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CONFERENCE PROCEEDINGS

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Foreword from the Program Chairs

On behalf of the organization, it is our great pleasure to welcome you and to present the proceedings of the International Conference Architecture In-Play held July 11–12, 2016 at ISCTE-IUL in Lisbon. The event is organized by a partnership between University Institute of Lisbon (ISCTE-IUL) and La Sapienza Universitá of Roma.

The possibility of hosting such an event at ISCTE-IUL emerged as a great opportunity to bring to Lisbon an international community to present the most recent and unpublished works in research, teaching or practice related to interdisciplinary use of Architecture, Digital Design, Technology, Computation, Mathematics and Geometry. In consequence, contribute to enrich the debate around the use of digital technologies in architecture. The focus of Architecture In-Play is exactly to think about responsive buildings, buildings that reshape themselves in order to respond to a particular need, interdisciplinary approach in Architecture, tools, methods and theories. In sum, bringing together people from all the fields that can merge and create new and improved architectural solutions.

The conference program represents the efforts of many people. We would like to express our gratitude to the Scientific Committee for their hard work in reviewing submissions and selection of the final papers. We are grateful to the authors (from 15 countries) of the papers for their contributions and their participation in the conference. The paper submission and reviewing process was managed using the EasyChair system. The list of reviewers is included in the proceedings.

We also thank the four invited speakers, Michael Fox (FOXLIN Architecture, United States of America), Ruairi Glynn (Interactive Architecture Lab at the Bartlett School, United kingdom), Arturo Tedeschi (Computational designer, Italy) and Paul Jackson (Origami Artist, Israel) for sharing their valuable experiences.

The Architecture In-Play conference is structured in four thematic sessions: (1) Interactive Architecture – adaptive world; (1) Interactive Architecture – laboratory; (2) Computational design; (3) Origami Geometry and Mathematics. Each session starts with lectures by international keynote speakers in the field, that share with the audience some of their most representative work in teaching, researching and practice, followed by paper presentation sessions. At the end of each session the debate allow a reflection on different approaches and results.

We hope that these proceedings can further stimulate research in different subjects and provide practitioners with better methods, tools techniques for architectural design. Hopefully, provide a point of departure for even greater achievements in the field.

Finally, we feel honored and privileged to provide the most recent developments in the field of Interactive architecture, computational design and origami to you through this exciting program.

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Spatial Cognition in virtual environment

Spatial cognition in video games

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Abstract: If spatial configuration is the main generator of natural movement in real environments, what happens when the navigation in virtual environments is mainly governed by properties of characters and not by the mathematical spatial configuration of a plan? This study is focused on the field of spatial cognition, navigation and wayfinding in the context of Half-life video game, where individuals -players- mainly navigate through by virtue of their decisions to approach certain goals (missions). The objective is to capture the correlation between space-time and observed movement in the virtual environment by analysing the video game space and conducting an experiment. The case under study is "Half Life 2 - Episode 2“; a strategy video game, with mission to find the best routes out of the virtual environment settings. Observations of players’ navigation are carried out supported by spatial analysis and a new methodology named time-convex to model space-time relationships.

Keywords: *Space Syntax; Spatial Cognition; Video Games; Wayfinding; Navigation.*

1. Introduction

Video games have changed the notion of space in time; more than the film and television did in the twentieth century (McLuhan, 1951, 1962, 1997; Barthes, 2000). The representation of players in digital spaces, avatars, culminate the creation of the illusion of reality. A pseudo-physical space that can extend from the two dimensions to three dimensions with a full package of social and 'object' interactions.

This alternative reality is mainly constructed by cognitively demanding environments. Movement is influenced by the revelation of a new path and short-term events. Where real world sees a path as a corollary of space, a path in a video game is revealed after a sequence of different decisions, actions and movements. Video games as cognitively demanding environments make obvious the need for conducting thorough research in order to obtain information about the processes of spatial cognition.

This research takes the theoretical background of spatial cognition and focuses on studying the video game environment by exploring the space-movement relationship and trying to find new patterns of cognitive processes and navigation, by using the theory and tools of Space Syntax.

In addition to syntactic analysis, the study entails a novel analysis named “time-convex”, which is an attempt to understand the patterns of movement and wayfinding in correlation with time. The combination of this analysis with space syntax analysis enables a preliminary understanding of how individual behaviour could be used to explain the cognitive processes of movement in virtual environments. The analyses were carried out using the plans of the six stages of “Half-life: Episode Two”, which were designed by the author.

