

SECTION – VARIA

ICID: 5617

(1.8)

A SCIENTIFIC EVENING WITH ARISTOTLE, C.S. PEIRCE AND A. EINSTEIN

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Keywords: induction, abduction, deduction, empirical researches, theory, motor science

Authors' contribution:

- A. Study design/planning
- B. Data collection/entry
- C. Data analysis/statistics
- D. Data interpretation
- E. Preparation of manuscript
- F. Literature analysis/search
- G. Funds collection

Abstract:

The author presents the universal relations between knowledge of philosophical, scientific and technical nature, seen from the perspective of the motor control. He discusses three technologies of thinking: induction, abduction and deduction, and emphasizes the function of theory in science. Basing on this, he builds some intellectual structures which may be presented in easily graspable graphical form: the Philosophy-Science-Technology Funnel (PST-Funnel), the Street Lamp Analogy (SLA), the Induction-Abduction-Deduction Triangle (IAD) and the House of Thoughts and Deeds (HTD). Finally, he shows the position of motor control among other biological and psychological sciences in a form analogous to HTD – the Hut of Sport Sciences (HSS). This clearly shows the fact that first of all, motor control needs philosophical and theoretical considerations – not rarely disregarded by “genuine scientists” – often even detached from reality. Only the apparently “blue sky thinking” makes up the “leading edge” of scientific progress, and not the “new, original, experimental data” – sober, hard, processed according to “acknowledged methodology”, indeed, yet in itself - infertile. The general issue of this paper regards the relation between experiments and speculations in science, and the general thesis – that especially in motor control, the share of scientific thinking is by far greater than that of experimental research. Moreover, in this discipline, the elegant and user-friendly mathematics cannot be successfully applied, as in, e.g., physics. This is why nowadays only motor control – no doubt the most theoretical from among all the sciences on physical culture – constitutes probably the greatest challenge to the whole of contemporary science.

*The whole of science is nothing more than a refinement
of everyday thinking*

Albert Einstein

*To my Mentor and Friend
Professor Janusz Maria Morawski*

Introduction: The Philosophy-Science- Technology Funnel

Following the convention of “a scientific evening” [1; 2], I would like to propose a meeting with Aristotle, C.S. Peirce and A. Einstein, accompanied by other outstanding scientists and thinkers. One might put forward the question: How may the three Giants contribute to

the explanation of motor control issues? I think that this question is wrong, and the problem is rather: How may motor control develop without them? Because, though it is not expressed clearly, one of the greatest problems of contemporary science is the relation between experimental research and theory creation. In this respect, we nowadays observe an obvious, disproportionate bias towards experiments. This evidently inhibits real progress (and not merely a barren development!) in motor control.

At first, let us be reminded of the statement by M. Heller, who claimed:

In the development of contemporary science one may discern a specific regularity. The early interests of empiricists were focused on the notion of fact, but soon they turned to the issues of

the laws of Nature. Then ... they concentrated their attention on scientific theory [3; transl. WP].

Next, let us confront it with the following view by R. Thom:

Biologists are happy with sheer recording of facts because they are not able to grasp them. They collect information without its understanding and they cannot develop a coherent image of the mechanisms they discover. Their knowledge became a cemetery of facts, not liable to any synthesis. And this is because biologists are fascinated with their observation devices like children. They stopped to think. Biology does not think, so it does not make any progress. Where there is no theoretical reflection, knowledge is merely a collection of archive records [4, transl. WP]

On the other hand, the reality around us is by far too complex to be grasped as a whole by the human mind. Thus, to understand it – as far as possible – it is necessary to create simplified representations of it, i.e., the theories. J. Cohen and I.N. Stewart wrote: “*A theory is a kind of code that transforms complicated messages from nature into much simpler ones*” [5]. Biologist P. Medawar succinctly stated that “*theories destroy facts*” [6]; one might add: “*and vice versa: theory may be built only on the dead bodies of facts, and not with direct, actual connection with them, because theory is interested not in facts, but in pure relations between them*”. M. Heller argued that “*science sees the world through theories*” [3]. In the same book he stated:

It seems that the possibility of idealization is not only a technical facilitation, but a trait profoundly connected with the existence of science.

In science, the observable facts may make up only the raw material for theory creation, but just the latter constitutes the most noble and desirable product of any scientific reasoning. Accordingly, to make use of just being collected data as fully as possible, it is necessary to confront them with the already existing knowledge. At best, with the theories which present the already ordered and “concentrated” knowledge, aimed at its immediate usefulness.

However, in this paper I propose to look at the issue of science development – and especially motor control – not from the perspective of facts, but from the perspective of free fantasy. The philosophy clearly related to fairy-tales resides in this region. As it was stated by B. Russell, “*science is what you know; philosophy is what you don't know.*” Accordingly, it is possible to invent what might be termed “Philosophy-Science-Technology Funnel” (PSTF), partially modelled on I. M. Feigenberg's way of thinking [7]. This is shown in Fig. 1.

Science – as well as philosophy and technology – is not a homogenous intellectual structure. It is partly adjoined the philosophy termed by B. Russell as “*theoretical science*”, and that bordering on technology – the “*practical science*”. He wrote:

*So far, I have been speaking of **theoretical** science, which is an attempt to **understand** the world. **Practical** science, which is an attempt to **change** the world, has been important from the beginning, and has continually increased in importance, until it has almost ousted theoretical science from men's thoughts... The triumph of science has been mainly due to its practical utility, and there has been an attempt to divorce this aspect from that of theory, thus making science more and more a technique, and less and less a doctrine as to the nature of the world* [8].

