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TacTower: Designing Physical Co-Located Multiplayer Interaction

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Abstract
Learning from the multiplayer interaction in sports, we describe our project TacTower; a flexible system for professional elite handball players to train game perception and kinesthetic empathy. The design is founded in ideas of Collective Interaction and qualities that is inherent in sport and is based on considerations about paralanguage, kinesthetic emphatic interaction, physical positioning of players and collaborative interaction.

Keywords
Multiplayer interaction, kinesthetic empathetic interaction, co-located, face to face, sportyfied interaction, project work.

Introduction
By studying multiplayer interaction in a sports context we found a potential for improving multiplayer interaction, especially in an interactive sports appliance. Having the parameters that constitute interaction sport in mind: physical, social, visual, verbal, and mental contact, we examined some examples of existing interactive sports equipment. We found that they do not fully embrace the physicality and co-located collaboration that is so characteristic of sport interaction. In this paper we present a design solution TacTower, a new appliance for training kinesthetic empathic ability. The kinesthetic empathic ability is in short the ability to read body movement. This ability is founded in bodyawareness, empathy in interaction, freedom in movements, and micro-tactics [3]. In our design we seek to employ physical abilities by incorporating a tangible user interface [7].

Sports qualities gone missing in interactive sports equipment
What often distinguishes a good athlete from a great athlete in motoractive sports is the athlete's capability to accurately perceive and acting upon the constant supply of information from the environment while performing complex movements [11]. Perception and action can be trained by either focusing on the physiological dimension: psychomotor abilities and partly reflex actions, or focusing on the cognitive dimension: in-game decisions and kinesthetic empathy [3].

In the following section we take a look at two existing pieces of interactive training equipment that aims to train perception- and action ability; the Octopus trainer [9] which train the athlete's psychomotor abilities and IntelliGym [5] which train in-game decisions.

Octopus trainer consists of a computer and 8 light stations, which can either be mounted vertically on a rack or placed horizontally on the floor. Lights turn on and the player has to turn them off, by waving a hand or foot in front of the light at an approximate distance of 30 cm. Octopus trainer allows the athlete to train speed, strength, concentration and reaction in an isolated context removed from the interactivity of the game. Even though it utilises the sports inherent movement patterns the interaction is stripped of visual cues from other players. IntelliGym focuses on tactical aspects of basketball; the objective is to train the ingame skills of decoding other players' movements on the court, and determining the optimal action in a given situation. IntelliGym is a screenbased computer game, where a basketball court is viewed from above. Players and ball is shown as coloured circles on the screen. The circles move around the court in movement patterns similar to the sport, and from this the player has to choose a suitable strategy. IntelliGym allows the users to train game perception individually in an isolated context. As it is a PC game it is a passive raining, for improving court sense and enhancing concentration [5].

The training of the in-game decoding skills is removed from the physicality of the game, both in IntelliGym, as well as in Octopus trainer. Because the psychomotor abilities and the tactical in-game decision-making are closely linked, IntelliGym and Octopus trainer are not adequate. Therefore we aim with our project TacTower to combine in-game decoding skills with physicality.

Sport possesses qualities like physical, verbal and mental contact. What otherwise extinguishes sport is the importance of social collaboration between team mates. Collaboration is affected by many factors, both internal and external [4]. When designing interactive artefacts for sport it is therefore important to create a colocated interaction [8,10] which enables human-human interaction.

Paralanguage in human-human interaction
A pure human-human interaction can be describes as an ongoing negotiation between the people involved and their surroundings. The interaction does not only contain what is clearly stated in the actual conversation, but also the paralanguage[1] that the participants express consciously or unconsciously.

[1]*Paralanguage is identified as "features of written language which are used outside of formal grammar and syntax and other features, related to but not part of written language which through varieties of visual and interpretive contrast provide additional enhanced, redundant or new meanings to the message" (Asteroff, 1987).*

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Paralanguage greatly depends on visual contact, in order to convey the full extent of what is being stated in the negotiation [2]. In order to enable a human-human interaction that incorporates paralingual cues it is vital that the players are collocated and positioned in a way which allows them to see each other.
--Understanding paralanguage and visual cues is an essential element in sport on elite level. The object of our project, TacTower has been to incorporate paralingual cues into an interactive appliance for training handball. With the TacTower we aim to create an appliance that facilitates the handball player's training of kinesthetic emphatic interaction [3] in a sport context.

Learning from Collective Interaction

Sport possesses some of the same qualities as described in the Collective Interaction framework proposed by [8], from which the following is excerpt:

The interaction invites for human-human interaction beyond what is in the interface […] The spatial organization of people induces expectations of use. […] the interaction may be assymetrical, in the sense people take on different roles […]

In sport the ball is the "interface". In itself the ball is an inanimate object, but through imagination, play and collective interaction it invites to an interaction beyond it's physical interface. Sport allows for a collective interaction were the participants often have symmetric roles; the referee, goalkeeper, try line player etc. In sport as in collective work the proximity of the participants and interfaces plays an important role in the interaction [4].

Physical positioning of players in multiplayer games

Communication, proximity and spatial organisation plays an important role in collective interactions. In order to include all these aspects in a design we have to consider the physical positioning of the players.

Looking at some examples of how players are positioned in different types of multiplayer games with sport relations, we find some clear differences on how multiplayer interaction is played in the digital version compared to how it is played in the actual sport. The Nintendo Wii ™ can be defined as a Single Display Groupware (SDG) [10], that enables co-located players to play on a shared display and simultaneously use multiple input-devices . Players using a Nintendo Wii ™ are positioned side by side while playing a multiplayer sports game.

