## Mokslas ir kalba

# THE NEED FOR ARISTOTLE IN CONTEMPORARY SCIENCE

**Peeter Müürsepp**

Faculty of Humanities and Social Science
Audentes Mainor University
Estonia
Tondi 84, 11316 Tallinn
Fax/Phone: +372 699 6600/+372 699 6555
E-mail: peeter.myyrsepp@audentes.ee

*In XVII-th century Aristotle was proclaimed outdated and uninteresting from the point of view of advancement of knowledge. This attack was mostly aimed at logic. The attackers did not notice the principal difference of the physical and metaphysical works of the Stagirite from his logic. Only in the last decades of XX-th century the idea of the two different Aristotles began to gain recognition. First of all we should thank Daniel W. Graham for this development. It is René Thom, however, who has presented a consistent conception about the need for the application of Aristotelian approach in contemporary science. Despite bringing up the excellent idea of connecting materialism with finality, R. Thom has failed to understand the real meaning of the Stagirite's system of four causes.*

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The conception that Aristotle has developed and modified his ideas throughout his scholarly life first appeared in XIX-th century Aristotelianism. In late XX-th century several scholars, including René Thom and Daniel W. Graham have continued the tendency by presenting the hypothesis of two quite distinct parts in the legacy of the Stagirite. It appears that we have to distinguish clearly between logical and physical-metaphysical aspects of Aristotle works. It is clearly the latter one that has significance for the methodology of contemporary science. R. Thom has rightly emphasized the importance of connecting materiality with finality by Aristotle. However, he has failed to understand the necessity to view the Stagirite's system of four causes in its totality. This is even more surprising as there are approaches to natural science already, where Aristotelian legacy has been treated in much more adequate way, i. e., the approach of Ilya Prigogine.

As the result of the intellectual changes in XVII-th century, Aristotelian science was, to a large extent, replaced by a new approach, which

started to yield remarkable practical results rather quickly. This tendency was deepened in science throughout the following centuries and culminated in the pragmatist-positivist science and analytic philosophy in late XIX-th century. The general outlook of the scientific scene remained rather bright until the last three decades of XX-th century, when it was suddenly realized that a different kind of metaphysical foundation is necessary to return some intelligibility into this world of ours.

Philosophers and methodologists of science started to look for new kinds of general approaches. In such situations it is natural not just to try to invent anything new and original, but to look into the past times. The current situation mostly, but not solely, in natural science, implies the ancient parallel between the Heraclitean and the Parmenidean approaches. Classical science has developed in a perfect accordance with the basic Parmenidean ideas. The search for idealized abstract entities, situations and processes has prevailed. Now it seems that such methodology has come to a dead end. This implies the necessity to turn the page into the direction that would be based on the Heraclitean approach.

Such turn needs to be explained in a greater detail. What does it mean to apply the Heraclitean approach? The somewhat obscure thinker from Ephesus is usually interpreted too superficially, in the manner of *everything moves*. In the few preserved fragments from Heraclitus probably only one exposes absolute relativism: "We step and do not step into the same rivers; we are and are not" (Heraclitus 1987). But even here the identity of the river and of the stepping and existing entity remain preserved. The main body of the fragments shows something else. It would more suitably be treated as an early attempt to describe the world as constant becoming, or even as synthesis of becoming and being. How could one speak about stepping into *the same* rivers, if nothing would remain the same at any moment in any sense?

As a matter of fact, Heraclitus has never said that absolutely everything is in a constant flux. Consider, for instance, fragment 12: "As they step into the same rivers, different and (still) different waters flow upon them" (Heraclitus 1987). The waters really keep flowing, but at the same time, the rivers themselves remain the same. In a greater detail, the same attitude has been exposed in fragment 91a?, (91b): "(a) [for, according to Heraclitus, it is not possible to step twice into the same river, nor is it possible to touch a mortal substance twice in so far as its state (*hexis*) is concerned. But, thanks to ⟨the⟩ swiftness and speed of change,] (b) it scatters ⟨things?⟩ and brings ⟨them?⟩ together again, [(or, rather, it brings together and lets go neither "again" nor "later" but *simultaneously*)], ⟨it⟩ forms and ⟨it⟩ dissolves, and ⟨it⟩ approaches and departs" (Heraclitus 1987). This fragment proves that, according to Heraclitus, things are in flux just as far as their hexis is concerned. The essence of things, however, tends to remain the same. Their identity is supported rather by the permanent change of state than by some unchangeable substance. Moreover, as the brackets in the last quote indicate, the example about the impossibility of stepping twice into the same river, may not be Heraclitus' own.

