Notes On The Methodology Of Pervasive Gaming

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ABSTRACT
The paper introduces four axes of pervasive gaming (PG): mobility, distribution, persistence, and transmediality. Further, it describes and analyses three key units of PG (rules, entities, and mechanics) as well as discusses the role of space in PG by differentiating between tangible space, information embedded space, and accessibility space.

Categories and Subject Descriptors
H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities.

General Terms
Performance, Human Factors, Theory.

Keywords
Pervasive gaming, game rules, gameplay, game theory, ludology, game space.

1. INTRODUCTION
New technology and new methods for networking digital systems are essential for the development, implementation, and conceptual understanding of complex adaptation in computer mediated games and play. At the same time, we must identify and rethink the social interactions as well as the formalisms and theories that are deployed in pervasive gaming. Since 'real life' is part of the game and the gaming arena itself, including rules and game parameters, concepts such as *probability*, *uncertainty*, and *contingency* gain importance in the design and understanding of PG.

First, I will depict the four axes of pervasive games: the mobility axis, the distribution axis, the persistence axis, and the transmediality axis. In the second part of the paper we shall look deeper into game rules, game entities, and game mechanics. Third, we shall concern ourselves with the renewed focus on space or spatiality in relation to PG.

2. PG FORMALISMS
I define 'pervasive game' as an over-arching concept or activity subsuming the following post-screen gaming sub-genres [9]:

- A *mobile game* is a game that takes changing relative or absolute position/location into account in the game rules. This excludes games for which mobile devices merely provide a delivery channel where key features of mobility are not relevant to the game mechanics. Hence, one could distinguish between *mobile interfaced games* and *mobile embedded games*.
- A *location-based game* is a game that includes relative or absolute but static position/location in the game rules.
- A *ubiquitous game* uses the computational and communications infrastructure embedded within our everyday lives.
- *Virtual realities games* are games generated by computer systems. The goal is to construct is to construct wholly autonomous and completely surrounding game worlds.
- *Augmented reality games* and *mixed reality games* are an interesting approach to the creation of game spaces that seek to integrate virtual and physical elements within a comprehensibly experienced perceptual game world.
- *Adaptronic games* are games consisting of applications and information systems that simulate life processes observed in nature. These games are embedded, flexible, and usually made up of 'tangible bits' that oscillate between virtual and real space.

Two essential qualities of pervasive computing stand out; 1) the explicitness of *computational tasks*, and 2) the all-importance of *physical space*. The former implies that actions are carried out in ways that transcend the traditional screen-facilitated environment; embedded computing shifts our attention from metaphorical data manipulation to simulated and natural interactions with things and physical objects. This interweaves with the second aspect of pervasive computing as objects obeying the laws of natural physics are open to (digital) manipulation and thus take on a double meaning: they are objects within the outside non-game world; yet they can also be objects within a game world.

Following this I will propose a general or 'classic' definition of PG:

Pervasive gaming implies the construction and enacting of augmented and/or embedded game worlds that reside on the threshold between tangible and immaterial space, which may further include adaptronics, embedded software, and information systems in order to facilitate a 'natural' environment for gameplay that ensures the explicitness of computational procedures in a post-screen setting.

2.1 The Four Axes Of PG

We will zero in on four axes that together mark the possible domains of PG. The four axes can be illustrated like this:

