Taxonomy of Exertion Games

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ABSTRACT
A new set of computationally-augmented games have emerged recently that require the user to move their body. These exertion games are believed to contribute to social, mental and in particular, physical benefits, marking a change in how we perceive computer gaming. However, although these games are a commercial success, research is lacking a theoretical understanding how to analyse existing and guide future designs. We present initial investigations towards a taxonomy of such exertion games with a focus on social aspects, based on work on traditional play and sports. Our contribution lays the foundation for the creation of a theoretical framework on exertion games, expanding our understanding of this exciting new area.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Theory.

Keywords
Exertion, model, framework, taxonomy, game, exergames, obesity, exertion interface, gaming, categorization.

1. INTRODUCTION
An intriguing new type of interaction experience has emerged recently that has captured the attention of the HCI community. This experience can be characterized by a combination of physical activity of the user’s body with interactive computing technology. We call them exertion games (and define them later in this paper). These new games are attributed with physical [9], mental and social benefits [12][2], changing what we understand of and how we see interactive gaming [16].

HCI research in games has suggested that the inclusion of body movements not only changes the player’s engagement with the game, but also the nature of that engagement: a transition occurs, from an “emotional” experience to a “social” experience [1]. De Kort hypothesises positive effects of these games “since humans have an intrinsic need to experience their physical and social environments kinaesthetically” [4]. She also found that embodied play can not only change the game experience for the player, but also “radically impact socially situated play”. Dourish also highlights the social potential of embodied interactions [5], and Eriksson proposes that bodily movement is especially suited for interaction that takes place in a social context [6]. Hummels et al. found that the “turn to embodied interaction can get human and social values back in balance” [8].

Our understanding of interactions that involve physical activity suggests that such an approach can have benefits to gaming experiences in terms of how these games are played, but also how it involves other people. However, there is no theoretical understanding about these effects and how they can be utilized in a way to support the design of interactive experiences. Several researchers in this area have pointed towards this issue, for example de Kort calls for more empirical research in this area [4]. Graves et al. [7] came to the conclusion that more studies are needed to “examine usability and adoption parameters”, and Mueller et al. have called for a theoretical framework to identify design issues [13].

A theoretical framework that focuses on the physical and social aspects of these games could support research in this field and address some of the questions mentioned above. In order to arrive at such a theoretical model, we believe we need a conceptual understanding of existing games first. We therefore propose a taxonomy centred on the issues of exertion and social aspects to serve as groundwork for future theoretical work. Such a taxonomy could be used to describe and analyse existing games, which in turn can support the identification of salient concepts for a theoretical model that explains the new types of interactions these games afford.

2. RELATED WORK
Research in HCI has investigated the role of the body and associated social aspects previously. For example, Larssen et al. used a theory of embodied actions to analyse movement-based games [10]. The authors investigated the applicability of four different frameworks to analyse an EyeToy game. The EyeToy game with its vision-only approach has very specific design features [6], quite different to other exertion games, so their findings are limited to a particular set of applications, however, their work inspired us to consider these frameworks when creating categorizations for other games.

Mueller et al. has defined an Exertion Interface [12] and used this to identify remaining issues in the creation of networked exertion games [13]. The authors presented several exemplary games that have informed our taxonomy. Other research introduced the concept of Computer-Supported Collaborative Sport, in allusion to CSCW(ork), to describe computer-augmented sports activities that are characterized by a social

OZCHI 2008, December 8-12, 2008, Cairns, QLD, Australia.

OZCHI 2008 Proceedings ISBN: 0-9803063-4-5

aspect [19]. The author of the Bodybug draws on concepts of psychomotor abilities to describe “kinaesthetic” movement interactions, but only tangents the relationship to other people and the environment [11].

Sinclair et al.’s work [16] aims to identify success factors to guide designers of exertion games to increased health benefits. They have analysed the history of exertion games to recognize such factors. Their work categorized these games based on the activity the user has to perform, but also based on the underlying sensor technology. This can contribute to a useful overview of how the various hardware platforms progressed. However, inspiring future designs based on this categorization could possibly lead to restrictions based on technical limitations.

Another listing of existing systems focuses on differentiating factors in terms of hardware [14]. The authors use them to highlight the importance of matching sensor technology with appropriate gameplay to create compelling user experiences. We agree with their findings, however, the authors were unfortunately not able to identify opportunities for novel advances based on their approach.