2. Research questions

The following research questions attempt to understand the spatial qualities and characteristics of video games and their implications in spatial cognition: 1. What are the spatial characteristics of the spaces in Half-Life, where players are spending their exploring and decision-making time? 2. How players move in Half-Life when they know their destination? 3. Where do players die in Half-Life video game?

For the research questions; three hypotheses constructed as well:

Hypothesis 1: Players are more likely to display explorative behaviour in more spatially central (integrated) spaces. Hypothesis 2: Players prefer to follow a straight (higher value of connectivity) 'unsafe' route when they know their destination than choosing a 'zic zac', but safe route. Hypothesis 3: Players die in places where there is an excessive amount of visual and spatial information.

3. Methodology

3.1 Experiment

The experiment identifies a continuum of cognitive skills used of players with short experience of games environments (T1), with no experience in First Person Shooter (FSP) video games (T2) and with high experience in FPS (T3), in order to make decisions and find destinations. The last group is used as a control group.

3.2 Time - convex analysis

The limitation and the challenge of this study is to conduct results in the content of spatial cognition by analysing a space that is actually a pseudo-space. Aiming to establish some links between cognition and behaviour, we analyse playing time in combination with space. We divided play-time into four categories; the exploring, the decision-making & acting, the narrative time and the time when players were completely lost in the stages of game.

3.3 Space syntax

The space syntax measures that will be used include; connectivity (axial analysis), and the amount of the visual information (APR value) by using isovist analysis. Axial analysis is a fundamental quantitative analysis of space syntax. Axial maps are a representation of the structure of space “spatial configurations”.

Isovist is a visibility field constructed from a point that represents everything that can be seen directly from a point or a space. The perimeter of the area of an isovist implies the visible area around a point or a person. A salient measure, as it introduced by Dalton et al (2010) is the Area-Perimeter Ratio (APR) or 'spikiness' of an isovist [APR=ISOVIST AREA ÷ (ISOVIST PERIMETER) ^{2}]. The range of the value of APR can range from 0.25 (circle) to 0 (the max value of spikiness).

4. Recording the experience

The main purpose of the experiment is to collect data of how players with different levels of experience in video games are navigating and moving. All the participants were unfamiliar with Half-Life video game. The experiment is 15 hours of recording in total. A sample of 10 healthy participants (3 females, 7 males, mean age: 26.6 years, range: 24 - 30 years) were asked to play “Half Life 2 - Episode 2”. Whilst observing their movement and generating data for their decisions, one significant limitation is that mere observation can make it difficult to determine the reasons or intentions behind some of the different actions performed. For example, choosing to turn right might be motivated by the need to protect himself/herself from the “enemies”.

In order to reduce these limitations as much as possible; many studies (Chebat, Gelinas-Chebat, & Therrien, 2005; Dogu & Erkip, 2000; Ericson & Simon; 1980, Gerber & Kwan, 1994; Holscher, Meilinger, Vrachliotis, Brosamle, & Knauff, 2007; Passini, 1981, 1984) have included verbal report protocols (speak and think aloud). In this study, participants of the experiment were asked during the task to think and speak aloud about their experience. All the participants were playing the video game in the same speed of movement and in lowest level of difficulty for the tasks. After the experiment, tracing plans were produced. The main criteria that the experiment focuses on are: 1. whether the navigator can discover or inform his present location, 2. whether a route to the destination can be found, taking as base that navigability means a successful performance at wayfinding tasks, 3. how well the navigator can accumulate wayfinding experience in space.

4.1 The behaviour and thinking process of the players

T1 tend to spend time exploring the space ('zic-zac' movement). They were focusing on all the information available to them. Determining the direction was the most important aspect of their thinking process. The need to transfer skills navigating real environments to find their way in virtual environments, was their strategy of moving. The thinking process of this team of players was from the general information to the specific.

T2 seems to play from the beginning with specific strategy. They do not tend to spend time exploring the space as their experience helps them to understand easily what they should not consider as destination. They are using for their navigation specific landmarks. When they had to choose between options, they were up to choose simpler rather than more intricate routes. The way of thinking in this team was a mix from general information to specific information, such as landmarks, and from the specific to the general according to the conditions.

T3 were the fastest in succeeding in the tasks of the game. Their characteristics were the quick decision-making and their focus on specific points. Fast movement occurred on the narrative parts of the game where the participants knew they did not need to make any further decisions, and at stages where decisions with regards to the destination were obvious for them. The parts explaining the narrative of the game were mainly the only parts that this group of players spent on exploring the environment. The thinking process of this team was shifting from the specific to the general information.