Heraclitus' philosophy of nature is an amazing example of a powerful mind of the early stage of the development of European civilization working in the same line as the minds of the most contemporary natural scientists dealing with the problems of self-organizing systems. During the dominance of positivist-pragmatist worldview Heraclitus' philosophy could hardly be adequately comprehended. The Ephesian was

considered to be in absolute opposition to Parmenides. The Heraclitean worldview could thus be taken just as a common sense description of nature, which is fundamentally different from scientific approach. Indeed, this was the case for classical science. From the position of "new science", however, things look different. The Heraclitean flexibility has become almost inevitable as the methodological basis for contemporary natural science.

However, the Heraclitean basis is obviously not a sufficient foundation for the methodology of contemporary science. If so, what could be more natural than making a fresh start with the thinker, whose ideas were once overthrown as obsolete, namely, the Stagirite. His views have normally been taken as those opposing to Plato's. It was long thought that Aristotle's criticism of Plato is a "territory", where nothing new can be found. Strangely, just from this territory a new kind of approach to Aristotle and may be also to the whole contemporary science was started.

The French philosopher and mathematician R. Thom has written: "It seems to me that in the heart of Aristotelianism there lies a latent (and permanent) conflict between an Aristotle who is logician, rhetorician and even, when he criticizes Plato and the Ancients, sophist, and another Aristotle, who is intuitive, phenomenologist, and almost in spite of himself, topologist. It is with this second (rather misunderstood) Aristotle that I work, and I tend to forget the first" (Thom 1990: 244). In addition, one can find the systematic exposition of two Aristotelianisms, incompatible according to the author, in a book by Daniel W. Graham (Graham 1987).

D. Graham speaks about the developmentalist and the unitarian view on Aristotle. Let us take a brief look at these views. Aristotle's treatises likely remained in his possession throughout his life and could be modified several times. This means that it should be hard to see any development in the Stagirite's philosophy. However, there still seems to be an objective basis of dating certain Aristotle's works. It is quite possible that Aristotle progressed from Platonism to a practical empiricism (Graham 1987: 5).

The unitarian view ignores the alleged presence of different temporal strata in the Stagirite's work. Aristotle himself does not seem to recognize a historical stratification. Why should his commentators do so then? However, the Stagirite's system is obviously not self-consistent. When an historian of philosophy discovers an inconsistency, he cannot simply flag it and continue his survey. He has to explain it.

Is it possible to reconcile the two points of view? Perhaps, the ideal would be accommodating both views. It is interesting to note that a strangely reversed view exists in the developmental case. It has been pointed out that Aristotle develops rather towards than away from Platonism (Graham 1987: 10). In order to establish the direction of Aristotle's development, a method involving the use of both genetic and systematic points of view should be employed. Thus, we can see Aristotle as a philosopher working out the systematic implications of his methods. In this process he seems to be hammering out a philosophical system that has roots in an earlier and different position (Graham 1987: 11). This means that, in principal, genetic and systematic points of view can be combined in an efficient way.

However, D. Graham goes on stating that there is a very natural place to draw a distinction between systems (Graham 1987: 14). There seems to be one major break in Aristotle's work, which potentially serves as a fault line. If this

holds, there are just two and only two major systems in Aristotle.

D. Graham writes: "The great divide that I see in Aristotle's work is roughly coextensive with the distinction between the *Organon*, or collection of logical treatises, on the one hand and the physical-metaphysical treatises on the other" (Graham 1987: 15). Usually developmental interpretation has been excluded as an explanation of this divide. In fact, there has been a general neglect of the relation of the logical to the physical works. Almost no research has been devoted specifically to this topic. Let us now summarize the core claim of D. Graham:

> (1) There are two incompatible philosophic systems in Aristotle, namely those expressed in the *Organon* and the physical-metaphysical treatises, respectively.
>
> (2) These systems stand in a genetic relationship to one another: the latter is posterior in time and results from a transformation of the former (Graham 1987: 15).

There probably does exist a way towards a consistent Aristotle. However, searching for this way is not among our primary tasks at this point.

Instead, one has to find out, if the second Aristotle of R. Thom can be taken as the creator of the second system of D. Graham. It is definitely the second Aristotle who has written the physical-metaphysical treatises. Another question would be, if the ideas expressed in these works are really sufficient for calling Aristotle a topologist. This specific issue has been discussed in a different paper (Muursepp 2002: 45–56).

It is quite obvious that in XVII-th century the first Aristotle of R. Thom was rejected and no one even did seriously think about the existence of the second, rather different one. Now things have changed and one can reasonably undertake an analysis of Aristotelianism of the second type.

