DIFFERENTIATION AND INTEGRATION IN SPORT SCIENCE, ROLE AND TASK OF INTERDISCIPLINARY SPORT SCIENCE

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Professional paper

Abstract
The article deals with questions of differentiation and integration of sport science. Analysing some special fields of sport science the auhors try to find true answers to the following questions:
- do we have a really independent (individual) sport science?
- is the sport science an interdisciplinary one?
- what are the development trends and tendencies in sport science (quo vadis sport science)?
- what are the dominant contradictions and other serious problems of the sport and sport science in the XXI century?

Key-words: elite sport, health, nutrition, performance-development, scientific research

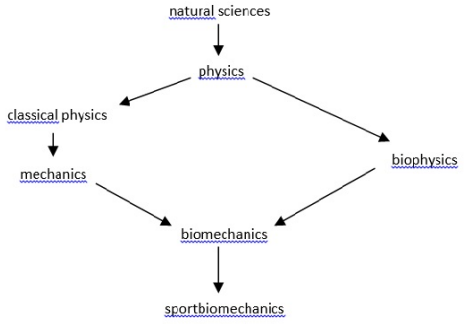
INTRODUCTION

The development of the sicence, forming and establishment of new scientific fields is a natural (normal) process, carried out in general by 2 ways: differentiation and integration. This trend of development is typical for the sport science, as well. To perform a classification of the research work, the R+D activity, in general 2 categories (theoretical or big science and applied science) have been in use. Although we accept more or less this type of classification, however let us mention the opinion of the famous french chemist and bacteriologist Louis Pasteur (1822-1895): „We do not have science, which may be mentioned as an applied one. What we have is the science with its application possibilities, and the connections are like the relations between the fruit-tree and the fruits."
This paper does not want to analyze the scientific literature of development of sport science, the aim is not to give a critical evaluation of many books and publications. Simply we would like to mention some important ideas concerning this topic.

DIFFERENTIATION AND INTEGRATION

The development of the science, the step by step accumulation of scientific knowledge will create special fields within the science, forming new, independent subsciences. This process - the differentiation one – is rather typical in the natural and even social sciences. Let us mention e.g. the development of chemistry, which was first separated from physics and biology. One of the special fields of chemistry – together with the others, like organic chemistry, inorganic chemistry, radiochemistry - is the analytical chemistry. Within analytical chemistry we have the separation techniques, and within this group the gas-chromatography (GC). Another important field of analytical techniques is the one of magnetic methods, and within this group the mass-spectrometry (MS). Sometimes differentiation means in the same time integration, as well, like the application of the combined technique GC-MS, which is widely used e.g. for doping analysis in sport.
Let us take an anothet typical case – fig. 1 - from physics! Physics is one of the natural sciences, today with a lot of special subdisciplines, like e.g. thermodynamics, optics, astrophysics, electronics, nuclear physics, relativistic physics, solid state physics, neutron physics. Fig. 1 shows the way how to go to sport biomechanics from classical physics and from biophysics, as well.

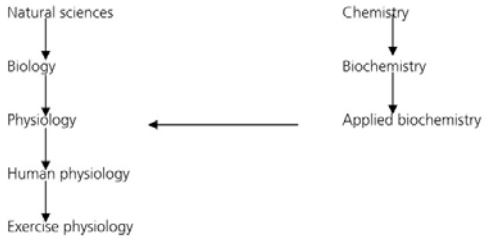
Fig 1. Differentiation in physics



If we take another case – biology – the sequence of differentiation is the following:
natural science – biology – physiology – human physiology – exercise physiology (Fig. 2). The

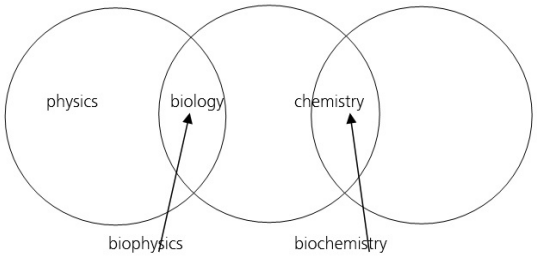
last one is a rather new, but very intensively developing part of human physiology and sport science, one of the most important part of subsciences, covering the real need of the coaches. Let us mention, that there is a way to exercise physiology from chemistry, as well, through biochemistry, applied biochemistry, having connection to physiology.

