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of (scientific) knowledge

Despre *tertium non datur*

Athanase JOJA

INTRODUCTION IN 2021

We publish a relevant paper of Academician Athanase Joja (1904-1972) who subordinated the inherent passion of philosophers, the history of philosophy, to his main professional passion, logic. Athanase Joja has many relevant papers. We chose the present one, about *tertium non datur*[1], not only because it explains clearly the topic – at the level of the 60s of the 20th century – but also because the topic itself is important in the present context of relativistic manner of the dominant thinking. This relativistic manner was taken over by those who did not know and understand the convergence and unity of the dialectical approach – that "seems" to invite relativism – and the rigour of analysis that always emphasises its *criteria* and the problem of criteria as such. Put more directly, the rigour of *tertium non datur* was rejected by the lay supporters of relativism in the name of a vague unity of things, of a "complexity" that cannot be deciphered and on which ground "those who know" can only urge the acceptance of *tertium* and the avoidance of tertium *non datur*.

Because in relativism – or rather, in this type of relativism – there is not about the consciousness of contradictions which must be solved *in* the systems, thus about systems firstly characterised and mined by contradictions and thus having a weak stability or even reason to be; no, in this type of relativism the consciousness ignores, neglects or transfers the contradictions to a distant *arrière plan*: existence "is", meaning it is stable and, if not the best, the only one that is sure, even for the contradictions as such. Consequently, this type of relativism considers identity – and the principle of identity – as if its contradictions would be unimportant and as if the principle of unity would annul the principle of the excluded third[2], the unpleasant contradictions being inherently included and thus not being a problem [3].

The (present) ethical – waving the idea that there is no absolute truth and thus all the moral contradictory opinions are equal – and epistemological relativism, considering that the discovery of contradictions in a theory generates their inclusion in this theory, so the acceptance of the included middle[4], can be expressed in logic and correspond to the rejection of the principle of the excluded third and its substitution with the principle of the included middle. But if there is no absolute truth, all the contradictory opinions relating to a certain system / problem are

[1]Certainly, the *either a – or non-a* (but not the third alternative) as expressing the true – false dichotomy refers only to declarative sentences or judgements (*apofantikos*) "that have in them either truth or falsity". Aristotle pointed the difference between this type of sentences and those of pray etc. All sentences are *semantikos* (transmit meanings), but not all are *apofantikos* (Aristotle *De interpretation*

[2]For now, it must be said that in English *tertium non datur* is translated as the excluded *middle*.

[3]If this type of relativism is assumed rather metaphorically by laymen "philosophising" in their spare time, it was sketched in philosophy by Stéphane Lupasco for whom every affirmative sentence includes its negative and thus, the coexistence of contradictories becomes the ontological principle substituting in logic the excluded middle.

[4]Lucian Blaga considered that this coexistence of contradictions is a new dogma in science, but that this dogma is only a transient moment, anterior to the construction of the new theory devoid of those contradictions. See Ana Bazac, Lucian Blaga and Thomas Kuhn: The Dogmatic Aeon and the Essential Tension.

not equal. There are ethical *criteria* – and especially the fundamental categorical imperative (of Kant) – and there are epistemological *criteria*. The fact that knowledge and opinions are historically and socially forged is not tantamount to the idea that neither the truth / false values do exist nor that they cannot be estimated in specific frameworks (of finite systems): clearer, there are always criteria either giving the limits or the peculiarity of a system, or the limits and the specific of its analysis; or both.

Therefore, the criteria of the finite systems are *in system / from within* criteria framing the decidability related to the truth / false values of the propositions of the system. The logical square mentioned by the paper shows the finite systems – framed by the type of connectives, if we speak in the language of mathematical logic, but Athanase Joja talked in the language of *formal classical* logic, with concrete, not mathematically symbolised propositions – where the *tertium* clearly appear. Thus, a system cannot support equally that "all men are good" and "no man is good"[5]: if both propositions appear, then only the *tertium* is or is true (*tertium datur*) and anyway, each of these propositions must be more or less impliedly "demonstrated". Or, "capitalism is either transient or impassable" / "capitalism is transient" and "capitalism is not transient"[6] imply the *tertium non datur*.

So, on the one hand, including because the systems are embedded in always larger and more complicated systems, there are also criteria *from without* the system. These criteria make the *in system* decidability of truth / falsity of the *in system* propositions to be *limited*, sometimes even called into question. On the other hand, all propositions, no matter how truthful, are questioned from the standpoint of the causes of the reported facts. But if the systems / the *in system* conditions of the propositions are clearly specified, the truth / falsity values can be precisely estimated and the *tertium non datur* works as the other logical principles[7].

It must be said that by discussing the *tertium*, Aristotle emphasised the importance of the criterion of the clear / finite / circumscribed system of statements or *system of reference*. A criterion does not mean and does not imply an abstract, absolute reference, but a specified one.

Truth is not only the result of non-contradiction, because something can be true here or beyond the Pyrenees (as Pascal said, after Montaigne), or now and not before etc.; it is always in specific systems of reference, not "generally" so that it support relativistic rarefaction[8]. (And we know that Aristotle believed that the logic of complex propositions involving *polyadic* predicates, expressing relations between entities, can be reduced to the logic of propositions with *monadic* predicates about properties of individual entities, and that just this reduction can emphasise the logical principles and their "discipline" that has always precise references). The possibilities, the necessity, the alternatives appear only within the systems of references: the problem of possibilities etc. may shed light on the exterior systems of reference only on the basis of exhaustion of the internal possibilities of truth or falsity. Thus, the *tertium* shows both the most basic condition of logical – and reasonable – truth, the "material" condition of existence of the system of reference, and the methodological condition for attaining truth, the discipline in the logical analysis. (In this framework, the Chryssypian rigidity was meaningful: in the sense that the reason to be of propositions, communication, requires criteria in the system of reference. We cannot speak without aiming to understanding the truth. If this intention is missing, what's the point of the speech?)

In this line, the discussion of the logical principle of the excluded third is cardinal for the understanding of both what criteria do mean and how they are constructed, and why and how, if the excluded third does not ignore or annul the included one, it can well coexist with this included middle, at the same time it being more important / fruitful in the development of decidability and demarcation of truth or valuable cognisance.

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[5]Examples given by the paper.

[6]Example given in the paper.

[7]In this regard, inferences inside systems can emphasise the true sentences, but because the systems as such depend ultimately on the intertwining with other systems inside a more comprising system etc., the "ultimate" truth is always given from outside the system. (See Ana Bazac, The Last Stage Explanation within the Study of Society).

[8]Obviously, the general statements or those about abstract things, categories etc. do have meanings, thus truth or false values, only within systems of references.

Aristotle and the formal logic specifying the systems of reference – later on in mathematical logic, finite axiomatic systems – linked logic to ontology, or better, to the logic of existence. This connexion led to a first set of problems, in a way a deviation from logic since this one concerns the formal structures of thinking: that of the relationship between the natural causality and that grasped by humans. According to this relationship, two extreme positions were outlined: in one, the natural causality as basis and legitimacy of the manners of thinking; here, the human thoughts were (better or worse) copies of the natural causality, and thus ignorance was the main cause of the mistakes of thinking[9]; in the other one, there is about an abstract constructivism, obviously developed late, and thus it is not considered here.

The second set of problems – still having in background the *ontos* – was the determinism of the logical positions or of the truth value of propositions and arguments by the philosophical concepts or principles. The *ontos* was the backmost background, but the most "efficient" explanation of the logical positions was that based on conceptual coherence of categories. Not necessarily in a sense of nominalism, but in the sense of certainty given by them. Thus even the formal analysis was developed if not always after, but at least in connexion with the metaphysical background. The third set of problems, rather a subset of the previous one, appeared in the transition from static to dynamic analysis, considering the time factor (and later the space factor) not as relativism but as realistic configuration of the logical determinism.

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The paper presented here only mention or suggests the above aspects, since it is devoted to the reviewing of four historical attitudes towards the principle of the excluded middle – that of Aristotle, that of Chrysippus, that of Hegel, and that of the modern mathematical logics – and to the sketching of a dialectical representation of this principle. When it is about principles – even in the ancient Greek etymology of origin – the discussion regards the universals. But, because of historical and epistemological causes, when talking about universals, people consider that they are abstract things far away from the concrete world and that they are closed and perfect entities, each of them. Or, as the paper observes by giving everyday examples, the universals represented here by the logical principles and specifically by the principle of the excluded middle integrate contradictory aspects which can be analysed and critically tackled: from the always human responsibility[10].

The above critique of relativism does not mean a rejection of *alternative logics* to the classical one. On the contrary: just by specifying the importance of criteria, types of systems and "determinism" of truth values, the *necessary* development of alternative logics (*many-valued logics* – with not only true and false –; *intuitionistic logic*, rejecting the excluded middle and the elimination of double negation; *linear logic; modal logic; paraconsistent logic; non-reflexive logic*, rejecting or restricting the principle of identity; etc.) and of theories of uncertainty[11] appear more clearly.

Then, it should be said that the paper does not insist in the difference between Aristotle's *term* logic and Chrysippus's *propositional* logic. It rather tends to consider the terms as "representatives" of things and the class or predicate logic as common to both Aristotle and Chrysippus, while the propositional logic is inherently considered only from the standpoint of the problem of the excluded middle.

And, only in a short proposition, mentioning the "excluded M" (as middle), the paper suggested that even the *tertium non datur* must be defined. This *tertium is the third party / the third*, i.e., an *alternative* to the two positions promoted by opposed situations / propositions and, generally, a *medium, a middle* between these opposite propositions. This is the reason of the English translation of *tertium non datur*. Literally, the Latin expression means *there is no a third / a third is not given*. But even in the ancient logic and especially in the modern mathematical / symbolic logic, there is not a single middle (or a single alternative). We must

[9]In order to see that logic is not as far from the real life as one thinks, let's mention that nowadays the argument that people do not have all the information or the best ones is used just by those who want to impose their truth against the logical analysis of facts.

[10]Étienne Balibar, Sur l'universalisme - Un débat avec Alain Badiou

[11]Lotfi A. Zadeh, Toward a generalized theory of uncertainty (GTU)—an outline

remember at least the temporal possibilities (discussed even by Aristotle). And thus *tertium* as *the third party* responds to the logical principles of *bivalency* (true / false) and *non-contradiction*, while translated as *middle* it rather suggests an undefined third, as a kind of mixture of the two opposite propositions. This is why the issue of *tertium non datur* – translated literally in Romanian – is being discussed in the paper, and not the excluded medium term. But as before, this introduction uses the consecrated English translation.

Finally here, the paper' sketch of the dialectical view about *tertium non datur* is obviously marked by a "Hegelian" standpoint about the final superiority of the materialist and dialectical level of knowledge, but nevertheless it is the result of a fine analysis of the historical contributions to the understanding of the principle of *tertium* and advances consistent and tenable conclusions. The first is that the dialectical logic assumes the functions / task of logic as analysis of forms of reasoning and the functions of *meta-logic*. Actually, the dialectical conclusions are of *meta-logic*, supporting the idea that the true-false dichotomy is necessary as a criterion of knowledge and it is necessarily malleable, just in order to configure the human knowledge of complexity. Then, even though the lifetime love of Athanase Joja was the formal classical logic (and especially Aristotle), the limits of this classical formal logic are emphasised by him together with those of modern symbolic logic, showing that logic exists and develops just with the questioning of fundamentals[12] and regularities retained by the logical principles and rules. Obviously, this doesn't mean the neglect of regularities – as those promoted by the *tertium non datur* – but the inquiry of modulations / adaptations / bends / flexibility of regularities: just because the principles as such (and here, the *tertium non datur*) modulate and are modulated. And this: just because this modulation or flexibility of the logical principle reflects "the complexity of objects and their relational positions, the movement, the development and complexity of the knowledge process". *The principle of the excluded middle avoids falling into sophistry, while the assumption of its flexibility avoids falling into metaphysics*, Athanase Joja underlined.

More: the many intermediary values – "neither true nor false", "partial truth", "partial falsity" etc. – cannot destroy the logical opposition between truth and false because even its negation by the intermediary values is only secondary: the *intermediary values as such are defined according to truth and false*.

And perhaps it is worth to mention that, discussing the flexibility of the principle both horizontally and temporally, when Athanase Joja spoke about the "absolute truth" as a result of a historical process of temporal partial truths, as their "*sigma*", he did not consider the reality of this absolute truth: neither advanced by the dialectical materialism and nor as cognisance in the knowledge process. For him too, the last truth related to a problem was not "the absolute truth" but only a historical *summum* – as a processing, a synthesis *and* analysis – of both the historical solving of the problem and the partial aspects considered in this solving process. The logical level of knowledge can but retain this very complex process by modulating the logical principles.

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For Athanase Joja, too, the logical level itself is composed of the *objects of thought*[13] – ideas already existing *in mente* as a result of previous processing and constituting – and the *logical manipulation* of these objects in propositions, reasoning, argumentation. The humans conclude the truth or the falsity of propositions, reasoning, arguments.

In order to show the ultimate origin of the logical level in the outside objective existence, Athanase Joja has explained the logical principles as arising from their "existence" in the *ontos*, an ancient philosophical problem of the explanation or determinism of the human *logos* as a correspondent of the *kosmos's logos*. This standpoint was later equated with materialism as determinism by the external objective world on the inner subjective world of the products of mind. In this line, Athanase Joja considered the logical principles as organisers of the reasonable

[12] As Edmond Goblot, *Traité de logique*, considered as fundamentals the premises of reasoning, allowed before the reasoning and then transformed into logical rules, Athanase Joja considered the logical principles and the rules.

[13] A. N. Prior, P.T. Geach, and J.P. Kenny, *Objects of Thought*.

thinking because these principles reflect the most general "positions of reality": *ordo cogitandi* reflects *ordo essendi*.

Nowadays, we know that the *ordo cogitandi* is rather the result of the autonomous constitution of mind. In this respect, the necessity of clarity was related to the appearance of the simplest images of objective causal relations, and then, obviously linked with the external world, to the complication, always in simple forms, of the previous simplest images. Here it is not the place to discuss or to speculate around the correlations between the objective unity of the simple and the complex in the development of systems. What can be said is that the *ordo cogitandi* is neither independent of the objective external world, as an autonomous edification of the ideas, and nor a copy of the external world. Actually, the logical principles of *ordo cogitandi* are the most general – in fact, the simplest – because they are the results of the autonomous need of the mind to understand, i.e. to organise the elements of thought in the most intelligible (thus, "the simplest") way. This autonomous need corresponds to the autonomous mechanic of the intellectual processing as such, but it is not tantamount to the idea of absolute autonomous constructivism of mind. Because, again: the fuel of the autonomous mechanic of the *in mente* processing is the external world.

Accordingly, the logical principles "must" be simple and the most general – as identity, non-contradiction and, constructively concluding them, the *tertium non datur* (that includes also *datur*) – because otherwise the complexity of the world could and would not be understood. But logic or the logical mind do not consist in a simple strategy of reduction of this complexity to a scheme given by the logical principles. The principles are only *fundamental* means of judgements, complex reasoning and argumentation, "corresponding" to the complexity of the world, reflecting it. The ancient Greek observation that the human logos is like the *logos* of *kosmos* has led to the extreme positions of absolute external determinism of mind or absolute independent ideas determining the world. But having the basis of the logical principles, the human science could grasp why and how the similarity of the subjective and the objective logos has been forged.

(However, we must conclude that in the history of (the ideas about the) relations between the *logos* of *kosmos* and the human logos, and although all ideas can be distorted (and they were), the belief of the external determinism of thinking was not only pragmatic, but also insightful. People understood that the multifaceted human experience is at the origin of forms and modes of the human reasoning: and even today the deployment of modes and logical structures mirrors human situations and experiences.