There are two branches in contemporary natural science, where Aristotle's approach is likely to remain and probably even to become more relevant: biology and physics. There already does exist a definite number of suggestions as far as physics is concerned.

In order to succeed in our present task we have to introduce the basic ideas of semiophysics of R. Thom. The term was suggested when the use of models in catastrophe theory was called the "physics of sense" (*physique du sens*), by Jean Petitot (Petitot 1985: 293). By the words of R. Thom: "Semiophysics is concerned in the first place with seeking out of significant forms; it aims to build up a general theory of intelligibility" (Thom 1990: VII).

According to R. Thom, two types of such significant forms exist: saliences and pregnances. R. Thom defines the first type as follows: "I shall call *salient form* any experienced form clearly separate from the continuous background against which it stands out" (Thom 1990: 3). Any visually perceived object could be called a salient form. A salient form that is seen will have an interior and a boundary.

Salient forms can have a certain impact on a subject's sensory apparatus. However, this impact remains transient and short-lived. Salient forms have no long-term effect on the behaviour of the subject or on its physiological state. Therefore, it is quite obvious that another type of forms should exist, namely such that carry a biological significance for a living being. R. Thom calls such forms *pregnant*, and the specific character of theirs *pregnance* (Thom 1990: 6). All pregnant forms are *ipso facto* salient. There are rather few pregnances, which are clearly encountered in higher animals (birds and mammals): hunger, fear and sexual desire.

The ideal of contemporary science and of positivist philosophy has long been reducing

everything to salient forms, with no interaction allowed other than collision between these forms (Thom 1990: 17). On the one hand, this idea of R. Thom may seem too simplistic and straightforward at the first glance. On the other hand, it is quite well grounded by the example of quantum mechanics. In this branch of physics the particle, which is a salient entity, is identified with the field, which is a pregnantial entity (Thom 1990: 17). But this means that there exists no serious consideration of intelligibility, which is, however, a property of phenomena prior to any conceptualization in the strict sense.

In order to bring intelligibility into the picture, R. Thom introduces the notion of intelligible ontology. By an intelligible ontology he means the following:

> 1. An intelligible ontology is characterized by a space where all the beings considered reside: the *substrate* space. We shall see it as a Euclidean space (or a differentiable manifold) of arbitrary dimension B.
>
> 2. Within B the beings of this ontology are divided into two classes: salient forms and pregnancies (Thom 1990: 16).

R. Thom seems to be striving for a qualitatively new approach to the world, in order to indorse intelligibility. His definition of intelligibility, however, has been given in a very traditional technical manner of positivist-pragmatist science. Still, this way of giving the definition may be a good start as it is understandable for thinkers used to reason in the style of classical scientists.

Positivists would prefer to believe that the notion of cause was only a metaphysical residuum to be dissolved in the more general notion of scientific regularity ("nomology") (Thom 1990: 33). They seem to be forgetting that if all science is necessarily general, the analysis of phenomena, whether theoretical or pragmatic, is always local. It was just neglecting this aspect that enabled to do away with natural philosophy in the age of positivism-pragmatism.

Today, there exists an attempt to propose an interpretation of Laplacean determinism in terms of Aristotelian causality (Rosen 1985). The differential law would depend on formal causality and the initial condition on material causality. Efficient causality appears only in the origin of the formal expression of the differential system. From this angle, Newtonian dynamics may be considered as an intelligible ontology, the salient entities of which are the material points and the pregnancies of which are kinetic momentum $J=mV$ and force F (Thom 1990: 35).

It should be made clear that the salience-pregnancy model does not aim to predict phenomena. The success of an action of a subject on an object is never certain *a priori*. The description of the universe in terms of this formalism is not stable but constantly subject to revision. "It is the function of Aristotle's *logos apophanticos* to keep the mind aware of changes in the state of salient entities, of pregnance invasions and of their effects" (Thom 1990: 36).

Although the origin and flow of the *logos* might be problematic, Aristotle necessarily enters the scene. A salient form has to be lit up before it can be seen. Now one may definitely wonder, whether darkness can be looked at as a pregnance. It should because of its propagative virtues. Light and darkness are antagonistic pregnances whose conflict is controlled by optics. "We see that science here is doing its best to get rid, as thoroughly as possible, of the fundamental qualitative indetermination of the model" (Thom 1990: 37).

R. Thom considers Aristotelianism especially interesting because of the association of materialism and finalism in Aristotle. Teleology of the Stagirite is probably indisputable. His materi-

alism, however, can certainly be debated. Still, R. Thom makes it quite clear, what exactly does he mean by the materialism of Aristotle, namely, the rejecting of the possibility of a Platonic existence without matter. (Thom 1990: 217). In this sense R. Thom's position seems to be justified.