5. Analysing the experiments in space and time

Time was divided in four categories. Every participants had 90' of playing. The time, in total 278.32', which the players were trying to translate all the information from their experience in real environment to the virtual one is the exploring time. The decision making & acting time, in total 387.18', is the time that participants reported to know their destination and how to navigate. The 'completely lost' time is the time, in total 118.10, that the players were feeling lost. During the narrative time a third person was giving directions or feedback for the player's actions. The story-telling time was 16.64'.

Furthermore, T1 spent more than 50% of time; exploring the surroundings, perhaps reflecting on the lack of experience in video games in relation to the other two teams. The gap of time spent on exploring escalates with the participants of T2. T2 has distributed time spending more equally, with percentages in exploring time close to the percentages of the control group. This proofs the importance of T3 as control group creating the baseline of the experiment. Having the routes of the participants; new plans were produced, mapping time spending on the spatial layouts of Half life video game (Fig.1).

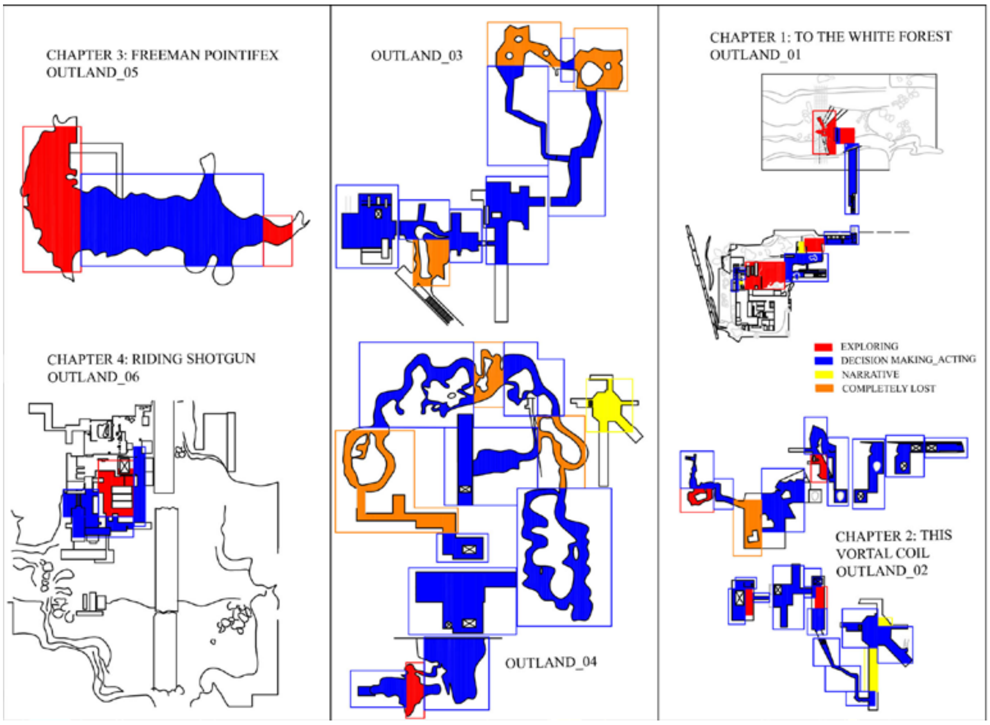

Figure 1: 'time-convex' maps

5.1 Analysing the space

Trying to obtain a clear picture of the configuration of the stages, the syntactic computer software "Depthmap" was used to analyse the game plans. The computational analysis has been done using the textbook "Space Syntax Methodology" (Al Sayed et al. 2014). All the graphs will be presented using the Depthmap classical range of colour (Fig.2). The chosen analysis for testing of hypotheses 1 and 2 is the axial analysis.

Figure 2: Color range of classical Depthmap Software

The all-line figure (Fig.3) is a collage of the axial analysis (all-line maps) of all the Half-Life' stages. The stages with more specific -orthogonal- shapes have much lowest values of connectivity than the stages with unspecific shapes.

