

Problems of the Biomechanical Analysis of the Rowing Technique in Real and Test Conditions

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INTRODUCTION

From biomechanical point of view, rowing is a cyclic sport with a relatively simple kinematic motor structure. This fact, as well as the possibility for a natural determination of reference coordinates, immovably connected with the boat, suggests that the biomechanical analysis for evaluation of the sports technique is not a very difficult task. Most of the authors however (Christov, Fukunaga), make a biomechanical analysis indeed in laboratory conditions by means of different kinds of training apparatus. In this case it is suggested that the transference of the coordinates, connected with the boat in real conditions on the training apparatus does not modify essentially the motor structure. The additional advantages are incontestable: the possibility of including of different apparatus equipment, without limitations for their volume and weight. It has to be noted immediately, that this kind of modelling has a very essential disadvantage – disturbance of the existing in the boat dependencies between kinematic and dynamic characteristics of the motor actions. In laboratory conditions for example the information about the effect of common displacements of the gravity centres of the boat and of the oarsman, about the character of the power characteristics etc. is lost. Finally, the degree of adequacy of the model in laboratory conditions remains quantitatively indefinite. The attempts for a biomechanical analysis of rowing in water involve the following fundamental difficulties:

— limitations in weight and volume of the study equipment

- requirements for hermeticity
- resistance to mechanical impact

The possible way for overcoming these problems is part of the basic equipment to be located outside the racing boat, in a concomitant motor boat by means of a wire connection or on shore by means of a telemetrical channel. In the first case, the shortcomings are grouped around the fact that the measurement interferes with the event under investigation, while in the second case, there are limitations affecting the precision and accuracy of the information obtained.

The direct solution of the problem is connected with the recording of the information in the experiment boat. Here we ought to mention the attempts of some authors (Nelson, Bachev) to create real time working systems. They are designed to submit limited volume of information.

The throughout biomechanical analysis presupposes additional, purposeful processing of the initial data. A suitably organized memory is required for that purpose. There are analogue recording devices (on a magnetic tape for example, Haralampiev) as well as a digital system (Haenyas). The last ones have substantial advantages as far as parameters, purposefulness and possibilities for direct computer treatment are concerned. The memory, uncomplicated by mechanical devices, as digital magnetic and disc devices for example, is most suitable for the hard working conditions.

Having in mind the analysis given above, a system for registration and analysis of the biomechanical characteristics on the base of RAM-plate was worked out. Its basic design is shown on fig. 1. It has a weight of 3 kg, its ADC is 8-bits, 16 channel, while its memory capacity is about 256 kB.

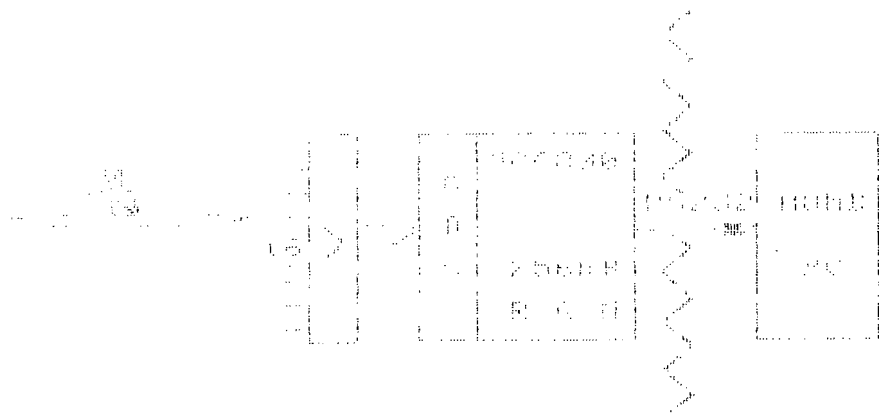


Fig. 1 Schematic diagram of a portable system for investigation in real conditions.

INVESTIGATION METHODICS

Highly qualified athletes of the national team took part in the experiment. The following constants were measured:

- ★ the angular displacement of the oars in horizontal plane $\Phi(t)$
- ★ the force applied to the oar grips $F(t)$
- ★ the boats acceleration $a(t)$
- ★ the speed of the boat $V(t)$ achieved mathematically by means of integration of the acceleration.

