via several different case studies which are covered in the presentation, based on recent major commercial games announced or published. The case studies showcase the strength of gameplay metrics analysis, namely the ability to provide quantitative and detailed data on player behavior, as well the ability to establish large datasets and mine these in order to establish detailed patterns of user behavior in specific contexts, thereby providing a tool for not only game development and –design; but also general user-oriented research in interactive entertainment.

Figure 1: An example of a simple gameplay metrics analysis. The diagram details a time-spent analysis [3] of the choice of weapons equipment for a single player during 25 minutes of Deus Ex gameplay. The diagram lists the weapons used, the duration of time that the weapon was equipped (note: not used), and the category of the weapon:

(d) = demolitions; (l) = low-tech; (p) = pistol; (r) = rifle; (h) = heavy weapon.

Gameplay metrics form a novel approach within game development and addresses one of the major challenges to user research in this business, namely that of tracking and analyzing user behavior when interacting with the very complex systems that contemporary computer games are. As a user-oriented approach, it complements existing methods utilized in the industry very well, providing detailed and quantitative data to supplement attitudinal and semi quantitative data from e.g. usability testing and playtesting [9,11,13]. Instrumentation data from users form an important contribution to not only user research and –testing during the development phases of game production, but also in monitoring and evaluating user (player) behavior during the extended usage, i.e. during the live periods of games, where given the right tools, data can be obtained directly from the users operating within their natural environments.

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ARTICLE 13 – PATTERNS OF PLAY: PLAY-PERSONAS IN USER-CENTRED GAME DEVELOPMENT

Alessandro Canossa & Anders Drachen full paper presentation at DIGRA 2009

ABSTRACT

In recent years certain trends from User-Centered design have been seeping into the practice of designing computer games. The balance of power between game designers and players is being renegotiated in order to find a more active role for players; there is in fact more and more evidence suggesting that players need to have some form of control in shaping the experiences that games are meant to evoke. A growing player agency can turn both into an increased sense of player immersion and potentially improve the chances of critical acclaim.

This paper presents a possible solution to the challenge of involving the user in the design of interactive entertainment by adopting and adapting the "persona" framework introduced by Cooper in the field of Human Computer Interaction. The original method is improved by complementing the traditional ethnographic descriptions of personas with parametric, quantitative, data-oriented models of predicted patterns of user behaviour for computer games. These models will then be evaluated using data generated by players engaged with the game.

Keywords: Play persona, game experience, game design, user centered design, user experience design, gameplay metrics, game mechanics.

1 Introduction: "Open" and "closed" games

The practice of designing computer games today cannot refrain from including player-driven issues, considering how standards such as the ones set by Web 2.0 geared players' expectations towards a higher degree of agency. In many of the critically acclaimed games today, it is possible to detect a trend in transferring at least part of the authorship to the players thereby increasing their agency.

User-generated content is one of the manifestations of this trend. In a scenario where people are growing used to expect a high level of customization and personalization from entertainment products, players react favourably towards being put in charge of the content, to a smaller or greater degree, as is evidenced by the sales figures of titles such as *Little Big Planet* [5a], *Spore* [7a] and *The Sims 3* [9a].

Other games, such as *Fallout 3* [2a], *Grand theft Auto IV* [4a], *The Elder Scrolls IV: Oblivion* [8a], retain complete creative control but opt for open worlds and modular narratives to increase player's agency.

There seem to be a push for games to become more democratic, the power balance between game designers and players could be shifting. The dictatorship of game designers, holding all the cards and slowly revealing the game at their own pace to the players, is coming to terms with players that need to feel more in control of the experiences that they will go through, in order to be more immersed or "incorporated" [4]. Furthermore, non-trivial choices and ability to express oneself are often seen as determining factors for critical acclaim and are required for adding player choice and broad appeal to computer games. [31]

This trend notwithstanding, there are many games still made by designers with a story to tell, that attempt to provide pre-designed, high quality, cinematographic experiences. Games like *Resident Evil 5* [6a], *Gears of War* [3a], or *Call of Duty 4* [1a], where there are less elements that designers can put up for negotiation with the players. The Aristotelian dramaturgic devices [28] of plot, characters, themes, style and settings are fixed by the designers and the experience they want to craft; these elements are not up for bargain.