But certainly, this determinism – ultimately, of the *ontos* – generated the pattern of knowledge as a *copy* of existence. In their turn, the philosophers have always suggested a constructivism *avant la lettre*: just in order to *correspond* to the objective existence, the human thinking must be *coherent* and the coherency is, however natural for humans, very complicated. And they devoted their time to grasp both the power of the empirical and the mysteries of reason, wondering about its mixture of discipline and indiscipline).

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Athanase Joja was interested about the logical principles and raised the problem of their fundamental nature for the understanding of the structuring of thinking. In this respect, he assumed that:

- the logical principles – which develop as a hierarchy from the principle of identity – are not only fundamental, but they constitute a level of horizontal logical structuring, based on interdependencies;
- the fundamental level of logical principles is a scheme and obviously it manifests linked to the semantic or "material" or the content's level. In this line, the schematic / formal and material levels are not only intertwining but also inter-conditioning, i.e., the formal level is not sufficient for the development of logical judgements and arguments, while without this formal level, the contents of arguments are unintelligible, unlogical;
- the logical principles do not close thinking in a rigid framework given by truth and false, but suggests: 1) only that bivalence is a fundamental criterion and 2) that bivalence

itself is open. From this standpoint, all that logicians developed was the unfolding of this opening or of the space framed by the truth - falsity.

- Therefore, once more we repeat what is commonplace today: symbolic / mathematical logic does not annul the formal logic[14] but develop it, the many intermediary values between true and false emphasising new aspects, not discussed before by the formal logic but not leading, if the logical coherence is respected, to relativism of values. This meaning that even though the true and false are historically construed in concrete finite systems (of problems, concepts etc.), namely in the space-time framework of the always last understanding of the problems constituted as finite systems, the true and false are *valid* criteria *and* the nuances of the many data, reasoning, conclusions are necessary clarifications *better lighting* the true and false.

In this respect, the relationship between the formal level of the structuring of thinking, level given by the logical principles and rules, and the level of contents can be rendered by the scheme of Georg Brutian[15] where the formal structuring – the *implicit* level – is the result of experimenting the *explicit* level of contents, given by language that reflects it but, further, the understanding of the explicit level depends on the structuring of the implicit level and on how clear and strong the formal logical structures are. All relations and interdependencies between the formal implicit structures and the content structures given by language that reflects both data of the sense organs and the fundamental / formal logical level – but once more, according to Athanase Joja who admitted the unanimous position of the ancient Greeks, this level (ultimately, the subjective *logos*) is legitimated by the objective *logos* – are synthesised in what, again Brutian, called *transformative* logic. Not only as expression of the discipline but also as objective process of thinking.

The legitimacy of the logical principles is, thus, given by reality, i.e., by the complex interdependencies of the logical levels and of forms and content, and always implies the complication of their study and of the image given by the study, by the inclusion of an "exterior" level to logic, that of *language*. The transformation of the logical structures themselves is supported by the grammatical transformation of syntactic categories which reflect the functions (of subject, predicate, direct complement etc.) given in language and reflecting the intentions of speakers[16]. By corroborating and developing the research of logic and philosophy of language, the extremes between which the unity, interdependencies and at the same time the autonomy of logic and language deploy, are better understood. These logical and linguistic extremes – absolute determinism and absolute relativism – were and are only limited / limited moments of the understanding of all of these relationships and phenomena. The interdependencies, the coexistence of levels, the nuances between truth and falsity are the aspects that annul any reductionism at the extreme points: there is *always* and *at the same* time both determinism and its relative manifestations. And determinism and its relative manifestations in the processes and structures of thinking are not tantamount to rigidity or extreme liberalism concerning truth-falsity.

The focus on logical principles reveals the *coexistence and interdependence* of multiple layers of levels in the structuring of thinking and its expression: the *logical* layer – comprising the formal syntactic level, the semantic and the pragmatic level –; the layer of *language*, comprising the grammatical implicit level that corresponds to the implicit logical level of forms given by the logical principles and the rules; the *linguistic* layer, comprising the explicit semantic level of meanings of words, expressions, propositions and discourses, and the explicit pragmatic level.

[14] As it is discussed in the paper, Hegel disregarded the formal logic as "summum" of logic. But if this is true for every logic, the formal one is that which reveal the deepest layer of structures and criteria of thinking.

[15] Hovhannes O. Hovhannisyan, Epistemological-methodological and applied aspects of Georg Brutian's philosophy.

[16] Lucien Tesnière, *Éléments de syntaxe structurale*, quoted by Vincent Descombes, Dire/donner. Note sur les verbes trivalents, La Découverte, ≪ Revue du MAUSS ≫, 2017/2 no 50, pp. 49-63. (For example, the grammatical subject is not always tantamount to the main subject of the action, the agent; the grammatical subject can be passive (the book is given by X to Y); or the syntax of the phrase may imply not only the action given by the verb, but also the relation (of the verb) on the actors, as to make someone to (do), in what Pierce called intentional sociality).

Briefly, the logical structures reflect the psychological – and, as Pierce (via Tesnière) showed, the sociological – structures, the intentionality through the medium of language.

Perhaps these synthetic standpoints are not sufficiently emphasised by different logics. This is because, on the one hand, there are still many aspects of the "nuances" of thinking that need to be examined and understood; while on the other hand, the presentation of these synthetic standpoints would be too general, thus fruitless. However, we can advance the idea that they are necessary and incredibly fruitful: both for science and for the human life as such. And just this is (was) the reason to be of a meta-logic, called by Athanase Joja dialectical logic.

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In a simple scheme, the logical square mentioned in the paper shows the complexity of situations and relationships between propositions, judgements, arguments. Everything is reduced in the logical square to relationships between propositions – the simpler the better to be understood – and thus the conclusions are clear and one may apply them. But just this application is difficult: especially when one has to choose after the judgement or just by judging. In this case, the logical solution being to see the different degrees of contradictions, as in the form of contraries or of contradictories, and to further analyse which relationships are definitely impossible to integrate / accept in a unity, and which relationships would be lesser logically (and humanly) harmful. Concerning our topic, the *tertium*: which relationships between propositions do accept *tertiums*, these ones becoming not only possible but even necessary alternatives; and which relationships exclude the *tertium*.

These latter situations are once more difficult: either some ones do not understand that the unity of contraries is possible (*tertium datur*) and the truth-value can be shared by the contrary propositions or that a unity of contradictories is not possible (*tertium non datur*) and one has to choose the truth. But obviously, the logical square is only a model and thus it is never shut. On the contrary, it opens the reasoning toward alternatives, since the abstract nature of the elementary situations posited in the logical square makes more visible the truth-value of the logical theory of contraries and contradictions.

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The principle of the excluded middle is a kind of heterotopia[17], a space[18], but a different one that mirrors and opposes – actually, opens – the concrete spaces of reality, utopia and the mirror itself: it is or supposes both the identity and unity of the entities of the *ontos* and of the logical entities (like logical principles and rules) *and* their opposition, since in the background of non-contradiction of the sound unity there are the contradictions and their possibilities and necessity, and since the excluded middle warns about both the existence of the above situations, and the possibility and necessity to not neglect both the excluded and the included middles.

An application of the dialectical view about the necessity of the principle of the excluded third *and* the necessity and possibility of its modulation and flexibility, is the theoretical mirroring of social relations by the model of rational players or the prisoner's dilemma. The prisoner's dilemma is a mental experiment related to the premise that rational agents would act according to the principle of the greatest expected utility irrespective of the consequences upon others or upon the social commonwealth. Thus, let's retain that what is at stake is the reasonable behaviour: here, the scissor of the excluded middle seems to be appropriate[19]. However, the above mental experiment is only a *model* that is never tantamount to the real life because it simplifies the conditions and neglects the complexity and opposite or different relations than those from the model. Therefore, a better model for the reasonable behaviour in the real life

[17]Michel Foucault, Des Espace Autres, was the basis of a lecture given by Michel Foucault in March 1967.

[18]The *space* is itself the sign of the present era, fully opposed to the 19th century that had as sign history, says Foucault, *ibidem*.

[19]And appropriate not abstractly, but concretely: the end of greatest utility is based on "the potential advantage of unilateral violation in the absence of retaliation", see Necip Fikri Alican, Fool Me Once, Shame on You, Fool Me Twice, Shame on Me: The Alleged Prisoner's Dilemma in Hobbes's Social Contract.

is that which is measured with the principle of included middle: that where it is reasonable (and more reasonable) to aim and follow a satisfactory level of utility for both the agent and the others, society as a whole. The measurement of the satisfactory level of utility takes into account the *ethically acceptable* utility for all. Thus, we return to the problem of criteria of the human action.

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Ana Bazac

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Legilor logic-formale ale identității și contradicţiei le corespund simetric și li se supraordonează legile logic-dialectice ale identităţii concrete și predicaţiei complexe contradictorii. Există oare o lege logic-dialectică simetrică şi supraordonată legii logic-formale a terţiului exclus? Pentru a putea schiţa soluţia acestei probleme de capitală importanță și semnificaţie, socotim util a înfățișa, mai întâi, principalele poziţii teoretice față de legea terțiului exclus, şi anume:

1. poziţia aristotelică;
2. poziţia chrysippiană;
3. poziţia hegeliană;
4. poziţia logisticii.

POZIȚIA ARISTOTELICĂ

Meritul de a fi formulat legea terţiului exclus îi revine, fără îndoială, lui Aristotel.

În *Metaphysica* I, Stagiritul dezbate pe larg legea terțiului exclus și implicaţiile ce decurg din acceptarea sau neacceptarea ei. El reia problema în *Organon*, aducînd legii terţiului exclus un important corectiv în *De interpretatione*, capitolul *De futuris contingentibus*.

Menţionăm, în treacăt, că celebrul capitol IX din *De interpretatione* a fost reluat și dezvoltat, în 1920, de logicianul polonez Jan Lukasiewicz, ducînd la crearea „logicii non-chrysippiene“, pe care unii preferă să o numească „nonaristotelică“.[1]

Legea terţiului exclus e formulată astfel în *Metaph.* I, 7, 1011 b, 23 a: „Nu e posibil să fie vreun intermediar între enunţurile contradictorii: trebuie cu necesitate sau a afirma sau a nega un singur predicat, oricare ar fi el, despre un singur subiect“[2].

Și Aristotel subliniază: „Aceasta e evident mai întâi pentru cine definește natura adevărului și falsului“[3].

Problema legilor logice în general, a legii terțiului exclus în particular, e legată consubstanţial de problema adevărului și falsului, a reflectării adecvate sau inadecvate a realităţii obiective.

Definiţia adevărului și falsului e dată în *Metaph.*, 10, 1051 b, 3: “Enunţă adevărul (ἀληθεύει) cel ce socotește că ceea ce e divizat e divizat şi că ceea ce e compus e compus; se înşeală şi spune neadevărul (ψεύδεσθαι) cel ce gândeşte contrariu de cum stau lucrurile”[4].

„Or, pentru cel ce definește natura adevărului şi falsului, zice Aristotel, spune despre ființă că nu e sau despre neființă că este, e falsul; a spune despre fiinţă că e și despre neființă că nu este, e adevărul; astfel încât acela care spune despre o ființă că este sau că nu este, va spune ceea ce e adevărat sau ceea ce e fals; dar (a spune că e un intermediar între contradictorii) nu înseamnă nici a spune despre fiinţă, nici despre neființă că este“[5]. Cum se vede, Aristotel înrădăcinează legea logică a terțiului exclus în ontologie, şi cum ontologia sa, în problema raportului dintre fiinţă şi neființă, e orientată antiheraclitic, el

[1] Ernest Bloomfield Zeisler, *Foundations of Logic and Mathematics*, partea I—, p. 123. Published by A. Isaacs, Chicago, 1955. Vezi A. N. Prior, *Formal Logic*, p. 240, Oxford, at the Clarendon Press, 1955: „That there is such a third truth-value was suggested by Aristotle himself in the ninth chapter of the *De interpretatione*“.

[2] Aristote,*Métaphysique.* Trad. Tricot. Librairie philosophique Vrin, Paris, 1935, t. 1, p. 235.

[3] *Ibidem*

[4] Traducerea lui Trendelenburg, *Elementa logices aristotelicae*, p. 24, Berolini, Sumptibus G. Bethge, 1852; itaque *verum indicat qui et quod divisum est, esse divisum et quod compositum, esse compositum putat; falsum autem, qui contra ac res se habent.*

[5] Aristote, *Métaphysique.* Trad. Tricot, p. 235.

formulează legea terțiului exclus cu aceeași rigiditate cu care în *Metaph.*, 3, enunţă legea contradicţiei.

În acest sens, Lenin notează „La începutul metafizicii, *lupta cea mai îndârjită* împotriva lui Heraclit, împotriva ideii de identitate a existenţei și nonexistenţei“[6] iar în fragmentul *În jurul problemei dialecticii*, tot Lenin scrie: „Dedublarea unicului şi cunoașterea părților lui contradictorii (vezi citatul din Philon asupra lui Heraclit la începutul părții a III-a („Despre cunoaştere“ a cărţii lui Lassalle despre Heraclit) este fondul (una din „esenţele“, una din particularităţile sau trăsăturile fundamentale, dacă nu chiar singura fundamentală) a dialecticii. Tocmai astfel pune problema și Hegel (în *Metafizica* sa, Aristotel se zbate mereu în jurul acestei probleme, combătându-l pe Heraclit, respectiv. ideile lui Heraclit)“[7].

În *Metaphysica*, Aristotel formulează în chip absolut legea terţiului exclus fiindcă polemizează cu Heraclit, Pitagora și Anaxagora, fiindcă se așază într-o ontologie antiheracliteană. Însă Aristotel era un genial dialectician.

„La Aristotel, scria Lenin, peste tot logica obiectivă se amestecă cu cea subiectivă, şi aceasta în așa fel încât peste tot *este vizibilă* cea obiectivă. Nu există îndoială în ceea ce privește caracterul obiectiv al cunoașterii... Logica lui Aristotel este pretenţie, căutare, apropiere de logica lui Hegel...“[8] . De aceea în *De interpretatione*, Aristotel înmlădiază legea terțiului exclus. Aceasta explică formule care par divergente cu cele din *Metaph.* Γ și din *De interpretatione*, IX.

De reţinut e faptul că, în ambele cazuri, Aristotel se întemeiază pe o concepție materialistă a logicii, logicul fiind reflectare esenţială a onticului.

J.-M. Bochenski[9] consideră pasajul din *Metaph.* Γ 7, 1011 b 23 ca fiind „logic" spre deosebire de pasajele din *Metaph.* Γ 8, 1012 b 10 și *De interpretatione*, 9, 18 a, 39 ca fiind metalogice.

Socotim că toate formulările aristotelice ale legii terțiului exclus au caracter metalogic, nu în sensul că aparţin unei „sintaxe“ alese mai mult sau mai puţin arbitrar, ci în sensul că sunt legi de bază ale sintaxei gândirii, reflectând trăsături generalisime ale sintaxei obiective.

Revenind la textul din *Metaph.* Γ 7, 1011 b 23, observăm că Aristotel bazându-se pe o interpretare rigidă a raportului fiinţă-nefiinţă, conchide la imposibilitatea "intermediarului în contradicţie" μεταξὺ ἀντιφάσεως.

După Aristotel, gândirea afirmă sau neagă un obiect de gândire, ori de câte ori spune adevărul sau falsul, aceasta fiind o consecinţă evidentă a definiţiei judecății adevărate sau false[10].

Gândirea nu are o a treia posibilitate: *tertium non datur*.