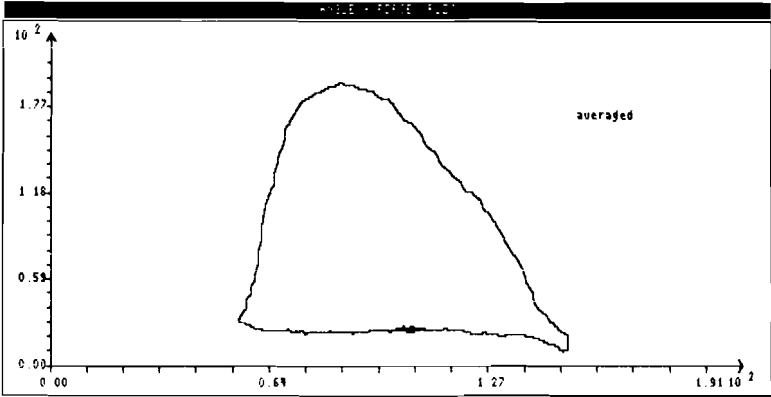
Methodics makes possible the complete mathematical analysis of the registered data by means of a specially worked out software of Turbo-Pascal for IBM PC/XT.

As far as we accepted the assumption that it is a work hypothesis, the basic differences between the model and actual rowing are reflected in the connection between the kinematic and dynamic characteristics, as a base for comparative analysis we adopted the dependency between the oar-angle and the grip-force in rowing.

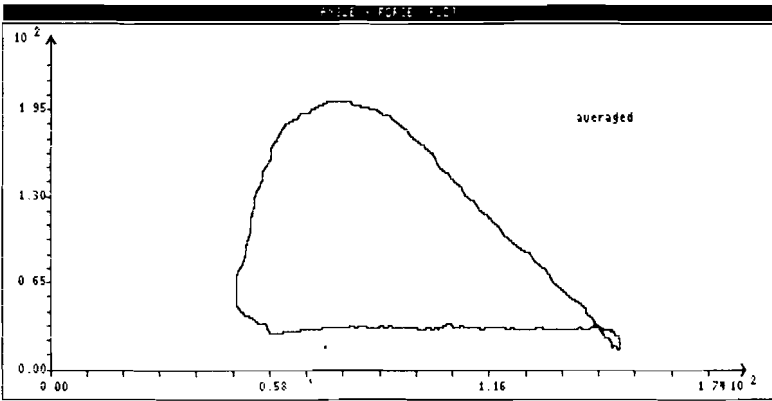
On fig. 2-A and 2-B are shown the original records achieved by means of a system based on the average result of 25 cycled angle-force diagrams, in skiff rowing for the right and left oar. The dependencies $\Phi(t)$, $F(t)$, $a(t)$, $V(t)$ are interpreted in fig. 3.

The character of the curves is a typical one in all cases experimented up to the present moment. The most important features is the maximum's position in the first half of the way during work in the water, the high volume of the initial compound part and the basic two types of dependencies of the transition between water and air phase when the oar is pulled out. These moments are the most important points for the efficiency of the rowing technique. The scientific approach for its further improvement envisages a more detailed analysis of the base of the additional information. For example, the negative values of the strength in a back final position could be the result of a technical fault as well as yielding, resulting from deformations of the oar. In other words, the single dependence could be achieved only after the inclusion of a suitable transducer which gives signals about the position of the oar in relation to the water. Only in this case, the lack of negative values of the strength of fig. 2-B can be explained.

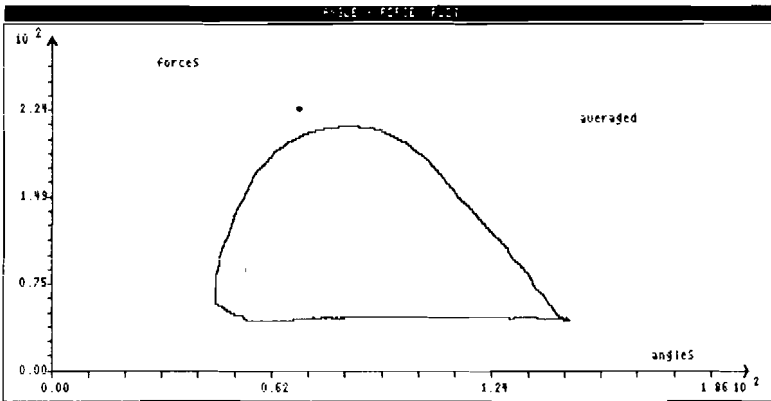
On fig. 4 is shown an analogical diagram typical for a rowing basin. The basic difference of the water cycle is the late position of the maximum in the 2nd half of the water phase, and the different behavior of the strength's compound part, in consequence. These new characteristics