This leads to the question about how more linear, traditional and narrative games such as *Tomb Raider: Underworld* [10a] (TRU) can keep up with the "democratising" trend when they lack the proverbial chips to put on the negotiating table with the player? In TRU there is no space for players to partake in the creative process, nor there is much of an opportunity for open-world type exploration since the game world, as open as it claims to be, it is quite straight forward and tightly constrained. Even the storyline is quite tight and does not allow much deviation. Furthermore, players are not expected to create content but to experience what was crafted for them. What elements can designers offer to players expecting some degree of control?

What is left for players is to determine *how* the events unfold, how they perform the tasks set forth by the designers, how they act in the gaps left open by the game, where there is not a single way to solve a puzzle or accomplish a task. Players are left free to decide the modality of interaction amongst those offered by the game. The classic example is *Deus Ex* [11a], which provides a wide variety of means for a player to navigate the tight confines of the game.

Play-personas are here introduced as a modeling tool that aims at ensuring that more restrictive games still allow some degree of influence from the player on the experience generated. This paper showcases the play-persona tool, derived from the domain of Human Computer Interaction (HCI) and experimentally in use at some EIDOS game development studios. Play-persona is a construct that can be used for opening potentially closed game experiences, games that cannot relinquish creative control on the assets nor are willing to let the player wander among disconnected narrative modules and procedurally generated landscapes. These games can instead provide different play styles [33], diverse means of accomplishing tasks. Play-personas are models that simplify and clarify player behavior, representing essential features and making the abstract concrete. They assist organising cognitively, both in the minds of designers and players alike, the mechanics provided by the game such as different types of weapons, different interaction methods to negotiate the environment or different devices used to deal with non-playing characters. Employing play-personas to transfer agency to players entails the same focus on the user that has dominated the field of HCI for the past years simply by adopting and adapting methods introduced by User-centered and Experience Design [26, 18].

2 Cognitive background for play-personas

The persona framework as a tool for modeling ideal users was originally suggested by Cooper [9, 10]. According to Cooper, personas are detailed, composite user archetypes that serve as main characters in narrative, scenario-based descriptions that iteratively inform the design of a product, so that features emerge directly from the goals. There might be a cognitive background to the immediate success of these narratives. The human mind has often been called an excellent belief-engine or a pattern-seeing device [39]. Pattern-seeing rather than pattern-recognizing, because recognition would imply existing patterns and often that is not the case. When presented with non correlated inputs the human mind still attempts at finding an organizing order behind it and seeing patterns and meanings there where there are none.

Recent work in cognitive- and neuroscience has proven that the human mind abhors void and emptiness and it does everything it can to fill the gaps as it’s shown by the phenomenon of scotoma, also known as the blind spot, whose blank field is filled with material produced by the mind [27].

Furthermore the work of human biologist Lewis Wolpert [39] showed how the compulsion to create a story, to weave drama in that blind spot, might actually be biological, it could represent a cognitive imperative, an innate need to have the world organized cognitively. The failure to find causes and to explain in causal ways apparently unrelated events creates anxiety and discomfort. This evolutionary biological imperative to connect the dots and weave stories to make sense of our experiences could explain why, long before the adoption of persona models by HCI practitioners or the abstract user representations utilized in marketing, our past history abounds with attempts at preemptively model behavioral patterns of people.

2.1 Origin and history of personas

In ancient Rome actors would wear a *persona* before going on stage: a mask that embodied socially agreed conventions to represent a certain type of character. Modern sociology speaks of social masks or fronts [15] to address the different roles that we have to play according to the different contexts we are presented with. It is as "self-construed self" that Jung listed persona as one of the archetypes populating the human unconscious. Hypothetical identity-constructs have been recognized as fundamental in many creative practices. In literary theory, Iser [17] introduced the term "implied reader" to address the model of a *"reader that a given literary work requires"*; an individual that, within the frame and the context imposed by the text, is able to make assumptions, has expectations, defines meanings left unstated and adds details through a "wandering viewpoint". By Joyce's own admission, *Finnegan's Wake* should be read by *"that ideal reader suffering from an ideal insomnia"*. Eco [13] expanded on the concept introducing the "model reader" as *"the author's foreshadowing of a reader competent enough to provide the best interpretation of a text"*. The author tries to prefigure a model reader by imagining what could be the actualization of the text. In social sciences, Weber [30] introduced the concept of Idealtyp as *"formed by one-sided accentuation of one or more points of view and by the synthesis of a great many diffuse, discrete, more or less present and occasionally absent concrete individual phenomena, which are arranged according to those one-sidedly emphasized viewpoints into a unified analytical construct"*. The ideal type is a pure mental construct used to assess the behaviour of social groups. It is totally theoretic, almost fictitious and generally not empirically found anywhere in reality, it is not backed by statistical data nor a model personality profile, it's more used as some sort of unit of measure, a standard much like "meter", "second" or "kilogram" not really found in nature, but useful to measure it.