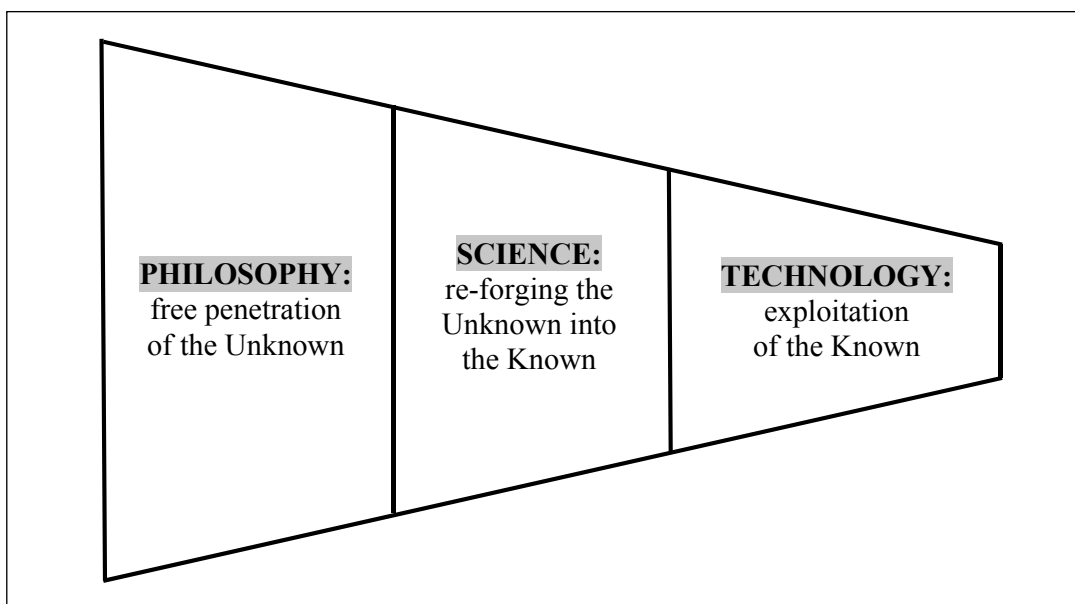


Figure 1. Relations between philosophy, science and technology: the Philosophy-Science-Technology Funnel (PST-Funnel)

In short, one might say that we are dealing with a specific, intellectual “analyser”:

- **Philosophy**, basing on the already Known, “penetrates” the whole body of the yet Unknown with tentative understanding, which in some cases makes up raw material for science.
- **Science** “separates” such potentially useful knowledge from the product of philosophy, which may be systemically ordered and assigned to already existing disciplines.
- **Technology** “distils” the product of science and from it extracts what may become immediately useful in everyday life.

Knowledge and theory: the Street Lamp Analogy

According to the concept shown in Fig. 1, one might learn that the highly utilitarian technology – this notion should be understood in a broad sense – starts its “life” in science. The essence of the latter is theory, aimed at producing a possibly reliable predictability.

There are no direct and obvious relations between facts and theory, or between theory and its applications. Already in the 18th century, I. Kant stated that “*general truths ... must be independent of experience, – clear and certain by themselves*” [9]. More recently, the physicist A. Staruszkiewicz argued that the “*mathematical*

theorems are validated by the strength of proof, and not by observations” [10; transl. WP]. M. Mazur argued:

In theory, nothing may be justified by empirical knowledge. The theory, in which even one evidential link is taken from empirical knowledge (e.g., because in all known cases it was observed that...), is no theory at all [11; transl. WP].

Also, S. Hawking stated:

A good theory will describe a large range of phenomena on the basis of few simple postulates and will make definite predictions that can be tested. If the predictions agree with the observation, the theory survives that test, though it can never be proved to be correct. On the other hand, if the observations disagree with the predictions, one has to discard or modify the theory [12].

Symptomatically, possible disagreement cannot be regarded as proof of falsity of the theory. Nevertheless, the latter sentence by Hawking might be modified and formulated as follows: “*if the observations disagree with predictions, a scientist should consider whether it has been adopted in the proper field of reality.*”

In this respect, the following words by B. Russell are very symptomatic: “*the power of using abstraction is the essence of intellect, and with every increase in abstraction, the intellectual triumphs of science are enhanced*” [13]. Thus, the abstract thinking underlying theory creation enables “illumination” of a much more extensive body of knowledge than that in which its premises “re-

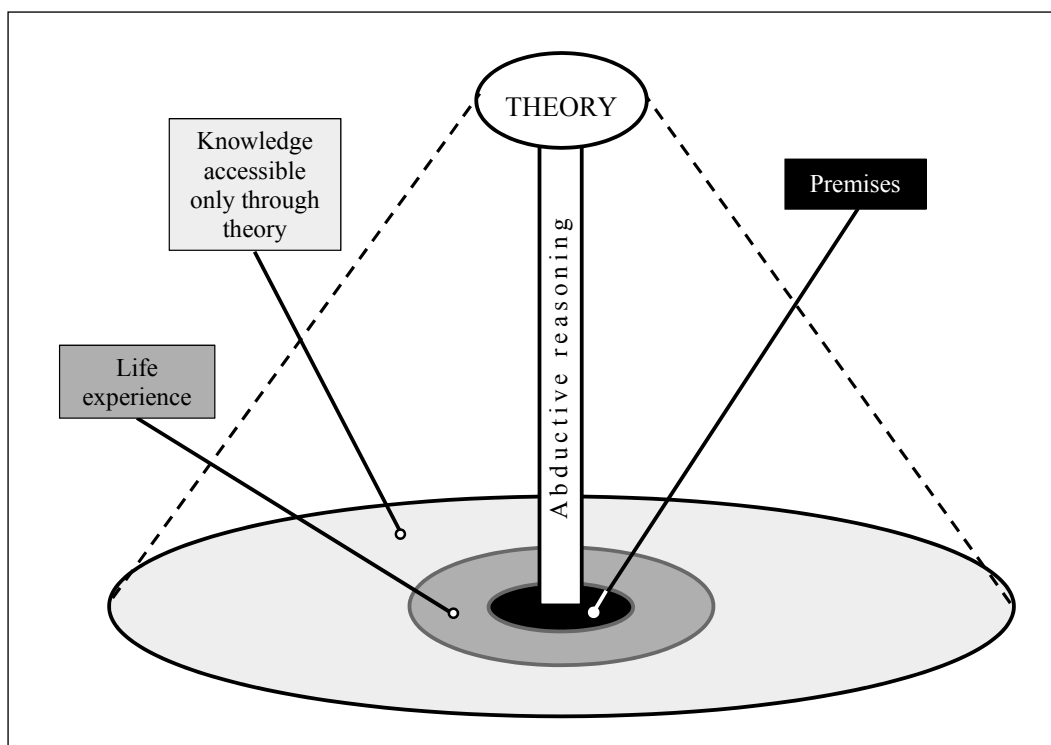


Figure 2. Premises, theory and the knowledge “illuminated” and ordered by the theory; the “Street Lamp Analogy” (SLA)

side". All this may be graphically shown with what may be termed the "Street Lamp Analogy" (SLA; Fig. 2); let it illuminate the road towards scientific success.