But R. Thom goes further than that by stating that this association has not been found ever since Aristotle. This statement implies the suggestion that the association of materialism and finalism is the key issue, which makes Aristotle's teachings so relevant for contemporary science. More specifically, we should say that by the presumption of R. Thom contemporary science has been suffering from the lack of finalism. It would be hard to find deficiency of materialism in it.

However, only after specifying, what do we really mean by Aristotelian finalism, we can evaluate its hypothetical necessity for contemporary science. By analyzing finalism we can find ourselves in the realm of Aristotelian causality, trapped in the problems raised by the notion of final cause. "It must be realized that a strictly final cause, i. e., a cause strictly posterior to its effect, raises almost insuperable problems of intelligibility" (Thom 1990: 215).

In modern science causality is usually thought of as resulting from the transport of invisible but efficient entities that come from the cause and bring about the appearance of an effect. This means that there are in principle two cases to consider:

> Either: The human experimenter has no way of acting on this transport, of stopping or of disturbing it.
>
> Or: He is able to stop this transport, for instance by erecting a wall impermeable to the efficient entities between effect and cause (Thom 1990: 216).

Most scientists reject the first possibility. Only some physicists admit it for quantum mechanics. The second case, however, would imply that the experimenter is able to intervene in his own past. Needless to say, this is something very difficult to accept. "In what we believe to be Aristotle's conception of the act, the aim of the act (its *telos*) is the organizing centre of a process that may be considered as a morphogenetic field, an anhomoeomerous part of space-time, a form imposed on the future" (Thom 1990: 216).

It is very important to emphasize, even more than R. Thom has actually done, that such validity is only qualitative (topological). Nothing can be said about the quantitative dimension of the domain where the model will be applied.

We can see that all finality is necessarily conditional, as is all formal causality involving the future (Thom 1990: 216). What about the connection of Aristotelian teleology and contemporary science now? Let us turn to a definite quote from the Stagirite: "The active agency is a cause, as being the source from which the origin of the movement comes, but the end in view is not active..." (Aristotle 1992: 13–15). The final cause is not active for the Stagirite, at least not directly. Active role is left to the efficient cause, like in the case of the statue example. All finality in Aristotle demands the presence of entities being in the state of privation, which will fulfil their need by realizing the requirements of the future form. They need not be aware of this themselves. Very often, probably in most cases, they are not (Thom 1990: 216). Now the problem of matter does arise. Aristotle would probably say that a material support *materia signata* is necessary to begin with. Just any matter would not do. Embryologists would call the required matter a competent terrain.

The formal cause acts on space-time creating there an anhomoeomerous part of given form.

But the extension to the future depends on contextual situations, which are generally difficult to describe in detail. In Aristotle, the model is given on a local map whose real extension in space-time we do not know. In physics such knowledge can be obtained, thanks to what R. Thom calls "the miracle of physics" (Thom 1990: 216).

All entities in "this world" have a beginning (*genesis*) and an end (*thora*). One can construct a graph limited in time, generally culminating in a unique vertex. The end of the graph (*teleute*) is sometimes identified with the *telos*. In the case of man the "time" function reaches its maximum at the adult age. This is the *teleion*, the perfect state. It should be clearly distinguished from the terminus (*teleute*), which is death in the case of a man (Thom 1990: 146). In the case of the Stagirite the *telos* appears to oscillate between the two meanings, *teleion* and *teleute*. This is a clear ambiguity in Aristotle, which seems not to bother him.

Let us take a look at the parallel situation in modern science. Classical (Newtonian) science seems not to bother about the real meaning of telos as well. It takes interest in formulating absolute fixed results and is hostile to ambiguities. The notion of telos, in the end, seems to contain an immanent ambiguity. Our original question about the need for finalism in modern science has acquired an unexpected form: should there be more ambiguity in modern science? Our answer to this question is affirmative and as such, begs for an explanation.