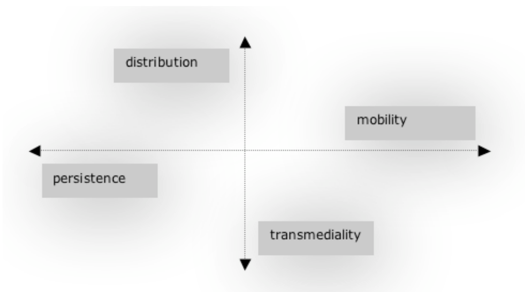

Figure 1. Four axes of PG

- *Distribution*. Pervasive computing devices are frequently mobile or embedded in the environment and linked to an increasingly ubiquitous network infrastructure composed of a wired core and wireless edges. This combination of embedded computing, dynamic networking, and discrete information sharing clearly affects and strengthens the distribution paradigm of IT. One example of a distribution system designed to work in huge networks is the so-called Twine resource discovery system. It uses a set of resolvers Twine nodes that organize themselves into an overlay network to route resource descriptions to each other for storage, and to collaboratively resolve client queries [1].
- *Mobility*. New challenges of pervasive computing further include mobility, i.e. computing mobility, network mobility, and user mobility, context aware (smartness), and cross-platform service. Particular interesting to the field of PG is the growth in mobile 3G technologies, Bluetooth, and LAN-LAN Bridging.
- *Persistence*. The idea of creating an online world in a mobile phone is the driving force behind the Danish company Watagame's *Era of Eidolon*. The persistence factor here touches upon the notion of temporality. Persistence means total availability all the time.
- *Transmediality* relates to modes of media consumption that have been profoundly altered by a succession of new media technologies, which enable average citizens to participate in the archiving, annotation, appropriation, transformation, and re-circulation of media content [7]. No medium in the present day can be defined as a self-sufficient application based on partial groupings. The junction of multiple media spread out over huge networks and accessible through a range of devices is rather a nice instance of how media commune in circular, not linear, forms.

2.1.1 The PG Possibility Space

Combining distribution, mobility, persistence, and transmediality we embark upon the 'PG possibility space'. It is a space that deals in *networking* given the focus on non-locality, non-metric systems, and constant accessibility. It is a space that celebrates the *freedom of device* – games can be played on anything; and game devices may trigger anything, anywhere, anytime. It is further a space that favors *non-closure*; although pervasive games still cling to the law of goal-orientation (closure) they open up new ways of collaborative world building as well as invite continuous structural expansion. Finally, the PG possibility space embraces *circular* storytelling as *the* norm of mediated entertainment.

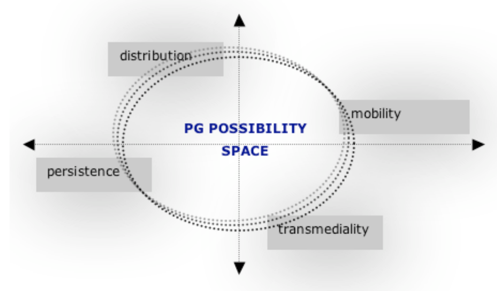

Figure 2. Four axes and the PG possibility space: networking, freedom of device, non-closure, and circular storytelling.

2.2 The Three Key Units Of PG

Games can be divided into three key units that are strongly interlaced: 1) Game *rules*, 2) game *entities*, and 3) game *mechanics*.

2.2.1 Game Rules

In Jesper Juul's generalized model there are six invariant parameters of game rules:

> **1) Rules:** Games are rule-based. **2) Variable, quantifiable outcome:** Games have variable, quantifiable outcomes. **3) Value assigned to possible outcomes:** That the different potential outcomes of the game are assigned different values, some being positive, some being negative. **4) Player effort**: That the player invests effort in order to influence the outcome. (I.e. games are challenging.) **5) Player attached to outcome**: That the players are attached to the outcomes of the game in the sense that a player will be the winner and "happy" if a positive outcome happens, and loser and "unhappy" if a negative outcome happens. **6) Negotiable consequences**: The same game [set of rules] can be played with or without real-life consequences [8].

