Game Design Principles in Everyday Fitness Applications

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ABSTRACT

The global obesity epidemic has prompted our community to explore the potential for technology to play a stronger role in promoting healthier lifestyles. Although there are several examples of successful games based on focused physical interaction, persuasive applications that integrate into everyday life have had more mixed results. This underscores a need for designs that encourage physical activity while addressing fun, sustainability, and behavioral change. This note suggests a new perspective, inspired in part by the social nature of many everyday fitness applications and by the successful encouragement of long-term play in massively-multiplayer online games. We first examine the game design literature to distill a set of principles for discussing and comparing applications. We then use these principles to analyze an existing application. Finally, we present *Kukini*, a design for an *everyday fitness game*.

Author Keywords

Everyday fitness games, design principles, Kukini.

ACM Classification Keywords

H5.0. Information Interfaces and Presentation (e.g., HCI).

INTRODUCTION AND MOTIVATION

Regular exercise is important to overall health, but many people find it difficult to increase or maintain higher levels of physical activity in their everyday lives [2, 3, 8]. Lifestyle trends lead many people to attempt to stay fit via focused periods of physical activity in a gym, as opposed to social fitness activities like sports. Perhaps due to this, many perceive fitness as a necessary chore and find it difficult to form good habits. Many potential solutions are suggested by the broad field of persuasive applications [5], but this note focuses on two specific bodies of work: *fitness video games* and *everyday fitness applications*.

Fitness video games have a legacy that stretches from Nintendo's *World Class Track Meet* (1989) to modern commercial successes like *Dance Dance Revolution* (1998) and *Wii Sports* (2006). These games use intense physical interaction as the primary mode of play. *Dance Dance Revolution*, for example, is played by stepping on a dance pad in tune to music. The human-computer interaction research community has explored similar approaches, including such exertion interfaces as Mueller *et al.*'s *Breakout for Two* [9]. Players achieve real exercise through such games, and Mayo Clinic research praising the effectiveness of *Dance Dance Revolution* has influenced experimental deployment in physical education classes [1].

Everyday fitness applications typically aim to integrate fitness into everyday life by combining simple sensing with tools for setting goals and measuring activity. For example, Consolvo *et al.* explore the social sharing of pedometer step counts in their *Houston* prototype [2]. Lin *et al.*'s *Fish'n'Steps* links pedometer step count to an animated fish avatar [8]. Although most players lost interest after the first two weeks, Lin *et al.* report that *Fish'n'Steps* was a catalyst for the formation of new routines leading to healthier patterns of physical activity in daily life. *UbiFit Garden* uses a combination of sensing-based activity recognition and activity journaling to track cardiovascular, resistance, and flexibility training. *UbiFit Garden* presents progress towards goals in a glanceable display on a personal mobile device [3]. The *Nike+ iPod* system uses a small sensor placed in a runner's shoe to track runs in support of multiplayer challenges on the *Nike+* website, making it a forerunner of commercial online social fitness applications.

Fitness video games and everyday fitness applications explore important approaches and have had some successes, but there are still significant opportunities to better promote fitness through long-term everyday use and behavioral change. On one hand, interaction with fitness video games generally does not extend into everyday life. Playing tennis in *Wii Sports*, for example, does not significantly improve a player's skill in real tennis. On the other hand, everyday fitness applications are not always fun. It is not uncommon, for example, for everyday fitness applications to create competitive challenges that are unbalanced to the point that players who fall behind choose to quit because a lead appears overwhelming. As this area continues to grow and mature, an important challenge is the need for a shared language for discussing, comparing, and evaluating the many different approaches to fitness applications.

This note presents a first step towards such a shared language. Inspired by the social nature of many everyday

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fitness applications and by the successful encouragement of long-term play in massively-multiplayer online games, we look to the language of the game design literature [6, 7, 11]. We start by discussing the design space of games, then present a set of relevant design principles distilled from the game design literature. We do not intend these principles to be prescriptive, but instead to provide a tool for furthering discussion. We therefore first illustrate these principles in the context of an existing fitness application. We finally discuss *everyday fitness games*, which combine the goal of compelling game experience with the goal of long-term everyday use and behavioral change, illustrating some of our thoughts via the everyday fitness game *Kukini*.