A



B



C

Fig. 2 Averged angle-force diagrams recorded on a skiff boat.

Cycle: 11 Intermediate: 0
Cyc.Length 146 Bytes done : 7765
Tempo : 20 /min ServEnd

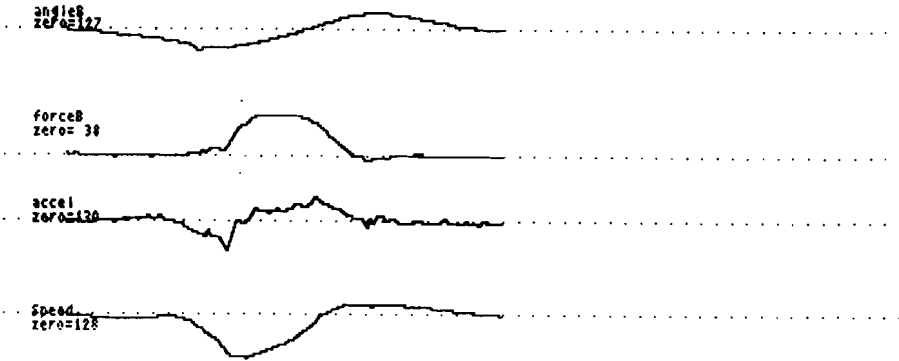


Fig. 3 Time dependence of the basic characteristics of the rowing cycle.

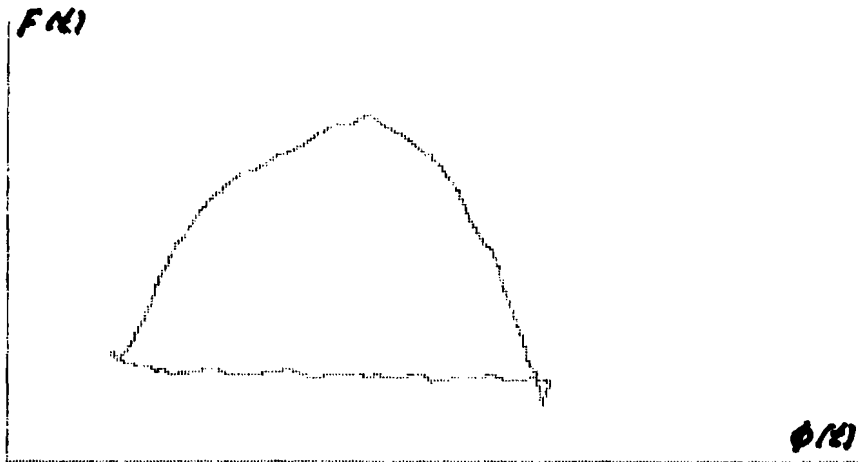


Fig. 4 Angle-force diagram of a rowing tank.

obviously change the structure of the motor action and have a direct effect on the training process.

On fig. 5 are illustrated some rowing cycles, realised on a GJESSING-ergometer. The general impression is that of a wide variation of the dependencies. For example on fig. 5-A there is not a clearly outlined maximum. The stabilization of such a structure into a motor habit will obviously bring forth some technical problems in rowing in real

conditions. On fig. 5-B the ergometer enables the competitor to achieve a high force component, which is difficult to maintain during the rest of the working phase. On fig. 5-C the maximum is situated in the second half of the active phase and is preceded by local extrema, which is an indication of instability and bad coordination of the work of the different muscle groups.