Comentatorul grec Asclepios serie în această privinţă: „dacă nimic altceva nu poate fi conceput alături de fiinţă și neființă, nimic nu este, în consecință, intermediar între contradictorii, iar Syrianus spune: οὐδὲν ἄλλο πέφυκεν ἀληθὺειν ἢ ψεύδεσθαι πλὴν φάσεως καὶ ἀποφάσεως, adică nimic nu se poate spune adevărat sau fals în afară de afirmare sau negare[11] Aristotel şi comentatorii săi fundează deci legea terţiului exclus pe disjuncția exclusivă a afirmației şi negației, a adevărului şi falsului, disjuncţie ea însăși întemeiată pe disjuncţia *in re* între fiinţă și neființă.

Între absurdităţile decurgând din neacceptarea terţiului exclus, Aristotel pomeneşte pe aceea care ar admite posibilitatea de a spune ceea ce nu e nici adevărat nici fals.

[6] V.I. Lenin, *Caiete filosofice*, E.S.P.L.P, 1956, p. 296.

[7] *Ibidem*, p. 321.

[8] —*em Ibidem*, p. 296.

[9] J.-M. Bochenski, *Ancient Formal Logic*, North-Holland Publishing Company, Amsterdam, 1951, pp. 40-41.

[10] Aristote, *Métaphysique*, p. 237.

[11] Apud Tricot, *Metaphysique*, p. 237, nota 1.

În concluzia argumentării sale din *Metaph.* Γ 7, Aristotel polemizează cu Heraclit şi Anaxagora:

> „Pe cât se pare, zice el, cugetarea lui Heraclit, spunând că totul este și nu este, face că totul să fie adevărat; dimpotrivă, aceea a lui Anaxagora, zicând că există un intermediar între contradictorii, face că totul să fie fals: într-adevăr, când există amestec, produsul amestecului nu e nici bun, nici non-bun,astfel încât nu se poate spune nimic adevărat“[12].

Concluzia lui Aristotel e că atât Heraclit, cât şi Anaxagora ruinează posibilitatea cunoașterii, primul desființând legea contradicţiei, al doilea legea terţiului exclus, pe care o consideră ca un fel de corolar al primei legi[13].

Formulele din *Metaph.* Γ 8, 1012 b și *De Interpr.* 9, 18 a 39 sună respectiv: „Dacă pentru orice necesar sau a afirma sau a nega, este imposibil să fie şi una și alta false, căci un singur membru al contradicţiei e fals“ — și „orice afirmaţie sau negaţie e adevărată sau falsă“.

Alte formulări se găsesc în *Organon*, ca de pildă *Analytica Posteriora* I, 1 72 a 11: ἅπανἢ φῆσαι ἢ ἀποφῆσαι ἀληθές (pentru orice e adevărat sau a afirma sau a nega)[14].

Aceasta e poziţia generală, de principiu, a lui Aristotel în problema legii terţiului exclus. În *Organon* – ca şi în —em Metaphysica – *„tertium non datur“* este totdeauna presupus a fi universal valabil[15].

Dialecticianul Aristotel descoperă însă o importantă derogare la legea enunțată de el în problema evenimentelor viitoare contingente (*futura contingentia*, τά μέλλοντα ἐνδεκόμενα) .

Capitolul IX, *De oppositionibus in futuris contingentibus*, e, probabil, adăugat ulterior tratatului *De interpretatione* şi relevă o deplină maturitate a gândirii aristotelice. Acest capitol aduce o surprinzătoare înmlădiere a legii terțiului exclus, dovedind capacitatea de înţelegere dialectică a Stagiritului.

Aristotel, după ce a enunțat cu strictețe legea, a adus o derogare importantă, indicând astfel, calea pentru rezolvarea ei.

Megaricii Diodoros Cronos din Iasos şi Philon din Megara dădeau legii contradicţiei o valoare absolută din care decurgea un fatalism absolut[16].

Atitudinea megaricilor ruina, în ochii lui Aristotel, liberul arbitru și contingenţa, dând o viziune necesitaristă și fatalistă asupra lumii.

Etician şi naturalist, Aristotel voia, pe de o parte, să salveze liberul arbitru, iar de altă parte, categoriile de posibil şi contingent. După ce a afirmat în mod riguros legile contradicției şi terţiului exclus, el a adus acesteia din urmă – corolar al acelei dintâi[17] – un corectiv important. —

În spiritul acestui corectiv, el notează că „în ce privește lucrurile actuale sau trecute (τῶν ὄντων καὶ γενομένων) e o necesitate ca afirmaţia sau negația să fie una adevărată și alta falsă, iar în ce priveşte propoziţiile (contradictorii) universale enunțate universal (τοῦ καθόλον) sunt totdeauna una adevărată şi alta falsă; la fel în ce priveşte propoziţiile (contradictorii) despre singulare, așa cum s-a spus. Nu e necesitate în ce priveşte propoziţiile (contradictorii) universale neenunţate universal (μή καθόλου λεχθένων). Și despre aceasta s-a spus. Nu acelaşi lucru e cu propoziţiile (contradictorii) despre singulare și viitoare (τῶν καθέκαστα)”[18].

[12] *Metaph.* Γ 7, 1012 a 24, trad. Tricot, p. 240.
[13] J.-M. Bochenski, op. cit., p. 40.
[14] Aristotelis, *Opera Omnia*, vol. I, Firmin-Didot, 1878.
[15] J.-M. Bochenski, op. cit., p. 41
[16] Tricot în trad. *De interpr.*, p. 95, nota 1, V.
[17] J.-M. Bochenski, op. cit., p. 40:”(Aristotle) considers it in the *Methaphysics* as a kind of corollary to this law”.
[18] Aristotelis, *Opera Omnia, De interpr.*, 18, 30 sq.

Aristotel arată că aplicarea regulii după care din două contradictorii una e cu necesitate adevărată şi alta falsă – la evenimentele singulare viitoare – duce la absurdităţi evidente și contrazice experienţa, desființând orice indeterminare şi contingenţă în procesul devenirii[19].

Ea duce la concluzia că ἅπαστα οὖν τὰ ἐσόμενα ἀνάγκη(toate evenimentele viitoare se produc în mod necesar). Nu există, în acest caz, decât categoria necesarului; dispar categoriile posibil ((δυηατόνşi contingent (ἐνδεχόμενον).

„Dacă (nu putem spune despre un eveniment) nici că va fi, nici că nu va fi mâine, nu va mai fi nimic care să se întâmple contingent ((οὐκ ἄν εἴη τὸ ὀπότερ ἔτυχεν– *non fuerit aliquid contingens ultrumlibet*). De pildă, despre o bătălie pe mare: ar urma cu necesitate ((δέοι) ca (să nu poţi spune) nici că mâine va fi bătălia pe mare, nici că nu va fi“[20].

„Aceste absurdităţi și altele de același fel survin, zice Aristotel, dacă pentru orice afirmaţie și negaţie, atât relativ la propoziţiile universale enunțate universal, cât și la cele universale neenunţate universal, (aplici regula că) e necesar ca una din contradictorii să fie adevărată şi alta falsă și dacă nu este nimic contingent (μηδὲν ἄν ὀπότερ ἔτυχεν) în procesul devenirii (ἐν τοῖς γενομένοις) şi dacă, dimpotrivă, toate lucrurile sunt şi devin din necesitate (ἐξ ἀνάγκης)[21].

Dacă așa ar sta lucrurile, susține Aristotel, n-ar mai fi posibilă nici deliberarea (βουλεύεσθαι), nici acţiunea (πργματεύεσθαι)[22]. Dar dacă aceste (consecințe) sunt imposibile, — căci noi vedem că este un principiu, o origine a evenimentelor viitoare atât în deliberare, cît şi în acţiune și că, în general, în lucrurile care nu sunt totdeauna în act (ἐν τοῖς μή ἀεὶ ἐνεργοῦσιν) există posibilitatea de a fi sau de a nu fi (τὸ δυηατόν εἶναι καὶ μὴ εἶναι); în aceste amândouă situaţii sunt posibile şi să fie şi să nu fie“[23].

Prin urmare, conchide Stagiritul, „e evident că nu toate lucrurile sunt sau devin din necesitate, ci unele se întâmplă contingent, (τὰ μὲν ὀπότερ’ ἔτυχε) şi afirmaţia sau negația nu sunt de loc mai adevărate una ca alta“[24].

Aristotel distinge între existentul necesar şi existentul care nu e necesar: „nu orice existent există cu necesitate și nu orice neexistent nu există cu necesitate; căci nu e același lucru (a spune) că orice lucru există cu necesitate, când există, şi că există în mod absolut cu necesitate (ἁπλῶς ἐξ ἀνάγκης)“[25]. „Același lucru e cu nonexistentul“[26].

Un lucru există în mod necesar când există: există și nu poate să nu existe; dar el ar fi putut să nu existe, căci nu era determinat necesarmente să existe: nu era un *anagkaion*, un *necessarium*. Însă lucrul care există şi nu poate să nu existe, fiindcă era determinat cu necesitate să existe, acela exista *simpliciter ex necesitate*[27].

Plecând de la o analiză a realităţii obiective, a necesarului şi contingentului *in re*, Aristotel trece pe planul logic *in mente*: „καὶ ἀεὶ τῆς ἀντιφάσεως ὁ αὐτὸς λόγος, *et contradictionis eadem ratio est*“[28]. Logica lucrurilor determină logica gândirii.

„Ca necesitate orice lucru este sau nu este; va fi sau nu va fi; însă cel ce le va enunța separat nu va putea spune care din ele e necesar“[29].

Și Aristotel dă celebrul exemplu al bătăliei navale: în mod *necesar*, mâine va fi sau nu va fi bătălie navală: *tertium non datur*. Dar nu e necesar ca mâine să fie bătălie navală,

[19] *Ibidem*, IX, 7.
[20] Aristotelis, *Opera Omnia, De interpr.*, IX, 3.
[21] *Ibidem*, IX, 7.
[22] *Ibidem*.
[23] *Ibidem*, IX, 10.
[24] *Ibidem*, IX, 9.
[25] *Ibidem*, IX, 16.
[26] *Ibidem*
[27] *Ibidem*, traducerea latină.
[28] *Ibidem*, IX, 12.
[29] *Ibidem*.

după cum nu e necesar să nu fie: nu există necesitate într-un sens sau altul. Ceea ce e necesar e ca mâine să fie sau să nu fie: (γενέσθαι ἢ μὴ γενέσθαι ἀναγκαῖον)[30]: *tertium non datur*.

Nu e o necesitate, ci o posibilitate ca mâine să fie bătălie navală, nu o posibilitate izvorâtă din necesitate, o *dynamis* care trece necesarmente —em in actu, ci o posibilitate de contingenţă.

Şi iarăși logica obiectivă determină logica subiectivă: „De aceea, deoarece propoziţiile sunt adevărate deopotrivă după cum sunt şi lucrurile (adică reflectă lucrurile) e evident că dacă lucrurile sunt astfel încât se produc contingent și cuprind potenţial contrariile (τἀναντία ἐνδέχεσθαι), în mod necesar se va întâmpla la fel şi cu contradicţia“[31].

Acest fenomen se întâmplă cu lucrurile care nu există întotdeauna, adică nu sunt necesare, ca și cu acele care nu sunt totdeauna neexistente, adică nu sunt imposibile, ci contingente[32].

În această ipoteză, e necesar ca una din acele două părţi ale contradicţiei (μόριον τῆς ἀντιφάσεως) să fie adevărată sau falsă, însă nu asta sau asta (τόδε ἢ τόδε), ci ὁπότερ' ἔτυχε, oricare dintre ele, și deşi una poate fi mai degrabă adevărată decât cealaltă, nu e încă adevărată sau falsă (οὐ μεντοι ἤδη)[33].

De aceea, conchide Aristotel, „e evident că nu e necesar ca din două propoziţii opuse ca afirmaţie și negație una să fie adevărată, iar alta falsă“[34].

Căci – din nou logica obiectivă determină pe cea subiectivă: „situaţia nu e aceeaşi (οὐ οὕτως ἔχει) în lucrurile care nu sunt ca în lucrurile care sunt, ci cele dintâi au posibilitatea să fie sau să nu fie, ci situaţia e cum s-a spus mai sus“[35].

Așadar, după cum lucrurile care nu decurg dintr-o necesitate vor fi sau nu vor fi, nu sunt încă determinate într-un sens sau altul, ci sunt indeterminate şi contingente, tot aşa propozițiile contradictorii *de futuris contingentibus* nu sunt definit adevărate sau false. Caracterul de adevăr sau fals e suspendat. Putem concepe o a treia valoare în afară de adevăr sau fals, absurdul, nonsensul, de pildă. Desigur, însă în ipoteza bătăliei navale de mâine, aceasta nu înseamnă că apare un *tertium*, ci numai că adevărul sau falsul e pus între paranteze. Nu putem opera cu formula J. B. Rosser și A. R. Turquette: „*Every statement is true or false or tertium*“[36].

Avem numai, cum spuneau scepticii, ο ἐποχὴ τῆς ο σκέψεως– paralelă cu ἐποχὴ τοῦ πράγματος, o suspendare, o punere în paranteză a faptului.

Nu e deci introducerea unei terțe valori, ci suspendarea aplicării valorilor de adevăr şi fals – Legea terţiului exclus e totuşi serios atenuată și însăși suspendarea afirmației și negaţiei apare ca un terț.

În acest sens, *tertium datur*.

După părerea noastră, Aristotel nu a admis el însuși o a treia valoare de adevăr, însă din tratarea bătăliei navale de mâine se poate degaja a treia valoare, aşa cum a făcut-o Lukasiewicz.

În acest sens, just observă A. N. Prior: „*That there is such a third truth-value was suggested by Aristotle himself, in the ninth chapter of the* De interpretatione“[37].

[30] *Ibidem*.
[31] Aristotelis, *Opera Omnia, De Interpr.*, IX, 3.
[32] *Ibidem*, IX, 13, apud. Tricot, *Organon*, I, p. 103, nota 1.
[33] *Ibidem*, IX, 13.
[34] *Ibidem*.
[35] *Ibidem*.
[36] „Orice enunț este adevărat sau fals sau tertium“, J. B. Rosser and A. R. Turquette, *Many-Valued Logics*, North-Holland Publishing Company, Amsterdam, 1952, p. 10.
[37] A. N. Prior, *Formal Logic*, p. 240, Oxford, At the Clarendon Press, 1955. („Faptul că există o atare terță valoare a fost sugerat de Aristotel însuși, în capitolul nouă din *De interpretatione*“)

Există deci propoziţii care nu sunt nici adevărate, nici false, ci numai „potenţial una sau alta“[38].

În evul mediu, Occam a încercat să arate, în comentariul său la *De interpretatione*, ce consecinţă, decurgând din propoziţiile „neutre“ a admis sau respins Aristotel[39].

Oricum, propoziţia neutră – nici adevărată, nici fals – deci având caracter de judecată și nu de simplu discurs semantic, se profilează în *De interpretatione*.

Atenuare a lui *tertium non datur*.

În însuși miezul terțiului exclus apare terţiul admis. Totuși, în ce priveşte enunţul apofantic, adică judecata, nu „*every statement is true or false or tertium*“, ci numai în propoziţiile de *futuris contingentibus*: „orice propoziţie purtînd asupra viitoarelor contingente nu e nici adevărată nici falsă, ci provizoriu neutră.

Aceasta e, credem, poziţia lui Aristotel în *De interpretatione*, despre *futuris contingentibus*.

Poate că funcţia propozițională, introdusă de Whitehead și Russell, e potenţial cuprinsă în *De interpretatione* și astfel polemica russelliană contra Stagiritului apare, o dată mai mult, ca o mare ingratitudine.

Căci funcţia propozițională nu e nici adevărată, nici falsă, ci are numai capacitatea de a deveni una sau alta, prin înlocuirea variabilelor cu constante care reflectă realitatea.