It is only natural that game designers would attempt at making assumptions on the nature of players; using personas helps them to map the extreme boundaries of the field of possibilities afforded by their game.

3 Persona modeling in HCI

The most recent iteration of pre-emptive user modelling techniques is the persona introduced by Cooper [9,10]. Cooper initially identified cognitive friction as the common problem that plagues computer software products.

He described cognitive friction as "the resistance encountered by a human intellect when it engages with a complex system of rules that changes as the problem changes" [9]. Cognitive friction was referred to the meta-functions arising from the elements composing computer software such as buttons, icons and commands; but those meta-functions happen regularly in videogames where, according to the context, pressing a button might result in the avatar climbing a wall, shooting a gun or opening a door. Cooper suggested a solution to this problem through Goal-Directed method. This method starts with a research phase, in which behaviours, patterns and modes of products' use are identified. These patterns suggest goals and motivations and in turn these inform the creation of personas.

Typically a persona is a description of patterns of behaviour, goals, skills, attitudes, and environment, with a few fictional personal details to make it a realistic character. The tools to create personas have evolved considerably from the beginning, but two key areas have not changed: an emphasis on the initial investigation and lack of ongoing data collection.

Main criticisms moved to personas are:

- Characters are often designed by a committee with little regard for real data;
- Characters are difficult to communicate because they often consist of a resume-like documents presented as a posters;
- Being the characters fictional, they have no relationship to real customer data [2].

Recent developments in persona research has considerably modified the approach of practitioners, Wiggins [35, 36, 37], for example, suggests to corroborate the narrative, ethnographic descriptions of personas with data about usage harvested from *Google Analytics*; Pruitt and Grudin of Microsoft [42] also emphasized backing the construction of personas on real data and maintaining the descriptions with ongoing data collection [1] and Warfel [34] presented practical methods for generating data-driven design research personas.

3.1 From personas to Play-personas

It is here suggested that game designers could benefit from procedural, data-backed preemptive models of play behavior. Additionally, game rules and spaces can be used to carve channels in the minds of players for helping them organizing experiences and guiding the emergence of sense-making patterns. Play-personas are offered as such devices, helping the emergence of narratives to make sense of what happens in game worlds. Play-personas can influence and control the ways that players categorize what they experience in game worlds; persona constructs can be triggers that inspire, incite and compel players into certain actions. These mind patterns can be expressed as behaviours undertaken in game worlds using mechanics and rules that the game affords [33]. Play-persona hypotheses emerge as relations between parameters derived from the set of interaction and navigation possibilities offered by the game in terms of rules and spaces.

Play-personas are defined as clusters of preferential interaction (*what*) and navigation (*where*) attitudes, temporally expressed (*when*), that coalesce around different kinds of inscribed affordances in the artefacts provided by game designers [6].

Moving beyond narrative descriptions of motivations, needs and desires distilled in ethnographic interviews, play-personas are expressed also as procedural description of preferential behaviours in terms of game mechanics used. This procedural description augments and strengthens the idea behind personas as formulated by Cooper because, due to the intrinsic numeric nature of procedural descriptions, it is immediately possible to compare different play-personas, provided that they are scored according to compatible parameters. At the same time it becomes possible to compare and evaluate play-personas postulated a-priori as hypotheses by the designers during the production of a game with actual behavior expressed by players engaged with the game, if directly coupled with instrumentation data in the form of gameplay metrics[6] gathered from game engine software during play sessions.

It is in this respect that play-personas are both theoretical models of ideal users (*metaphors*) and data-driven representations of player behaviours (*lenses*).

[6] The term “gameplay metrics” refers to data about players’ behaviour in a game (location, use of skills, powers, abilities, interaction with other players, deaths, etc.), automatically recorded during a play session.

