capable of interacting on different levels. From this relationship, rich patterns of behaviour can emerge under a range of constraints. In recent times, empirical work has sought to investigate how individual agents in the system co-adapt their behaviours as system outputs emerge. This theoretical approach to sport performance has important implications for pedagogical practice in sport. A key idea is that self-organisation processes, inherent to many different biological systems including human movement systems, constrains the emergence of movement patterns, cognitions and decision making processes in performers as well as learners during practice. A major role for pedagogists is to identify key constraints on learners, particularly informational and task constraints, and manipulate them so that individuals are pushed to a region of self-organised criticality during practice. In the region of self-organised criticality, interdependence between system agents exists and slight changes in near-neighbour interactions can break the balance of equally poised options leading to transitions in system order. Rich, creative patterns of behaviour can emerge as individuals co-adapt their actions to satisfy the specific task constraints imposed by coaches and teachers. Variability of actions can lead to novel behaviours and pedagogists should understand how to design learning environments to facilitate the emergence of functionally variable cognitions, decisions and actions in individuals.

In-door skill training in rowing practice with a VR based simulator

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This paper presents the design of a Virtual Reality (VR) based rowing simulator for sport training. The proposed simulator (figure 1) aims at bringing in an indoor location the situations of outdoor rowing, by means of an enhanced Virtual Environment (VE) that combines visual, haptic, acoustic feedbacks.

The overall system is composed of a mechanical platform, sensors that capture the user performance and a software system that elaborates, stores, and sends data to the VE. The mechanism allows the user to reproduce the out-door rowing stroke in both sculling and sweep rowing. A commercial fluid-dynamic energy dissipater was chosen (Hase et al., 2005) to simulate the water resistance to the oar. Both position and force sensors allow to

Figure 1. - The rowing simulator integrated in a VR environment.

reconstruct an analytical description of the gesture performed by the athlete, and gathered data are input to a racing boat dynamics model, so that boat velocity can be computed according to Cabrera et al., (2006). Since the main technique errors influence the boat pitch, simplified 2D models of both user and boat were developed. The VE is composed of a boat which moves in a rowing landscape with a sufficient level of environmental realism. The virtual oars motion and the point of view are synchronized respectively with the real oars motion and the user's head position. The boat model output determines the virtual boat motion.

Experimental activities were carried out on in-door rowing to characterize the main features of skilled rower stroke gesture. User motion and force profiles as well as the calculated boat motion allow to compute on-line performance indexes, such as boat speed, timing, coordination, energy expenditure, and gesture's efficiency. All data are stored by the training manager and used to output the correct feedback. The performance indexes are displayed overlaid to the VR scenario, allowing the user to be aware and to correct in real time her/his errors.

Figure 2 shows a preliminary assessment of the system in which it is possible to understand how intermediate rower's motion is more regular than beginner one. Both the force profiles and the hands' trajectories allow to differentiate an intermediate rower from a beginner.

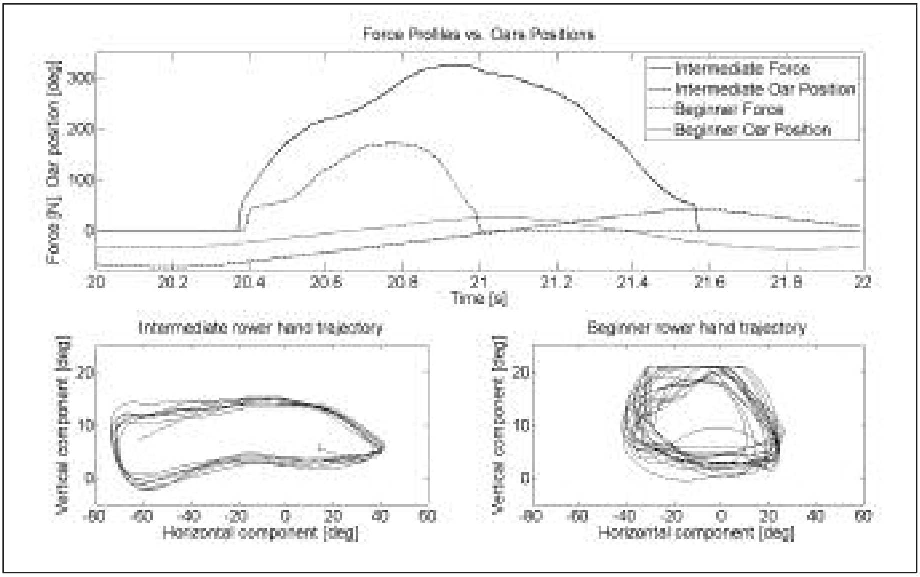

Figure 2. - Intermediate rower and beginner performance.

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Task failure can be explained by a general underlying mechanism

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Introduction

Recent research about the causes of fatigue questions the possibility to explain the task failure in different types of exercise by a general physiological mechanism. The available experimental evidence of continuous, although