Funcţia propozițională reprezintă o generalizare a „neutralității“ şi indeterminării propoziţiilor *de futuro contingenti* la orice propoziţie.

„*A propositional function*, scrie Bertrand Russell, *is simply any expression containing an undetermined constituent, or several undetermined constituents, and becoming a proposition as soon as the undetermined constituents are determined*“[40].

Însă – cum observă Bochenski – deși în *De Interpretatitone*, IX, „aplicarea legii terţiului exclus: $(\chi, \phi) \cdot \phi\chi \vee \sim \phi\chi$ este respinsă – totuși, în corpul *Organon*-ului, nu găsim nici urmă de vreo consecinţă a acestor îndoieli. *Tertium non datur* este presupus întotdeauna a fi universal valabil“[41].

Aristotel formulează cu fermitate legea terțiului exclus – corolar al legii contradicţiei[42] – fiindcă ea desparte adevărul de fals, fiindcă fără ea adevărul și falsul s-ar confunda într-un μεταξύcare ar face imposibilă cunoașterea şi ar justifica argumentul sofistic al grămezii (σῶρος), imagine a indistinctibilității adevărului şi falsului.

În domeniul necesarului – și, într-un anumit sens, existentul trecut şi prezent, chiar dacă nu e *simpliciter* universal, e necesar, dacă nu după esenţă după existenţă; *secundum esse* — în domeniul necesarului și al universalului luat universal (= necesar), legea terțiului exclus se aplică riguros[43]. Același lucru pentru propoziţiile despre singulare: Socrate e alb — Socrate nu e alb[44]. Propoziţiile singulare se comportă ca universale.

Acesta e domeniul legii terţiului exclus. Acolo unde e necesitate şi determinație, se aplică riguros terţiul exclus.

Analiticele înfăţişează acest domeniu. Ele tratează demonstraţia și știința demonstrativă[45].

În *Analiticele secunde* citim: a spune că pentru orice lucru adevărul rezidă în afirmaţie

[38] *Ibidem*, p. 241.

[39] *Ibidem*.

[40] B. Russell, *The Monist*, 1919, p. 192, apud L. S. Stebbing, *A Modern Introduction to Logic*, p. 130, Methuen and Co, London, 1953 (reprinted). (O funcție propozițională este o expresie care conține un constituent nedeterminat sau multe constituente nedeterminate, și care devine o propoziție atunci când se determină constituentele nedeterminate).

[41] J.-M. Bochenski, op. cit., p. 41.

[42] Ibidem, p. 40.

[43] Aristotelis, *Opera Omnia. De interpr.* cap. VII şi IX. Cap. VII, 6 şi 7.

[44] Exemplul lui Aristotel în *De interpretatione* (AB).

[45] *Ibidem, Anal. Pr.*, cap. I, 1.

sau negaţie, înseamnă a spune că lucrul există[46]. Aristotel enunţă astfel legea terţiului exclus în *Anal. Post.*, 4, referindu-se în mod precis la lucrurile a căror definiție implică existența.

Obiectul ştiinţei demonstrative e necesarul: „este imposibil ca lucrul a cărui cunoaștere e absolută să fie altfel de cum este“[47].

Topicele se ocupă de verosimil şi probabil, însă – ca și în *De Sophisticis Elenchis* – Aristotel e preocupat în ele de risipirea confuziilor sofistice. Atunci însă cînd studiază, în *De interpretatione*, IX, indeterminaţia și contingența (sau în *De interpretatione*, VII, opoziția propoziţiilor), el aduce restricţii valabilităţii legii terțiului exclus.

Și sub acest aspect, Aristotel se manifestă ca un mare dialectician. Terţiul exclus e ferm enunțat ca o lege fără de care distincţia între adevăr şi fals nu poate subzista şi fără de care gândirea s-ar prăbuși în incoerență, ar înceta să mai fie reflectarea exactă a obiectului, însă în acelaşi timp Stagiritul deschide o fereastră menită să permită reflectarea a ceea ce este încă indeterminat, a proceselor, a dezvoltării de la *dynamis* la act.

POZIŢIA CHRYSIPPIANĂ

Numele lui Chrysippos e rezumativ pentru şcoala logică stoică-megarică, deşi între megarici şi stoici există notorii diferențe şi chiar între gânditorii stoici unanimitatea e departe de a domni într-o serie de probleme importante.

Bochenski notează că megaricii par a fi fost, în anumite privinţe, superiori stoicilor; şi pentru trei din logicienii lor vestiți – Pubulides, Diodorus şi Philo – cunoaştem numai unul din marii gânditori stoici: Chrysippos. În plus, pe câtă vreme teorii importante pot fi atribuite celor dintâi, nimic de acest fel nu poate fi atribuit cu certitudine lui Chrysippos ca inovator. În fine, nu e îndoială că însuşi Zenon a învăţat logica de la Diodorus, şi că întreaga mișcare se organizează la şcoala „dialectică“ din Megara. Totuşi, cum școala megarică a dispărut și cum stoicii au cultivat logica un timp îndelungat, întreaga doctrină a ajuns să fie denumită „logica stoică“. Pare mai corect să o numim „stoico-megarică“[48].

Totuși, Bochenski socotește că „Chrysippos merită o menţiune specială“[49] El amintește ca în antichitate, se spunea despre acest „logician riguros“: „dacă nu ar fi existat Chrysippos, n-ar fi fost Stoa“ și „dacă zeii au o logică, aceasta trebuie să fi fost chrisippiană“[50].

În problema terţiului exclus, poziţia lui Chrysippos era deosebit de clară și originală, astfel încât – cu sublinierile de mai sus – socotim legitim a vorbi de poziţia chrysippiană în această problemă.

În acest spirit, Lukasiewicz – care a adus o prețioasă contribuţie la istoria logicii – denumeşte logica polivalentă, logica non-chrysippiană.

Diogenes Laërtius ne spune că stoicii defineau logica drept „știința (enunțurilor) care sunt adevărate, false sau nici una nici alta“[51].

Adevărul, falsul şi neutrul există ca și la Aristotel, însă obiectul logicii îl constituie numai adevărul. Pentru stoici „logica consistă esențialmente într-o dialectică, o ştiinţă a discursului corect, prin întrebări şi răspunsuri, şi capabilă să discrimineze adevărul de fals prin raport la adevăr, adică la real care se distinge de adevărat precum corporalul de incorporal“[52].

[46] *Ibidem, Anal. Post.*, cap. I, 4.
[47] *Ibidem*, II, 2.
[48] J.-M. Bochenski, *op. cit*, pp. 78—89.
[49] *Ibidem*, p. 89.
[50] *Ibidem*.
[51] 7, 42, *apud* Bochenski, p. 83.
[52] L. Robin, *La pensée grecque*, p. 421, L'Évolution de l'Humanité, Paris, 1923.

Dialectica stoică poartă nu asupra lucrurilor, ci asupra enunţurilor adevărate sau false, relative la lucruri[53].

Logica chrisippiană – logică a propoziţiilor, precursoare a logisticii – e ca și logica aristotelică, logică a claselor sau predicatelor[54], o logică bivalentă și chiar mai riguroasă decât ultima.

Din această poziţie a stoicismului decurge teoria chrysippiană în problema terțiului exclus, pe care Chrysippos îl afirmă cu multă vigoare, în care „sau“ avea sensul exclusiv[55] şi care se simbolizează astfel: $(p).T\lceil p\rceil \vee F\lceil p\rceil$, adică p e adevărat sau (disjuncţie exclusivă) p e fals.

„Chrysippos, notează Antoinette Virieux-Reymond, „pune un principiu care stabilește determinismul indispensabil științei, declarând că ≪ nimic nu se întâmplă fără cauză ≫ şi, de altă parte, susține că nu există poziţie intermediară între adevăr şi fals. ≪Totul e adevărat sau fals≫“[56].

Chrysippos, subliniază A. Virieux-Reymond, admite însă că posibilul este ceea ce nici nu este nici nu va fi adevărat, trecutul fiind totdeauna adevărat, imposibilul putând decurge din posibil[57].

Aceeaşi autoare se întreabă dacă, în ciuda spuselor lui, Chrysippos admite nici adevărul, nici falsul și dă următoarea interpretare celor două definiţii chrysippiene în aparență contradictorii: „atâta vreme cât posibilul rămâne în stare de posibil, indeterminarea e prea mare ca să putem spune că e sau că va fi adevărat sau fals; numai când posibilul se realizează sau nu se realizează, indeterminarea dispărând, se vede care e poziţia de adevăr; dar prin esenţă posibilul nu e adevărat nici fals; el e posibilitate de adevăr sau de fals“[58].

A. Virieux-Reymond observă că, pe planul logic, orice fenomen şi orice propoziţie are valoarea sa de adevăr sau de falsitate, însă, „*dans le plan vécu*“[59] multe evenimente sînt încă prea indeterminate pentru a putea defini poziţia lor de adevăr, căci, spune d-sa, „*la logique ne fait pas intervenir le facteur temps; elle étudie les oppositions statiques entre le vrai ei le faux; mais la notion du possible fait sauter les cadres de la logique en introduisant un facteur qui lui est étranger*“[60].

Și autoarea se referă la Brunschvicg, pentru care „în logică nu există poziţie intermediară între ceea ce este şi ceea ce nu este, dar de îndată ce apare factorul timp, apare o noţiune nouă, aceea a posibilului“[61].

Ni se pare că explicaţia e valabilă pentru logica chrysippiană şi pentru logica formală în general. Aceasta – cel puţin sub forma sa prelogistică – studiază, în adevăr, poziţiile statice între adevăr și fals.

Credem însă că posibilul – așa cum a arătat chiar Aristotel în cap. VII *De interpr.*, – e o noţiune logică, dar care *fait sauter* nu cadrele logicii în general, ci numai cadrele logicii formale. Din momentul ce între posibilitate şi act, între viitorul indeterminat şi realizarea sa, între momentul α și ω al procesului se interpune timpul, înseamnă că el se va reflecta în logica dialectică, în principiile identităţii concrete și ale predicaţiei complexe contradictorii, ca și în atenuările terțiului exclus. Factorul timp intervine chiar

[53] E. Bréhier, *Histoire de la philosophie*, 3, p. 304. Presses Universitaires de France, 1955.

[54] J.-M. Bochenski, op. cit, p. 80.

[55] *Ibidem*, p.91.

[56] A. Virieux-Reymond, *La Logique et l'Épistémologie des Stoiciens*, pp. 197-198. Éditions ≪ Lire ≫, Chambéry, 1950.

[57] *Ibidem*, p. 198.

[58] *Ibidem.*

[59] Fr. *în planul trăit*, sau cum spunem noi repede, „în realitate“ (AB).

[60] A. Virieux-Reymond, op. *cit.* („logica nu face să intervină factorul timp; ea studiază opoziţiile statice Între adevăr şi fals; dar noţiunea posibilului sparge cadrele logicii, introducând un factor care îi este străin“).

[61] *Ibidem*, pp. 198-199.

în legea formală a contradicției, deoarece chiar în formularea clasică e vorba de ἅμα, *simul*[62], în acelaşi timp. De pildă, propoziţiile contradictorii: x e tânăr, x nu e tânăr nu pot fi adevărate în acelaşi timp, dar pot fi adevărate în timpuri diferite. Factorul timp intervine şi creează noţiunea logică de posibil și viitoarele contingente. Însă, în bivalenţa extremă chrysippiană, interpretarea d-nei A. V. Reymond ni se pare justificată, deşi nu putem fi de acord cu extinderea concepției chrysippiene la orice logică.

Totuşi, chiar în necesitarismul stoic apare o înmlădiere a terţiului exclus; deoarece posibilul nu e nici adevărat, nici fals. Virieux-Reymond o recunoaşte în cele din urmă, precizând însă superioritatea funcţiei propoziţionale, care prin valoarea dată lui x, poate deveni adevărată sau falsă şi poate deci exprima posibilul.

Justă, de asemenea, ni se pare interpretarea dată de autoare, care – referindu-se la poziţia lui Chrysippos, dar considerând și în general problema – afirmă că posibilul nu infirmă valoarea principiului terţiului exclus, deoarece posibilul nu e o a treia valoare care ar fi prin esenţă nici adevăratul, nici falsul[63].

Credem, totuși, că o nuanțare se impune: există două poziţii de adevăr, dar câtă vreme posibilul nu e realizat, o a treia valoare se profilează pe orizontul logic.

În *De fato* al lui Cicero, Chrysippos afirmă, de acord cu Epicur, că nimic nu se produce fără cauză și, de acord cu Diodoros Cronos, că viitorul cade sub imperiul legii terțiului exclus[64].

În același loc, Chrysippos susţine că o propoziţie nici adevărată, nici falsă prin esență e de neconceput.

Prin urmare, principiul terţiului exclus apare în formularea sa cea mai rigidă la Chrysippos, care nu e depăşit decît de Diodoros Cronos. Acesta din urmă nu admite contingentul. Pentru el, posibil e numai ceea ce e adevărat, sau va fi adevărat; regula contradictoriilor e universală[65].

În raport cu Diodoros megaricul, Chrysippos apare nuanţat, deoarece el sustine că realizarea unui posibil depinde și de composibilitatea cu alte fenomene[66]. El vrea să salveze, astfel, libertatea voinţei[67]. În concluzie, în problema terțiului exclus, poziţia şcolii stoico-megarice reprezintă un pas la dreapta faţă de Aristotel.

POZIŢIA HEGELIANĂ

Hegel are, desigur, merite nemuritoare în formularea principiilor logicii dialectice, însă poziţia lui faţă de logica formală suferă de o miopie evidentă. El a arătat just că, „(logica) nu e universalul abstract ci universalul care întrupează în el bogăţia particularului“.

„Excelentă formulă: „Nu numai universalul abstract“, ci universalul care întruchipează în el bogăţia particularului, a individualului, a singularului (întreaga bogăţie a particularului şi a singularului !) !! *Très bien!*“[68].

Hegel a arătat insuficienţa logicii formale în explicarea proceselor complexe ale realităţii.

Referindu-se la textele hegeliene, Lenin scrie că „În vechea logică nu există trecere, dezvoltare (a conceptelor şi a gândirii), nu există legătură necesară internă... între toate părțile şi trecerea unora în altele.

Şi Hegel formulează două cerinţe fundamentale:

[62] Lat., *împreună, în același timp*, etc. (AB).
[63] A. Virieux-Reymond, op. *cit.* p. 200.
[64] *Ibidem*, p. 201.
[65] *Ibidem*, p. 204.
[66] *Ibidem.*
[67] *Ibidem.*
[68] V. I. Lenin, *Caiete filosofice*, E.S.P.L.P, 1956, p. 71.

1. Necesitatea legăturii şi
2. generarea imanentă a deosebirilor.

„ Foarte important !! Iată ce înseamnă aceasta, după părerea mea:

1. Este necesară legătura, legătura obiectivă între toate laturile, forţele, tendinţele etc. într-un domeniu de fenomene dat;
2. „generarea imanentă a deosebirilor“ – logica internă, obiectivă a evoluţiei şi a luptei dintre deosebirile polare“[69].

Critica făcută de Hegel principiilor identităţii şi contradicţiei formale e profundă şi, totuşi, unilaterală: 1) întrucât nu le formulează pe plan logic; 2) întrucât le neagă metafizic şi nu dialectic, considerându-le ca fără valoare logică.

Într-adevăr, vorbind despre principiul identităţii, Hegel scria: „*Der Satz der Identität lautet demnach: Alles ist mit sich identisch, A=A; und negativ: A kann nicht zugleich A und nicht A sein. Dieser Satz statt ein wahres Denkgesetz zu sein, ist nicht als das Gesetz des abstrakten Verstandes. Die Form des Satzes widerspricht ihm schon selbst, da ein Satz auch einem Unterschied zwischen Subjekt und Prädikat verspricht, dieser aber das nicht leistet, was seine Form fordert*“[70].