Fig 2. Differentiation In Biology



The other direction of the development of the sciences – often paralel with the differentiation – is the integration process, which means the connection and collaboration of 2 or more fields of science, searching and finding the common topics. (Fig. 3). E.g. if we speak about biophysics, this is the product of integration of biology and physics, although within biology or physics in the same time this is a differentiation, because biophysics belongs both to biology and physics, as well. Similar situation is with chemistry and biology (biochemistry). The mentioned exercise physiology is also a result of interaction of physiology and sport science, it is a typical interdisciplinary subscience.

Fig 3. Integration In The Natural Sciences



INTERDISCIPLINARY SPORT SCIENCE

The very fast development of sciences produced the formation of many interdisciplinary scientific fields, the combination of different disciplines, which are or can be – apparently – even rather far from each other. E.g. food physics and radioecology are such types of interdisciplinary sciences. Sport science is also a typical case for representation of the interdisciplinary sciences.

What is the essence of interdisciplinary sport science – in other words exercise science – is it possible to have a definition for it? To our mind the interdisciplinary sport science is a manysided applied science, based on theoretical principles with practical delivery, trying to solve real problems of individuals and groups within the sport environment. An interdisciplinary approach has been defined as: "More than one area of sport and exercise science working together in an integrated and co-ordinated manner to problem solve." (Burwitz et al.,1994).
The skills required for this approach include:

- Bridge building - the coming together of special knowledge from different disciplines
- Restructuring - methodologies, theories and practices from one discipline are borrowed and transposed into another discipline to restructure the approach to a problem
- Integration - the application and combination of different disciplines.

The sport science is a multidisciplinary science, integrating such types of various natural and social sciences, where the target is the competitor, the athlete. There are many topics, a lot of problems, concerning the sport science. E.g. the real and valid definition of sport science, is it an independent science or not, what are the most important fields of sport science, connection between the development of sport science and top sport, doping (illegal performance-improvement) in sport, health and performance-requirement, social expectations, role and task of sport science in the modern (industrial and post-industrial) societies, special questions of sport nutrition, role and importance of olympic movement etc. Let us see some ideas, thoughts, dealing with some of these questions! Anyway, human kinesiology – meaning dominantly experimental and clinical movement science with practical applications – is an interdisciplinary science, as well, having connection to a lot of diffeent fields, like e.g. prevention and rehabilitation. This interdisciplinary science is the study of anatomy, physiology and mechanics of body movement especially in humans. To the definition of Wikipedia: „Kinesiology, known also as human kinetics, is the scientific study of human movement."

FIELDS OF SPORT SCIENCE

We do not want to go into details about the question: do we have independent sport

science - in old words trainer's science – or sport science is a termin, meaning the integration of particular fields of many disciplines, relating with sport. No, we do not analyze this question, because to our mind this is not the main point. Let us take an instance! If sport science as an independent science exists, definitely e.g. sport-biomechanics is an important part of this science. However, if we think that independent sport science does not exist, there is no question about the existence of biomechanics, and a special and important segment of this science is the sport-biomechanics. So – although we can have different opinions concerning the place of sport science among the other parts of sciences – definitely the independent fields (in our case within the biomechanics the sport-biomechanics) exist. By the way let us emphasize, that to many sport scientists the sport science fulfils all the requirements of formation of independent science, so it exists as an independent sport science, as well.

Some important fields of sport science are the following segments:

- sport physiology
- sport biomechanics
- sport antropometry
- sport nutrition
- sport psychology
- sport pedagogy
- sport sociology
- sport history

No question that there is a strong interdisciplinarity between the mentioned fields. However – also within the sport science category – there are many other disciplines (without the requirement for covering all segments), as well. E.g. sport traumatology, sport surgery, sport orthopedy, sport ethics, sport law, sport economy, sport management, sport informatics or sport and environment. We are sure that these fields have also right to belong to the inter- and multidisciplinary sport science, using the termin sport science in wider interpretatition.

Of course we have the right to ask: do we have also other important segments of sport science? If we have literature and science of literature, definitely we should have sport-literature and science of sport literature, as well. Or take e.g. the case of architecture and science of architecture. If these phenomenon exist, definitely there is also sport-architecture (e. g. building of sport facilities) and science of sport architecture.