In summary, other research has begun to investigate individual aspects of exertion actions and social aspects when users interact with technology, and some systems have been analysed. Technology-focused characterizations have been undertaken to highlight the relationship between bodily action and engagement. However, there is limited understanding of exertion games with a social focus that can provide an encompassing view applicable to the diverse set of systems that have emerged.

3. RESEARCH QUESTION

We propose a taxonomy to serve as groundwork to further a theoretical understanding of the topic. Unlike other approaches, we focus not on the hardware issues, but on a user’s perspective in regards to a social aspect. Our work answers the following research question:

How can computationally-augmented games that are characterised by a consideration of exertion activity be categorized with respect to a social aspect in order to advance theoretical modelling?

Our contribution is a taxonomy that offers a means to categorize exertion games, with a focus on the social aspects. Having such a categorization provides opportunities for research and design. The taxonomy can be used to help understand the similarities and differences between existing games and which of these differences are important to determine salient theoretical concepts.

4. TAXONOMY

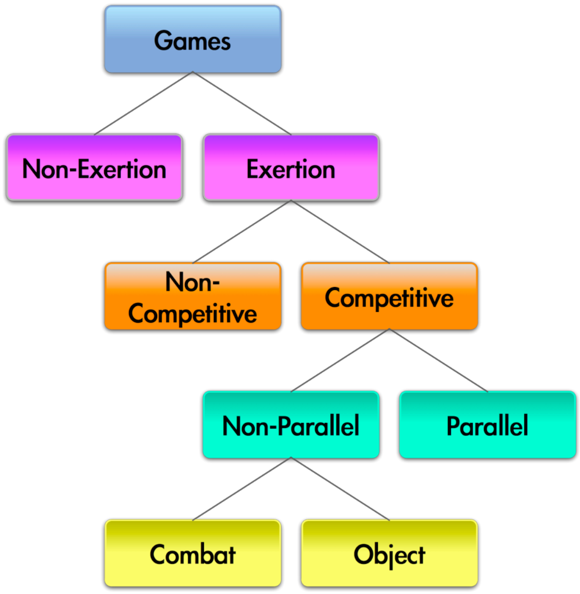

Figure 1. Taxonomy of Exertion Games.

We looked at traditional non-computationally augmented sports and games to inspire our taxonomy (Figure 1), as these areas have been researched previously and are at the origin of our topic of investigation. The work by Vossen [18] proved to be inspirational especially, as it challenged a traditional differentiation between play, games and sports to come to a new understanding of games and sports by considering play an attitude, not an activity. We adopted some of her work and extended it as well as applied it to interactive experiences to arrive at a taxonomy of exertion games.

Although we drew extensively on Vossen’s game classification, we do not want to imply that this is the only categorization of games or sports (as a starting point for others, see [17][3][15]). However, we think this one is particularly useful for our purposes as it lends itself an application to augmented exertion games. We believe the focus on the player’s perspective in relation to social aspects is particularly useful, and argue that directing such a focal point to the analysis of computationally-augmented games can help us in identifying the salient issues in the field.

The aim of this taxonomy is to contribute to our understanding of exertion games. However, as the field of exertion games is emerging and an established conceptualization is lacking, we begin our taxonomy work by defining what exertion games are and how to distinguish them from other computationally-augmented games. This helps strengthen the taxonomy by identifying clear boundaries for the topic of investigation.

4.1 Exertion vs. Non-Exertion

Although we focus on exertion games in this taxonomy, we need to firstly define what an exertion game is before a further categorization can be made. Therefore our first taxonomic unit helps differentiating exertion games from other computationally-augmented games. We begin by defining an exertion game and declare all other games as non-exertion. As this is probably the most challenging categorization unit, we utilize a couple of concepts to illustrate our point.

We define exertion as the act of exerting, involving skeletal muscles, which results in physical fatigue, often associated with physical sport. An exertion game has an input mechanism in which the user is intentionally investing physical exertion. Such an exertion interface has been previously defined as being physically exhausting and requiring intense physical effort [12]. The goal of the game is impossible to reach for the player except by means of varying degrees of gross motor competency. As Vossen describes it: "physical activity must actually influence the game outcome by either omission or commission" [18]. In non-exertion games the participants can achieve their goals by other means, such as moving a mouse, however, in exertion games the player relies on his or her own physical skills.