E adevărat că legea identităţii e o lege a intelectului abstract, dar aceasta e o etapă necesară a înțelegerii și, ca atare, avem de-a face cu o adevărată lege logică. Forma negativă e o altă lege logică a intelectului abstract, care ne împiedică să ne contrazicem: legea contradicției. E iarăși adevărat că forma principiului e contradictorie și revelă o altă lege: aceea a identității concrete și apoi aceea a predicației complexe contradictorii.

Vorbind despre legea terțiului exclus, Hegel scrie: „*der Satz des ausgeschlossenen Dritten ist der Satz des bestimmten Verstandes, der den Widerspruch von sich abhalten will, und indem er dies tut, denselben begeht. A soll entweder + oder – sein; damit ist schon das Dritte, das A ausgesprochen, welches weder + noch – ist, und das ebensowohl auch als + und – A gesetz ist*”[71]. Hegel ia poziţie împotriva tezei conceptelor contradictorii, potrivit căreia unul din concepte se numeşte, de pildă, albastru, iar celălalt nealbastru, astfel încât acest „'altul' nu e un afirmativ, cum ar fi galben“, ci numai un negativ abstract.

În *Wissenschaft der Logik*, Hegel enunţă legea terţiului exclus astfel: ceva este sau A sau non-A ; nu există terţ şi observă: „Această lege implică mai întâi că orice este un termen al unei opoziții, este determinat sau ca pozitiv sau ca negativ. Aceasta e o propoziție importantă, care urmează din faptul că identitatea trece în diferență și aceasta în opoziție. Dar nu e în general înțeleasă în acest sens; în mod obișnuit e înțeleasă ca însemnând că, din toate predicatele, ori un predicat particular oarecare, sau negația lui, poate fi predicat despre un lucru. Opozitul semnifică aici numai lipsa, sau mai degrabă indeterminarea; și propoziția e atât de neînsemnată încât nu are nicio valoare[72].

[69] *Ibidem*, p. 69.

[70] G. W. F. Hegel, *Encyclopädie der philosophischen Wissenschaften*, § 115, p. 129, ed. G. Lasson, Leipzig, 1934, Verlag von Felix Meiner.

„Principiul identităţii sună prin urmare în felul următor: totul este identic cu sine, A=A; şi negativ: A nu poate fi în același timp A și non-A. Acest principiu, în loc să fie o lege adevărată a gândirii, nu este altceva decât o lege a intelectului abstract. Chiar forma propoziției o contrazice, deoarece o propoziție promite și o deosebire dintre subiect și predicat, acesta însă nu realizează ceea ce cere forma sa“.

[71] *Ibidem*, § 119, p. 132. „Principiul „terţiului exclus este principiul intelectului deteminat care vrea să îndepărteze de la sine contradicția și întrucât face acest lucru, comite tocmai aceasta. A să fie ori + ori – prin aceasta este enunțat deja al treilea A, care nu este nici + nici –, și care este pus în aceeași măsură ca + și ca – A“.

[72] Neavând la îndemână textul original, citățm după *Hegel's Science of Logic*, translated by W. H. Johnson and L. G. Struthers. Volume two. London, G. Allen, New York, The MacMillan Company, Second impression, 1951, p. 66.

Spiritul, se întreabă ironic Hegel, e dulce sau e amar ? verde sau non-verde? Hegel remarcă: există un terţ chiar în propoziţia că nu există terţ: A este acest terț căci el nu poate fi +A sau –A. Acest A nu e nici +A nici –A, și prin urmare este și +A și –A. Astfel, acest ceva este el însuși cel de-al treilea termen care este considerat că trebuie exclus[73].

„Perspicace și just, spune Lenin. Fiecare lucru concret, fiecare concret se află în raporturi diferite și adesea contradictorii cu tot restul, *ergo* el este el însuşi şi altceva“[74]. Critica hegeliană dezvăluie insuficiența explicativă a terțiului exclus. Analiza dialectică a conceptelor şi a relaţiilor lor dovedește valabilitatea acestui terțiu, τρίτον τι, de care şi Platon a vorbit în *Sofistul*. Această analiză dovedeşte că gândirea abstractă e limitată și deficientă, inexhaustivă. A nu e nici +A nici –A, ci un *tertium*. Devenirea nu e nici fiinţă, nici neființă, ci și ființă și neființă, unitatea, fundamentul și realitatea lor. Atomul nu e sau electricitate pozitivă sau electricitate negativă, ci, in raport cu + şi –, e un terțiu care le înfășoară și le cuprinde.

Orice obiect e un *tertium quid*, întrucât implică elemente contradictorii. Lucrul cuprinde unitatea şi în acelaşi timp diversitatea elementelor sale componente dar el nu e nici pura lor unitate, nici pura lor juxtapunere și diversitate ci un existent în care unitatea şi diversitatea se contopesc într-un terţiu.

Această stare *in re* se reflectă *in mente*. Conceptul nu e sau comprehensiune sau extensiune, ci terţiul în cadrul căruia ele ființează. Judecata e terțiul care înfășoară pe A și non-A, subiectul și predicatul. Ea nu e sau A sau non-A, ci A + non-A: *tertium datur*.

La nivelul opoziţiei conceptelor: *tertium datur* – în anumite cazuri.

La nivelul opoziţiei judecăților, *tertium datur* în anumite cazuri în pătratul logic: se poate întâmpla ca nici A nici E să nu fie adevărate, îndeosebi când nu e vorba de atribute esenţiale. Ex.:

A – toți oamenii sunt buni

E – nici un om nu e bun – e adevărat terțiul:

I – unii oameni sunt buni – sau

O – unii oameni nu sunt buni.

Ergo tertium datur.

Însă, în raportul de contradicție A – O, E – I, *tertium non datur*:

A – toți oamenii sunt buni

O – unii oameni nu sunt buni

E – nici un om nu e bun

I – unii oameni sunt buni

Aici se aplică cu necesitate regula: din două contradictorii una e cu necesitate adevărată.

Hegel ironizează principiul terţiului exclus, întrebându-se: „spiritul e verde sau nu? Spiritul nu e nici verde, nici neverde, dar „neverde“ nu e contradictoriul lui verde, ci contrariul lui; or, cum observă Aristotel, *contradictio non patitur medium; admittunt autem contrario*[75].

În planul propozițional, ca și în cel conceptual, *tertium non datur* are o vastă aplicare, deși are și numeroase limitări = unitate dialectică a principiului. Astfel:

[73] *Ibidem.*

[74] V. I. Lenin, *Caiete filozofice*, E.S.P.L.P., 1956, p. 108.

[75] Contradicția nu suportă termenul mediu, totuși admite contrariul (AB).

Tertium non datur	1) Societatea sau are legi de dezvoltare, sau nu are	Plan intra-propozitional
	2) Capitalismul e sau trecător sau netrecător	
	3) Atomul e sau contradictoriu sau necontradictoriu	
	4) Societatea are legi de dezvoltare	
	4') Societatea nu are legi de dezvoltare	
	5) Capitalismul e trecător	Plan inter-propozitional
	5') Capitalismul nu e trecător	
	6) Atomul e pozitiv și negativ	
	6') Atomul nu e pozitiv și negativ	

În planul propozițional inter sau intrapropozițional (conceptual) – dacă opoziția e *definită*: *tertium non datur*.

Prin urmare, deși conținând o critică ascuţită şi justificată a caracterului absolut al principiului terțiului exclus, critica hegeliană păcătuiește şi ea prin acest absolutism şi, negând o lege logic-formală, sapă, după părerea noastră, coerenţa şi consecvența gândirii, deschizând drumul sofisticii.

Problema terțiului exclus trebuie tratată nuanţat, dialectic, în multiplicitatea aspectelor sale – atât din punctul de vedere logic-formal, cât şi logic-dialectic.

Nu putem fi de acord cu nihilismul hegelian faţă de legea terţiului exclus şi socotim mai nuanţată poziţia aristotelică.

POZIŢIA LOGISTICII

Logistica s-a ocupat îndeaproape de principiile gândirii și în special de principiul terţiului exclus. Aceasta se explică prin faptul că de o parte, construcţia matematicilor moderne, de altă parte, mecanica cuantică şi teoria relativității au pus probleme în explicarea cărora principiile logicii clasice se arătau nesatisfăcătoare.

Chiar în cadrul logicii simbolice bivalente, principiul terțiului exclus s-a părut că suferă o atenuare, întrucât funcţia propozițională nu e în ea însăşi nici adevărată, nici falsă, ci simplă posibilitate de adevăr şi de fals. „Nici adevăratul, nici falsul“ caracterizează funcția propozițională „întrucât unul sau altul din elementele sale sunt provizoriu puse de gândire ca absolut indeterminate, sau sunt îndepărtate de ea ca absurde, fiindcă sunt în afara câmpului de realitate definit de funcţie“[76].

Dimpotrivă, există funcţii propoziţionale care sunt totdeauna adevărate: acelea care, exprimând caracterul imuabil al legilor logice, arată legătura gândirii cu ea însăşi în diversele sale operaţii[77].

În fine, Reymond distinge, în raport cu funcţia propozițională, „când adevăratul, când falsul, care creează posibilitatea erorii“[78].

Russell şi Whitehead consideră negația ca o idee primitivă, necesară pentru a caracteriza falsul şi a defini implicaţia[79].

Astfel, implicaţia determină principiul identităţii: p implică p. Principiul terţiului exclus e formulat ca :

$$p \vee \sim p$$

[76] A. Reymond, *Les Principes de la logique et la critique contemporaine*, p. 133, Boivin et co., Paris, 1932.
[77] *Ibidem.*
[78] *Ibidem.*
[79] *Ibidem*, p. 89.

p e sau adevărat sau fals[80].

În *Principia Mathematica*, principiul terţiului exclus nu apare, astfel, ca o *primitive proposition*[81], ci – împreună cu legea contradicţiei, legea dublei negaţii, principiul transpoziţiei, al tautologiei şi al absorbției – printre „*Some simple propositions*“[82].

Legea terțiului exclus pare, ca şi în cazul viitoarelor contingente studiate de Aristotel, căruia Russell îi datorează, în această privință, mai mult decât se crede, ca suspendată în aplicarea ei. Whitehead și Russell o spun explicit: „*Let* y x *be a statement containing a variable so and such that it becomes a proposition when to* x *is given any fixed determined meaning. Then* y x *is called a propositional function"; it is not a proposition, since owing to the ambiguity of* x *it really makes no assertion at all. This* 'x *is hurt' really makes no assertion at all, till we have settled who is* x*. Yet owing to the individuality retained by the ambiguous variable* x*, it is an ambiguous example from the collection of propositions arrived by at by giving all possible determinations to* x *in* 'x *is hurt' which yield a proposition, true or false*“[83].

Ambiguitatea sau indeterminarea[84] variabilei în funcţia propozițională face terțiul exclus provizoriu inoperant, ca și în viitorul contingent.

Logica russelliană e bivalentă ca și logica tradiţională; ea admite în esență valorile de adevăr şi fals, însă ca și în logica aristotelică, se profilează terţiul.

Semnalăm profilarea terțiului în ceea ce Russell și Whitehead numesc „a considera o propoziție în opoziţie cu aserțiunea ei“: „Orice propoziţie poate să fie asertată sau numai considerată. Dacă spun 'Cezar a murit', asertez propoziţia 'Cezar a murit'; dacă spun „'Cezar a murit' e o propoziţie“, fac o aserţiune diferită și 'Cezar a murit' nu mai e asertată, ci numai considerată. De asemenea, într-o propoziţie ipotetică, de exemplu 'dacă a e b, atunci b e a', avem două propoziţii neasertate, anume '$a = b$' și '$b = a$', deoarece ceea ce este asertat este faptul că prima din acestea implică pe cea de a doua“[85].

În notația russelliană, „p“ se numește „semnul aserțiunii“ şi înseamnă: „e adevărat că“[86].

Astfel, indeterminarea, care suspendă provizoriu mediul exclus, apare atât în propoziția funcțională yx, ca și în propoziţiile cu semnul aserțiunii „t. p.“

Pentru ca terţiul exclus să se aplice, e necesar ca „$p \vee \sim p$” să fie valoarea, pentru un argument p, al unei funcţii φp și „aceasta este posibil numai dacă negaţia sau disjuncţia implicată are semnificaţia fixată dinainte şi dacă, prin urmare, p este limitat la un tip. Astfel, aserțiunea legii mediului exclus în forma implicând o variabilă reală e mai generală decât în forma implicând o variabilă aparentă“[87].

Deci, legea terţiului exclus își recapătă valabilitatea în funcție de un *tip determinat*. Cu toate acestea, logica russelliană e bivalentă.

„Adevărul și falsul, spun Whitehead și Russell, este caracteristica esenţială a propoziţiilor“[88].

[80] A. N. Whitehead and B. Russell, *Principia Mathematica*, vol. 1, p. 13. Second Edition. Cambridge. At the University Press, 1950.

[81] Propoziție primitivă (AB).

[82] *Ibidem*, pp. 13—14 (câteva propoziții simple, AB).

[83] *Principia Mathematica*, I, p. 14. „Să considerăm un enunț y x conținând o variabilă în așa fel încât devine o propoziţie când lui x i se dă orice semnificaţie determinată fixă. Atunci numim y x 'o funcţie propozițională'; aceasta nu este o propoziţie, căci datorită ambiguității lui x nu facem niciun fel de aserțiune. Acest ‚x este lovit' nu face în realitate nicio aserțiune, până când nu am stabilit cine este x. Totuși, datorită individualităţii reținute de către variabila ambiguă x, avem un exemplu ambiguu din colecția de propoziţii la care s-a ajuns prin conferirea tuturor determinărilor posibile lui x în ‚x este lovit', ceea ce lasă o propoziție să rămînă, adevărată sau falsă“.

[84] L. S. Stebbing în *A Modern Introduction to Logic*.

[85] *Principia Mathematica*, p. 92.

[86] *Ibidem*.

[87] *Ibidem*, p. 129.

[88] *Ibidem*, p. 660.

Dar, adaugă restrictiv autorii *Principiilor matematice*, „Când spunem că adevărul sau falsul e, pentru logică, caracteristica esenţială a propoziţiilor, nu trebuie să fim rău înţeleşi. Pentru logica matematică nu are importanţă ceea ce constituie adevărul sau falsul; toată chestiunea e că ea împarte propoziţiile în două clase potrivit anumitor reguli“[89].

Logica matematică consideră adevărul sau falsul formalistic, în sensul că unul sau celălalt rezultă din conformitatea cu regulile stabilite, „în virtutea regulilor, fie că propoziţiile lor constitutive sunt adevărate sau false“[90].

Cu tot aspectul său formalistic în tratarea logicii, *Principia Mathematica* sunt bazate pe bivalența adevăr-fals şi, prin urmare, cu precizările de mai sus, legea terțiului exclus rămîne valabilă.

Notăm că *Principia Mathematica*, deşi „au lărgit considerabil și au generalizat sistemul logicii formale“[91], au fost demult depășite de dezvoltarea ulterioară a logicii matematice şi în primul rând de succesele dezvoltării şcolii sovietice de logică matematică[92].

În opoziţie cu logica sa, în care calculul relaţiilor este conceput ca depinzând nu de gândire, ci de lumea exterioară, gnoseologia și ontologia lui Russell sînt idealiste[93].

O contribuție excepţională în logica matematică au adus și aduc D. A. Bocikov, P. S. Novikov, B. A. Trahtenbrat, 1. S. Jegalkin, A. V. Kuzneţov și alţii, ale căror lucrări sunt urmărite cu mult interes de logicienii de pretutindeni.