4 Defining play-personas using gameplay metrics

Initially, during the concept and early design phases [29], persona modeling serves as a planning tool for implying the player behaviors in the design of the game. In this phase of game production, play-personas are metaphors for the actual players, in a manner similar to the way that personas can form metaphors of customers when developing a website [10, 19]. As soon as a playable version of a game is available, play-personas become data-driven rather than theoretical (Figure 1). In other words, actual player behaviors are mapped and any patterns in their behavior located. These form the basis for defining a new set of concrete play-personas which can be compared with the theoretical, initial set. The data utilized can potentially be both qualitative and quantitative, stemming from e.g. surveys, interviews or analysis of gameplay footage. However, an effective approach towards gathering data on the in-game behavior of players in large quantities and with high precision and detail is **gameplay metrics**, an approach that takes inspiration from the data-driven personas used in general HCI [see e.g. 35-37]. Gameplay metrics form objective data on the player-game interaction; these are usually registered by the game engine or a dedicated logging program. In general, gameplay metrics can be recorded for any type of user-initiated behavior where interaction takes place in or with the virtual environment. Additionally, the behaviors initiated by agents or systems operating in the virtual environment outside of the control of the player, e.g. autonomous agents [32], can form the basis for metrics logging. Metrics also include information about the user hardware configuration, game install language, etc. which, in an industry context, is useful for e.g. marketing, as well as in a user-oriented research [38].

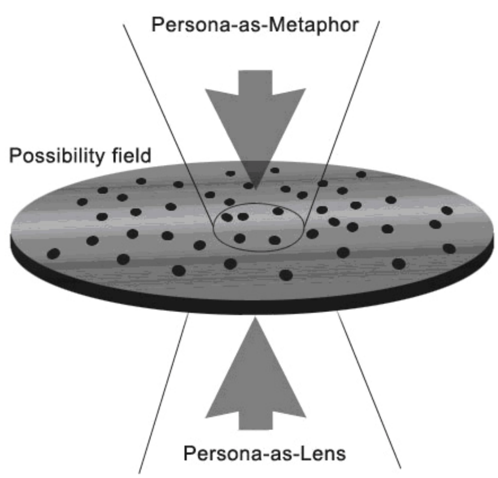

Figure 3: Two sides of the same coin: Play-personas as metaphor and lens. The black dots on the "possibility-field" plane represent game mechanics of the specific game. Thanks to the a-priori description of the persona-as-metaphor a certain subset is individuated. This persona hypothesis can be checked against

gameplay metrics data gathered from players and inform the creation of persona-as-lens, in this case the two sides match, but it is not always necessarily the case. [Source: 34]

Gameplay metrics are used by several different game publishers and developers and is seeing increasing interest in the industry [31]. Within the academia, the data type is also being utilized as a tool for exploring player behavior. While a full review of the literature is out of scope in this paper, it should be noted that the current work is generally divided into those originating from the industry [11, 16, 18, 25, 31, 33], a few papers focused on researching player behavior [e.g. 38] as well as a few examples of systems developed for capturing gameplay metrics-like data targeted at Virtual Environments rather than games specifically [3, 7, 8].

Gameplay metrics are a specific form of instrumentation data. Instrumentation data have been utilized in the general software and website development industry for over two decades as a tool for mapping user behavior and draw inferences about cause and effect [18]. In the context of play-persona modeling, gameplay metrics are of interest because they permit the analysis of user behavior in a *detailed* (each user initiated event can be logged), *precise* (events can be logged with a high frequency, and the specific time of the event and location of the player in the world can be logged) and *unobtrusive* manner (playing the game is not affected by the logging systems). In the industry and research, gameplay metrics tracking acts as a supplement to the established user-oriented testing methods: *usability testing* focuses on measuring the ease of operation of a game; *playability testing* explores if users have a good playing experience; and *gameplay metrics analysis* offer insights into how the users are actually playing the games being tested [11, 33, 40, 41]. In short, gameplay metrics form a useful tool for evaluating player behavior, and it is this data type that the play-persona models are based on.

In order to illustrate how this method can be applied in practice, a case study from IO Interactive (IOI), a game developer of EIDOS, is presented. At IOI, game metrics have been utilized for a variety of purposes, not the least in user-oriented testing, and a team at IOI currently functions in an advisory capacity to other EIDOS developers. The case study presented here is based on the game *Tomb Raider: Underworld* (TRU), developed by Crystal Dynamics and one of the major selling titles in late 2008. The reason for choosing this game is that an extensive (terabyte size) library of gameplay metrics data are available, collected via the Xbox Live! service. A sample of these data is used to showcase the principles behind generating data-driven play-personas. Due to confidentiality issues, the design processes applied for TRU cannot be disclosed, however the principles of applying play-personas during the design phase (personas as metaphor), is described.

