Problems in the Computerization of Sports Biomechanics Research

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Human movement has been the object of observation from prehistoric times. Evidence for that interest is illustrated by the number of monuments rock paintings and objects in places like Central Sahara, Egypt, Syria, Latin America, Ancient Hellas and Rome. Information about that can be found in the works of many scientists, especially in the report of E. Asmunsen. The author draws the bounds of this first stage of knowledge of motor activity from the invention of photography, realized by Meybridge, 1887.

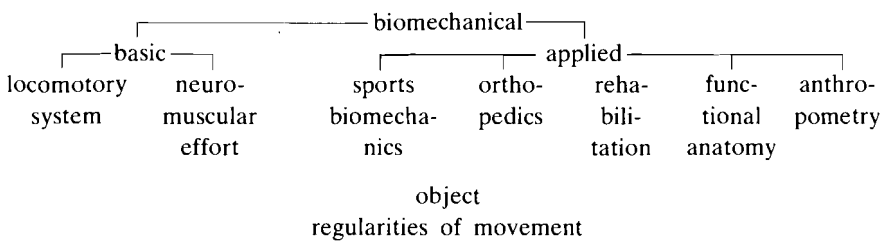
The application of photography, chrono-photography and subsequently of the stroboscopic effect allows to objectify the research, and on that ground to reveal number of regularities in the kinematics of movement.

A reliable knowledge of the nature of movements, i.e. of their dynamic structure was obtained at the end of the nineteenth century, with the experiments of Maray, 1886, who applied for the first time a method for direct registration of movement during walking and running. This fact marks a new stage in the knowledge of movement, a transition from analysis of the visible form of the movements to the knowledge of its hidden nature. This view stage is also characterized by numerous attempts of physiologists, kinesiologists, anatomists and biomechanists, to reveal the processes and the phenomena occuring in the locomotory system, allowing the realization of movement. Independently of the fact that at the end of the sixteenth century Galvany made his first experiments with muscles, according to Asmunsen, the first systematic investigation in vivo was done by Duchenne (1885). That was the beginning of the application of electromyography (EMG).

These aspects of the interest in human motor activity required biomechanical research in different fields, from the point of view of functional anatomy, orthopedics, ergonomics etc., and the necessity for analysis, discussion and classification of the investigations became obvious. The problem of biomechanics related to its methodology emerged as important and significant.

Of special interest is the report of C. Matsiu, presented in 1981, in Poland. The autor made an attempt to outline the biomechanics as a special science and to classify the investigations in this field. The final detachment of the biomechanics as a science occurs according to him during the fifties of our century. He divides the biomechanics in two fundamental parts: a basic and an applied part, and he distinguishes many aspects of the practical application of research.

Chronologically arranged, investigations in the field of biomechanics allows us, to classify them. Biomechanical research, up to now, can be systemmatized from the point of view of their functional application:



Each of the enumerated aspects can be considered in depth as different substructures. For example, the biomechanical research on the locomotory system can be divided in investigations on muscles, joints, ligaments etc. The conventionality of such a classification is due to the fact that the object of observation is the same.

Taking into consideration the steady tendency for a large use of the achievements of technical progress, the integration between the different formal orientations outlines a new evolution stage in biomechanics. This qualitatively new stage is marked first of all by the use of the computer technique, permitting to carry out complex and integral investigations, and on the other side, by the restriction of the partial, one-factor studies. It is no accident that at the last congresses in biomechanics, a greater part of the presented investigations were dedicated to sport, most often classified by the sport studied (athletics, swimming etc.), or by the methods of research used (tensometry, EMG, accelerometry etc.).

Up to date research in sports biomechanics, which integrates inevitably the efforts of a large number of experts, requires the creation of an algorithm of the cyclic system of activities, which can be conventionally divided in:

preceeding the computer treatment	computer treatment	post-computer treatment

"Preceeding the computer treatment" sphere of activities has the purpose to set up:

— the object of investigation and its main characteristics
— the providing of correct information, consistent with all the metrological requirements for standard, precision, reliability, validity, and specifying all the remaining problems concerning the technology of the investigation
— the apparatus equipment and the program design
— the methods for analysis and treatment of the information.