Thus, a theory acts like a specific servo: a small body of premises enables ordering a quite large field of knowledge. This systematically ordered knowledge makes up science. However, the greater distance from the field of premises, the greater load of probability.

It is worth noting that in the history of science, it often turned out that just the theory "illuminated" the regions of knowledge – and thus, transformed it into science – not accessible through empirical research or simple inductive reasoning ("life experience", "common sense"). This was especially clearly visible in the development of physics.

Thinking technologies: the Induction – Abduction – Deduction Triangle

Philosophy, science and technology primarily deal with transformations of the internal images of the world. Both in everyday thinking and in science, a human applies three basic strategies of such transformations: induction, abduction and deduction. C.S. Peirce wrote:

Abduction is the process of forming an explanatory hypothesis. It is the only logical operation which introduces any new ideas (my emphasis – WP); for induction does nothing but determine a value, and deduction merely evolves the necessary consequences of a pure hypothesis.

Deduction proves that something must be; Induction shows that something is actually operative; Abduction merely suggests that something may be [14, 15].

The relations between induction, abduction and deduction may be graphically presented as the Induction-Abduction-Deduction Triangle (IAD). This is shown in Fig. 3 [16, 17].

The process of prediction building starts in perception, i.e., recovering from one's own memory a specific

piece of information corresponding either to just being received stimulus, or independently retrieved from the memory. Then, one may use either induction based on previous experiences or abduction, which needs creation of a theory and following deduction. Another possibility consists in assigning an already existing theory to the current situation and applying the method of deduction.

The idea by A. Einstein, expressed in the motto of this paper, may be, however, understood in a much broader sense. Because one might ask if it is possible to achieve predictability either by induction or by abduction-deduction, and then why to take the more complicated and intellectually risky latter way of inferring instead of the simple, easy and obvious former way?

The answer may be found in SLA (Fig. 1). In this respect, highly instructive (and illustrative) is the following anecdote.

Once, when asked by someone if she could see his laboratory, Einstein took a fountain pen from his pocket and said: "There it is!" [18].

Therefore, it becomes clearly visible that without Einstein's fountain pen, it is not possible to develop science, no matter how technologically advanced the laboratory devices applied to the production of "new, original, experimental data". Paradoxically enough, already in 1871, L. Pasteur remarked:

There does not exist a category of science to which one can give the name applied science. There are science and the applications of science, bound together as the fruit of the tree which bears it [13].

Here, instructive seems to be the statement by G.V. Coyne and M. Heller that "if not Einstein in 1905, then somebody else would have formulated it (specific theory of relativity – WP) soon afterwards". However, the same cannot be said about the general theory of relativity. Only Einstein's mind was able to develop it [19]. So, it was a happy point in scientific development, where the is-

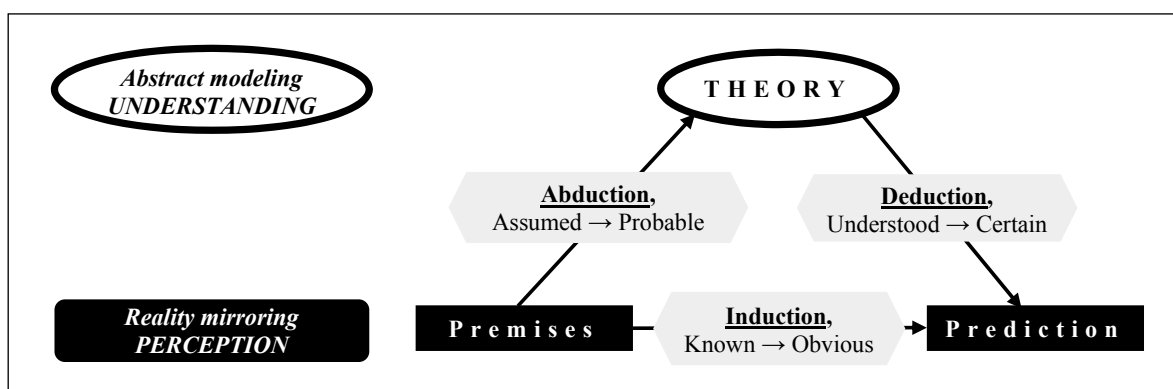


Figure 3. The relations between induction, abduction and deduction (the "IAD Triangle")

sue not explainable by the already existing knowledge and Einstein's brilliance came together. Accordingly, "new, original experimental data" are sometimes useful, indeed, but nevertheless, only Einstein's fountain pen is able to create science. Hence, analogously to Pasteur's idea, one might formulate a thesis that does not exist something like "empirical science." Empirical findings may merely make up a basis for the formulation of premises, where the arduous climbing up the abduction slope starts, which may be identified with what is commonly addressed as "theoretical science". In fact, only that way of thinking, leading towards creation of a theory, deserves the noble title of SCIENCE, without any adjectives. The theory, residing at the apex of the IAD, constitutes the ultimate product of science. It opens the way down the deduction slope towards reality, where it becomes possible to verify not whether a theory is right or wrong, but whether it is applicable (and sometimes even reliable) in a specific field of reality.