Semnalăm cu acest prilej contribuţia acad. Gr. C. Moisil în domeniul atât de complex al logicii modale, ca şi lucrările lui E. Gh. Mihăilescu și Iulian Petrescu. Lucrările logisticienilor noştri sunt urmărite cu interes.

Noţiunea de ansamblu transfinit, introdusă de Georg Cantor, a avut repercusiuni în logică în general, în problema terțiului exclus în particular. „Această noțiune a silit gândirea modernă să reia de la un capăt la altul problema aporiilor logice pe care sofiştii din antichitate se amuzaseră să le pună în lumină și pe care Aristotel se sforțase să le depășească“[94].

Cantor a dezvoltat ideile lui Bolzano despre paradoxele infinitului, Russell, ca şi Peano şi Hilbert, au căutat să rezolve antinomiile din teoria mulțimilor. Matematicianul olandez Luitzen Egbertus Jan Brouwer a căutat să dea o interpretare nouă caracterului matematicilor, problemei infinitului şi principiului terțiului exclus. El e întemeietorul intuiționismului matematic, reprezentat de asemenea de Hermann Weyl, Hans Freudenthal, Arend Heyting și la care, în mai mică sau în mai mare măsură (de obicei însă neincluzând respingerea legii terțiului exclus)[95], aderă J. Richard, Th. Skolem şi semiintuiţioniștii francezi E. Borel, H. Lebesgue, R. Baire şi N. Lusin.

După părerea lui Brouwer, construcţia matematică e o devenire imprevizibilă şi antinomiile „provin din faptul că matematicile s-au înfeudat formelor şi structurii limbajului, căzând astfel sub jurisdicţia unei logici străine de adevărata lor natură“[96]. Brouwer socotește că matematicile se dezvoltă *sui generis*, scăpând legilor logicii formale. De aceea aplicarea legilor logicii la construcţia matematică duce la situaţii paradoxale. Cum se vede, Brouwer adoptă o poziţie exact la opozitul celei russelliene, care reduce matematicile la logică. Dimpotrivă, logica depinde de matematică[97]. Acest punct de vedere

[89] *Ibidem*.

[90] *Ibidem*, p. 661.

[91] B. V. Asmus, „Critica teoriilor burgheze idealiste din logică în epoca imperialismului“, în *Analele romîno-sovietice, seria filozofie*, nr. 1/1957, p. 110.

[92] *Ibidem*, p. 113.

[93] *Ibidem*, pp. 113-114.

[94] A. Reymond, *op. cit.*, p. 134.

[95] Alonzo Church în *The Dictionary of Philosophy*, by D. D. Runs, *verbo* Intuitionism, Philosophical Library, New York, 1943.

[96] A. Reymond, *op. cit.*, p. 339.

[97] J. Piaget, *Traité de logique. Essai de logistique opératoire*, Librairie Collin, Paris, 1948.

a fost unul din izvoarele logicii trivalente[98], și interesează. direct şi indirect, principiul terţiului exclus. Brouwer susţine că principiul terțiului exclus trebuie să se justifice pe terenul experienţei și nu pur logic[99].

Tertium non datur nu trebuie să fie *a priori*, ci *a posteriori*[100].

„Exigenta verificării cu titlu de posibilitate pentru gândire rămâne deci fundamentală și nici un principiu logic n-ar putea-o înlocui“[101].

Principiul terţiului exclus e subordonat verificării experimentale. Rezultă că *tertium non datur* se aplică – după verificarea experimentală – la colecţiile finite, dar nu se aplică la cele infinite. Iată o limitare serioasă a principiului, provenită de o parte, din însăşi imprecizibilitatea (după Brouwer) a construcţiei matematice, şi de altă parte din specificul colecţiilor infinite. Indeterminarea suspendă *tertium non datur* provizoriu în prima ipoteză și definitiv în cea de-a doua.

J. Piaget apreciază că Brouwer nu contestă valoarea universală, adică interesând atât finitul cât şi infinitul, a faptului contradictoriu, însă că el a pus în evidenţă dificultăţile aplicării sale la colecţiile infinite, iar în ce priveşte terţiul exclus, n-am putea fi siguri de absența oricărui *tertium* între A și non-A decît în cazul unei colecţii finite.

Într-o colecţie infinită, termenul „toţi“ este afectat de indeterminare şi, în acest caz „demonstraţia falsităţii unei propoziţii nu antrenează adevărul contradictoriei sale, căci acest adevăr n-ar putea fi admis decât după ce am asigurat construcţia elementului făcând excepţie la propoziţia negată. De pildă, faptul de a demonstra că e fals că un ansamblu infinit nu cuprinde cutare element, nu constituie *ipso facto* dovada prezenţei sale. Această existenţă n-ar putea fi determinată decât printr-o construcție evidentă și efectivă şi nu deducând-o din negarea negaţiei sale“[102].

„Întinderea acestei limitări a principiului terțiului exclus, zice Piaget, e evidentă în ce privește semnificaţia logicii bivalente în raporturile sale cu deducţia matematică. A contesta generalitatea excluziunii înseamnă, în adevăr, a refuza să admiţi că o propoziţie poate să fie demonstrată prin negația falsităţii sale, cu excepția unei colecţii finite. Aceasta înseamnă, de o parte, să recunoşti ireductibilitatea construcţiilor operatorii de caracter matematic în raport cu operaţiile logicii bivalente. De altă parte, înseamnă să limitezi domeniul logicii bivalente, nu numai la ansamblurile finite, dar chiar numai la relaţiile de la parte la tot, conform concepției apărute în această lucrare“[103].

„De îndată ce intervine infinitul, spune Piaget, universalul ‘toţi’ își pierde semnificaţia logică“[104].

Prin urmare, după suspendarea lui *tertium non datur* în logica aristotelică a viitorului contingent, după negarea lui în cadrul devenirii (auto şi hetero-raport) la Heraclit şi Hegel, după suspendarea lui provizorie în funcția propozițională russelliană, iată o nouă suspendare şi chiar negare în teoria brouweriană cu privire la colecţiile infinite. Nici la Brouwer însă nu e vorba de o negare absolută, ci de o aplicare condiţionată – adeseori imposibilă – de recenzarea colecţiei infinite prin mijloace matematice.

A. Reymond crede că, în concepţia lui Brouwer, n-ar fi numai adevărat sau fals ca condiţie anterioară oricărei poziții funcționale a gândirii, ci că el „ar putea da naștere la propoziţii care, de drept şi de fapt, n-ar fi nici adevărate nici false și care, fără a fi funcţii propoziţionale, ar exclude însuşi uzul lui *tertium non datur*“[105].

[98] *Ibidem.*
[99] A. Reymond, op. cit., p. 140.
[100] *Ibidem.*
[101] *Ibidem.*
[102] Piaget, *op. cit.*, p. 390.
[103] *Ibidem.*
[104] *Ibidem*, p. 391.
[105] A. Reymond, *op. cit.*, p. 151.

Din această poziţie ar decurge că bivalenţa clasică evoluează în trivalenţă = adevăr, fals, indiferent la adevăr sau fals[106].

A. Reymond, urmat de Antoinette Virieux-Reymond, socotește însă că însăși definiția absurdului „pare să implice totdeauna uzul principiului care e pus în cauză“[107]. În studiul său *Le principe du tiers exclu et la verification mathematique*, Reymond, comentînd poziţia lui Brouwer, susține, de o parte, că „*c'est se méprendre sur le principe du tiers exclu que de le restreindre au domaine du fini*“[108] şi invers „*il se peut que devant un fait complexe, mais qui appartient au domaine du fini, le principe du tiers exclu, soit d'un usage malaisé*“[109]. Și el dă ca exemplu organismul viu, în care adeseori starea de sănătate e greu de deosebit de cea de boală.

Reymond conchide că Brouwer comite greșeala de a considera aceeași judecată de existență matematică când fiind absolut indeterminată, când fiind determinată în anumite limite şi datorită acestui echivoc, Brouwer condamnă uzul terțiului exclus[110].

După Reymond, principiul terțiului exclus intervine chiar în cazul absurdului, deoarece trebuie să hotărăşti dacă o propoziţie e absurdă sau nu. Consideraţiile însă asupra terţiului exclus devin posibile nu acolo unde le caută Brouwer, ci în funcţia propozițională, care face să intervină factorul timp („totdeauna“ – „uneori“) și deci devenirea[111].

Socotim că suspendarea brouweriană a principiului terțiului exclus în cazul colecţiilor infinite e justificată, deoarece seria fiind infinită e imposibil să o demonstrezi. şi, în consecință, să decizi dacă cuprinde pe non-A. Socotim însă că e vorba de o suspendare şi nu de o anihilare a principiului. Acţiunea principiului e anulată, dar nu principiul însuşi. Principiul e pus într-o stare de ineficienţă. Teoria intuiționistă a creat o discordanţă între domeniul matematicii clasice și cel al celei intuiţioniste[112].

Antinomia a fost depăşită de teoria marelui matematician şi logicistician sovietic A. N. Kolmogorov, care, în lucrarea sa *Despre principiul tertium non datur*, a dovedit că teoremele matematicii intuiționiste sînt astfel legate încât, cu ajutorul unei metode speciale, o teoremă demonstrată prin mijloacele logice ale matematicii clasice poate fi transformată într-o teoremă demonstrată prin mijloacele logice ale matematicii intuiţioniste, adică fără aplicarea, în anumite cazuri, a legii terțiului exclus, dar şi fără recunoaşterea tezei gnoseologice idealiste a intuiționismului“[113].

La concluziile lui Kolmogorov – formulate în 1925 – a ajuns, în 1928, și matematicianul austriac Gödel.

Din punct de vedere logic, trebuie să recunoaştem lui Brouwer meritul de a fi semnalat un caz – acela al colecţiilor infinite, în care comportarea normală a lui *tertium non datur* e pusă în paranteză. El a adus astfel, o contribuţie la luminarea complexei probleme a principiului terţiului exclus, în care devine posibil un *tertium datur*.

Heyting a creat o axiomatică bazată pe intuiţionismul brouwerian, în care figurează valorile 1 (adevărat), 0 (fals), 1/2 (nici adevărat nici fals). Avem, deci, de-a face cu o logică trivalentă[114].

„El (Heyting) contestă numai dreptul de a decreta că în gândire nu există mediu între adevăr şi fals“[115].

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[106] *Ibidem*.
[107] *Ibidem*, p. 152.
[108] („Ne înșelăm asupra principiului terţiului exclus restrângându-l la domeniul finitului“, AB).
[109] *Ibidem*, p. 161. („se poate ca în fața unui fapt complex dar care aparține finitului, principiul terțiului exclus să fie de o întrebuințare greoaie“, AB).
[110] A. Reymond, *op. cit.*, p. 152.
[111] *Ibidem*, p. 163.
[112] B.V. Asmus, loc. cit., p. 108.
[113] *Ibidem*.
[114] Ch. Serrus, *Traité de logique*, p. 127. Aubier, Édition Montaigne, Paris, 1945.
[115] Ibidem, p. 129.

În 1920, Jan Lukasiewicz a creat o logică trivalentă, vecină cu aceea a lui Brouwer şi destinată să furnizeze o schemă logică deductivă noilor descoperiri în fizică[116]. Sistemul comportă valorile adevărat, fals, posibil. Ulterior, Lukasiewicz a creat un sistem al negaţiilor generalizate, în care funcţionează nu principiul terțiului exclus, ci acela al lui M. exclus.

Între 1926 şi 1930, un grup de logicieni polonezi, Tarski, Lindenbaum, Sobocinski, Wagsberg, Lesniewski, sub conducerea lui Lukasiewicz, a creat un nou calcul propoziţional considerat ca o „logică non-chrysippiană". Esenţa acestei teorii constă în dezvoltarea unui grup de propoziţii care nu sunt nici adevărate nici false[117].

Cu această ocazie Lukasiewicz scria cu entuziasm: „Nu e ușor de prevăzut ce influență va exercita nașterea sistemelor non-chrysippiene de logică în speculaţia filosofică. Cred, totuşi, că importanța filosofică a sistemelor dezvoltate aci ar putea fi cel puţin tot atât de mare ca şi importanţa geometriei neeuclidiene"[118].

Vorbind despre terțiul exclus, Lukasiewicz scria: „Legea este cel mai adânc fundament al întregii noastre logici, deşi acest fapt a fost contestat energic chiar în antichitate; Această lege, cunoscută de Aristotel dar atacată şi hotărât negată de epicurieni ca aplicându-se la propoziţiile privind evenimentele viitoare contingente, apare pentru prima oară în deplină claritate (*sharpness*) cu Chrysippos şi cu stoicii, și este într-adevăr un principiu al dialecticii lor, care reprezintă anticul calcul al propoziţiilor. Lupta privitoare la legea terțiului exclus are o bază metafizică: susținătorii acestei legi sunt hotărât determinişti, pe câtă vreme oponenții ei tind la o vedere nedeterministă asupra lumii. Astfel, suntem readuși la vechile concepte de posibilitate și necesitate.

Cel mai adânc fundament al logicii pare astfel a nu fi complet evident. Cu ajutorul unor somităţi venerabile, care se originează la Aristotel, am încercat să răstorn legea terţiului exclus prin următorul raţionament:

Pot, fără inconsecvenţă, să presupun că prezența mea la Varşovia într-un anumit moment al anului viitor, de exemplu amiaza lui 31 decembrie, nu este determinată astăzi nici în sens pozitiv nici în sens negativ. În acest caz, este posibil, deşi nu necesar, ca în momentul dat să fiu în Varşovia. Cu această presupunere, propoziţia 'să fiu în Varşovia la 31 decembrie, la amiază, anul viitor' poate să fie astăzi nici falsă, nici adevărată. Căci dacă aceasta ar fi adevărat azi, atunci prezența mea viitoare în Varşovia ar fi necesară ceea ce e contrariul ipotezei, iar dacă azi ar fi falsă, atunci prezența mea viitoare în Varșovia ar fi imposibilă, ceea ce este deopotrivă contrariu ipotezei. Prin urmare propoziţia dată nu este astăzi nici adevărată nici falsă, şi trebuie să fie altceva". E. B. Zeisler obiectează că:

1. expresia 'evenimente viitoare contingente', întrebuințată de Lukasiewicz, prejudecă în sens negativ problema determinismului, termenul de 'evenimente viitoare' fiind contrazicător cu sine în concepţia deterministă. Lukasiewicz, observă Zeisler, se declară în favoarea indeterminării.

2. Lukasiewicz asumă concluzia pentru a dovedi teza sa. Lukasiewicz confundă „adevărul fizic" cu cunoaşterea noastră a adevărului fizic, astfel încât el vorbeşte într-adevăr despre posibilitatea unor evenimente viitoare în lumina lipsei noastre de cunoştinţă a viitorului, oricât de departe a considerat evenimentul.

3. Lukasiewicz nu distinge între posibilitatea fizică și cea logică „deşi cea din urmă nu are nici o legătură cu timpul"[119].

[116] *Ibidem*, p. 133.
[117] E. B. Zeisler, *Foundations of Logic and Mathematics*, vol. I, p. 123. Published by A. J. Isaacs, Chicago, 1955.
[118] *Apud* E. B. Zeisler, *op. cit.*, p. 125.
[119] E. B. Zeisler, *op. cit.*, p. 125.

O obiecţie asemănătoare îi face lui Lukasiewicz, Paul F. Linke; el susţine că adevărul şi falsul nu depind de timp; dacă, de pildă, se descoperă mai târziu că o prognoză e falsă, ea a fost falsă de la început[120]. Observaţia că logica nu depinde de timp nu poate fi acceptată însă *simpliciter*, pentru că, de pildă, chiar principiul contradicţiei din logica formală clasică depinde de timp, așa cum observă însuși Aristotel. Ce altceva înseamnă adverbul ἅμα (în același timp), întrebuinţat de Aristotel în *Metaph.* pentru a enunţa principiul contradicției? Ἅμα e un termen relativ la temporalitate.