And the other fields? The segments which belong dominantly not to sciences, but to arts. E.g. painting, sculpturism, art of movies, art of photos. We think that the barrier is not sharp between science and art, and in this case we can speak about sport-painting (see picture 1) sport-sculpturism, as well. To the opinion of Bay (1986): „There is no difference between science and art, both have common source, which is the ambition of mankind to go further and higher".

Gustave Courbet (1819-1877) Wrestlers (1853)
Budapest, Museum of Fine Arts

TOP SPORT AND SPORT SCIENCE

Recently – with cruel frankness – rather frequently is the question asked: do we need elite sport? Is it necessary to reach new and new records? Do we have the right to apply limit loads to athletes, is it acceptable the expectation to win by all means? Do we need the gigantism of olympic movement and games, the money-dependence of professional sports, the victory of the profit-making activities? In 1996, before the Olympic Games in Atlanta some former USA olympic champions were asked by sport reporters about the importance of olympic games. Norbert Shemansky - winner of the 1952 Olympic Games in weightlifting, category 90 kg – had the following answer to the question of the young reporter, concerning the development of olypic movement. „Today there are no Olympic Games. There are only Money Games."

Of course the sport science should act not only concerning the needs of top sport, however to serve the below the top sport level, as well, the segments of the physical culture, producing not top results, but motion programs for

healthy life, public and school sport, etc. So including all sport activities, like competition sport or recreational level sport. Even the therapeutic physical culture, rehabilitation, medical gymnastics and the research work, covering these fields, belong to sport science.

However it is evident, that the top sport gets the biggest help from the science, today parctically the high level scientific background is an essential element of the top sport results, it is a must for the excellent performances. So the science is a necessary (but not sufficient) element of the high level performance, because the biological (and mental and psychic) parameters are the the dominant fundaments of sport performance. E.g. if the height of the ahlete is 160 cm, definitely he/she will be never an excellant player in basketball, and in case of dominancy of slow muscle fibers even the best coach of the world will not be able to produce a good sprinter.

Anyway, if we see the sport science, as dominantly applied science - the applicable science by the trainers, application of the scientific results in the practical coaching work - we do not have to forget, that it is not possible to produce from every competitor a world famous athlete. However the main task (target) of the coach is not to make champions, but to make strong, healthy, stabile and in the same time happy and satisfied human beings, good competitors, good athletes, good players (Szabo, 2012, 2014). Pierre de Coubertin (1863-1937), the founder of the modern olympic movement said: *„The most important thing is not to win, but to take part"*. Yes, really the most important thing for athletes is the regular physical activity, and the most important thing for the coaches is to help, control, conduct, support this activities.

QUO VADIS SPORT SCIENCE?

To tell the future is not easy and in general not a fruitful task, and obviously the probability of error is bigger if the wanted extrapolation is further. It is evident, that all trends – which seem very stabile at present – will be broken sooner or later, the new effects and requirements will change the direction of the history. The different segments of sport science – the various fields of natural and social subsciences – will develop with different manner and speed, however it is absolutely sure that without help of the manysided sport science the results of the athletes will be far from the international level of elite competitors. To apply the newest results of the modern sport science we need of course new frameworks, strong financial background, effective education and further-education of the coaches and up-to-date scientific research activity, as well.

We think – of course reserved the right to mistake – that in the near future on the fields of sport science (mainly the natural scientific segments) the effective innovative activities and real and valuable developments will be in the following directions:

- informatics, computer technology in sport
- measurement technique (3D and 4D methods, spectral image processing techniques, non-destructive, non-invazive techniques, like e.g. NMR-CT, biosensors, measurement of very low concentrations, ppb, ppt range)
- biotechnology (e.g. genetic doping, human GMO-s)
- nanotechnology (e.g. production of new sport equipments)
- nutrigenomics, genetic diagnosis, individual sport nourishment, predictive medicine

SPORT NUTRITION

We can expect development in recognition of necessity of sport nutrition, covering the special requirements of different sport branches (exercise nutrition like exercise physiology) and application of these knowledges in the practical everyday work of the coaches. On the other hand we see serious possibilities in the research of nutrigenomics, and in application of the results in the diet of athletes (Pucsok, 2008)(Szabo, 2013). Nutrigenomics means „intelligent diet", based on the principle: eat right to your genotype! (www.moodfoods.com/nutrigenomics).