Higher and higher: the scientific staircase

While looking at Fig. 2 one may learn that the higher the street lamp (and more powerful the theory), the greater portion of knowledge is being lit with it. Thus, the important issue is, at what level the premises are located? They may be found at the level of the "new,

original, experimental data". However, in such a case, the lamp-theory cannot be positioned very high. Here, the extraordinary invention of human race – the culture – is of crucial significance. It enables intra- and inter-generational transmission of already existing theories. So, a young scientist does not need to start from the level of "new, original, experimental data", but, as if s/he ascended up the staircase, from the level of the already existing science. In fact, just this phenomenon makes up the very essence of culture as well as science. This makes it possible to place a just being created theory at a much greater height than it would be possible while starting from the level of – fashionable and seductive, indeed – "new, original, experimental data", which always remain at the level of reality.

Back to the roots: the House of Thoughts and Deeds

In the 4th century BC, Aristotle invented the peripatetic axiom, formulated in the 13th century by Thomas Aquinas in the form: *Nihil est in intellectu quod non sit prius in sensu* ("nothing is in intellect that was not first in the senses") [20]. Not until the 17th century did G.W. von Leibniz supplement the peripatetic axiom with the words: "*excipe: nisi ipse intellectus*" ("except the understanding itself") [21]. The latter might be joined with

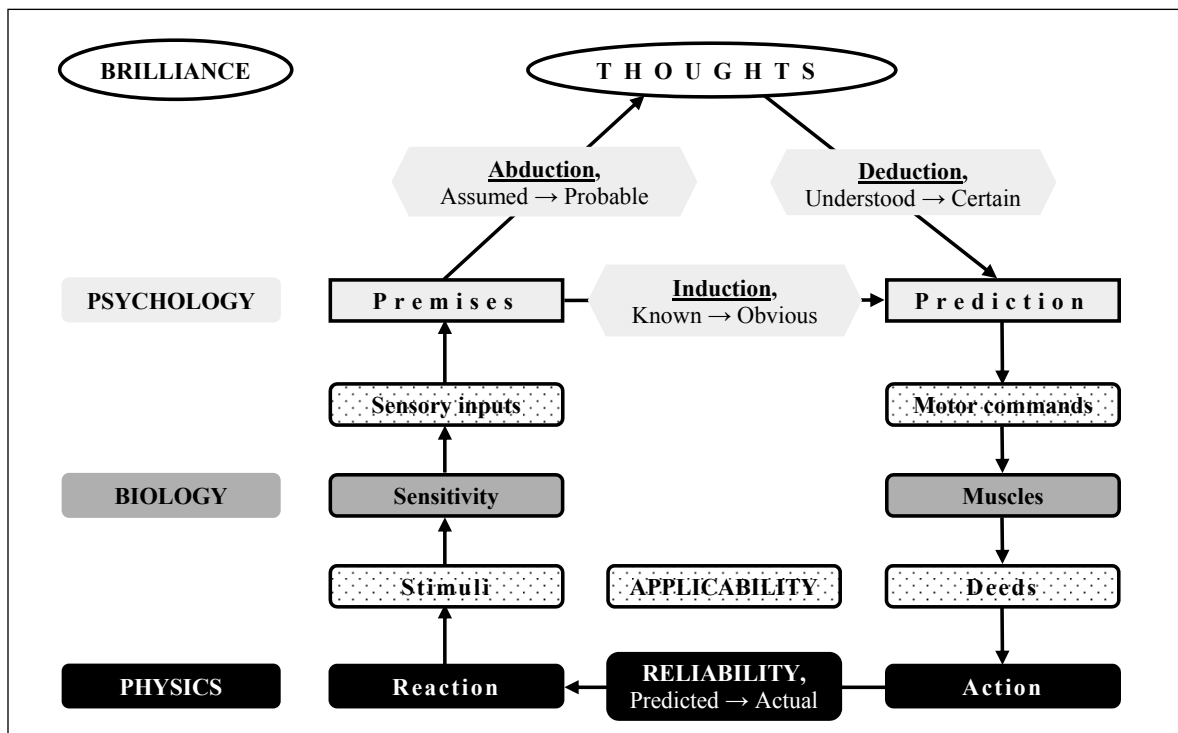


Figure 4. The House of Thoughts and Deeds (HTD). The oval block "Thoughts", while accompanied by understanding, may be identified with a theory. Human activity is limited by levels of deeds and thoughts, whereas the action-reaction level is of purely physical nature. The dotted blocks symbolize the borders physics – biology and biology – psychology

the IAD Triangle, which comprises the specific roof over the more primary structure, of biological and physical nature, which clearly corresponds to the original peripatetic axiom. So, the full physical, biological and psychological structure may be termed “House of Thoughts and Deeds” (HTD). It is presented in Fig. 4.

While looking at it, one may discern four separate levels:

- Physics (basement, Aristotle and Isaac Newton; black blocks, white letters) – action-reaction; important element of the reaction is the production of biologically recognizable stimuli, which starts sensitivity.
- Biology (first floor, Jean-Baptiste de Lamarck and Charles Darwin; dark grey blocks, black letters) – physiology and neurophysiology (motor commands, muscles, sensitivity, sensory inputs); reception, production of sensory input initiated by stimuli which arouses the sensory organs;
- Psychology (mansard, Wilhelm Wundt and Philip G. Zimbardo; light grey blocks, black letters) – “working” psychology; perception, identification of stimuli, i.e., joining them with information which resides in the memory; simple induction;
- Brilliance (cupola, Charles S. Peirce and Albert Einstein; oval white blocks, black letters) – intellect, revelatory, innovative thinking; creation of abstract, “inner reality” images, abduction.

The basis of the “mansard” needs a short comment. Information retrieved from the memory may be identified with facts. The arbitrarily chosen facts, with some probability useful (or even necessary) for starting the thinking way up the abduction slope – towards understanding and theory, potentially applicable in a given field of reality – are termed premises. Moreover, the way down the deduction slope should be no longer assigned to the level of brilliance, but to the sheer life experience. Just this phenomenon underlies the power of theory: it enables substituting arduous, risky abduction with simple, nearly mechanical deduction, without reduction of efficiency.