Science should not just give complete ordered narratives about distinct pieces of objective reality. To put it briefly, progressive science has to deal with looking for the *telos* of ongoing processes. Does it do this? Well, in some cases the most contemporary science in fact does do it. This concerns mostly the theory of self-organization of Ilya Prigogine, synergetics of Hermann Haken and chaos theory. In the scope of the current paper we cannot analyze the nature of all these theories. Therefore we shall limit ourselves with a look into R. Thom's catastrophe theory. R. Thom holds a clear opinion about the place of the *telos* in catastrophe theory. "From the catastrophist viewpoint, the *telos* could thus be seen as the *organizing centre* of a morphogenetic field of beings and events evolving in time. In this case the *telos* should always be distinct from the *teleute*" (Thom 1990: 147). The boldness of R. Thom's claim is obvious. He implies on having created a mathematical (not scientific) theory, which can present formalism compatible to Aristotelian metaphysics. Maybe it really is so, but this is not science. One cannot even be absolutely sure that we have got a mathematical method in the form of catastrophe theory. Maybe a system of natural philosophy is all we've got here. If this is the case, it is not a big deal to construct a narrative, which is compatible with Aristotelian philosophy. Moreover, it definitely becomes compatible with the Aristotle of *Physica* and *Metaphysica* and hardly with the Aristotle of the *Organon*. Is this the reason, why R. Thom so explicitly claims that he has nothing to do with Aristotle - the logician? Maybe he has to forget about the second Aristotle in order to add value to his own creation.

However, the above-mentioned is not likely to be the reason for D. Graham in presenting a theory of two Aristotles. One should be very careful about R. Thom's intentions as the latter states that he discovered the book by D. Graham only after he had already presented his own conception of Aristotle (Thom 1990: 252).

If we leave aside R. Thom's probable personal intentions, we have to recognize, however, that he has pointed to a very important aspect in the methodology of contemporary natural sci-

ence. Another question is the validity of his evaluation. Maybe there is already enough teleology in some branches of contemporary natural science. R. Thom is just not able to recognize this as he himself approaches the contemporary scientific method from the traditional Newtonian platform.

Aristotle's four cause theory (FCT) can help us in taking a closer look at the current situation. At the first stage of its development there are just independent causes. Only at the second stage the correlation of causes does appear. The creation of the system of causes is still the matter of the third stage. D. Graham has explicitly pointed to this aspect (Graham 1987: 156–172). It is crucial to understand at this point that only the second (metaphysical) type of Aristotelianism admits FCT as a system. Eventually, the causes form a closed system with respect to explanation (Graham 1987: 181). FCT offers us a new paradigm, a new way to look at things in the world. If we attempt at taking a full-fledged view over worldly matters, we have to approach objective reality from the position of the four causes taken as a complete system. Newtonian science has definitely failed in this task. Stress has been laid on the efficient materialism, which really helps to designate the structure and dynamics of things. This is, however, only a half way towards intelligibility. At some point it can even lead away from it. Recognition of the role of formal and final causes is essential.

It seems that the theory of self-organizing structures, created and developed by I. Prigogine, has succeeded in this task. Here the stress has been laid correctly. There is no bold strife for a complete formulation of strict laws. The researcher is consciously aware of his principal limits. The finality of any process can really be characterized as topological, not as arithmetical. Somehow, R. Thom has not recognized this, although he has explicitly demonstrated his awareness of the existence of theories of the kind. "Present-day theoreticians who speak of self-organization and of the order of dissipative structures as though they were something new are doubtless unaware of how old these concepts are" (Thom 1990: 18). The existence and order of dissipative structures themselves is definitely nothing new. It is, however, hard to believe that R. Thom has understood the real nature of self-organization theory. Pierre Curie has got it right that before natural processes can take place "it is necessary that certain elements of symmetry be absent. *Asymmetry* creates natural processes" (Thom 1990: 18). But this quote is more likely to refer to the difference than the similarity of P. Curie's approach to that of contemporary self-organizationalists. It is quite short-sighted to speak about *absence* of certain elements of symmetry, like the latter could be taken as something primary in nature. In fact, there is no symmetry in nature at all. One can speak about symmetry only as a seemingly convenient abstraction that should be treated very carefully, while applied to processes going on in the real world. Therefore, P. Curie is right stating that asymmetry creates natural processes. Maybe P. Curie is really thinking in the same direction as present-day theoreticians of self-organization, but he clearly didn't manage to formulate the postulates of the theory. It would even be difficult to say, who was actually closer to the general understanding, P. Curie or Heraclitus.

Let us, still, take a closer look at the idea of asymmetry from the point of view of more contemporary thinkers. The Russian system theoretician Yunir Urmancev writes: "any system is asymmetrical from at least one point of view" (Урманцев 1988: 44). It seems that even the very recent analysis of the notion of symmetry has failed to cope with the most advanced theo-

ries of natural science. As stated above, from the philosophical point of view, no system can ever be really symmetrical from any angle. The quality of symmetry is just an abstract result of mental activity. It can be real only as far as mathematical notions are real.

One can, however, speak about "nonlinear" symmetry in the morphological sense. Such approach to the category of symmetry may really bring some intelligibility into this world of ours', the guiding line of R. Thom's speculative metaphysics.