Nu mai vorbim de logica dialectică, unde temporalitatea logică e evidentă în principiile identității concrete și predicaţiei complexe contradictorii.

Frederic Benton Fitch, profesor la Yale University, distinge propoziţii care nu pot fi asertate nici ca false, nici ca adevărate. El le numește propoziţii indefinite, în opoziţie cu propoziţiile „definite“, ce pot fi asertate ca adevărate sau false. „Principiul terţiului exclus, scrie el, asertează că toate propoziţiile pot fi asertate ca adevărate sau false. Acest principiu nu va fi asertat însă decât în sensul aplicării sale la propoziţiile definite“[121].

Benton Fitch împarte propoziţiile astfel:

A. Definite

1. Adevărate
   (a) Necesar adevărate
   (b) Contingent adevărate
2. False.
   (a) Necesar false
   (b) Contingent false

B. Indefinite.

Ca exemplu de propoziție indefinită, Fitch dă următoarea propoziţie: „această propoziție este ca însăși falsă“. Propoziția aceasta, spune el, nu poate fi considerată adevărată fără a fi considerată şi falsă şi nu poate fi considerată falsă fără a fi considerată de asemenea falsă. Dacă o astfel de propoziţie e privită ca satisfacând principiul terțiului exclus, atunci trebuie tratată ori ca adevărată ori ca falsă, şi astfel deopotrivă ca falsă şi adevărată. „Astfel, – zice Fitch – nu putem aserta că satisface principiul mediului exclus“[122].

Fitch notează că în unele sisteme de logică, propoziția $(p \vee \sim p)$ poate fi dovedită pentru orice p, dar un sistem de logică pentru care $(p \vee \sim p)$ poate fi dovedit pentru orice p este considerat că posedă principiul terţiului exclus, care afirmă că orice propoziție e adevărată sau falsă. Fitch socotește – ca şi intuiționiştii – că unele sisteme logice pot să nu posede principiul terţiului exclus.

El observă că —faptul de a nu include acest principiu printre principiile logice ar putea părea „contrariu intuiției noastre logice“. Aceasta se întâmplă însă, spune el, fiindcă de obicei înțelegem prin „propoziții“ „propoziţiile care sunt adevărate sau false, adică definite“. „În această carte, continuă el, emitem însă părerea că există și alte propoziţii și pe acestea le numim indefinite“[123].

John W. Blyth de la Hamilton College consideră că principiul terțiului exclus corespunde postulatului existenţial în logica modernă şi aristotelică a claselor. EI nu garantează existența vreunui membru oarecare în universul discursului, dar garantează că cel

[120] În Paul Bernays, "Review", *The Journal of Symbolic Logic*, vol. 17, nr. 4, 1952, pp. 35-42 — recenzie la Paul F. Linke, *Die mehrwertigen Logiken und das Wahrheitsproblem*, 1949.
[121] F. B. Fitch, *Symbolic Logic*, The Ronald Press Company, New York, 1952, p. 8 (2.12)..
[122] F. B. Fitch, *op. cit.*
[123] *Ibidem*, p. 57 (10 – 16).

puțin o propoziţie este adevărată dacă universul discursului poate fi adevărat. El implică faptul că propoziţia „toate propoziţiile sunt false“ este ea însăși o propoziţie falsă[124].

Cercetările moderne asupra principiului terţiului exclus – continuând observaţiile aristotelice cuprinse în *De interpretatione* – nu duc, după părerea noastră, la anularea principiului, ci numai la limitarea lui. Chiar intuiţionismul lui Brouwer şi Heyting nu face decât să arate că, în colecţiile infinite, principiul își suspendă valabilitatea, câtă vreme experiența n-a dovedit că el se aplică. Intuiționismul e o reactie empiristă împotriva logicismului, dar nu o anulare a principiului terțului exclus.

Cercetările logistice și construcţia unor sisteme în care nu funcționează logic-automat terţiul exclus vădesc importanţa acestui principiu și insuficiența – arătată încă de Aristotel – a tratării lui pur formale și metafizice.

LA QUESTION DU TERTIUM NON DATUR RÉSUMÉ

Dans *Cercetări filozofice (Recherches de philosophie)*, no 5/1957, l'auteur a proposé deux lois de la logique dialectique, à savoir: la loi de l'identité concrète et la loi de la prédication complexe contradictoire. Ces lois năbolissent pas les lois symétriques de la logique formelle, qui demeurent parfaitement valables, entre les limites de la logique formelle.

Y a-t-il une loi dialectique, symétrique de la loi formelle du tiers exclu ?

Afin de répondre à cette question, l'auteur passe en revue les principales théories, successivement adoptées, dans histoire de la logique, par: Aristote, Chrysippe, Hegel et, dernièrement, par les logisticiens.

C'est, sans conteste, Aristote qui le premier, a formulé la loi du tiers exclu (*Metaph.* Γ 7, 1011 b 28 a – *Metaph.* Γ 8 1012 b 10 et *Organon* passim).

Le principe du tiers exclu est ici enoncé *simpliciter* et est fondé sur des considérations ontologiques, mais, dans [*De interpretatione* IX, Aristote assouplit singulièrement la rigueur du principe du tiers exclu. Il montre que les *futura contingentia* jouissent d'une indétermination temporaire qui suspend provisoirement, c'est-à-dire tant quîl reste des *futura contingentia* qui ne se réalisent pas, l'action logique du tiers exclu. Cette exception est dîmportance et est à l'origine des logiques non-chrysippiennes.

Chez Aristote, à l'intérieur même du tiers exclu, apparaît le tiers admis; Pourtant, dans le discours apophantique en général, il n'est pas vrai que ≪*every statement is true or false or tertium*≫ (Rosser and Turquette), mais seulement dans les propositions de *futuri contingenti* toute proposition portant "sur des futurs contingents n'est ni vraie ni fausse, mais provisoirement neutre".

Lăuteur estime que la fonction propositionnelle, introduite par Whithead et Russell, est virtuellement contenue dans *De interpretatione* IX, puisque la fonction propositionnelle n'est ni vraie ni fausse, tant que les variables n'ont pas été remplacées par des constantes. La conclusion de l'auteur est quĂristote pose fortement le principe du tiers exclu, mais quîl y apporte une importante dérogation. Ce fait témoigne du profond sens dialectique du Stagirite.

En revanche, Chrysippe pose avec une rigueur inflexible le principe du tiers exclu; mais Chrysippe lui-même admet – à l'encontre de Diodore Chronos – que la réalisation du possible dépend de sa compossibilité avec d'autres phénomènes.

Pourtant, la position de l'école stoïco-mégarique représente un pas vers la droite par rapport à la doctrine aristotelicienne.

[124] John W. Blyth, *A Modern Introduction to Logic.* Houghton Miflin Company, Boston, The University Press, Cambridge, 1957, p. 284.

Pour ce qui est de Hegel, l'auteur – tout en relevant les grands mérites de Hegel dans la considération dialectique de la logique – souligne son incapacité foncière de comprendre les lois de la logique formelle, ainsi que sa façon superficielle de traiter le principe du tiers exclu.

La logique russellienne est bivalente comme la logique traditionnelle, puisqu'elle admet deux valeurs de vérité, mais la fonction propositionnelle, par sa structure même, apporte une importante atténuation du tiers exclu. Dans la logique russellienne le tiers exclu vaut en fonction d'un type déterminé (*Principia Mathematica*, I, p, 129).

Dans la conception de Brouwer, le principe du tiers exclu est subordonné, comme on le sait, à la vérification expérimentale. Il en résulte que le *tertium non datur* săpplique – après vérification expérimentale – aux collections finies, mais quîl ne s'applique pas aux collections infinies, puisque celles-ci échappent, par définition, à toute vérification.

Par conséquent, après l'époché du *tertium non datur* dans les propositions de *futuribus contingentibus* (*De interpretatione*, IX), après sa négation dans le cadre du devenir (Héraclite et Hegel), après sa mise entre parenthèses dans la fonction propositionnelle (Russell), voilà la négation brouwerienne du tiers exclu par rapport aux collections infinies. Mais, chez Brouwer lui-même, la négation n'est pas absolue, mais relative au problème des collections infinies.

Selon A. Reymond, le principe du tiers exclu intervient cependant, même dans le cas de absurde, car il faut décider si une proposition est absurde ou non = *tertium non datur*.

L'auteur pense que la suspension brouwerienne du tiers exclu dans le cas des collections infinies est justifiée, parce que la série infinie est impossible à démontrer, mais qu'il s'agit justement d'une suspension et non d'un anéantissement du principe. C'est, en substance, l'application du principe qui est annulée et non le principe lui même. Le principe est mis en état dînaction.

L'auteur se réfère ensuite aux théories des logiciens polonais et notamment à la doctrine de Lukasiewicz. Il cite les objections de E. B. Zeisler (*Foundations of Logic and Mathematics*) et les objections de P. F. Linke, qui pense que le temps doit être totalement exclu de la logique. F. Benton Fitch introduit la distinction des propositions indéfinies et définies et pense, de cette façon, résoudre la querelle du tiers exclu.

Dans la première partie de son travail, l'auteur conclut que – tout en développant les suggestions du Stagyrite – les recherches modernes sur le tiers exclu ne conduisent pas effectivement à l'annulation du principe du tiers exclu, mais seulement à sa limitation.

Les études logistiques et la construction de systèmes excluant le tiers exclu marquent tant l'importance capitale de ce principe que ses limites logiques et la nécessité de trouver un point de vue complet et supérieur, qui ne peut être que celui de la logique dialectique.

Despre *tertium non datur* (II)[125] Concluzii

Athanase JOJA

Am analizat poziţiile principale — aristotelică, chrysippiană, hegeliană, logistică — față de problema lui *tertium non datur*. Formulat cu vigoare de către Aristotel, însă uimitor înmlădiat în domeniul evenimentelor viitoare contingente, principiul terțiului exclus a fost prins în focul unei critici negativiste de către sofiști, confirmat apoi cu

[125]În *Studii de Logică*, vol. I, București, Editura Academiei RPR, 1960, pp. 110-118. Deci întregul studiu – I si II / Concluzii – se află la pp. 87-118.

rigiditate de către Chrysippos și mai ales de Diodoros Cronos, înmlădiat de Epicur, subpreţuit de Hegel în forma sa tradițională, dar lărgit într-o perspectivă dialectică — şi în cele din urmă, a fost eliminat din unele sisteme logistice.

Problema, atât de acută și de importantă, a terțiului exclus nu poate fi rezolvată satisfăcător nici de pe poziţiile logicii formale clasice, nici de pe acelea ale logicii simbolice, pentru că cea dintâi priveşte static legile şi formele logice, iar cea de-a doua le tratează formalistic (ceea ce face atât originalitatea, cât și limitarea ei). Problema legilor logicii în general, a legii terțiului exclus în particular, nu poate fi exhaustiv rezolvată decât de pe poziţiile logicii dialectice, care asumă, în același timp, funcţia de știință a formelor concrete de raționament, ca și pe cea de metalogică sau metateorie (în sensul de teorie despre teoriile logice). Nu avem pretenția de a rezolva problema terțiului exclus, ci numai de a sublinia posibilitatea de-a o rezolva de pe pozițiile logicii dialectice.

In acest spirit, socotim că, în logică, trebuie să plecăm de la dihotomia *adevăr-fals*, reflectare exactă sau inexactă a realității obiective.

Cunoașterea nu e însă un proces simplu și rectiliniu, ci complex şi asimptotic.

„Cunoașterea, zice Lenin, este apropierea veșnică, infinită a gândirii de obiect. *Reflectarea* naturii în gîndirea omului .trebuie înțeleasă nu într-un fel 'mort', 'abstract', *nu fără mișcare*, NU FĂRĂ CONTRADICȚII, ci în PROCESUL veșnic al mișcării, al apariţiei contradicțiilor și al rezolvării lor"[126].

Dihotomia logică nu trebuie înțeleasă ca fiind dată o dată pentru totdeauna, într-o formă absolută, ci ca fiind în devenire logică, trecând de la adevăruri relative la adevărul absolut, care e suma adevărurilor relative, sigma lor. Deși logicul e considerat ca esenţial extra-temporal, există o temporalitate logică definind mişcarea conceptelor de la alpha la omega, de la prima formulare aproximativă și aproximantă la formularea plenitudinară, multilaterală, poliscopică, atotcuprinzătoare, care practic se desăvârşește de-a lungul generaţiilor. „Suveranitatea gândirii, spune Engels, se realizează la un șir de oameni care gândesc într-un mod cu totul nesuveran; cunoașterea, având un drept necondiționat la adevăr, se realizează printr-o serie de erori relative; niciuna, nici cealaltă nu pot fi realizate pe deplin decât printr-o durată la infinit a vieții omenirii.

Avem din nou aceeași contradicţie, ca şi mai sus, dintre caracterul gândirii omenești, reprezentat în mod necesar ca absolut, și realizarea ei prin indivizi a căror gândire este limitată, contradicție care nu poate fi rezolvată decât de progresul infinit, de succesiunea, practic infinită, cel puţin pentru noi, a generaţiilor omenești. În acest sens gândirea omenească este în aceeași măsură suverană ca şi nesuverană, iar posibilitățile ei de cunoaștere sunt în aceeași măsură nelimitate şi limitate. Suverană și nelimitată prin natura ei, prin misiune, prin posibilitatea, prin scopul ei istoric final; nesuverană și limitată prin realizarea individuală şi prin realitatea ei din fiecare moment dat"[127].

Temporalităţii ca proces de cunoaştere de-a lungul generațiilor, îi corespunde temporalitatea logică, procesul de trecere de la a, b, c, ... la omega, deci la sigma adevărurilor relative, la adevărul absolut. Nu numai atât: de la aspectul a, b, c, al unui obiect sau grup de obiecte la sigma aspectelor şi relaţiilor, interdependenţelor, corelațiilor şi solidarităților obiectului sau grupului de obiecte şi conceptelor și propoziţiilor respective.

„*Ansamblul* tuturor laturilor fenomenului, ale realităţii şi raporturile lor (reciproce) – iată din ce se compune adevărul. Raporturile (= trecerile = contradicţiile) conceptelor = principalul conținut al logicii, și aceste concepte (precum și raporturile, trecerile, contradicţiile lor) sunt arătate ca reflectări ale lumii obiective: Dialectica *lucrurilor* creează dialectica *ideilor* și nu invers"[128].

Firește, temporalitatea logică e de altă natură decât cea fizică – e o temporalitate

[126] V. I. Lenin, *Caiete filosofice*, E.S.P.L.P, 1956, p. 162.
[127] Fr. Engels, Anti-Dühring, E.S.P.L.P., București, 1955, p. 100.
[128] V.I. Lenin, *Caiete filosofice*, p. 163.

conceptuală, noetică, reflectare în forme specifice a celei materiale.

Un autor francez admite noțiunile de „timp logic și anterioritate logică". „Fiind admis, spune el, că orice propoziție poate, *a priori*, să fie acceptată (să primească valoarea A), respinsă (să primească valoarea B) sau rezervată (să primească valoarea T), orice sistem de valori atribuit propoziţiilor unei teorii şi care va fi incompatibil cu regulile logicii, de o parte, cu axiomele teoriei, de altă parte, va defini un moment (instant) logic al teoriei"[129].