TRU is the eighth installment in the long-running series featuring one of the most-well known game protagonists, Lara Croft, a combination between an action heroine and Indiana Jones. The game, played in third-person perspective, sees the player controlling Lara Croft on a series of missions to exotic locations, entering tombs and lairs and solving more than 200 puzzles along the way, unfolding a fairly linear storyline. TRU is at heart an advanced platform game, where players need to adopt strategic thinking in planning their way through levels (Figure 2). The core game mechanics are based around jumping between platforms and eliminating mobile enemies. Another threat is the environment itself – players risk drowning, electrocution, falling into a trap, catching fire etc. Navigating the environment, surviving dangerous enemies and solving puzzles form the core gameplay components.

Figure 2: Screenshot from Tomb Raider: Underworld. The screenshot captures two of the ever-present dangers in the game: Mobile computer-controlled agents and platform-style jumping.

4.1 Play-personas as metaphors of players

A metaphor is a rhetorical device that allows describing something unknown by transferring attributes from a known entity. Metaphors are utilized before the accumulation of experience, in a similar way personas allow designers to "imply" unknown player behavior in the process of creating digital games, i.e. by pre-defining the intended play-patterns in the game in question and design to accommodate these.

According to Lakoff & Johnson [20, 21, 22] cognitive metaphors allow mapping a more familiar *source* conceptual domain onto a less known *target* conceptual domain in order to better understand the latter. For example: "love (target) is a journey (source)". These mappings are considered to be pre-linguistic and concern time, space, movement and other core elements of embodied human experience.

When players control an avatar in a game world, the process of modeling the avatar’s behavior through a metaphor is strikingly less abstract than attempting to understand “love” through “journey”. That is because the avatar, as the medium that transfers agency from the player to the game world and receives feedbacks from the game world on behalf of the player, is a representation of the player’s body.

The play-persona metaphors are models of possible patterns of behavior in the game world that are wished by the designers and embody different ways of behaving in the game. These models are not necessarily enforced: they emerge as clusters of preferential usage of game mechanics. Designers can utilize these models to plan experiences of play: shaping the spaces of the game world and distributing challenges and rewards. By opening up the negotiation of the game space to multiple, consistent alternatives, designers allow players the freedom to express themselves by choosing to behave in the game as they prefer, even if the choice means combining mechanics in ways that were not considered optimal. At the same time designers can maintain control on those variables such as plot, characters, themes, style and setting, that determine what kind of story is told, therefore still being able to deliver pre-designed, cinematographic experiences. The freedom experienced by the player is not expressed by deciding what characters take part to the story, what the task to complete is or where is the setting, the freedom lies in deciding how the action takes place and seeing this difference acknowledged by the game world.

Play-personas as design tools represent an expectation of how players would like to craft their experience. In practice, when developing metaphorical play-personas during the concept/design phases, the first step taken consists of mapping and unfolding the possibilities that the player is to be allowed within the confines of a specific game, thus creating a comprehensive list of game mechanics. These are used to define initial **play-persona concepts**. One play-persona might be interested in jumping, sneaking and navigation, another in fighting enemies and using very big guns. The goal is to ensure that the personas encompass the interests of the players, but operate within the confines of the design that cannot be affected by player agency.

The second step is relating the mechanics to specific gameplay metrics. For example, for the mechanic “shooting guns” the metrics “accuracy”, “weapon choice”, “weapon carrying time” etc. could be defined. At this point each game mechanic is scrutinized in terms of relevance to the gameplay, descriptiveness of players' behavior, interest of the design team, and resources needed to track, transmit and store that game variable as a game metric [18]. There are different ways that mechanics can be categorized and related to player behaviors. This will depend heavily on the game genre and the specifics of the gameplay. An example was published by Tychsen & Canossa [33], who focused on character-based games, defining a set of categories of metrics that relate to specific character traits and abilities: **Navigation** metrics, **Interaction** metrics (with the game world, with non-playing characters and with the player-controlled character), **Narrative** metrics and **Interface** metrics.

One way to apply a focus is to consider the key mechanics of the game. For example the "jump" mechanic is very relevant to TRU; is one of the foundational mechanics of the game, and one that players will be using consistently throughout the game. It is therefore descriptive of a major part of the player behavior. However, it might be expected that players approach jumping differently and/or with different levels of success. Furthermore, it is of interest to the design team to monitor the different layers of player's proficiency at jumping and finally, being a triggered mechanic and not a continuous variable like tracking the location of the player avatar, it is comparatively simple to capture.