The same system can really expose both symmetry and asymmetry (dissymmetry) as Y. Urmancev suggests (Урманцев 1988: 48 ). This is, however, not due to different approaches from the same, i. e., scientific, level, but rather to the plurality of approach levels. Let us give just one example. It concerns the interpretation of the ideas of the pre-Socratic philosophers.

This is often the vocabulary with human and social origins used by the pre-Socratic thinkers to describe the physical world that prevents the modern thinker to take their formulations seriously. "... I think that they were far from wrong because they had the following fundamentally valid intuition: *the dynamical situations governing the evolution of natural phenomena are basically the same as those governing the evolution of man and societies*, profoundly justifying the use of anthropomorphic words in physics" (Thom 1975: 323). This result, far from being trivial, should be considered one of R. Thom's most remarkable philosophical achievements. It testifies the principal fertility of R. Thom's approach to metaphysical matters. In the current case of evaluating Anaximander and Heraclitus, R. Thom's obvious motive is drawing attention to his own philosophical program of geometrizing some fundamental notions. Hegel held that such a program could never be fulfilled in principle.

A notion has traditionally been taken as something abstract, being abstracted from every possible kind of sense perception. But this is not quite the case for Hegel. For him the notion is concrete. "Abstraction does not have this meaning in this opinion that one or another feature is taken out of the concrete for our subjective use, so that nothing will be lost of the value and honour of the thing by eliminating so many other properties and characteristic features (Beschaffenheiten) of the thing; but they are eliminated as real, only on another side, still holding to the full; so that the mind cannot take this richness because of its own inability and has to remain at the state of limited abstraction" (Hegel 1834: 20). A certain amount of reality becomes necessarily lost in the notion. However, it appears that the notion is able to recreate at least part of the lost reality. The notion creates from itself, not from the outside for Hegel.

The latter can be explained by logic as follows. The content of the logical form must be compatible to the form itself in order to be true. The nature of this truth alone is worth studying. Aristotle has been the first to undertake this scrupulous analysis. "It is time to proceed and learn partly about the systematic connection of forms, partly about their value" (Hegel 1834: 30). This is, however, definitely not the approach of R. Thom. His study of the succession of form is physicalist, not logical. "Instead of building geometry in a logical manner, we will seek to base what is logical on geometry" (Thom 1990: 2). R. Thom considers logic a derived activity, a rhetoric, a secondary one, after all is said and done in the history of the human mind.

As a matter of fact, Hegel holds even a more critical opinion about geometrizing notions. Hegel writes: "If we take notions as corresponding to such [mathematical – P. M.] signs, they cease being notions. Their determinations are

not such dead ones like figures and lines, lacking their own relation; they are alive motions; the different determination of one side is immanent also to the other side; an absolute contradiction for the figures and lines is natural for the nature of a notion" (Hegel 1834: 56).

R. Thom can oppose by reminding that geometrization in the sense of catastrophe theory is qualitatively different from geometrization in the Euclidean sense, which was the only geometry known to Hegel. Let us, however, see what else does Hegel have to say: "... draws two straight lines beside each other and does this inside the arc, but different from the arc; as relates to the infinite, which is important here, direct it to imagine" (Hegel 1834: 57). Hegel really considers just the Euclidean approach to the application of geometry. A vivid imagination, however, can trace a slight strife for spherical geometry in this quote. Therefore, one of our tasks is to find out, if R. Thom's catastrophe theory is "noneuclidean enough" for him to fulfil his main philosophical programme.

We have reached the stage in our analysis, where it would be appropriate to reformulate the central claim of R. Thom. His emphasis has probably been not quite correct. Both materialism and finalism are really necessary for contemporary science, but can hardly be sufficient. It would not be correct to stop at halfway. One should consider the whole Aristotelian causality, not forgetting about the formal and efficient causes. One of the greatest achievements of Aristotle-the metaphysician is not to connect materialism with finalism, but the creation of the system of four causes. The latter has been misunderstood to a great extent in classical science. It probably remains misunderstood for R. Thom as well. R. Thom is pointing in the right direction, but not to the right object. Or, to put it differently, R. Thom is pointing at a detail, where the whole structure should be considered as an indivisible whole.

Having expressed such opinion, we have accepted that contemporary science needs just the Aristotelian type of finalism, based upon the concept of the *telos*. Do we have enough ground for such statement? The answer cannot be absolutely straightforward in this case. It would be very difficult to give a better answer to the given question than - probably yes. As we could see, there are clear ambiguities in the Stagirite's system that can hardly ever be consistently eliminated. This is another confirmation for our claim that one needs to deal with causality as a whole, not trying to abstract some parts from it. This does not mean for a minute that one can neglect the four parts of Aristotelian causality. One constantly has to keep in mind the double quality of the case. Namely, that there do exist four types of causes and that they can be properly understood only in their totality.