So utilization of the sport nutrition knowledge covers the following levels:

- nutrition at recreational level sport activity (practically well-balanced, up-to-date nutrition)
- nutrition of competitors (depending from the sport-branch, adequate nutrition, concerning the requirements)
- nutrition of top athletes (dominancy of the performance-increase)
- nutrigenomics (special nutrition from point of view of sport-branch and individual nourishment for the genom)

PERFORMANCE-INCREASE, HEALTH AND EXPECTATIONS

Today the members of the society meet continuously new and newer tasks, the technical and technological development is very fast, information explosion is typical for our world and the consequences are often rather negative: frustration, depression, anxiety, distress, uncertainty, disillusionment, cynicism. Of course there is a need for compensation, as well, so the drug-use, the spread of violence, suicidal lifestyle became more common, the intensification of negative trends is not by chance. The change is valid of course in the sports world, as well, concerning also the athletes and the fans, according to the "Panta Rhei" principle (all going on, in the world everything is changing) properly. One of these is new demands aims the sports spectacle sports and extreme sports, and the satisfaction of this expectation on social level today is comparable to the fulfilment of the "Panem et circenses" principle of ancient times.

Let us mention the question of legal (e.g. food supplements, physiotheraphy, balneology) and illegal (e.g. application EPO, steroids, HGH) performance enhancement and the answer to this topic, like antidoping politics of IOC and sport federations, doping control, establishment of WADA and International Court of Arbitration for Sport, out of competition testing, athlete whereabouts requirements, disqualification, sanctions (Ajan, 2013). Of course if we deal with questions of top sport and performance enhancement we should not forget about the traditions, the national pride, and about the fact that many top athletes (in case of the necessary level of mental and moral parameters) are role models for the younger generation. On the other hand we should see clearly that today top sport is a hard-core business, and we can remember the opinion of russian olympic champion (1960) Yury Vlasov, as well, who said even some decades ago, that today the top sport begins there, where the health finishes. And to the opinion of a hungarian sport medical doctor, György Langfy the elite athlete of today is the potential invalid in the future. Sapienti sat.

Of course if the question is about the normal body fitness, the easily acceptable physical load in consequence of sport activity, the picture is definitely positive. The adequate physical load and nourishment (based on the age and physical state) with optimum bodyweight will have a favourable effect on the life expectancy and life quality (Tolnay et al., 2012). It is evident, that the scientific principles – e.g. on the field of exercise physiology – are valid in case of human beings with recreational level physical activity for fitness and well-being and for top athletes with very high level sport performance, as well (Powers et al., 2008).

CONTRADICTIONS, PROBLEMS, SPORT SCIENCE IN THE XXI CENTURY

Today, at the beginning of the XXI century the society is confronted with many critical phenomenons, like ecologocal crisis, demographic explosion, global warming up and climatic changes, global economic crisis, debt crisis. The critical situation can be observed in the sport, in the sport science, as well. Let us take one example, the question of Youth Olympic Games. Prof. László Nádori (1923-2011) a world famous hungarian sport scientist, specialist of training methodology was absolutely against the creation of this new wave. Why? Because this means a performance expectation even in a very young age, and this can be in very close connection with application of illegal methods and substances for perfermance enhancement. Of course this statement is valid for all age groups, however the side effects in younger age are more powerful and destructive.

We should also answer the questions: what will be the task and role of sport science in the postindustrial society? What about performance enhancement, what about the idea: to win by all means? Is it possible that the sport science of the future will work in the interest of clever human beings (homo sapiens) with healthy life style? It is of course also a question about the existance of postindustrial society with normal mental and moral background, sustainable environment, necessary financial fundament, like the ideas of some future-tellers and philosophers.

One thing is rather probable – maybe not within short time. With genetic measurements it will be possible to determine for evereybody the specific disease-susceptibilities. The total genetic diagnostics will open a rather new page in the book of sport science, as well. Based on the DNS-analysis of one drop of blood of newborn baby it is possible to predict who can be a sport genius and in which sport branches? To recognise the talent (talent identification, selection) till this time this was the task of PE teachers and coaches, in the near future perhaps this will be carried out by

genetic diagnostics and much higher correctness.