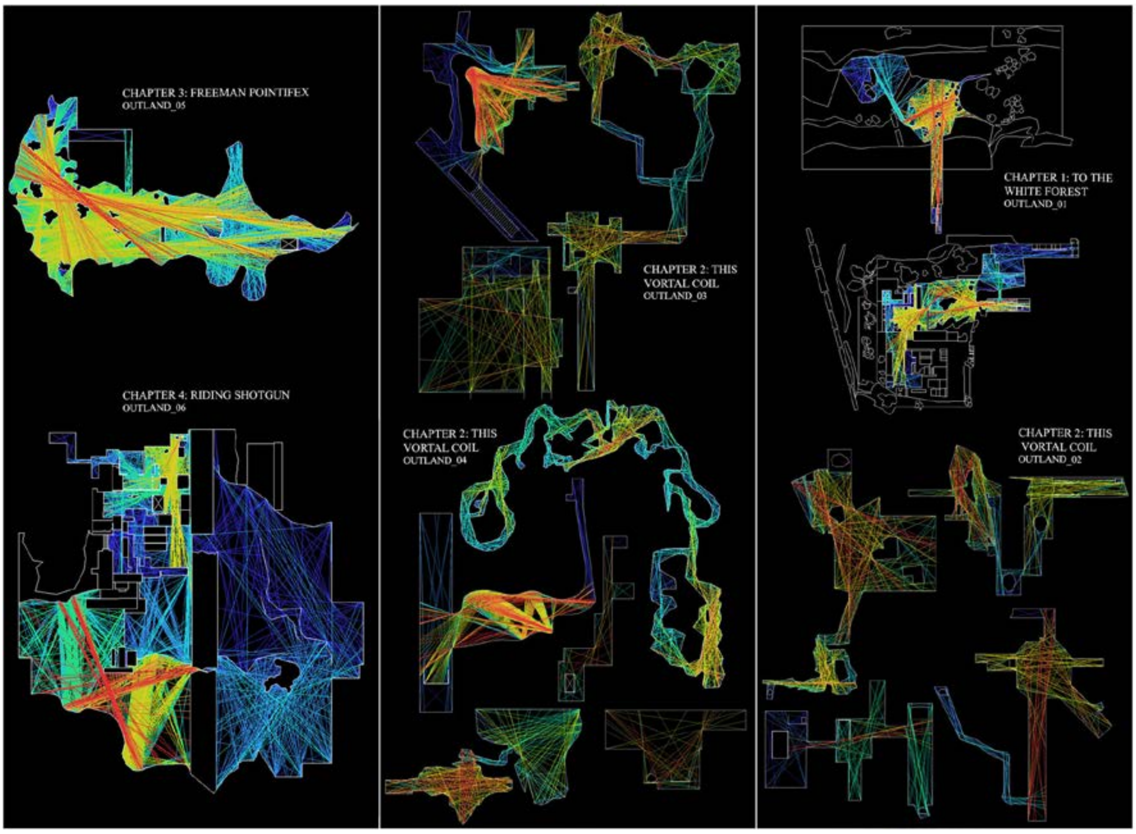

Figure 3: All-line maps

5.2 Results of the analysis

The combination of the axial analysis with "time-convex" analysis is being shown in figure 4. Considering again the limitations of constructing a spatial analysis close to the one of a real environment, the aspect of this map is to give the idea of the time that the users of the game spend in different parts of the stages and to extract information about the spatial characteristics of where players explore or make their decision and actions. In order the observations to be more accurate, the narrative time and the time that the players felt completely lost will be excluded from the analysis.

The outcomes of the comparison are linked with the geometry and the psychology. People in spaces with clear geometry (orthogonal shapes) tend to walk straighter and not exploring the surroundings. In videogames environments, there are also other factors that can influence the navigation of the player, but in games like Half-Life the main character navigates mostly by his/her own perception of the space. Also, in spaces with clear shapes, players were feeling safer to act and to decide their destination. The feeling of safety, that reported in the think-aloud protocols, was result of having less information to scan objects that caught his/her attention. In spaces with unspecified shape players recorded feeling the need to explore the environment with a 'zic-zac' movement, in order to get the 'whole view' of the area.