It is evident that some of these rule parameters are altered with respect to PG. Let me narrow this alteration down to two issues:

1) Take the vital concept of variable, quantifiable outcome. To Juul, this mean that the outcome of a game is designed to be beyond discussion, and that this trait is an instinctive token of game rules. This fits perfectly well with practically all computer games. However, when moving the logic structure of the digital computer into the tangible world the quantifiability of a rule system seems to shift into a more fuzzy type of interaction between constitutive

and regulative rules. In *The Construction of Social Reality* Searle explains that social rules may be regulative or constitutive [12]. *Regulative* rules legalize an activity whereas *constitutive* rules may create the possibility of an activity. It is the constitutive rules that provide a structure for institutional facts. In the context of explaining the (extended) rule system of PG, computation can be regarded as a conceptual framework that constitutes the possibility space for regulative behavior. Constitutive rules belong to the set of quantifiable norms while the regulative rules govern the ad hoc player interference with the game world. Another way of distinguishing the computational rule logic from the real-time interaction pattern of gameplay would be to differentiate between *global regulations* (provided by the computer's state machine) and *local operatives* (controlled by the player's behavior with the physical as well as information embedded game world).

2) Next, we should consider the term 'negotiable consequences'. In pervasive gaming 'real-life consequences' is exactly that which drives the play experience forward. The entire teleology of gameplay in fact rests on these outcomes that transpire and are enacted on the physical arena. A game of chess might have ferocious consequences if played out in real life. However, since the movement of pieces across the board merely *represents* physical structures it follows that the rules of chess apply to the discrete topology of the game and not the phenomenological experiences that this topology may cause. In the domain of pervasive gaming it is precisely the 'negotiability' signifying the toggling back and forth between real-life consequences and discrete representations that pushes gameplay forward. Thus, the 'tangibility consequence' of PG brings forth a level of uncertainty to the gaming phenomenology; and this uncertainty becomes part of the rule structure, as it must be inscribed in the computational representation.

2.2.2 Game Entities

In line with the Object Oriented Programming paradigm I define a game entity as an *abstract class of an object that can be moved and drawn over a game map*. There can be an enormous amount of entities in a game; inventory objects in an adventure game; Non Playing Characters (NPC's) in a FPS (First Person Shooter); or a text message in a strategy game. Since a game has more entities, the ways that they can react together increases geometrically.

A PG entity can take the shape of a) *game object*, i.e. any object that can be encountered, seen, or interacted with during gameplay; b) a *human agent*, since an essential part of a pervasive game is to collaborate and engage in conflict with 'flesh polygons'; and c) a *physical object*.

It is the negotiability or uncertainty principle that do the trick. Pervasive gameplay implies *contingency handling*.

2.2.3 Game Mechanics

Lundgren & Björk define game mechanics, as simply *any part of the rule system of a game that covers one, and only one, possible kind of interaction that takes place during the game, be it general or specific*. A game may consist of several mechanics, and a mechanic may be a part of many games [10].

Thus, one can generally define game mechanics as an *input-output engine*. The task of this engine is to ensure a dynamic relation between game state and player interference, and it is responsible for simulating a direct connection between the I/O system of computational, discrete logic and the continuous flow from initial to final state in a physical setting. Game mechanics postulates a deep transport from the laws of computation to the natural laws of physics.

The following issues of mechanics are specifically noteworthy:

- *Physically embedded game mechanics*. Frontrunner in pervasive gaming, German-based Fraunhofer FIT, has designed *Net Attack* (www.fit.fraunhofer.de). The game is presented as a new type of indoor/outdoor Augmented Reality game that makes the actual physical environment an inherent part of the game itself. The mechanics apply to the outdoor environment where players equipped with a backpack full of technology rush around a predefined game field trying to collect items as well as to the indoor setting where a player sits in front of a desktop computer and supports the outdoor player with valuable information. In order to control the information flow linking physical and virtual space the various components communicate via events and a TCP/IP-based high-level protocol. A central component guarantees consistency and allows the configuration of the game. Before starting to play the game, the outdoor game area must be modeled and the game levels configured. In other words: modeling the game means embedding the necessary mechanics into physical space. The configuration is done with XML.
- *Input-output engine with dual purpose*. Since interaction with tangible objects in PG implies, as noted above, a level of contingency handling the input-output engine must be constructed in such a fashion so that it provides a probability algorithm for the actual interaction as part of the rules and dictates a global, discrete and binary rule (state) to the interaction. That is why PG mechanics may serve a dual purpose; on the one hand maintaining and stimulating the contingency of interaction with real-life objects, and on the other hand structuring the controlled set of actions embedded in the state rules.