Other top-level core mechanics involve the following:

- **Navigation** in 3D environments
- **Shooting** enemies
- Avoiding **traps** and **environmental hazards**
- Solving **puzzles** (including using the native Help-on-Demand system to solve puzzles)

The core mechanics are generally defined in the game design document in a commercial context; however, design teams can add to this list or modify it when defining the play-personas – it is important to keep in mind that personas are about behavior, experience and motivation. After the game mechanics of interest have been defined and expressed as gameplay metrics, it is possible to condense them in fewer, higher-order parameters such as gameplay gestalts [24].

Converting the mechanics of interest into concrete gameplay metrics is not always a straight-forward process and can require the logging of multiple metrics. For example during design it was wished to permit players both to combat and avoid mobile enemies. In order to define these behaviors in terms of gameplay metrics, information such as the number of deaths caused by enemies, the number of times a weapon was fired, and the path of the player through the environment, needs to be logged. It is necessary to strike a balance between the need for play-personas to be defined in real behaviors which can later be tracked, logged and analyzed; and avoiding excessive logging.

It is possible to utilize the play-personas directly, basing them on decisions about the kinds of playstyles that the design team would like to promote in the game in question. For example, the TRU team could define a set of personas, each with different dominant behaviors in relation to navigation, shooting, jumping and puzzle solving. An alternative approach is to consider player skill or use of, specific metrics. This essentially involves generating a multi-variate space where each metric (or higher-order group of metrics/gestalts focusing on the same game feature), is mapped along an axis (Figure 3). Combined, the axes span a conceptual possibility space (with as many dimensions as there are variables) within which players must operate, and behaviors can be defined as combinations of the selected metrics. In this space it will be possible both to hypothesize possible patterns of play a-priori, in terms of play-personas as *metaphors*, and to chart the patterns of real players a-posteriori, in terms of play-personas as *lenses*. The axes can be defined abstractly such as "+" and "-" prior to a playable version of the game, when personas are used to imply user behavior patterns in the design. However, the axes can also be defined based directly on collected gameplay metrics. For example, the percentage of total puzzles solved. This provides a means for defining detailed quantitative components of the persona models.

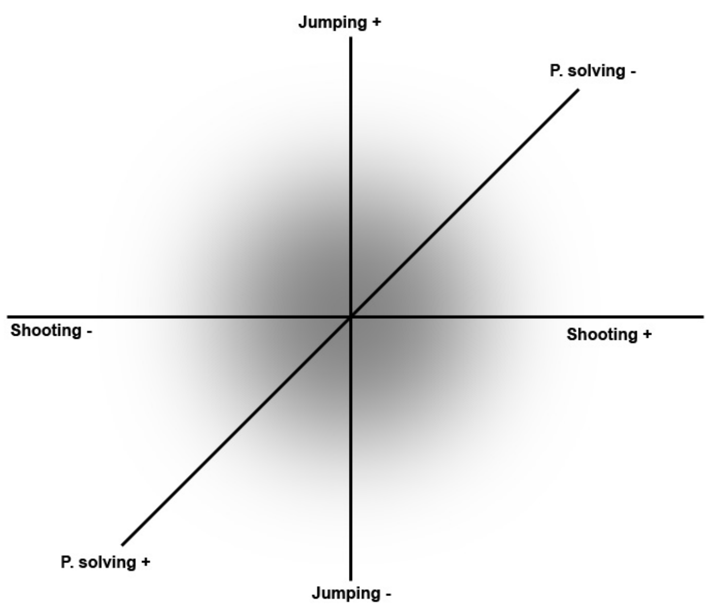

Figure 3: the conceptual space identified by the three axes: jumping, shooting and puzzle solving.

In the case of TRU, the three parameters *shooting*, *jumping* and *puzzle solving* could be selected (figure 3). These are higher-order groupings of more detailed game metrics, but serve to provide an idea about what the operational space is for the players. For example, players could either spend a lot of time solving puzzles, preferring to solve them, or conversely use the Help-on-Demand system, largely ignoring the puzzle element of the game.

At this point it is possible to select which play-personas will guide the design process. Play-personas can be defined as extreme cases, one-sided accentuations that delimit a set of variables (e.g. players who never fight enemies), however, experiences from TRU indicate that most players will fall outside of the extremes. It appears more useful to define the play-personas as covering segments of a variable axis. For example, defining the "Athlete" play-persona as a player who does not do well with shooting or in combat with enemies, but navigates carefully and dies very seldom from jumping errors. The gameplay metrics component of the persona provides quantitative information about the expected behaviour of the play-persona – which can later be tested.