Figure 1

The illustration shows how the players' focus is projected onto the screen instead of on each other, thus loosing the possibility to perceive the paralanguage. However the game tries to convey the physical positioning of the actual sport by digitally positioning the players face to face. Most likely the players actually exhibit paralingual cues, but because of their physical positioning, they are not able to pick them up. Instead the players are limited to watching the digital representations, which is a poor substitute compared to actually seeing ones opponent.

If we compare the screenbased Nintendo Wii™ interaction e.g. with the kind of interaction that would take place during a real handball match, the positioning of the players and their visual focus is quite different. In a real handball match, visual contact, focus on opponents and teammates are vital. Face to face positioning enables the players to use their kinesthetic empathic ability to read their opponent's paralingual cues.

The drawing below shows a setup where players using Octopus trainer are positioned face to face. The positioning enables the players to have visual contact and to read the paralingual cues. But there is no direct interaction between them, as they only have to react on the basis of the system and not on the other player. In a real match the players are not acting upon random digital cues from a system, but instead acting on the paralingual bombardment of the match. So the ability to react on a systemic output is only valid as a way of training the reaction ability.

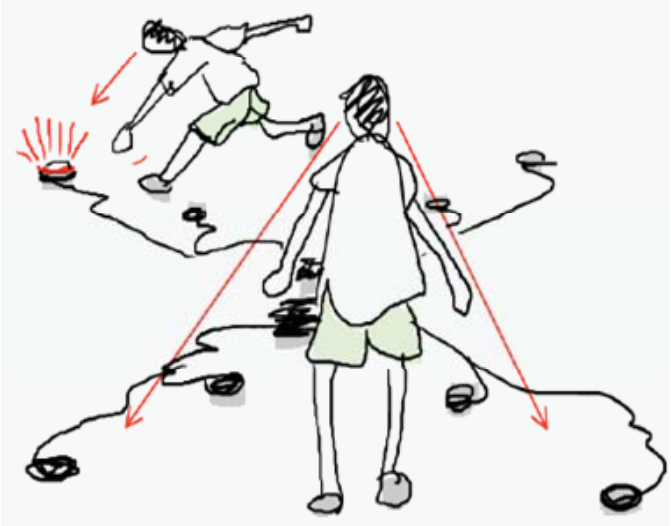

Figure 2

When designing for a sportyfied context, it is important both to have the players positioned opposite each other and to create a setting where it is possible and necessary for them to interact directly. But positioning the players opposite each other raises a problem: How to create an interactive interface that is positioned between two players and still allows them to see each other and physically interact with each other?

TacTower – training kinesthetic empathy

We answer the question above by designing a tangible interface distributed on four pillars, TacTower. The design allows for visual and physical contact between the players.

The TacTower is an interactive appliance for handball training which positions the players face to face and enables players to train their kinesthetic empathic ability and thereby developing the players' in-game micro-tactics. Micro-tactics in games like handball concentrate on decoding the opponent's actions and reacting upon them, e.g. by feinting or by preventing an attack. This particular ability is not only important in handball, but in many other branches of sport, where players are directly confronting their opponents.

TacTower is a modular system that consists of four TacTower which define the playing field. Each pillar consists of eight spherical units; each unit is illuminated from the inside by multicolored LEDs, and can be operated by striking or hitting the unit. Each unit can be affected from six directions; from four hitzones distributed at 90 degrees around the center and one from the top and one from the bottom. The user interacts with TacTower by hitting the hitzones, thus turning on the light in the unit or pushing the light signal in the direction of the hit. The direction of the hit is registered by an accelerometer placed inside each unit. By hitting the zones the player is able to shoot the light signals from one unit to another both horizontally and vertically. The TacTower can either be placed in a line or in a spatial grid, according to the gameplay.

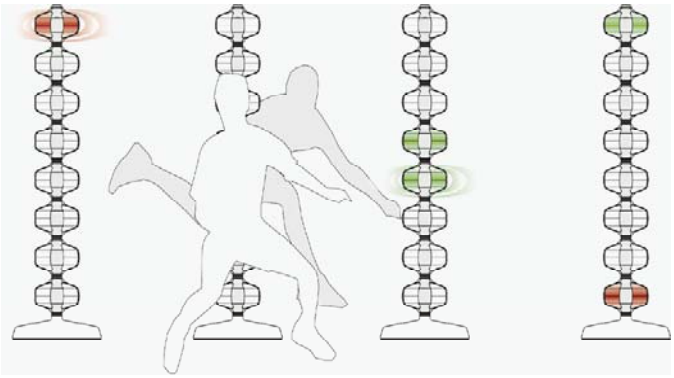

Figure 3

One person cannot play a game on TacTower alone, as it requires an opponent to play, because the game's main focus is the ability to create a powerful micro-tactic from reading the other person's movements.

Learning from sports - TacTower collaborative interaction

In sports there is a difference between acting and reacting, as the players have an opportunity to intercept and prevent an action by using their kinesthetic emphatic ability. But in a screenbased interaction the players are limited to reacting, as there are no hints of the next action, as the screenbased interaction is striped from paralingual cues.

A significant aspect of sport is the physical proximity of the players that creates a closeness which intensifies the interaction between them. We tried with TacTower to centre the interaction on the possibility to act on the opponents physical cues before the actual event occurs. This gives the player the opportunity to prevent an action as the visual cues are available. With TacTower we deliberately worked on increasing the players' proximity in order to maintain the sportslike qualities in the interaction. By positioning the player face to face we created a space to explore the potential of a physical paralingual interaction.

Future work

We are currently working on creating a working prototype, and setting up tests with handball players in order to see how effectively the TacTower train the empathic part of the bodily intelligence. We are aware of the difficulty in measuring the player's progression, as the game always depends on the opponent, which make it difficult to create a constant factor in order to compare each result. Instead we intend to collect data empirically through a prolonged test setup and evaluate by qualitative interviews from both players and trainers.

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