THE DESIGN SPACE OF GAMES

Salen and Zimmerman define a game as a closed system, intentionally designed with explicit rules to create a simplified *representation* of reality. The play of a game is built upon formal *interactions*. Through interaction with the game, *conflict* arises naturally as players pursue goals which result in quantifiable outcomes. Conflict is intrinsic to the play of games, creating the basis for interaction [11].

This definition highlights several important aspects of both game design and game play. For example, interactions, conflicts, rules, goals, and outcomes are all designed, as are narrative and aesthetics (elements of representation). All of these pieces influence play, enjoyment, and sustainability. In particular, interaction influences behavior through the repetition of interactive patterns that form habits.

Whether a game is played largely hinges on whether play is fun. A player is willing to adhere to the constraints of the game because of the pleasure which meaningful play can afford. Koster defines fun as "the act of mastering a problem mentally," or the feedback the brain gives a person who is absorbing patterns for learning purposes. Fun is born of the analysis of a problem and of solving that problem better and faster (e.g., the quantifiable outcome of getting a better lap time or breaking a personal record). According to Koster, pleasure can also be derived from aesthetic appreciation, narrative, and social interaction [7].

Today's most successful games place a heavy emphasis on narrative and social interaction. Role-playing games are intended to be open-ended and typically have no single quantifiable outcome. The game is instead made up of session-to-session missions, personal goals, and levels of power that players attain. Because the narrative is driven by the player, the game is essentially never-ending.

Massively-multiplayer online role-playing games, such as *World of Warcraft*, combine the infinite narrative of a traditional role-playing game with complex communication layers that drive social interaction and the development of relationships with other players. Players return to the game not only to play, but also to interact and socialize with friends. This powerful combination has proved incredibly enduring, developing a large community of players which remain active for the long-term [4]. The community can be

leveraged for a deeper play experience, additional game content, and better matching for competitive play, all of which further encourage sustained play.

DESIGN PRINCIPLES FOR EVERYDAY FITNESS GAMES

Analyzing prior work on fitness video games and everyday fitness applications in the context of the work by Salen and Zimmerman [11], Koster [7], and Juul [6], we distilled a set of design principles relevant to everyday fitness games.

Core mechanic. The core mechanic of a game is the set of essential interactions which a player repeats during play. The core mechanic is typically easy to learn but difficult to master, making learning and improvement both fun and challenging. Because the core mechanic is the most frequently repeated activity, it is the key area in which a designer can influence the formation of physical habits.

Representation. Enjoyment of a game is also often derived from aesthetics and narrative, both of which fall under the principle of representation. Elegant representation requires abstraction without loss of meaning (e.g., Atari's *Pong* uses only two lines and a square to project a game of table tennis). A good representation is neither too complex nor too shallow, provides context for play, drives player interaction, and helps immerse players in the game world.

Micro goals. Conflict necessitates interaction and play. In games, conflict is transformed into goals which a player must achieve to advance within the game. Short-term micro goals provide frequent gratification through more quantifiable outcomes and rewards, enticing sustained play. Micro goals also help players to gauge progress in the game, providing a path for reaching long-term macro goals that might otherwise seem overwhelming.

Marginal challenge. Achieving flow and fun, or inducing the feeling of a series of challenges well met, requires challenges which are always at the margin of a player's ability. This requires a sense of the level of ability possessed by the player. If done correctly, marginal challenge is one of the most crucial pieces to invoking a fun and meaningful play experience, giving the player the desire to meet the next challenge and play the next session.

Free play. Narratives, goals, and challenges can benefit from design that leaves a maximal number of choices open to the player. By placing fewer restrictions on interaction, play can occur at the pace of the player. This means rules should be designed to shape play without being overly restrictive on when and where play can take place or how the player chooses to explore the narrative of the game, thus easing the integration of play into everyday life.

Social play. In games, social relations take on two forms: internal and external. Internal roles emerge from the formal structure of the game. In the game of hide and seek, for example, players assume the internal roles of the seeker and the hiders. External roles are those brought into the game from outside, such as friendships, rivalries, and other roles that affect in-game strategic choices.