At this point it is useful to define a narrative description, which serves to anchor the play-persona in game design language. *"Athletes enjoy exploration of the environment; they will try to avoid fights if at all possible. They are players with experience and are comfortable with navigation controls. Athletes will rarely lose direction and will display relatively fast completion times, which is also reflected in few requests for help with spatial puzzles".*

Play-personas defined during the design phases form the basis for selecting which gameplay variables that should be monitored during later-phase testing.

The term "lens" is here intended as the choice of a context from which to sense, categorize, measure or codify experience. As lenses, play-personas are derived from gameplay metrics gathered from players. Play-personas can be used as tools when evaluating games by comparing the patterns of player behavior with the defined play-personas. By comparing designers' and players' goals it is possible to evaluate whether the game design actually supports and facilitates the planned behaviors and experiences in practice, and if any new personas emerge from the user-interaction.

Alternatively, during testing and following game launch, logged metrics data can be analyzed to discover patterns in the behavior of the players, thus enabling the building of a-posteriori personas of how players interact with the game.

In TRU, several hundred variables are being tracked through custom-build software. Via this system it is possible to collect data from players around the world, in the current case more than one million. Every time players ask for help solving puzzles, die from a bad jump, etc., the information is logged. These data can subsequently be analyzed and form the basis for detailed persona models. This information also helps designers answering straight forward questions such as: "Where do players get stuck more often?", "Which parts of the level maps do players experience?" etc.

Considering the core compounded mechanics, "shooting", "jumping" and "puzzle solving", and the play-personas that can be constructed from these, a selection could be made that considers the following:

- **Causes of death:** These can be grouped into three higher-order variables, e. g. death by falling, by mobile enemies and by environmental factors. These gameplay metrics provide tacit information about how well players handle different kinds of threats in the game. For example, a player who dies often from mobile enemies, can be hypothesized to have low skill in terms of combating mobile threats
- **Shots fired:** TRU includes a variety of weapons. Tracking weapon use involves registering what type of weapon was fired, location of the player and whether the shot hit a target, and number of different types of target killed (kill-score). These data allow the construction of weapon-use profiles that can be cross-correlated with e.g. causes of death.
- **Puzzle solving:** The number of times a player requested help for solving a puzzle from the TRU Help-on-demand system. This metric informs about how well the player in question handles the puzzle-solving element of the game.

Additional variables could be added to support these, as follows:

- **Total number of deaths occurring to a player:** This provides a measure of the skill level of the player in general. The fewer deaths, the better the player navigates the dangers of the game. This information can be cross-correlated with the causes of death metrics.
- **Completion time:** Basically the time it takes the player to complete the game. In the metrics database, information can be extracted as to completion times of the entire game, each level or each sub-level unit. Long completion times can mean different things – the obvious conclusion is lack of skill compared to players who complete faster, however, it can also mean that the player in question has a preference for environment exploration.
- **Navigation:** Usually the path of a player in a 3D game is logged as a series of coordinate positions (X,Y,Z) with a given frequency. Analyzing the path taken by players provides insights

into which sections of the levels that players utilize, and can also be used to locate areas where players are confused about how to progress.

Note that higher-order variables such as these selected here can sometime mask underlying details in the behavior of the player – it is important to consider exactly what inferences that can be made from a given gameplay metric. For simplicity, in this case study it is assumed that such underlying patterns do not occur in the gameplay metrics data.

There are several approaches that can be applied to locate patterns in sample-based datasets (such as gameplay metrics datasets). The majority of these are based on multivariate inferential statistics, for example variance analyses, clustering techniques, ordination methods and similar approaches from population studies. Additionally, factor-based algorithms and neural network algorithms can be utilized to find the patterns of play in game metrics datasets (provided that any patterns are present).

One of the most direct approaches towards evaluating if there are any underlying patterns (or clusters) in the collected data is to use a clustering method. K-means clustering and Ward´s method, the latter utilizing Euclidean coordinates, form two possibilities. A cluster analysis will inform whether there are any strong groupings in the way that the underlying variance of the metrics dataset is organized.

A different approach considers dividing the ranges of each variable into categories (after removing outliers). For example, if the "number of deaths" varies between 1-100, a simple binary division could define two ranges: 1-50, 51-100. Care must be taken when manually devising these ranges to ensure that they are meaningful. If for example 99% of the players die between 80-90 times during the game, the remaining 1% could be considered outliers (or a very minor group of players behaving in a non-typical fashion). By allocating ranges to all variables of interest, it is possible to allocate players into play-persona categories based on the requirements defined in the design phase. Experiences with TRU and other games suggest that there will always be some players who fall outside the defined personas. This may or may not be an issue, depending on the nature and number of these outliers. However, the ulterior goal is to evaluate if the play-personas intended, actually manifest in the metrics data for a statistically significant portion of the players. If not, this means that there are problems with the game design, and in-depth analysis of the data may be necessary. It is possible for example that certain game-levels facilitate the kinds of behaviors aimed for, while others restrict the players´ agency more. This may or may not be a problem and always requires case-by-case evaluation.