SPORT AS A DOMINANT FACTOR IN THE SOCIETY

This topic is really interesting and huge number of books were published dealing with such type of questions. We think that it is evident, that sport is a dominant factor in the society recently. It is a dominant factor not only in case of athletes, coaches, sport scientists and researchers, but for the fans, for those people, who enjoy the competitions, the sport games, as well. A famous hungarion actor, Gyorgy Kalman (1925-1989) said the following sentences: „I never envied anyone, conserning e.g. theather role, money, house, car, success, woman. Only Beamon, because of his fantastic 8 meters and 90 cms jump." Yes, so important is the sport in the society, in the life of some individuals of the society. By the way this jump – see picture 2 – improved the previous world record by 52 cm. Based on the biomechanical analysis of this fantastic jump the scientific research proved that this jump would have been 20-25 cm less if the competition is at sea level altitude and not in Mexico, 1800 m above the sea level. On the other hand the precise analysis proved also the fact, that this excellent jump was also not fully perfect from biomechanical point of view, so theoretically Beamon could have been produce even a few centimeters longer jump.

Bob Beamon, USA athlete, olimpic and world record, 1968

WHAT ABOUT THE FUTURE?

We do not know. However we hope that the future will be not without sport and exercise. And in case of existence of sport very probable is the existence of sport science, as well. To the opinion of Shakespeare art should support people, but not serve. So, this is valid in case of sport science, as well, it should support the clever and creative human beings, the homo sapiens and the homo faber. If in the future we will have sport science, definitely there will be sport scientists, as well, and of course sport conferences, sport books, sport journals. So there will be possibilities for publication and discussiuon of research materials, scientific results, ideas. Let us bring 2 thoughts, the first may have closer connection to the sport. These thoughts belong to an indian thinker and a world famous german physicist.

Swami Vivikananda:

„Your way is the most appropriate one for yourself, but it is not applicable for other people. Always use your own way, and do not copy the others."

Werner Karl Heisenberg (1901-1976):

„During the history the mankind made a lot of mistakes. However only 2 really dramatic mistakes. The first, as poking into the nucleus of the atom and the second as poking into the nucleus of cell.

IMPORTANCE OF RESEARCH

In the Bible you can find (Mathe's Gospel, 4,4) : „The man does not live by bread alone, but the word of God." Yes, we need not only physical-biological nutriment, but intellectual one, as well. And in this case – if we use the word (word of God) in wider interpretation – word can mean the knowledge, the culture, the mental and intellectual property, the demand of the acquisition (and development) of the knowledge. The thesis is wellknown and accepted by the representatives of the development that the research of today is the development of tomorrow and the practice of after tomorrow.

However, to realize this thesis, to bring benefit from the today's research we need investment today into the scientific sphere. There is a need for support the scientific research and the researchers. And not tomorrow but today. Financial and moral support. Both are necessary. It is not enough if in some countries the support of R+D activity is only appr. 1 % of the GDP. The need of more effective support of general scientific research and technical development is valid for the sport science, as well. To our mind the goverments should recognise the importance of scientific research

(the pawn of the successful future) and to give powerful support for the sport scientists, as well.

CONCLUSIONS

Let us try to summarize the most important statements of the article:

1. Sport science is a typical interdisciplinary science, based on many segments of natural and social sciences.
2. Some specialists belive that sport science is an independent one, others think that sport science is an integration form of many subsciences, like sport-biomechanics, sport-physiology, sport history.
3. The difference between science and art is not very significant, both have the ambition of mankind to go further and higher.
4. The main directions in the development of sport science are the following fields: sport informatics, up-to-date measurement techniques, biotechnology and nanotechnology, nutrigenomics.
5. There are many contradictions, problems in the modern sport, one of the biggest problems of the application of results of sport science is the use of illegal performance enhancement substances and methods.
6. The reseach today is the development of tomorrow and the everyday practise after tomorrow. This is valid in case of sport science, as well, so there is a need for more powerful support (moral and financial) of sport researchers.

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