3. PG SPACE

Space differs when we look at it from a human and a strictly mathematical angle [11; 14]. The space of every day life is *heterotrophic* because it confronts its user with a surplus of potential, spatial strategies. The space of mathematics is *isotropic* in which all matter and every coordinates are evenly spread in all directions. When a human subject navigates through space it becomes *contingent* and *intentional*. Suddenly, space *matters*..

The point here is that the space of pervasive gaming mixes the isotropic and heterotrophic space. The teleological goal structure of a game necessitates *accessibility* by which the user can obtain information about space and proceed from e.g. one level to the next [13]. A PG space must amalgamate the physical *metric* space and the informational and networked *non-metric* space and, finally, merge these into the accessibility space [4]. A metric space consists of a non-empty universe of points together with a family of distance relations satisfying the axioms of distance [3]. A non-metric space may be defined as a topological or nodal connected space. 'Real life' as such would not alone be interesting in a gaming sense. We need to organize and structure the non-teleological and open meaning of the mundane space in order to make it playable. Therefore, accessibility is the portal to the information embedded spatial game world.

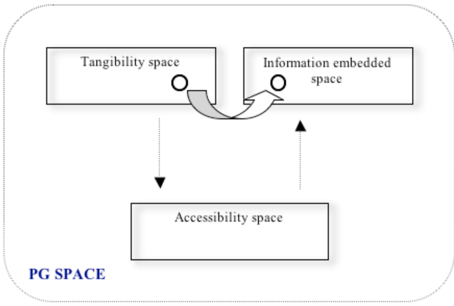

Figure 3

3.1 Tangibility Space

The whole idea of 'playability' in PG is the player's interaction with the physical reality. The tangibility space, however, is not just the sum total of this available, real-time world and the vast amount of objects it possesses. Rather, it must be understood as the *heterotrophic organization of potential spatial patterns of behavior*. This organization or vectorization of space facilitates a 'playground' and is often aided by multiple information units located in material objects as 'tangible bits' [6].

3.2 Distributed Information Space

PG involves the blending of physical and virtual space. In spatial terms this means that the tangibility space is facilitated by and projected onto information embedded space. This kind of space is the digital representation of the tangibility space. Yet, besides serving as a map of the gameworld, it may also function as a phenomenological space in its own right.

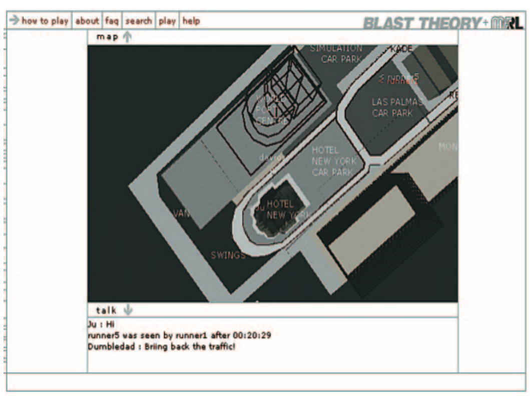

Figure 4. Information embedded space [2].

3.3 Accessibility Space

Finally, we have the accessibility space that is the key to the oscillation between embedded and tangible information. One way of explaining the delicate relation between the triadic space structures is to say that accessibility space *maps* the information embedded space system that is in turn *mapped* onto the tangible reality.

4. CONCLUSION

A great many challenges await us in the field of post-screen gaming. On the analytical side it may be rewarding to think PG in terms of axes, key units, and space modalities, as I have suggested in this context. Regarding the continuous innovation of production schemes and technology enhancement it might prove equally gratifying to integrate the rising world of adaptronics in tomorrow's pervasive games.

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