DESIGNING TRAINING GAMES FOR SOCCER

Mads Møller Jensen, Aarhus University
Majken K. Rasmussen, Aarhus University
Florian 'Floyd' Mueller, RMIT University
Kaj Grønbæk, Aarhus University

Advancements in wearable and ubiquitous computing have exposed the interaction design community to a new perspective on sports. As a result, increasing effort has been directed toward creating technology-enhanced systems that can improve sports experiences. So far these technologies have focused primarily on gathering data on a single user's performance, for example through individual activity tracking, or on encouraging general physical activity, for example through exertion games. In contrast, only a few examples focus on improving the training experience for team sports [1,2].

While most players recognize the importance of training, they would readily agree that playing the actual sport is significantly more engaging than training for it. Consequently, our vision is to design engaging yet transferable training experiences, realized through interactive spaces that use sensors, actuators, and game elements. We call these *interactive sports-training games*.

Here, we present an interactive soccer-training system called Football Lab, together with three related games that explore the possibilities of combining technology and training. We discuss the design process and evaluation of the system, highlighting opportunities as well as challenges we encountered.

TRAINING BALL HANDLING, FIELD SURVEYING, AND MICRO TACTICS

Football Lab [1] is a public interactive soccer-training system created in cooperation with a Danish soccer academy and Munin Sports, a company that manufactures soccer-training equipment. It is an enclosed, 12x12 meter soccer field. Four rebounding surfaces, called M-stations, each measuring 2.7 x 2.7 meters, are positioned at the center of each of the four sides of the playing field. The M-stations consist of a large frame strung with wire, similar to a tennis racquet, capable of returning a ball with 95 percent of its

The Football Lab installation.

The mounted sensor and embedded light.

The scoreboard.

original speed. The four M-stations are mounted with sensors that detect soccer ball hits and fitted with multicolored LED lights and a speaker. The combination of these elements creates a training space for soccer players, where the embedded light and sound signals facilitate game interfaces that players interact with by hitting the M-stations with soccer balls.

Football Lab has been operating for more than two years. During this period we created a variety of games by continuously engaging with players and coaches.

Ball handling: Pass and Turn. Our first game for Football Lab is called Pass and Turn. The aim of the game is to train players' ability to pass, receive, and turn with the ball—important soccer skills. Pass and Turn is a single-player game where the player starts in the middle of the field and the M-stations randomly call for the ball with light and sound cues that represent co-players. Points are rewarded based on the number of successful hits, with the final score posted to a high-score list. Pass and Turn takes one minute to complete. It is an intense way of training passing skills, as players average around 17 passes in a single one-minute game. In comparison, the top passers in the English Premier League average 78 passes in 90 minutes of play. As such, an average player

playing five games of Pass and Turn makes more passes than a professional player in an entire soccer match. The game has been widely popular, with more than 10,000 games played.

Pass and Turn has been regularly used in training sessions, and coaches consider it an important tool for training younger and less-skilled players, as the game allows them to focus on basics. However, during the first year we noted that coaches gradually stopped using the game with advanced players. The coaches found that the game encouraged players to perform inexpedient and undesirable movements, as they based their perceptions and decisions

mostly on sound cues. This meant that players were playing with their heads down and not surveying the field, as they should in a soccer match. The finding highlights that designers of interactive sports-training games face the challenge of avoiding inexpedient movements that players might adapt as a result of the game's incentives.

Field surveying: Look Ahead. In collaboration with coaches we designed a new game called Look Ahead, aimed at supporting more advanced players. Look Ahead is based on two essential changes. First, we removed the sound cues from the game, forcing players to visually survey the field for their next target. Second, we utilized multicolored LED lights to enable players to predict the next target in the game by using a blue color to indicate the current target and a red color to indicate the next. Through these alterations, the game rewards players who are skillful in surveying the field while passing, receiving, and turning with the ball [3].

Micro tactics: One vs. One. Soccer is not just about technical skills—it is also about acting and reacting in response to opponents, making feints, and fighting close combat. Thus, we created a game called One vs. One that allows two-player games [4]. In the game, two players compete for possession of the ball, and at all times both players have the possibility to score. The players receive points by hitting the M-stations illuminated with their respective color (player one is blue and player two is red), and the lights change every 10 seconds or if an M-station is hit. The dynamic and unpredictable targets encourage players to engage with micro tactics, as the opponent's intended direction is unknown. This motivates players to continuously attempt to read and anticipate their opponent's actions based on their movements. By designing One vs. One, we learned technology can facilitate unpredictability in exercises and flexibility in the number of players beyond the support of individual training.

OPPORTUNITIES OF INTERACTIVE SPORTS-TRAINING GAMES

The three games illustrate how the same training installation afforded different kinds of interactions:

Pass and Turn.

reacting to multimodal cues, predicting outcomes, and anticipating opponents' actions, which reflect three important elements of soccer: ball handling, surveying the field, and micro tactics. Based on our work with Football Lab, we see a number of opportunities where interactive technology can support training experiences: enabling flexibility in the number of players, adding variety to exercises, motivating players through game elements, and quantifying individual player progress.

Flexibility in the number of players. Using technology to create training games offers flexibility with regard to the number of players needed to perform an exercise. Pass and Turn and Look Ahead both illustrate how light and sound cues can be used to simulate co-players in order to facilitate individual training for a team sport. This enables players to practice alone, therefore making them independent from peers. Furthermore, Football Lab shows how technology can support both individual and small group exercises, allowing players to join and leave a training session at any time.

