KINEMATIC AND DYNAMIC ANALYSIS OF THE ROWER'S GESTURE ON CONCEPT II ERGOMETER

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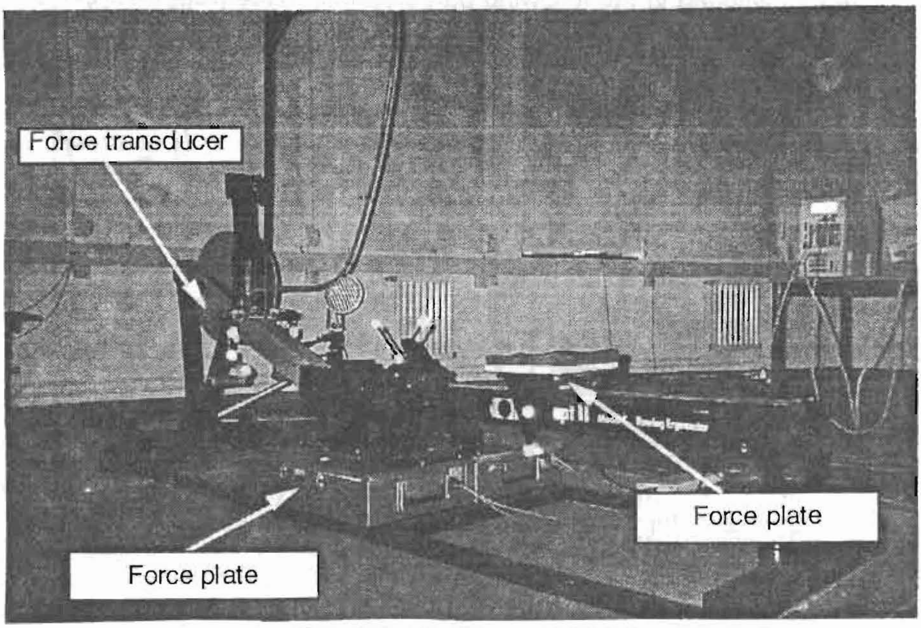
INTRODUCTION

The research carried out are aimed to the "complete" optimization of the rower's gesture on the Model C Concept II ergometer. The literature shows that the studies carried out in that domain very often use one or several algorithms of optimization and/or the interactive simulation with trainers (Dal Monte 89). In order to interpret its results at best, a good knowledge of the rower's gesture is necessary. Accordingly, the first works, to carry out that optimization successfully, are the kinematic and dynamic analysis of the rower's gesture on the ergometer. The objective is "to understand" the rower's gesture making use of the technical characteristics of the rower's gesture defined in (FFSA 91). The object of this article is the presentation of the first results stemming from experimentations carried out on a novice, a male rower with a regional level and a female rower with a national level.

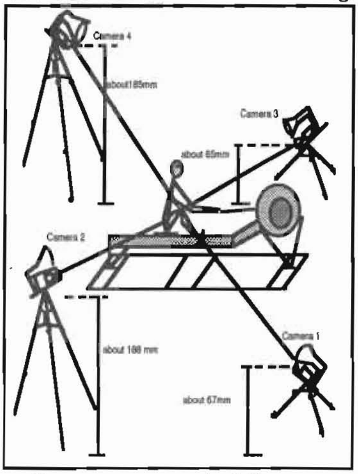
METHODS

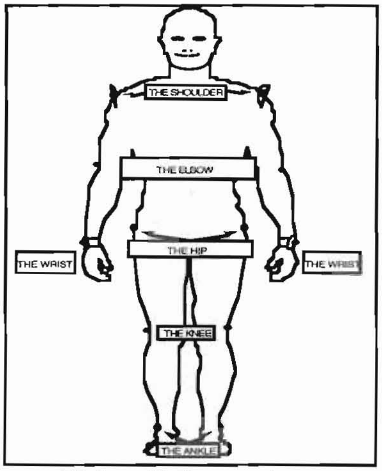
An original device was set up. It's made up an Model C Concept II ergometer instrumented and of a system of gestural analysis SAGA3. The instrumentation of the ergometer consisted of placing two force plates under two new feet stretchers, a mini force plate under the slide and two force transducers to the level of the two new handgrips (PUDLO 96) (picture 1).