However, R. Thom's catastrophe theory is properly connected to the formal cause and cannot do without the efficient one. Therefore, it is hard to understand, why R. Thom has neglected this aspect, while talking generally about the Aristotelian impact in contemporary science. The reason can probably be that catastrophe theory is not considered to be a proper science, which is quite right. Still, one has to keep in mind that R. Thom fails to recognize the presence of full-blooded Aristotelian causality in the theory of self-organization. Here the reason can be in his misrepresentation of the theory of four causes.

However, in this paper our main concern should still be the Stagirite himself, not R. Thom. We haven't treated probably the most general aspect of the problem yet. It should be obvious by now that some basic ideas presented in Aristotle's philosophy are vital for contem-

porary science. But we have also observed that their presence is already a fact. Therefore, the following question arises. Maybe it's not reasonable to waste time on studying Aristotle, the appropriate methodology comes from an appearance of the *Zeitgeist* for the researcher? The correct answer to such proposal still seems to be negative. The position of R. Thom serves as proof to the latter suggestion. Although having studied Aristotle carefully, he fails to take the Stagirite's teaching into full consideration. It is, however, not quite clear, if Aristotle should be treated in the same way by both mathematicians and natural scientists. Maybe mathematicians should just pay more attention to Aristotle-the logician.

R. Thom's ultimate metaphysical aspirations are certainly higher. He attempts to express an overwhelming generalization of the development of science since Aristotle. R. Thom refers to "the importance of analytic continuation as a criterion of process individuation" (Thom 1990: 218). He is quite right stating that analytic continuation is not a strong tool for quantitative extrapolation. "This means that only a pre-existing theory, based on an underlying ontology of global nature, can specify families of functions that are restricted enough to allow reliable extrapolation" (Thom 1990: 218). Here comes the miracle of physics. In fundamental physics the symmetry groups (Lie groups) define the geometry of space-time. How could this work? We know that there is no symmetry in the reality. However, it has been considered working for a long time. R. Thom calls such attitude "demiurgic". Has the world really been constructed with the help of a few formulas? Maybe it even has, but these formulas cannot be compared to the ones we know from classical science.

R. Thom has called the opposing attitude "hermeneutic". "To reconstitute a body in three dimensions from its apparent contour is the special task of hermeneutics" (Thom 1990: 218). The process starts from observation, which then gives way to modelling. There may be the need to change the underlying ontology, if that would make a model more intelligible.

"Modern science has made the mistake of foregoing all ontology by reducing the criteria of truth to pragmatic success" (Thom 1990: 218). Being a source of pregnance, pragmatic success does have significance. But this is a purely local meaning.

Here we do probably have the clearest aspect of contemporary science, where one should remember about the Stagirite. The latter would never give in to pragmatic success in his research work. It may seem that truth was not the key issue for Aristotle-the metaphysician. Maybe there is an amount of truth in such belief itself, but the Stagirite definitely never attempts to work out something that doesn't hold. At least the question of ontology is crucial to him. Positivism, on the other hand, has constantly tried to do away with any ontology. Not an easy task though. As soon as we recognize the existence of others and accept a dialogue with them, we are in fact ontologically involved (Thom 1990: 218).

However, R. Thom's further elaboration of the theme raises questions. He advises to accept the entities suggested to us by language. But we all know that language from time to time suggests us quite bizarre entities and nonsensical relations between them. Is this really "the only way to bring a certain intelligibility to our environment" (Thom 1990: 218, 220)? Maybe following the suggestions of language would mean just behaving on an advanced level of animal nature. Is it language that has suggested to us mathematical notions and operations with them? Is it language that initiated Plato's theory of

ideas? Is it language that suggested Parmenides the idea of an unchangeable and indivisible Being? If so, then language is everything. Such interpretation can hardly be valid mainly thanks to Aristotelian metaphysics. The relevant words have become notions only in the process of creation of the corresponding theories. They could hardly suggest the Stagirite the conceptions of the period of his maturity.

We have reached a relatively widespread critique of Aristotle, namely the common sense issue. It is obvious that to a certain extent Aristotle's philosophy is a philosophy of common sense as any other philosophy (with the exception of pure logic of course). The Stagirite's formal ontology is not a datum of the common sense. "Rather it is a highly abstract construct modelled on grammatical forms" (Graham 1987: 324). Grammatical forms are forms of language of course. This creates an ambiguity. Is Aristotle's ontology still suggested to him by language? We have never denied that language plays a crucial role in the creation of any kind of theory. But it is being created along with the emergence of the theory and does not precede it. Just like sensual observations, an everyday language is common to a definite social system. It should suggest the same things to anyone. However, only single powerful minds are able to respond to this suggestion.