The statement “separate levels” does not mean that they are independent of each other. To the contrary, as already remarked by Aristotle in the 4th century B.C., “*the whole is greater than the sum of its parts*”. In fact, this might be regarded as the first description of a system. It is able to produce a system effect, unpredictable and qualitatively new, i.e., not derivable from the attributes of its parts [22, 23,24,25]. Accordingly, to produce a system effect – a brilliant theory, being the very heart of science – all the levels shown in Fig. 4 have to cooperate harmoniously with each other. In conclusion, one might say that:

- Physics is merely passive “software” (deprived of active intentionality), and makes up the “hardware” for biology,

- Biology uses the product of physics as “hardware”, and with “software” specific to it, it produces “hardware” for psychology,
- Psychology uses the biological “hardware”, and using its specific “software” creates “hardware” for brilliance,
- Brilliance bases on the psychological “hardware” and produces the pure “software”; it is so distal to physics that the constraints residing in it cannot directly influence the processes which happen at the level of brilliance.

At this point, let us be reminded of Fig. 2 and the already cited words by B. Russell: “*the power of using abstraction is the essence of intellect, and with every increase in abstraction the intellectual triumphs of science are enhanced*”. Accordingly, the higher the lamp – and the brilliance resides only at the greatest heights – the more extensive area lit by it. However, at the same time the small details are less clearly visible.

While analysing the essence of Fig. 4, one might discover that the higher the level, the greater share of elusive abstraction and the smaller – that of hard reality. Physics itself is of wholly realistic nature, whereas theory located at the apex of the “mansard”, is in its core absolutely detached from reality. Theory is an abstract structure, valid on the basis of proof and not experiments [10]. At the level of reality, one might only check whether a given theory is applicable in a given field of reality, and not whether it is right or wrong. There is no unambiguous “common denominator” for abstract theory and observable reality. This is why creation of science needs Einstein’s old-fashioned fountain pen, and not modern computers.

In Fig. 4, one might also discover a specific relation between certainty, applicability and reliability. The most abstract is **certainty**. It results from deduction and – by definition – is infallible. However, while going down towards reality – with a lower and lower share of abstraction – one comes across **applicability**. This notion means the potential ability of the prediction to be applied in reality. However, it says nothing about the sense of such an operation. So, still lower lies **reliability**, which includes both applicability and its desired effects. Thus, the excellently developed theory, followed by flawless deduction, may build impeccable certainty and prediction, which produces applicability, indeed, but not reliability. In short, reliability is located at the physical basement of action-reaction, whereas certainty – in the theoretical mansard of the HTD. This is why building a theory is much more risky than sheer collection of “new, original, experimental data.” However, only theory makes up science because, as H. Poincaré remarked, “*an accumulation of facts is no more science than a pile of bricks is a house*” [13].

This quote – in the context of the whole structure of the HTD – may be especially dedicated to the worshippers of “new, original experimental data”.

Stratification of science: mathematics and other fairy-tales

Science “resides” in the sphere of full abstraction, related to “tangible” reality or not. So it needs virtual representations of events, phenomena and processes not currently existing in reality or meta-reality. Sometimes even impossible – or apparently impossible – in reality. In this respect, science does not differ much from ... fairy-tales. Incidentally: in this respect, highly instructively is the title of the book by R. Fulghum: “*All I really need to know I learned in kindergarten*” [26].

However, it has to be emphasized that – as H. Poincaré put it – science has to be logically ordered. In this respect, the following words by biologist J. Cohen and mathematician I. Stewart sound highly instructive:

Physics takes a pragmatic and severely critical stance. It concentrates on simple, highly controlled systems; in return it expects impeccable agreement between experiment and theory ... Physics deals with an invented, simplified world. This is how it derives its strength, this is why it works so well ... Sciences like biology are less fortunate [5].

In climbing up the abduction slope towards theory, the scientists dealing with non-living matter have a very elegant and user friendly tool to their disposal: mathematics. However, already at the beginning of the 20th century (1913-1917), A.A. Bogdanov stated:

Moreover, the quantitative relations I perceive as a specific kind of structural ones, and mathematics itself – as an earlier developed, branch of general science on organization because of other reasons. This is why it has such great power as a tool for life organization [27; transl. WP].

In 1927, B. Russell described the mutual relations between mathematics as follows:

Physics is mathematical not because we know so much about the physical world, but because we know so little; it is only its mathematical properties that we can discover. For the rest, our knowledge is negative [28].

A source of such intellectual difficulties one might trace to the following statement by R. Penrose:

There are two other words I do not understand – awareness and intelligence. Well, why am I talking about things when I do not know what they really mean? It is probably because I am a mathematician and mathematicians do not mind so much about that sort of thing. They do not need precise definitions of the things they are talking about, provided they can say something about the connections between them [29].

So, mathematics, declared by F. Gauss as the “Queen of Sciences”, has two faces. While perceived as a field of intellectual penetrations, it is extremely pure and seducing, full of fantasy, yet not useful. To gain this attribute – and thus applicability in other scientific disciplines, e.g., physics or technology – it has to show its other face: it has to be reduced to the level of sheer, boring calculations. Symptomatically, it “distils” from the reality only relations between what it describes, but says nothing about their essence. J. Cohen and I. Stewart argued:

Mathematics wallows in emergent phenomena. It also came to terms, long ago, with something that often puzzles non-mathematicians. By definition, mathematical statements are tautologies. Their conclusions are logical consequences of their hypotheses. The hypotheses already ‘contain’ the information in the conclusions. The conclusions add nothing to what was implicitly known already. Mathematics tells you nothing new [5].

A similar view has been presented by A.A. Bogdanov. A. Gare wrote:

Bogdanov argued that all advances in knowledge are based on ‘substitution’. Knowledge is organised by cognitive models through substitution. Substitution begins with language [30].

The latter sentence is very symptomatic. It had been written 30 years before N.A. Bernstein presented his – systemic in its nature – five-level model of movement construction [16, 17, 31, 32, 33]. Language is no doubt the product of Bernstein’s abstract D-level, detached from real, physical stimuli. Such a detachment was the necessary price to pay for extending the time axis far into the past and future, beyond the limits marked by sensory organ potentialities [17]. Hence, science as a whole, metareal in its essence, is being “woven” of words and notions. While seen from such a perspective, something like “empirical science” ... does not exist at all! It is merely an auxiliary procedure either for the selection of premises, or for verification of applicability (and sometimes reliability) of a theory. It has to be earlier worked out in the region termed “theoretical science”.