The second sphere of activities — «the computer treatment» — may be independent or dependent. In the first case the data are put in the computer to be treated according to a designed program not in real time. The information treated in this way is given to the researcher for analysis in analytical, graphic and table form. In the second case the treatment of information proceeds in real time (on line), without interruption, which requires an automated measuring and treatment process.

The third sphere — «following the computer treatment» — is designed for the analysis, comparisons, interpretations, conclusions and decision making, in a view to gain knowledge about the phenomena or to do efficient corrections of the directed process.

From the point of view of the object of observation and the purposes of the investigation, the computer technique can find an application in:

1. training	2. competition	3. scientific control

In the «training» session the computer can be applied: at loading in natural conditions (running, swimming, volleyball, gymnastics etc.), and at loading in modeled conditions, by means of training machines for the development of the specific capacities and skills (technical skill, speed, strength). The movements and the activity of the sportsmen in the time and space are of course different, dependent on the characteristics of the different sports. Some sports are practised with little displacement of the

body (weight lifting, shooting etc.). In other sports the displacements in the space are moderate (apparatus gymnastics, shot put, hammer throwing, diving, wrestling etc.). In the third kind of sports the displacements are great (athletic races, ski, cycling, motor sports etc.).

Significant success in computerization at modeled conditions of loading are achieved in the cyclic sports, where the possibilities for automation of the entire process are considerably greater. In this case the treatment of data proceeds in real time, and in this way it is possible, at the end of the training session to obtain data about the effects (A. Tsvetkov, L. Leonardi, A. Comor, A. Dalmonte etc.).

The use of a computer during the competition is most practised. The explanation is very simple. It is to inform the spectators observing the event on TV. We have now good possibilities to repeat, several times (slow motion or stop frames), interesting moments of the performance. The interest for the competition performance of the sportsmen is one reason for the development of videometric and kinematic methods for recording and analysis. These video and kinematic data are submitted to a transformation, allowing a comparative analysis. Along this line investigations were carried out during the European Championships in Swimming, 1985 (K. Boichev and col., 1986, D. Piperov, 1986 etc.).

Taking into consideration the achievements of electronics today, we can say that in the near future the automated computer analysis of the performance at competition will be possible, by mixing the videometric signals with signals obtained from devices giving information about its dynamic structure (force, acceleration, etc.).

As to the scientific control in sports, its contents changes towards a more specific investigation of sportsmen, by means of testing, from pure laboratory conditions to laboratory-field and purely field conditions. This move from the general to the specific, is an interesting phenomenon of the computerization process, especially of the computerization in motor research. This is the orientation where most radical changes will occur. Of a great help in this respect will be the computer. This process toward computers will greatly facilitate the designing of apparatus like swimmills, treadmills, ski-mills, rowing ergometers, etc.

The greatest advantage is that the apparatus allows to study biomechanical parameters synchronously with physiological indices. In this respect the scientific control and the effective guidance of sports preparation will find the greatest field of development. This will occur for the following reasons:

— The movements and the physical efforts are studied in near natural conditions.
— The parameters revealing different aspects of the sports prepation are recorded synchronously (on line).
— The computer will help to gain more knowledge of many other aspects of the human performance unknown till now.

The training process parallel with the scientific control over its efficiency, offers the possibility to perform three types of computer investigations:

(a) simple (one-factor) investigation
(b) complex (multi-factor) investigation
(c) integral investigation.

We can specify biomechanical investigations according to their purpose in two types:

1. Investigations permitting to formulate model characteristics of the desired state that we wish to achieve.
2. Studies aimed at establishing the actual.

In conclusion, we can say that the structural and the methodological problems of the biomechanics in the future will be more and more closely related to the problems of computerization. The future problems however will not be the computerization of research, but rather the designing of software to meet training needs.

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