The common sense problem has not lost its relevance for the contemporary scientist. Here it has, however, obtained a reverse angle. It may seem that looking for the roots of European philosophy in Ancient Greece would mean descending to the common sense level. It may sometimes really be the case, i. e., if the pre-Socratics are concerned. But at least from Plato's "Parmenides", not to speak about the Stagirite himself, the situation is fundamentally different. It would even be rather difficult to assign a common sense meaning to the Heraclitean *logos*. And does the idea of the macrocosm and the microcosm belong to common sense?

Let us summarize the meaning of the Stagirite's philosophy for contemporary science. First of all, one cannot overestimate the role of causality. It is not just finalism combined with materialism that makes Aristotle so remarkable, but all the four causes as a system. We have also raised a secondary, but still very interesting problem. What is the role of the theory of two Aristotelianisms for the Stagirite's evaluation in contemporary science? In other words, has the Two System Theory played an important part in rediscovering the Stagirite or maybe even initiated this process? The middle way seems to be an appropriate solution to this puzzle. Several scholars, including I. Prigogine and R. Thom, would have started the wide process of rediscovering the Stagirite anyway. The Two System Theory of D. Graham is just part, although a relevant one in its generality, of the overall tendency.

The general conclusion would thus be twofold. Aristotle-the logician retains his remarkable historical significance, pointed out explicitly by Hegel already. Aristotle of *Physica* and *Metaphysica* is a valuable source of intellectual brightness and depth of thought for any progressive thinker even in our age.

This is just in the light of Aristotelian metaphysics that contemporary science and mathematics can find its way in the age of the end of the rule of classical science and positivist philosophy.

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## ARISTOTELIO STYGIUS ŠIUOLAIKINIAME MOKSLE


**Peeter Müürsepp**



Santrauka

Ypač sparti gamtamokslio pažanga ir stulbinantys praktiniai jo taikymai XVII a. lėmė kvantitatyvinės metodologijos įsivyravimą, taigi ir sprendimą, jog Aristotelis paseno ir tapo nebeaktualus mokslo pažangos prasme. Parmenidiškomis idealizuotų abstrakčių esinių paieškomis grįsta tendencija truko keletą šimtmečių, o jos kulminacija buvo pragmatistinė-pozityvistinė mokslo samprata. Tik paskutiniame XX a. trečdalyje susigriebta, kad analitinės filosofijos propaguojamas kiekybinis požiūris paverčia mokslą instrumentiškai efektyvia, tačiau ne atveriančia, o veikiau pasaulį paslepiančia veikla, t. y. buvo suvoktas pasaulio suprantamumo stygius, principinis kitokių metafizinių prielaidų poreikis. Taip paskutiniais XX a. dešimtmečiais atsigręžta į Aristotelio idėjas. Aristotelio renesansą filosofinėje mokslo refleksijoje paskatino D. W. Grahamas, atkreipęs dėmesį į tai, kad būta dviejų Aristotelių: *Organono* Aristotelio – logiko, retoriko, ir Aristotelio – fizinių ir metafizinių traktatų autoriaus. Kaip tik antrasis susigrąžino tyrinėtojų dėmesį. Vienas ryškiausių bandymų atskleisti šiandien aktualias Aristotelio pažinimo interpretacijos ypatybes buvo prancūzų matematiko ir filosofo R. Thomo mokslo koncepcija. Joje Aristotelis iškyla kaip intuityvus mąstytojas, kaip fenomenologas. Thomas didžiojo stagiriečio filosofijoje netgi įžvelgė šiuolaikinės topologijos prielaidas ir pateikė svarbiausius argumentus įrodinėdamas, kad būtent aristoteliškų kvalitatyvinių idėjų stokoja šiuolaikinis mokslas, vedantis į anonimizuojančią pasaulio fragmentaciją. Šiame straipsnyje analizuojamas dviejų Aristotelių skirties aktualumas, aptariami R. Thomo bei kitų mąstytojų, mėginančių grąžinti į pasaulį suprantamumą, argumentai. Autorius daro išvadą, kad Thomo bandymas pademonstruoti stagiriečio aktualumą nebuvo pakankamai sėkmingas, tačiau pati intencija grįžti prie kvalitatyvinio požiūrio moksle yra neabejotinai šiuolaikiška, aktuali ir plėtotina.



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