Variety in exercises. One might ask how Football Lab is different from kicking a ball against four surrounding walls? We believe using technology offers variety in exercises that might be difficult to achieve in traditional training. Football Lab's single-player games are designed to exploit the unpredictability of where the next target is, which appears to be a key source of engagement for players. Unpredictability also plays a role in

One vs. One, as players do not know where their opponent is trying to score, making the game seemingly more appealing in terms of reading and anticipating an opponent's actions compared with playing a game between two static goals. This unpredictability adds variety to the exercises and facilitates engagement.

Motivation through game elements. Technology also enables designers to incorporate game elements to make the training more motivating for the players. For example, we noted how players used their scores to compare results and compete against one another, creating small tournaments resulting in increased training effort. Furthermore, with Football Lab we also maintained high-score lists. This supports an asynchronous training experience, as it allows players to compare their score with that of teammates who are not present. Technology can of course support richer game design besides points and high score lists, but this is yet to be further explored in our work.

Quantifying player progress. Technology also enables us to quantify individual aspects and progress of a player's athletic performances. With Football Lab it is possible to measure how fast players turn and hit a target to their right and compare it with how fast they can do it to their left. This could be used to tailor exercises targeting specific weaknesses. Quantifying individual performance aspects allows both players and coaches to monitor progress, which can

Look Ahead.

One vs. One.

support evaluation of current training exercises and improve the design of future ones.

HIGHLIGHTED CHALLENGE: INEXPEDIENT MOVEMENTS

Despite the aforementioned opportunities that introducing interactive technology in training exercises offers, designers should be aware of the challenges that emerge. Designing interactive sports-training games is a complex task, as the goal of the game is not winning, but rather to strengthen a certain skill. Designers need to consider this, as players will aim to win. This challenge appeared in our work with Pass and Turn, where the game motivated players to perform inexpedient movements. Since players immerse themselves in the competition, and primarily focus on how to beat their peers, they may end up ignoring the training aspects. In our case, players looked down to focus on handling the ball in order to get a better score, instead of looking up, as desired in a soccer match. The challenge of balancing game elements and sport expediency makes the design of interactive sports-training games complex, as it is hard to foresee how players will approach the game and how their actions will relate to the targeted sport. A way of addressing this challenge is to create games in collaboration with coaches and reward the optimal movements of the sport. In our case, Look Ahead rewards players who can survey the field while handling the ball, as they get the opportunity to predict and anticipate the next move, and this helped players improve their movements in general.

CONCLUSION

Our work with a public interactive soccer-training system highlights the opportunities of introducing technology to sports to support the training experience. This work can be expanded to other sports and other training aspects, such as perception and decision-making, which are important but difficult to train. Technology affords exploration of training these aspects in new ways, unavailable in traditional training. We believe the field of interactive sports-training games holds much potential for interaction designers, opening up new opportunities to apply their digital design knowledge to the world of sports. In return, athletes and coaches can provide insights on the potential, power, and prowess of the active human body, expanding our understanding of bodily interactions.

ENDNOTES
1. Jensen, M.M., Grønbæk, K., Thomassen, N., Andersen, J., and Nielsen, J. Interactive football-training based on rebounders with hit position sensing and audio-visual feedback. *Intern. J. Computer Science in Sport 13*, 1 (2014), 57–68.
2. Footbonaut. Borussia Dortmund training facility. 2012; https://www.youtube.com/watch?v=WhAyX81zP2M
3. Jensen, M.M., Rasmussen, M.K., and Grønbæk, K. Design sensitivities for interactive sport-training games. *Proc. DIS 2014*. ACM Press, 2014, 685–694.
4. Jensen, M.M., Rasmussen, M.K., and Grønbæk, K. Exploring opponent formats. *Proc. Entertainment Computing – ICEC 2013*. Springer Berlin Heidelberg, 2013, 48–60.

⬢ **Mads Møller Jensen** is a Ph.D. student in the Ubiquitous Computing and Interaction Group at Aarhus University, and a visiting researcher at the Exertion Games Lab at RMIT University. His research focuses on the intersection between human-computer interaction, ubiquitous computing, and sports, explored through prototypes and inspired by games.
→ mmjensen@cs.au.dk

⬢ **Majken K. Rasmussen** is a research assistant in the Ubiquitous Computing and Interaction Group at Aarhus Univeristy, with a background in design and architecture from the Aarhus School of Architecture. Her main research area is interaction design, focusing on designing interactions and experiences for different contexts.
→ mkirkegaard@cs.au.dk

⬢ **Florian 'Floyd' Mueller** is director of the Exertion Games Lab at RMIT University. Previously, he was a Fulbright Scholar at Stanford University and has worked at the MIT Media Lab, Microsoft Research, Media Lab Europe, FXPal, Xerox Parc, University of Melbourne, and CSIRO.
→ floyd@exertiongameslab.org

⬢ **Kaj Grønbæk** is a full professor in computer science at Aarhus University and lab manager at the Alexandra Institute, Denmark. His research area is ubiquitous computing and interaction. He has conducted projects integrating architectural design and computer science for more than 12 years in his Lab for Interactive Spaces.
→ kgronbak@cs.au.dk