Thus, mathematics is highly useful in the world of non-living items. Such a thing neither “remembers” its previous experiences, nor does it have any expectations directed towards the future. So, they have no influence on its current behaviour. It is absolutely indifferent to future events. Consequently, the relations joining the non-living items are highly predictable and easily mathematically describable. On the other hand, in biology between stimulus and response, a new element appears: the information. In biology, it is of evolutionary nature. It is directed towards future, so here arises a qualitatively new ability: purposefulness. Symptomatically, a living being cannot actively influence evolutionary shaped purpose-

fulness. Still higher, in psychology, a living being gains the ability to actively shape its expectations and to plan its behaviour, i.e., intentionality. Both purposefulness and intentionality include no simple relationships, hence mathematics in this region of human knowledge is hardly effective. J. Życiński argued:

It cannot be excluded that those fields (emotions, aesthetic, ethics – WP) determining the specificity of the human soul will turn out to be inaccessible to attempts of mathematization and thus, one might speak of relative transcendence of human spirituality as related to the mathematical matrix of the world [34; transl. WP].

However, as only ordered knowledge deserves the noble title of science, another tool for knowledge ordering has to be applied. In this respect, the theory of systems seems to be the most promising. L. von Bertalanffy is credited for its creation [35]. However, about a half century earlier, A.A. Bogdanov invented the universal science on organization which he termed “tektology” [27, 36, 37, 38]. It is worth noting that Bogdanov’s perspective included all the regions of human cognition, whereas that of von Bertalanffy – mainly the biological ones.

However, the great service of mathematics is that it opened the perspective towards the abstract world of events, phenomena and processes, completely detached from reality. Only this underlies the way from premises to predictability through theory. As Bogdanov stated, in mathematics such a discovery was relatively obvious and easy. Moreover, it turned out to be highly effective also in non-living physics. Unfortunately, in biology and all the more, in psychology (and motor control as well), the road to success is much more bumpy than that in physics.

To put it briefly, one might imagine a specific “Bogdanov’s dominoes”. *“Mathematics itself – an earlier developed branch of general science on organization, because of other reasons.”* Then, physics itself (being firmly rooted in mathematics) developed as the next branch of general science on the basis of organization. It was (and is) the main engine of science development in the several past centuries. The next challenge is biology. It is worth noting that already in 1864, A. Comte divided physics into two sub-categories: *“physique organique”* and *“physique inorganique”*; the latter may be identified with biology [39]. So, the connections of physics and biology seem to be obvious. This is why M.L. Latash, repeating the idea of I.M. Gelfand, wrote:

We live in very interesting times. The few previous centuries were those of physics... If human beings want to survive as a species, the twenty-first century has to be the century of biology [40].

At that point, Bogdanov’s dominoes include three tiles: mathematics, physics and biology. The next one

is psychology, for which biology makes up merely the “hardware”.

At that point, it seems instructive to fasten a buckle joining those highly abstract considerations with motor control. In this respect, A. Wohl maintained: *“All that we dispose of, all what constitutes the resource of our culture, all the pieces of art, science and technology – all that results from motor activities”* [41]. So, the only manifestation of each and every mental process is a movement, and our last domino tile is motor control. In summary:

- Mathematics itself is indifferent to reality; it “developed earlier”;
- Physics itself is indifferent to future; it “developed later”;
- Biology bases on purposefulness, passively directed towards the future; it should develop as soon as possible;
- Psychology bases on intentionality, actively directed towards the future; it has to grow and bloom as “software” basing on biological “hardware”;
- Motor control adds physical execution potentialities to psychological intentionality, realized with biological mechanisms; it underlies any observable manifestation of psychological processes and thus, makes them (indirectly) researchable.

In short, motor control makes a specific “buckle” joining physics (external to it) with biology and psychology. Physics makes up the “hard ground”; biology “cares” for common sense and realizability, here and now; psychology – for dreams, not always realizable. While seen from such a perspective, the statement that nowadays motor control constitutes the greatest challenge for science as a whole, sounds by no means absurd.

A propos, according to S. Dehaene, the process of mathematic development stemmed from a primeval number sense [42], firmly rooted in observable reality. In motor control, the process of intellectual development returns its products back to reality. This may be associated with the “strange loops” described by D.R. Hofstadter [43; 44], as well as with the “logic of loops” or “nonlinear logic” discussed by M. Heller [45].

While generally speaking about the stratification of science, it seems worth quoting the statement by M. Nadin that *“philosophy remains a science of sciences”* [46], i.e., just philosophy makes up “leading edge” of knowledge penetrating the Unknown, not yet “harnessed” by the human mind. Moreover, he also claimed that *“science was born together with the magical, and would continue to develop in this symbiosis”* [46]. In this respect, the words by R. Thom sound instructive, who said: *“It is true that mathematicians envy each other, but as far as hatred is concerned – they reserve it for physicists”* [4; transl. WP]. One might paraphrase

this aphorism and say that “scientists envy each other, but they reserve their hatred for philosophers”. This is why among scientists, the label “philosopher” is by no means meritorious. It should be added that this makes up a very significant inhibiting factor in the progress of science, which is nowadays dominated by serious, methodological scientists, whom I term “with noses by the ground”. In the PST-Funnel (Fig. 1), their achievements should rather be positioned in the field of technology than science. To say nothing of philosophy, in which real progress can find its roots.

Sport and physical education sciences: computers and Einstein’s fountain pen

In science, knowledge as a whole has been divided into particular disciplines. Also, in the branch of physical education and sport it was necessary to create separate fields of knowledge. Each of them has its own specificity, sphere of interests and methodology of research. All of them should cooperate with each other and constitute not separate “islands of knowledge”, but one consistent SYSTEM of ordered knowledge. Unfortunately, the actual situation is, no doubt, far from such an ideal image of science. This is why K.R. Popper stated:

... universities, completely foolishly, have fragmented the knowledge into different, specialized branches; each of them, without any necessity, has been closed into its own ritual and terminology [4].