Picture 1 : The Concept II ergometer instrumented

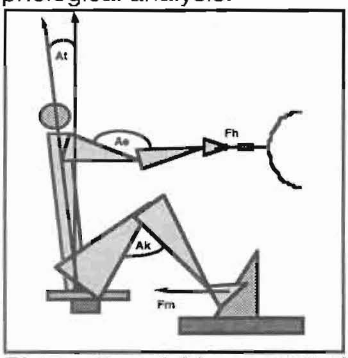
The SAGA3 system is equiped with 4 cameras CCD 50Hz. They are placed so as to capture all the markers placed on the rower (pictures 2 and 3). Some precision tests were made and highlight a 0,1% error of the flield of measure for the coordinates 3D and 2° on the angles.

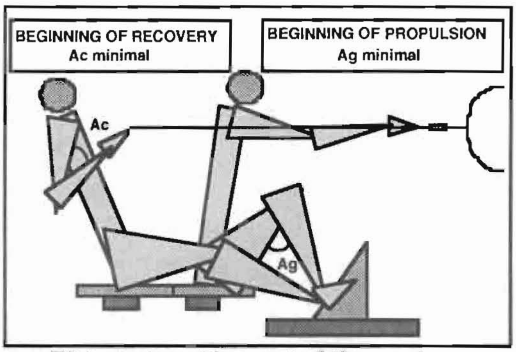




Picture 2: arrangement of the cameras Picture 3: the markers

Biomechanical studies falling on rowing, remain very often global and consider the gesture as an indivisible whole (classiffication in style in (Dal Monte 89), coefficients of efficiency in (Zatziorsky 91), pick of force on the handgrip (Hartmann 93)). If the assessment of the gesture remains global, the causes of its inefficiency are hard to bring out and the corrections provided to the rower's gestures are less pertinent. In that case and in order to apprehend the rower's gesture much closer, the analysis of kinematic and dynamic variables which is accepted, developed in the following paragraph, is made from their combined morphological analysis.





Picture 5: variables accepted Picture 4: cutting out of the cycle

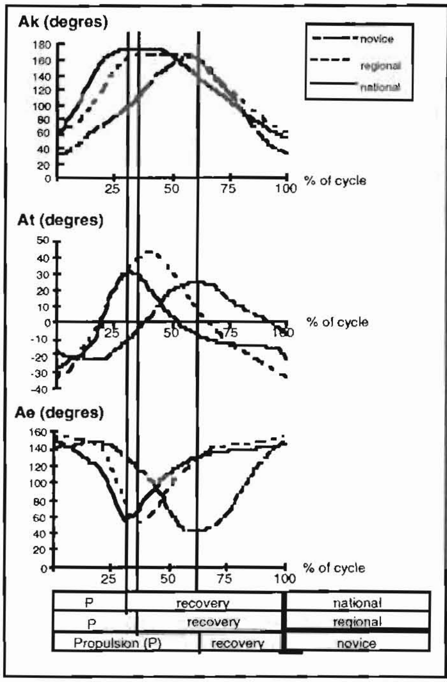
The rower's gesture is based upon 3 movements: a movement of the legs, a movement of the trunk and a movement of the arms. So, the angle of the elbow (Ae), the angle of the trunk (At) and angle of the knee (Ak) are accepted for the analysis. Furthermore, for assessment purposes, the force Fh (force developed to the level of the handgrip) and Fm (force developed in the direction of the movement) are accepted (picture 4). On the boat, the propulsion starts with a phase of resting place of the blades in the water, which comes from the sharp opening of the knees and an upholding of the trunk (FFSA 91). As a consequence, the phase of propulsion on the ergometer is determined by the minimal angle of the knee. Likewise, the push on the blades in the water is made by lowering the arms which provokes the opening of the elbows (FFSA 91). Therefore, the return phase on the ergometer is determined by the minimal angle of the elbows (picture 5).