In a quantitative approach towards finding clusters of player behaviors, Drachen, Canossa and Yannakakis [12] utilized an Evolving Self-Organizing Map (a form of Korhonen neural network) to analyze data from a small sample of 1365 players of TRU, all of whom had completed the game. The analysis considered six variables (completion time, numbers of deaths, death by falling, death by enemy, death by environment and the use of the Help-on-demand system). Four clusters of behavior were located (table 1) based on the core mechanics of the game encompassing more than 90% of the examined players. Each group was rated on a low-average-high scale, which is based on the underlying range in the gameplay metrics. Each group was given a metaphorical label, which serves to provide an illustration of the core behavior of the group, and is essential when communicating results of an analysis to the design team in a game development company.

	Veterans	Solvers	Pacifists	Runners
Death count	low	average	n/a	average/low
Completion time	low	average/high	average/low	low
Death by falling	low	high	average/high	average/low
Death by enemy	low	average/low	high	high
Death by environment	high	low	low	High
Help on demand	average/low	low	low	high / low

Table 1: the four clusters of player behaviour according to the game metrics tracked

Veterans: These players where characterized by low death counts, fast completion times and very few deaths by enemies or falling, and low numbers of request for help in solving puzzles. The only weakness was environment related deaths, which this group handled rather badly. A closer look at the metrics data could be utilized to locate the specific areas or traps where this otherwise very well performing group ran into problems.

Solvers: This group of players where characterized by very low numbers of requests for help in solving puzzles, but average to high numbers of death by falling and enemies. Completion time was average. Perhaps surprisingly, environment-related deaths were low, indicating careful navigation through the environment.

Pacifists: These players are characterized by average numbers of death to environment and falling, but low numbers of death to environment effects such as traps, and low numbers of requests for help, and very high numbers of deaths by enemies. These players generally navigate the game well, but are very bad at handling mobile threats.

Runners: This group completes the game in record time, but also generally have very high help request rates, indicating a lack of interest in the puzzle-solving element of the game (or a lack of puzzle solving skill). They appear to die a lot, with however average rates of death from falling.

These categories provide an example about how gameplay metrics can be used to define data-driven patterns of player behavior in computer games. While the study is based on a limited number of variables, it indicates the kind of approach necessary to develop data-driven play-personas. Summarizing, combining gameplay metrics with persona modeling provides a powerful tool for game design and –testing, permitting game developers to test if their games are being played the way it was intended. Running these analyses on a per-level basis, enables level designers to achieve better balance and facilitate the different play-persona models; to obtaining a greater insight on the landscape of possible player types and eventually make games that can cater for a broader audience.

5 Conclusion and discussion

Using game mechanics as the underlying driver for defining play-personas as metaphors is not the only way, however, it provides a means for defining personas during the design phase that are directly testable in the later production phases where actual gameplay metrics can be logged and analyzed.

It should be noted that gameplay metrics cannot inform how players relate to the character of Lara Croft, or similar kinds of psychological effects. Simply put, gameplay metrics can reveal what players are doing, not necessarily why, for that a more qualitative approach is needed. An alternative means is to use for example personality profiling of the target audience, and use these profiles to define the expected behaviors [5]. These behaviors can then subsequently be defined using gameplay metrics.

There are a few delimitations on the applicability of the framework proposed: for puzzle games with one solution or extremely linear games such as point-and-click adventures it makes limited sense to employ play-personas: the player's sole duty is to second guess the designer's mind and therefore push forward the story.

The method described is intended to assist in the design and production of closed, narrative games that run the risk of failing to provide non-trivial choices, i.e. collapsing all the potential personas into only one profile that players have to conform to in order to proceed. For these types of games a key design challenge is to ensure varied experiences and playstyles in order to reach as broad a target audience as possible [23, 26]. Play-personas attempt to address this requirement both by modelling preliminary hypothesis of in-game behaviour and by categorizing and analyzing character-bound gameplay metrics variables. In this paper a case study has been presented that shows how play-personas allow designers to aggregates data in a way that binds ludic and narrative aspects of the game.

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