Using the methodology adequate for one discipline in another discipline seems to be especially inefficient. The space of possible methodologies might be perceived as limited on the one hand by computers, and on the other – by Einstein’s fountain pen. The former are nec-

essary, indeed, not only to yield the premises for theory creation, but also for delimiting the area of applicability of that theory. However, for the production of a theory, being in fact the essence of science, Einstein’s fountain pen is absolutely necessary.

In the branch of physical education and sport, let us choose three especially important disciplines: physiology, biomechanics and motor control. Their mutual relations have been shown in a graph, which – analogously to the “House of Thoughts and Deeds” – may be termed “Hut of Sport Sciences” (HSS; Fig. 5).

The way from physiology to biomechanics may be lead through the induction path. It does not include a deep understanding of the phenomena and processes involved. It is short, easy and yields immediate effects. However, without understanding, they are inevitably of rather poor quality. Such a relation between physiology and biomechanics might be compared to the two inner circles (physiology – premises; biomechanics –life experience) in Fig. 2.

The other possibility is the abduction-deduction path. It is much longer and gives no immediate results. However, only such a path enables creation and application of high-tech intellectual products, e.g., periodization in sports training.

It seems instructive to quote the question posed by physicist M. Grabowski, whether the quality of knowledge just being collected influences the “visibility” of the ideal of truth and, as a consequence, the attitude towards it? To what extent do the efforts of numerous scientists, all over the world, contribute to the production of triviality [47]? In other words, to what extent do they merely extend R. Thom’s useless “cemeteries of facts” [4]?

Nowadays, while using modern, sophisticated laboratory devices, it is highly seductive to a scientist dis-

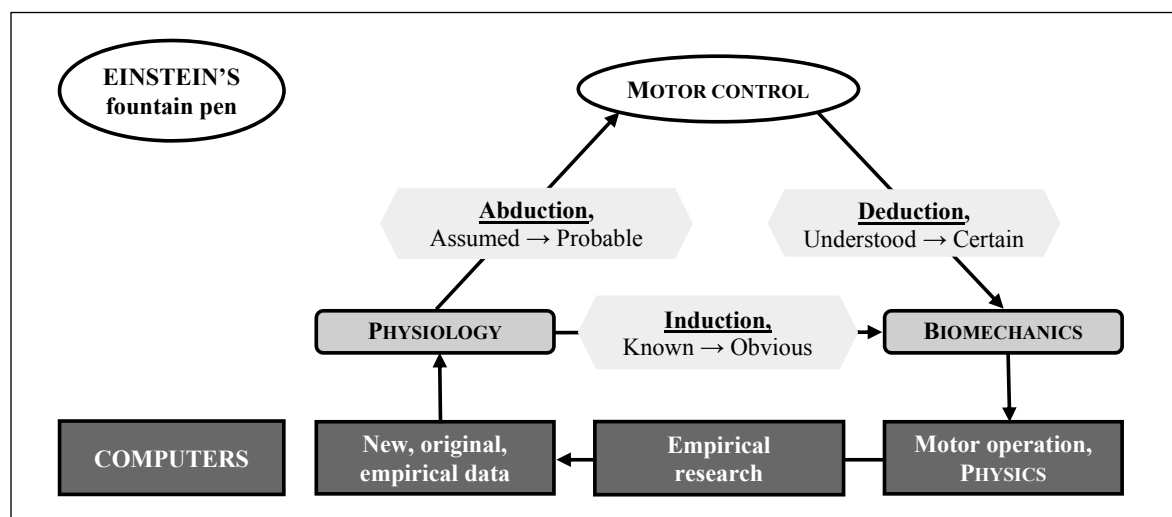


Figure 5. The Hut of Sport Sciences (HSS). Mutual relations between physiology, biomechanics and motor control in the branch of physical culture and sport

posing of sophisticated laboratory equipment to label him/herself as a “researcher” and to produce, sometimes completely mindlessly, “new, original, experimental data.” This is why R. Thom melancholically remarked:

... information stallholders push the scientific world towards the new, and new hope and fact collecting towards observation without reflection. Modern science has got breathlessness, because scientists term true that which is, in fact, merely a technological achievement [4; transl WP].

However, such a methodology, while applied to motor control, confines it to the low region of the schema shown in Fig. 3, where there is no element of understanding of the mechanisms underlying human motor behaviour. As a result, the purely empirical research rather contributes to development of “life experience” (or even the “cemetery of facts?”), and not to that of science. In fact, motor control resides somewhere at the apex of the “roof” of the IAD Triangle. To cross the t’s and dot the i’s, the computers are useful somewhere in the basement and low floor of the HTD shown in Fig. 4 – where the “scientists with their noses by the ground” work – but at the peak of it, Einstein’s fountain pen is prerequisite. In short, in motor control the experimental methodology is hardly effective. So, there is no escape from Einstein’s fountain pen procedure, however painful it may be ...

The considerations about truth in science go far beyond the scope of this paper. This has been exhaustively discussed by many philosophers, among them P. Feyerabend [48, 49, 50]. However, Grabowski’s question shows that scientists may produce either trivial, or significant science. In this paper, I am attempting to show that in motor control, applying the empirical way of research leads – in advance and straightforwardly – towards banality.

Nevertheless, scientists dealing with motor control try, again and again, to “tinker” with this field of science using empirical research and elementary statistics. In this respect, the quotation Thom’s sounds especially instructive. Still, the aphorism, attributed to A. Einstein sounds more categorical, which states that “*insanity: doing the same thing over and over again and expecting different results*”.

J. Życiński melancholically remarked that “*the concern for the intellectual environment of a human needs cultivation of the difficult art of thinking. However, nowadays, this art remains a solitary job with an extremely low rating in rankings of popularity* [34; transl. WP]. For motor control, it is especially important because this discipline of science is being produced more by thinking than by experimenting. Fortunately enough, one might discern a light at the end of the tunnel. J. Życiński argued:

In contemporary science, a profound retreat from empiricism took place. The whole process of development of modern science shows discovery of the fundamental role of abstract structures being realized in specific natural processes [34; transl. WP].