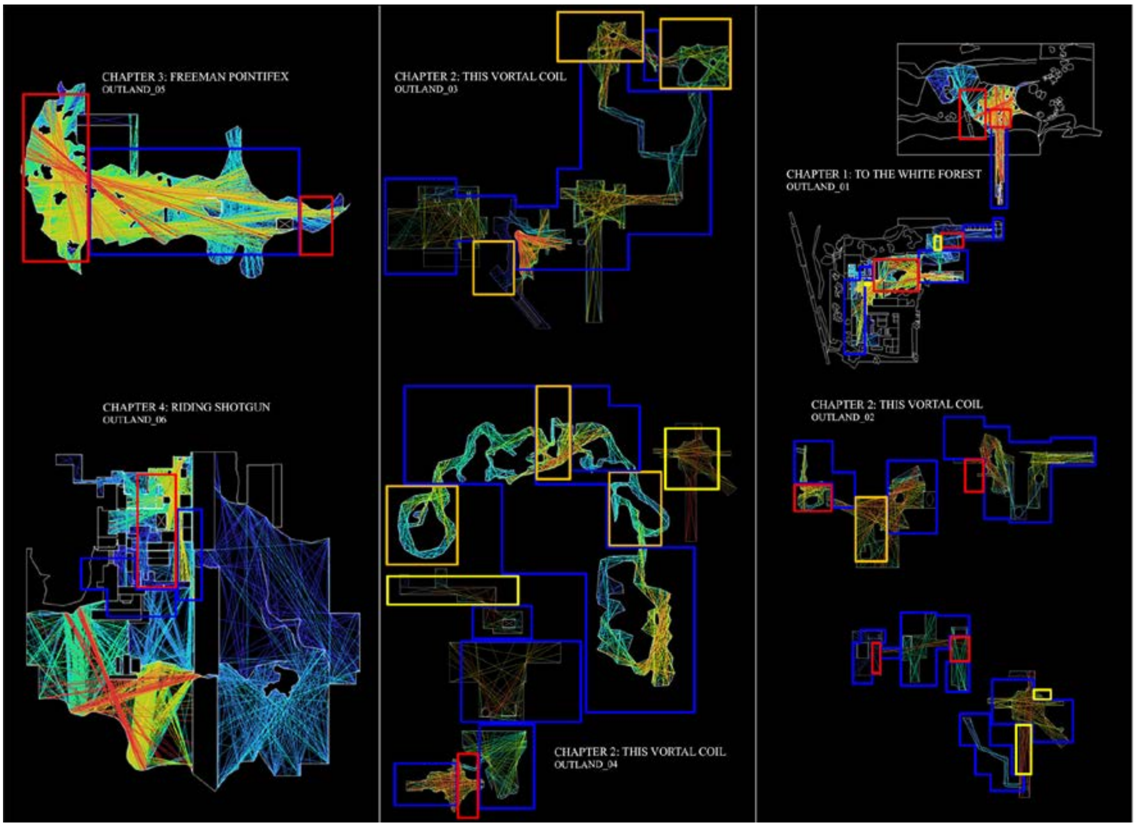

Figure 4: Axial maps and 'time-convex' maps

6. Why people die in video games?

If people die in places where there is an excessive amount of visual and spatial information (Hyp.3) then a noticeable measure to test this hypothesis is the 'spikiness' (Dalton et al,2010). For the purpose of this study, the points where the factors of the death caused from the design of the game (more enemies etc) excluded.

APR can range between 1/4 (perfect circle) and 0 (high value of spikiness). If the hypothesis would be correct the spikier isovist would result to the most 'deadly' stage. By extracting the geometry values from the isovist analysis; APR measured and compare them with the deadly stages (Table 1) it appears that they are close enough (outland_04b and outland_02 are in the lower position of the descending order) but are not the same. It seems, that in this type of virtual environment, the movement and the interaction of the players are influenced by many variables, which overcome spatial characteristics.

more DEADLY stages (in descending order)	more 'SPIKY' isovist (in descending order)
OUTLAND_03	OUTLAND_04a
OUTLAND_05	OUTLAND_05
OUTLAND_04a	OUTLAND_06
OUTLAND_06	OUTLAND_03
OUTLAND_04b	OUTLAND_02
OUTLAND_02	OUTLAND_04b

Table 1: 'deadly' stages Vs APR

7. Contributions of the research & further study

The analyses confirmed two of the hypotheses and disproval the third. Variables as the design of the game influence the players behaviour, movement and understanding of the space. This study tried to exclude many of these factors, in order to extract findings that can be related with cognitive processes that take place in real environments. The results have to be carefully considered as there is a need for a greater diversity of analysis of the relation of time and space in cognition processes to establish more definitive answers and advance this early study.

A further study would be the creation of a highly accurate virtual reality simulation to explore what thoughts are associated with wayfinding, in relation to higher resolution time segments, 3D space and eye-tracking. Another factor that can progress this study would be the opportunity to test how people move and react playing the same stages in different versions (black & white, no enemies, be able to change the speed of moving).

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