RESULTS

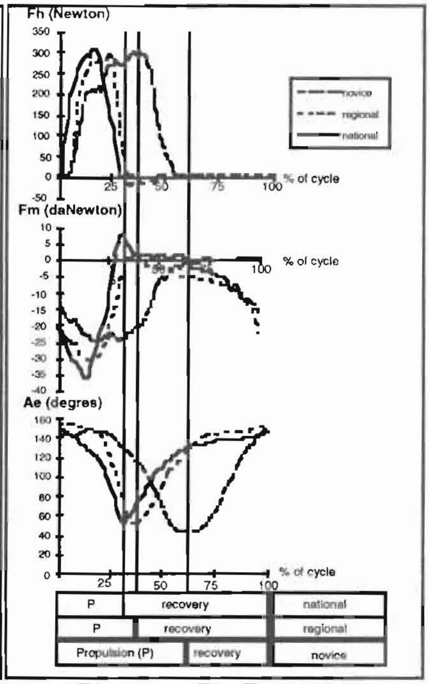
The chart presents the general characteristics (Tc is the time of cycle, Tp is the time of propulsion and Tr is the time of recovery) of a stroke for each of the subjects. The rate of propulsion of 59% with the novice is well above the values of the experienced rowers. The novice lacks of dynamics in propulsion and comes back too quickly.

	Tc (ms)	Tp (ms) ; %	Tr (ms), %	Rate (stroke/mn)
novice	3360	1980 ; 59	1380 ; 41	18
regional.	3520	1280 ;36.5	2240 ; 63.5	17
national	3160	980 ; 31	2180 ; 69	19

Chart: general characteristics of the stroke of rowing



Picture 7: the angles Ak, At, Ae



Picture 8: Fh, Fm et Ae

The curves Ak, At and Ae presented in picture 7 are significiant for, they enable to distinguish the novice from the experienced rowers. Indeed, for the experienced subjects: - Ak opens very quickly and the trunk (At) bends right from the beginning of the propulsion. The movement is sharp and dynamic, essential to the success of the resting place in the water (it's the attack), - Ak reaches its maximal value before the propulsion ends and remains constant as long as At is not equal to zero (technical learning), - Ae closes very quickly (final whip) at the end of the propulsion and opens very quickly at the beginning of the return (it's the removal of blade of the water). On the contrary, with the novice, the action of the segments from the body is approximate (lack of dynamics in the opening of Ak, stage of Ak missing, simultaneity of the action, rounded shape of the curves, small slopes during the propulsion). Moreover, the novice carries out a risky movement. In fact, Ak is 60° inferior at the start of the propulsion (FFSA 91) and the back comes forward again under the pressure of the legs (no protection of the lumbars). The return of the back partly nullifies the action of the legs. The gesture is then inefficient at this instant.

Picture 8,a shows the existence of an ineffective phase with the 3 rowers. The force exercised on the handgrip is equal to zero well before the end of the propulsion. The rowers then exercise a movement of the elbows which has no incidence on the force. The gesture is therefore ineffective for it doesn't contribute to the acceleration of the boat. Moreover, that phase is a waste of time.

Lastly, the analysis of the curves enables to distinguish the national from the regional. Indeed, the steep slope of Fh (picture 8,a) and the high amplitude of Fm (picture 8,b) at the beginning of propulsion shows that the female rower makes a much frankier attack. The resting place is then more quickly obtained. Moreover, the return of the national is mastered. Indeed, with the national force Fm is positive (in direction of the movement) at the beginning of the return and remains pratically equal to zero until the end of this phase. On the contrary with the regional, the force Fm is negative (in the opposite direction to the displacement of the boat) at the start of the return and decreases regularly until the end of the return. The regional has a tendancy to slow the boat down in the return phase. It seems that the variations of Fm are conditionned by the return of the trunck forward. In fact, the increase of Fm, with the national at the end of the return, coincides with the final return of the back toward the front. Likewise, the back of regional regularly comes during the return, Fm decreases regularly during that phase.

CONCLUSION

The preliminary results carried out on novice, a male rower with a regional level and a femal rower with a national level have enable to 1) show the lack of coordination with the novice 2) notice the automatism of the gesture with the experienced rowers 3) hightlight a phase of inefficiency common to the 3 rowers and 4) contribute to the explanation of the difference in level between the two experienced rowers.

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