Sadly, now the words by Życiński may be interpreted as “wishful thinking”. One cannot help the feeling that in contemporary science, the mindless race of lemmings, in the spirit of “The Guinness Book of Records” – supported by hi-tech computers and branded with great names – goes on unperturbedly. Nevertheless, the life of a scientist without hope would be impossible ...

Conclusion: stop working, start thinking

The necessity of thinking in science – however paradoxical it may sound – becomes more and more obvious. Biologists J. Cohen and G. Medley point out that necessity in the book with the very symptomatic title: “Stop Working & Start Thinking: A Guide to Becoming a Scientist” [51]. The message of this book may be summed up by paraphrase of the 16th century physician - W. Oczko’s – adage; one may state that thinking may substitute a computer, but no computer is able to substitute thinking. Originally, Oczko claimed that movement may substitute medicine, but no medicine may substitute movement.

In previous stage of scientific development, it mainly based on observations and experiments. R. Thom argued:

Since the 17th century modern science is only possible to such an extent as theoretical progress overtakes the experiment. We owe great achievement no more to the discovery of new facts, but they appear rather as new ways of thinking or interpretations of already known facts [4; transl. WP].

At the end of 19th century, such an “overtaking” enabled the creation of quantum physics. The thoughts of M. Planck, who invented the concept of “quant” and thus laid down the grounds for quantum physics, went far beyond not only the possibilities of direct observation, but also potentialities of the then existing laboratory equipment. Application of the same thinking methodology is – all the more – necessary in contemporary motor control. However, it has to be positioned much higher on the scale of abstraction than physics, so one has to take into account that in our discipline, any support by observations and experiments is by far weaker. If it even exists at all.

Motor control is probably the most theoretical among all contemporary physical culture disciplines. As a result, admitting that motor control is an almost purely theoretical discipline – however strong the intuition of worshippers of “new, original, experimental data” protest against it – becomes more and more necessary. In 2009, at the

International Association of Sport Kinetics conference in Belgrade, the outstanding researcher P. Komi stated that the whole data bank collected by contemporary scientists comprises the legacy for next generations [52]. So, nowadays scientists dealing with human motor activities either do not want, or are not able to order that huge empirical body of data. As a result, they may be positioned in the “cemetery of facts” rather than the lively mental structure producing scientific theories. Moreover, in physical education and sport sciences using the data collected by others, and not gathered with their own hands, i.e., mental, and not manual work has low value within the scientific society. In this respect, the following quote by R.A. Schmidt sounds like a warning: “*Fleishman’s work leaves a legacy for future efforts on solving problems of prediction*” [53]. It is to be emphasized: not “for solving”, but “for future efforts on solving.” Let us be reminded that E. Fleishman worked on the identification of motor abilities which might underlie prediction of fitness of a given individual for say, a specific sport discipline. This way of thinking turned out to be a dead end. The following statement by R.A. Schmidt and C.A. Wrisberg is symptomatic:

Thus, it appears that predicting future performance on the basis of people’s abilities alone is, at best, an imperfect science [54].

Still more categorical – or even downright ominous – sounds the following quotation of psychologist G. Gigerenzer:

Some years ago I spent a day and a night in a magnificent library reading through issues of the “Journal of Experimental Psychology” from the 1920s and 1930s ... What depressed me was that nearly all of this meticulous work has been forgotten. Most of it involved collecting data without substantive theory. Data without theory is like a baby without a parent: Its life expectancy is low. Are these the kind of babies we want to produce? [55].

Thus, while adhering to experimental methodology in motor control research, and not to wise and inventive conceptualization, it seems highly probable that we are just producing properly processed, scientific knowledge which will never contribute to real progress in our discipline of science. So, the statement that “*motor control is an empirical science*” [56] is not only false, but simply harmful.

Motor control also enables a specific perspective on the role of particular types of “knowledge factories” in the creation and ordering of human mental representation of reality and delimiting their fields of interests:

- Philosophy – **universities**; high abstraction, creation of general ideas (pure knowledge), without any specific goal in mind;

- Science – **academies** and **polytechnic institutes**; making use of university knowledge; production of ordered, applicable knowledge;
- Technology – **everyday life**; exploitation of the applicable knowledge produced by academies.

Let us be reminded that probably the most challenging issues in modern science – as a whole – are the problems of human behaviour. The only manifestation of them, the movement, is being assigned not to universities, but – all over the world – to academies of physical education, being in fact vocational schools. Their motto may be expressed with the words “*citius, altius, fortius*”. As soon as possible. Now! Even without any understanding, without theory creation! It is important, both in sport and in everyday life, indeed. But, to immediately achieve the aforesaid goals, the activities of such schools have to be focused on the lower parts of the HSS (Fig.5). However, to build any understanding of the phenomena and processes underlying human behaviour – physical education pedagogy, theory of training, psychology of sport, etc. – it is necessary to look at them from a university perspective. Unfortunately, nowadays, the latter is also more and more directed towards immediate, practical usefulness; let us bear in mind the considerations of B. Russell, melancholic in their essence, about “theoretical science” and “practical science”. So, it seems more and more necessary to go back to the roots and shape the proper structure of human knowledge, alike that presented in Fig. 1.

Accordingly, expectations that university knowledge – even if produced in higher education schools other than universities – should yield immediate effects, applicable in everyday life, may lead to the death of science. This is what the quoted words of both Russell and Thom were about. And this is why in this paper, I am joining those who exhort: Let us build the ark before the deluge! Save the profound, though apparently useless, philosophy before it is completely overwhelmed by the superficial, though the immediately useful, technological revolution! Let us be reminded of the words of the philosopher V.V. Rozanov, who stated that “*revolution has only two dimensions, length and width, and lacks the third, depth*” [57]. And out of all the physical education sciences, only motor control needs – as oxygen – “philosophical air”, an “intellectual depth” enabling successful climbing up the abduction slope, and not “new, original experimental data” which at best, may bear spectacular technological development – immediate, impressive, often with some air of magic, indeed, yet deprived of depth and far reaching perspectives for future progress.

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