To develop strong social play, a designer can utilize internal roles to assist in establishing new external relationships. Relationships can then be built and maintained through communication tools provided by the game. As roles shift and social interaction changes, new meanings are derived from play, creating better long-term play experiences.

Fair play. Social play requires a level playing field in which all players have an equal chance of winning. This involves establishing fairness in the rules and the core mechanic, matching players of approximate skill level, and sometimes giving players who are behind a temporary advantage to restore competitiveness.

REVISITING AN EXISTING DESIGN
In order to illustrate the value of developing a shared language for discussing, comparing, and evaluating fitness applications, this section revisits an existing design and uses the above principles to support comparison to other applications, to identify a potential design concern, and to suggest a potential approach to the concern.

Nike+ iPod
Nike+ iPod uses running as its *core mechanic*. As a person runs, data from the shoe sensor is recorded for later upload to the *Nike+ iPod* website. *Nike+ iPod* thus does not require running as part of a game, but rather is designed as a tool to support the tracking of runs. This style of use bodes well for integration into everyday life and creates the potential for behavioral change, as a person may continue running even if they later tire of the application itself. Other potential approaches include core mechanics that have little or no relationship to everyday activities (as in *Dance Dance Revolution* and *Wii Sports* tennis) or designs that focus on directly enhancing a real-world activity (such as Mueller *et al.*'s *Jogging over a Distance* [10]). No one of these approaches is fundamentally better, but instead it is important that our design principles enable the comparison.

The *Nike+ iPod representation* is focused on minimalistic graphics and simple lines. Runs are presented as graphs and goals are presented in a fill-in-the-bar format. *Nike+ iPod* illustrates positive aspects of *social play* and *free play* in its challenge system, which allows players to cooperate and compete in a wide variety of long-term challenges. Unfortunately, a lack of communication tools in *Nike+ iPod* can make it difficult to find other players to challenge. The challenge system is also primarily focused on *macro goals*, at the expense of the frequent gratification associated with *micro goals*. Finally, a key opportunity for *marginal challenge* is missed because *Nike+ iPod* does not use personal running history to suggest new goals.

Looking more closely at the *Nike+ iPod* design, Figure 1 shows an actual 100 mile challenge that Runner 1 seems guaranteed to win [12]. Although this may seem unremarkable, considering the challenge in the context of our design principles helps to identify a lack of *fair play.* The challenge is no longer motivating to the two trailing runners, but might instead appear overwhelming and

Figure 1. An actual 100 mile challenge within the Nike+ iPod system [12]. A lack of *fair play* means that this challenge is no longer motivating for the two runners that have fallen behind.

provide negative reinforcement that works against the goal of promoting increased activity. Examining such concerns in the context of game design principles also suggests the potential for employing techniques from games to address identified concerns. In this case, the imbalance might be addressed via the rubber-banding technique used in many racing games (wherein players who are losing by a large margin go faster or receive better bonus items until the race is again competitive). Our claim is not that rubber-banding is necessarily the right addition to *Nike+ iPod* (for example, a group of experienced and highly-competitive runners might see rubber-banding as 'cheating'), but rather we note that examining *Nike+ iPod* in the context of principles from the game design literature helps to identify both potential design concerns and potential solutions.

EVERYDAY FITNESS GAMES AND KUKINI
Inspired by the successful encouragement of long-term play in massively-multiplayer online games, we are drawn to the notion of *everyday fitness games*. Our goal is to combine the compelling game experiences of fitness video games with the everyday impact and behavioral change targeted by everyday fitness applications. As a first step in this direction, we have designed the everyday fitness game *Kukini*. This section presents *Kukini* and uses our design principles to compare *Kukini* with *Nike+ iPod*.

Kukini
Kukini is a design for an *everyday fitness game* for runners. Hawaiian in origin, the word kukini means messenger. Within the game, it refers to an elite class of swift runners of legend, known to undergo strenuous training as warriors, messengers, spies, and foot racing athletes. Players are messengers in a massive game world. Play is modeled on modern massively-multiplayer role-playing games, with players exploring the environment and taking quests to deliver messages between towns. To drive sustainable play, the game slowly shifts players from system-provided quests to more complex *social play*, including player-created challenges, quests, and tournaments.