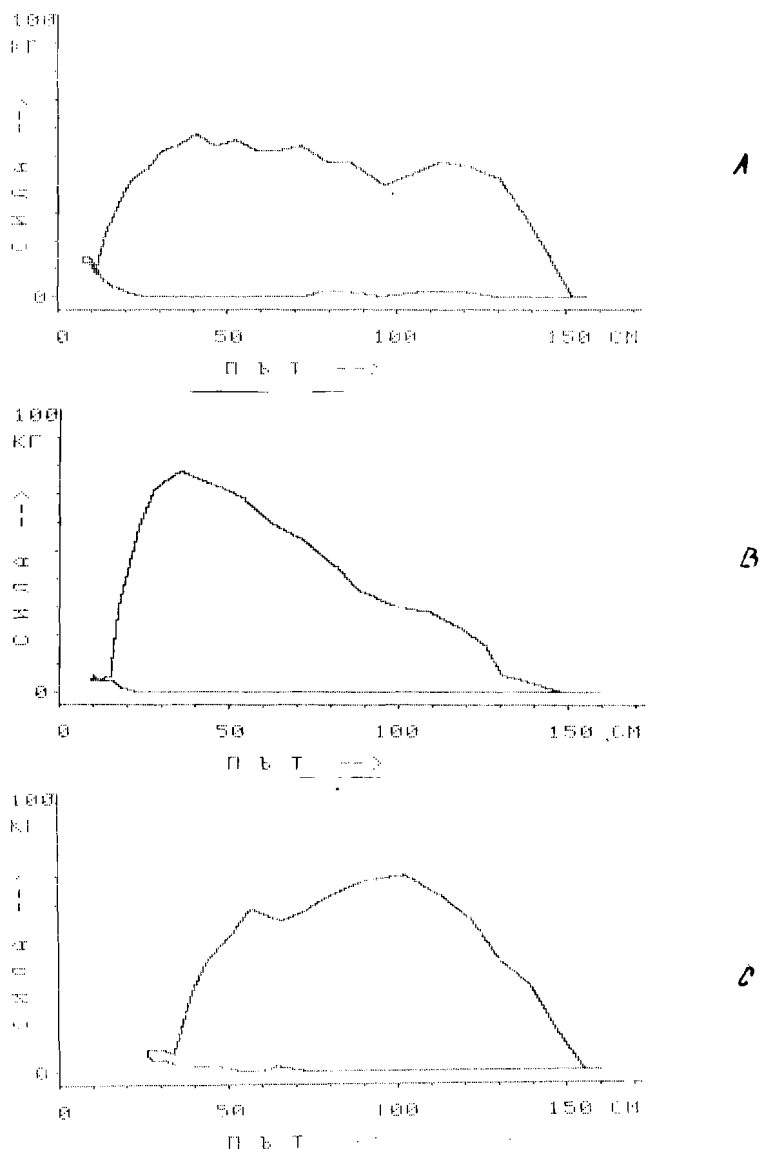


Fig. 5 Gripdisplacement-force diagrams of a rowing GJESSING-ergometer.

SUMMARY

There are significant differences in the biomechanical structure of the motor actions in rowing in real conditions, in a basin and on GJESSING-ergometer. Rowing in a rowing tank doesn't stimulate the explosive implication of force in the initial phase. On the other hand, ergometer rowing changes the competitor's technique in a quite diverse manner. That is why the ergometers application must be parallel with a preliminary biomechanical analysis for the individual evaluation of these influences.

In conclusion we must underline that the comparative analysis gives the basic frame only of the main differences between the actual and model rowing and the possible influences on the training process. The developed system for recording allows a considerably deeper analysis of the problems discussed above, which will be the subject of our future investigations.

BIBLIOGRAPHY

- Fukunaga, T., Biomechanical approach of rowing in Japan; Fisa-Trainercolloquim, Koeln 1984.
- Keese, S. and Witt, F., Vergleichende kinematische und dynamographische Technikanalyse im Rudermessboot; Rudersport, 16/1984.
- Haenyes, B., Koerndle, H. and Lippens, V., Geraetetest mit Hand und Fuss; Rudersport, 10/1986.
- Christov, R., Control, assesment and optimizing system for some parameters of special efficiency of top-qualified rowers; Convegno internazionale, Roma 12/1986.