4.2 Competitive vs. Non-Competitive

We define non-competitive games as games in which no opponent exists, and hence competitive games as activities where there is an opponent or multiple opponents. An opponent is a player or a computer representing a player who pursues the goal of the game in a manner that the results "can be compared under regulated conditions" [18].

In games it is often necessary that another person is present in order to start and continue playing. This should not be confused with non-competitive play, because the opponent does not assist the other player in pursuit of the game's goal, but rather is only required to provide an obstacle preventing the player to attain the goal. It may help to look at the description of the game's goal to clarify any ambiguity: If a game is competitive, the goal's description highlights the goal as an end that can only be attained by one competitor to the exclusion of an opponent. In a non-competitive game, the notion of opponent and exclusivity is absent.

4.3 Parallel vs. Non-Parallel

We define a non-parallel game as a game that involves at least one participant who creates, or functions as, an obstacle an opponent (or opponents) is meant to overcome in pursuit of the game's goal. Essentially then, non-parallel games involve the concept of "offence" and "defence" during gameplay [18]. Players interact with one another's activity, and a player can actively prevent the other player from achieving his/her goal. To do so, she/he will utilize offensive or defensive activities, depending on the opponent's actions. An offensive move is a direct attempt to attain the goal of the game; a defensive manoeuvre is an attempt to prevent the opponent from attaining that goal such as yielding an obstacle that must be overcome. This can also be described in terms of how an athlete's performance is highly dependant on how the opponent allows him or her to play.

In parallel games, these features do not exist. The participants' activities are performed independently and inconsequential. The player has no direct influence upon the difficulty of the task faced by the opponent. This characteristic, however, offers an opportunity for technical augmentation: parallel games can be played asynchronously, whereas non-parallel games cannot.

Vossen calls these games interactive and non-interactive [18], however, we prefer the term parallel, as the word "interactive" is already convoluted in the context of digital technology. Furthermore, Vossen considers only direct *physical* effects to determine "interactiveness", however, her work looked at non-technologically augmented games and therefore did not include virtuality as characteristic in digital games. Our approach differs here by not requiring physicality.

Vossen points out that all non-parallel games are competitive, as they involve an opponent, and this opponent is aiming for the same target [18]. We agree on this interdependency and we carry it over to the context of exertion games.

4.4 Combat vs. Object

Given that there is a number of exertion, competitive, non-parallel games, it seems appropriate to introduce another taxonomic unit to delimit their scope. This goes beyond the initial work by Vossen, but draws on criteria from Stefani [17]. We define a combat game as a game in which the player tries to control the opponent. In an object game, the player tries to control an object in direct competition with the opponent.

An extension in terms of a game tool is not an object: for example, if a player is engaged in a fencing activity with a sword-like controller, the sword is not an object in terms of determining whether the game is an object or combat game. The sword can be regarded as an extension of the body (as could gloves in boxing), therefore the game should be labeled as combat game.

As the goal in either a combat or an object game involves an opponent, and the players' performance highly depends on how their opponent allows them to play, these games are necessarily competitive and non-parallel.

5. DISCUSSION & CONCLUSION

Our taxonomy demonstrates that these new games can be categorized, and not all exertion games are the same. Each category has unique features that can be readily identified. Our taxonomy can be used by researchers to drive their theoretical work, but also by designers to inspire future developments. Researchers can use the taxonomy to analyse existing games and identify opportunities for further research. They can use the categorization to ground specific aspects of their contributions and use it as guidance tool. As new systems emerge, researchers will be able to identify additional taxonomic units and extend the categorization further, contributing to our understanding of games. Designers can use the taxonomy to inspire their work and clarify where opportunities exist to differentiate their designs. The taxonomy can serve as a tool to guide decisions in the process of gameplay development; for example, designers might contemplate whether a future game should include a competitive feature. If they decide against including competition, it has implications for other aspects, such as that the game cannot contain elements of offence and defence.

Exertion games have potential to change our understanding of what it means to play computer games. We have contributed to this phenomenon by describing a taxonomy of these types of games to offer a basis for future theoretical and design work in order to advance the field. Having a tool to analyse existing and guide future games can help identify future opportunities, contributing to the beneficial aspects of playing exertion games and therefore ultimately contributing to the way people experience technology, impacting their lives.

6. ACKNOWLEDGEMENTS

The authors wish to thank Stefan Agamanolis from Distance Lab for his support.

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