Kukini is designed for the existing *Nike+ iPod* hardware and based in the same *core mechanic* of running. As noted earlier, the fact that people can run at any time, without needing to be bound to the system, creates the potential for behavioral change because players can continue running even if they eventually tire of the game. Applying the principle of elegant *representation*, *Kukini* is based in a large and immersive world (see Figure 2). Players explore the world by moving between towns across a variety of
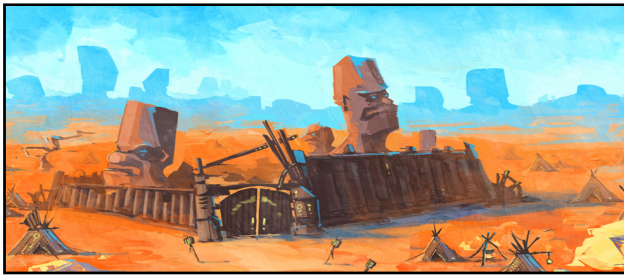
Figure 2. Kukini's emphasizes an aesthetic *representation* of its running *core mechanic*, casting players as foot messengers.

terrain. In contrast to fill-in-the-bar representations, Kukini's representation emphasizes complex paths and beautiful scenery as positive aspects of running.

Players set goals by accepting quests that require they run specific distances or paces before a specific date. Kukini emphasizes *micro goals*, and so large quests (analogous to the *Nike+ iPod* 100 mile challenge) are split into several subquests (requiring, for example, a player to first retrieve ingredients, take them to a craftsperson, deliver the resulting item, then return to collect their trophy reward). Kukini's representation also supports micro goals, as moving around the game world is itself a reward. Completing tasks in different areas of the game world allows the collection of unique items, and each town has a distinct appearance and provides new types of quests. *Free play* is supported by providing a variety of quests in each town, and *Kukini* provides *marginal challenge* by using a player's previous runs to inform potential quests.

An important challenge in addressing *fair play* is the fact that the *Nike+ iPod* hardware is not robust to cheating. Players might modify the simple XML data format that *Nike+ iPod* uses to track runs, or they might ask a friend to wear their sensor while they run. *Kukini* therefore eschews approaches like global leaderboards and automatic player matching. *Kukini* is instead designed for *social play,* and communication layers throughout the game support building relationships, forming teams, and interacting with other players both cooperatively and competitively (see Figure 3). These social relationships form the basis for trust in competitions. Special types of quests both encourage new players to join existing social structures and encourage existing players to welcome and nurture new players. These social structures also enable sustainable play, as players can create challenges, quests, and tournaments and can award personalized trophies to players that complete these.

CONCLUSION

This note has identified the opportunity for *everyday fitness games*, combining the fun aspects of fitness video games with the everyday impact and behavioral changes targeted by everyday fitness applications. By looking to the game design literature, we have taken a first step toward a shared language for discussing, comparing, and evaluating the many different approaches to fitness applications. Finally, we have applied our distilled design principles to frame a discussion of *Nike+ iPod* and our design of an everyday
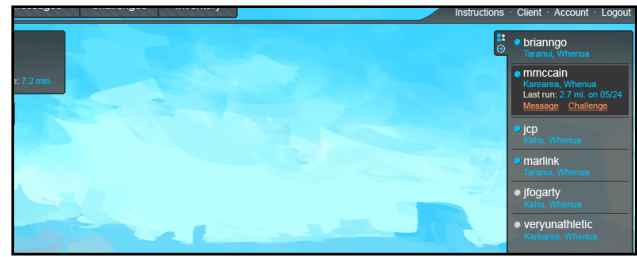

Figure 3. Kukini is designed for sustainability via *social play*. The world emphasizes player relationships as well as player-created challenges, quests, tournaments, and trophies.

fitness game *Kukini*. In addition to our focus on fitness, we believe this work helps to fill a gap in the design of persuasive applications targeting such goals as healthy eating, resource conservation, and financial management.

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