Temporalitatea și devenirea logică circumscriu în anumite limite – în limitele unui moment logic – principiul identităţii abstracte (A = A) și impun și suprapun principiul identităţii concret-dialectice (A = A, A', A"'etc.). A = multiplicitatea aspectelor, formelor, relaţiilor şi solidarităţilor sale. *Eo ipso*, principiul contradicției abstracte e și el afectat de temporalitatea logică și corectat şi lărgit de principiul predicaţiei complexe contradictorii (A = A B).

Principiul terțiului exclus e și el afectat de temporalitatea logică şi urmează a fi inflexionat – ceea ce s-a produs, cum am văzut, în problema evenimentelor viitoare contingente ca și în logica intuiţionistă (Brouwer - Heyting) și în logicile plurivalente (Lukasiewicz - Post).

In partea I a acestei cercetări, am înfățișat limitările pe care le suferă principiul terțiului exclus în logica aristotelică a viitoarelor contingente, în logica hegeliană ca și în logica tri- și plurivalentă.

„S-a propus, scrie Van Orman Quine, chiar revizuirea legii logice a terţiului exclus ca un mijloc de a simplifica mecanica cuantică – și ce deosebire există în principiu între o astfel de schimbare şi schimbarea prin care Kepler a inlocuit pe Ptolemeu, sau Einstein pe Newton, sau Darwin pe Aristotel"[130].

„Intr-o logică Ln de valori n, observă Piaget, ajungem la un principiu al lui „n exclus" înlocuind terțiul exclus. Acest principiu este $(p \vee \bar{p})$, adică în limbaj de negaţii $(\bar{p} \vee \bar{\bar{p}})$ pentru n = 2. Dat fiind că propoziția de rang n este singura exclusă, el devine, în general, $\bar{p} \vee \bar{\bar{p}} \vee \bar{\bar{\bar{p}}} \ldots$ până la n negaţii"[131].

Este limpede că, sub presiunea dezvoltării ştiinţei, principiul terțiului exclus a suferit inflexiuni profunde, ajungându-se până la „suspendarea"[132] lui în intuiționismul lui Brouwer -Heyting sau la lărgirea considerabilă în logica plurivalentă.

Ştiinţa modernă, dezvăluind complexitatea microparticulelor și realizând un determinism micro-fenomenal statistic, a dus la reconsiderarea principiului terţiului exclus.

Din excursul istoric schiţat în partea I și din considerarea principiului terțiului exclus, tragem concluziile următoare:

Dihotomia adevăr - fals este imprescriptibilă în logică – logica nu poate funcționa în afara sau deasupra ei. Recunoaștem legitimitatea, originalitatea și fecunditatea logisticii care se așează într-un plan formalistic, rezervându-şi dreptul de a face combinaţii diverse asupra regulilor şi simbolurilor, fără a ţine (provizoriu) seama de aplicabilitatea lor în lumea obiectivă – însă aceste încercări şi combinaţii, în primul rând, pornesc de la datele furnizate de lumea obiectivă şi, în al doilea rând, se justifică, mai curând sau mai târziu, prin aplicabilitatea lor la lumea obiectivă, tot așa cum se originează și se justifică, în ultima analiză, construcţiile matematice în aplicabilitatea lor la lumea obiectivă.

Aceasta, lumea obiectivă, este *punctum a quo și punctum ad quod*[133] e suspendată arta combinatorie a logisticianului.

[129]Fr. Moch, "Oui, non, peut-être", în *Dialectica*, 35-36, 1955, pp. 244-262, Edition du Griffon, Suisse.
[130]Van Orman Quine, *From a Logical Point of View*, Harvard University Press, Cambridge, Massachusetts, 1953, p. 43.
[131]J. Piaget, *Traité de Logique. Essai de logistique operatoire*, Librairie Collin, Paris, 1948, p. 400.
[132]Van Orman Quine, p. 125 n.
[133]Lat. *Punctul în care; punctul la care* (AB).

În afară de această originare și sosire, totul nu e decât deșertăciune şi formalism (în sensul peiorativ al cuvântului).

Nici o formă de pozitivism şi de formalism nu poate înlătura dihotomia adevăr - fals. „Pentru știința modernă, scrie J. Ullmo, rațiunea n-are un conţinut permanent: nu există un dat raţional. Rațiunea nu se defineşte ca un ansamblu de principii: ea e puterea de a opera după anumite reguli; ea e esențialmente o activitate. Raționalismul este astfel convingerea că activitatea rațională va putea să construiască sisteme care se vor egala diversităţii fenomenelor“[134]. Chiar în formula neopozitivistă a acestui autor, activitatea de cunoaștere nu se poate exercita în afara dihotomiei adevăr-fals, sistemele construite trebuind să se „egaleze“ fenomenelor, să le reflecte.

Dacă considerăm o logică cu patru valori – adevăr, plauzibilitate, implauzibilitate, fals – dihotomia subtinde politomia, căci plauzibilitatea și implauzibilitatea apar, în fond, ca intermediare, între adevăr și fals, plauzibilitatea evoluând spre adevăr, iar implauzibilitatea spre fals.

În sistemul lui Post, există şi valori de adevăr care pot fi notate cu 1,2, 3..., (n – 1), şi n[135]. Aceste valori de adevăr nu pot fi, totuşi, concepute decât prin raportarea la valoarea fundamentală a logicii – adevărul – şi ele pot fi considerate, într-o interpretare dialectică, drept n momente ale procesului de reflectare a lumii exterioare.

Adevărul nu poate fi expulzat nici din logica cea mai formalistică, nici chiar din logica combinatorie (elaborată de Schönfinkel, Rosser, Kleene, Curry și Feys).

Intr-o, carte recentă – probabil, primul tratat de logică combinatorie – Haskell B. Curry şi Robert Feys definesc logica combinatorie ca „o ramură a logicii matematice care se ocupă cu fundamentele ultime. Scopul ei este analiza unor astfel de caractere de bază încât sunt considerate de obicei ca acordate“[136]. E vorba de procesele de substituire, indicate prin întrebuinţarea variabilelor, de clasificarea entităţilor construite prin aceste procese în tipuri și categorii etc.

Conceptul de adevăr - fals e aproape absent în logica combinatorie, totuşi Curry şi Feys observă că „atunci când un sistem formal e considerat în legătură cu o aplicare, trebuie să distingem două genuri ale conceptului de adevăr (*truth concept*). Adevărul unei teoreme elementare a sistemului formal e determinat de natura abstractă a teoriei însăși.

Validitatea și acceptabilitatea sunt proprietăţi ale sistemului ca un întreg în relații cu materia dată ; dacă materia e empirică, și ele sunt empirice. Dacă analogul contensiv al unei teoreme elementare e găsit fals, aceasta nu afectează adevărul teoremei; aceasta arată numai invaliditatea interpretării. Pentru o materie empirică validitatea poate fi numai determinată ipotetic. Intr-un astfel de caz, un sistem convenabil și util e considerat a fi acceptabil atâta timp cât nici o nevalabilitate nu e cunoscută ; când o nevalabilitate e descoperită, sistemul trebuie părăsit sau modificat“[137].

Prin urmare, chiar din punctul de vedere al logicii combinatorii, fie înăuntrul sistemului formal, fie în legătură cu lumea obiectivă, conceptul de adevăr nu poate îi eliminat.

Naturam expelles furca, tamen usque recurret[138].

Desigur e vorba de adevăr formal. Nu e vorba de adevăr material, concret, de cutare sau cutare adevăr, de adecvarea cutării sau cutării propoziții la realitatea obiectivă afirmată sau negată.

[134] J. Ullmo, *La pensée scientifique moderne*, Flammarion, Paris, 1958, p. 229.

[135] Paul C. Rosenbloom, *The Elements of Mathematical Logic*, Dover Publications, New York, 1950, p. 51.

[136] H. B. Curry and Robert Feys, *Combinatory Logic*, North-Holland Publishing Compamy, Amsterdam, 1958, p. 1.

[137] *Ibidem*, p. 23.

[138] Lat. *Alungi natura cu furca, și ea revine oricum* (AB

E vorba de adevărul operaţiilor logice, de adevărul, mai întâi, a principiilor logice, care nu sunt niște simple reguli, ci, reflectând poziţii generalisime ale realității, organizează și conduc activitatea gândirii.

Ele au această capacitate de organizare a gândirii tocmai fiindcă reflectă in *ordine cogitandi* forme și poziţii de extremă generalitate în *ordine essendi*.

Principiile logice sunt adevărate, nu simple simboluri și scheme convenţionale, asumate ca atare de logician. Dacă n-ar îi adevărate – formal adevărate – dacă nu s-ar raporta adecvat la adevăr, de ce le-ar asuma logicianul și ce utilitate operaţională ar prezenta ele? De unde le-ar veni eficiența?

Cum remarcă Marie-Louise Roure : legile logice implică totuși toate, cu titlul de postulat universal, un principiu prim, fără de care nici nu ar avea vre-un sens logic, anume principiul non-contradicţiei.

Toţi logicienii recunosc în mod evident aceasta când atribuie spiritului omenesc capacitate a de a construi sisteme pur formale, supuse numai condiției de a fi coerente[139].

Figurile silogismului:

$$\begin{array}{cccc} M-P & P-M & M-P & P-M \\ S-M & S-M & M-S & M-S \\ \overline{S-P} & \overline{S-P} & \overline{S-P} & \overline{S-P} \end{array}$$

sunt adevărate, fiindcă procesele obiective, care se produc *materialiter* şi pe care ele le reproduc *formaliter*, sunt schematic aceleași.

$$M(x) \supset xP(x),\ S(x) \supset xM(x),\ S(x) \supset xP(x)$$

e formal adevărat, fiindcă reflectă procesul obiectiv“ şi e suficient să-i dăm un conținut material, pentru ca *adequatio rei et intellectus* să apară evidentă.

Implicația „$p \supset q$“ e adevărată şi de aceea e logicește fecundă.

$p \vee \bar{p}$ e adevărat în logică, fiindcă in re un lucru e el insuși și nu altceva, fiindcă e sau animal sau plantă, sau bun conducător de căldură sau nu.

Dintre principiile logice, terțiul exclus e legat imediat de problema adevărului și falsului, desparte nemijlocit adevărul de fals.

O judecată e sau adevărată sau falsă; principiul terțiului exclus trece ca o linie între adevăr şi fals.

Între adevărul absolut și negația lui = *tertium non datur* — opuse ca doi poli, adevăr și eroare se exclud și principiul capătă deplina lui valoare.

Privit însă ca proces gnoseologico-istoric raportul se înmlădiază. Între a și a: b, c, d .... *dantur*[140]. Privit ca o cunoaștere a aspectelor, formelor și relaţiilor multiple, n *dantur*.

Prin urmare:

simpliciter = tertium non datur

secundum quid[141] *= tertium datur*.

Logica, spune Hegel, „nu e universalul abstract, ci universalul care întrupează în el bogăţia particularului“.

„Excelentă formulă : ‘Nu numai universalul abstract’, ci universalul care întruchipează în el bogăţia particularului, a individualului, a singularului (întreaga bogăţie a particularului și a singularului!) !!“[142].

[139] M. L. Roure, *Logique et Metalogique*, E. Vitte. Éd., Paris, 1957, p. 159.
[140] Lat. *dat* (AB).
[141] Lat. *Potrivit cu ceea ce este* (AB, acolo, concret).
[142] V. I. Lenin, *Caiete filozofice*, p. 71.

Și această observaţie se aplică şi la particularitatea momentelor cunoașterii și la raportul între propoziţii in cadrul procesului cognitiv alpha-omega.

Inmlădierea se aplică *secundum quid* principiul terțiului exclus, fiindcă se aplică *in re*.

„Fiecare lucru concret, spune Lenin, fiecare ceva concret se află în raporturi diferite și adesea contradictorii cu tot restul, *ergo* el este el însuşi și altceva“[143].

Aceasta explică înmlădierile ce s-au adus terțiului exclus de la Aristotel la Lukasiewicz - Post.

Concluzia noastră este: *menținerea fermă a principiului terțiului exclus*; nici vorbă nu poate fi de abolirea lui ci numai de inmlădierea, de inflexionarea lui potrivit complexității științei moderne, reflectare aproximantă a realităţii obiective inepuizabile în multiformitatea ei.

Dihotomia adevăr - fals – bază a gândirii – impune menținerea lui cu fermitate.

Complexitatea obiectelor şi poziţiilor lor relaţionale, devenirea, mișcarea lor, ca și procesualitatea și complexitatea procesului de cunoaștere impun inflexionarea lui.

Afirmarea principiului terțiului exclus împiedică căderea în sofistică; afirmarea inflexionării lui împiedică căderea în metafizică. Această poziție – pe care o socotim obiectivă – ferește gândirea de Scylla scepticismului şi sofisticii şi de Charybda metodei metafizice.

Subliniem că valorile „nici fals, nici adevărat“, „adevăr parțial“, „eroare parțială“ nu pot nimici opoziția logică între adevăr şi fals, nu o pot nega decât *secundum quid*, fiindcă ele se definesc în raport cu adevărul și cu negarea lui.

Bazându-se pe indicațiile lui Lenin, poziţia adoptată aici corespunde, credem, dezvoltării științei moderne și naturii legilor logice. Ea menţine cu tărie principiul terțiului exclus, dându-i o fermitate care nu degenerează in rigiditate metafizică și o flexibilitate care nu degenerează în neprincipialitate şi confuzionism sofistic. Recunoscând necesitatea unei atitudini ferme față de terţiul exclus, această poziţie îi conferă maleabilitate, ceea ce corespunde structurii gândirii și obiectului, și admite posibilitatea manifestării, în unele cazuri, la un principiu al terțiului *supervenient*[144]. *Exempli gratia*, considerăm ca manifestări ale terțiului supervenient – inflexionare a terţiului exclus:

1) existența semanticului pur fără valoare enunțiativă în domeniul propoziţiilor interogative, imperative, precative, exclamative etc. Dat fiind că acestea nu au valoare enunțiativă, ele sunt în afara dihotomiei adevăr-fals şi, prin urmare, principiul terțiului exclus nu le afectează;

2) existența trihotomiei adevăr – fals - non-sens, în care non-sensul fiind exterior logicii, principiul terțiului exclus nu se aplică;

3) în procesualitatea cunoașterii de la alpha la omega, de la adevărurile parțiale la sigma lor, adevărul absolut, ca și în reflectarea multiplicităţii aspectelor și poziţiilor relaționale (Lenin: „fiecare lucru e în raporturi diverse și adesea contradictorii cu tot restul – *ergo* e el însuși și altceva“) principiul terțiului exclus se inflexionează;

4) aplicarea terțiului exclus e suspendată în cazul evenimentelor “viitoare contingente („bătălia navală de mâine“) ;

5) aplicarea terțiului exclus e inflexionată și adeseori suspendată în mecanica cuantică (cel puţin, în faza actuală a cunoştinţelor);

6) terţiul exclus e suspendat în colecţiile infinite (Brouwer) ;

7) de asemenea este suspendat în propozițiile indecidabile, în care sunt deopotrivă. indemonstrabile un enunț p și enunțul contradictoriu non-p (teorema lui Gödel).

Pe câtă vreme, atunci când am examinat legea identităţii, am formulat o lege dialectică supraordonată legii abstract-formale a identității – legea identității concrete; pe câtă vreme, în ce privește legea contradicției, am formulat o lege a predicaţiei complexe

[143] *Ibidem*, p. 108.

[144] Lăsat în urmă / venit pe deasupra, AB.

contradictorii (e drept, privind numai planul intrapropoziţional), în ce priveşte terţiul exclus, nu vedem posibilă o lege simetrică supraordonată legii terţiului exclus, ci numai o inflexionare a acesteia, terţiul supervenient reprezentând numai această inflexionare.

Aceasta se datorează faptului că legea terţiului exclus se leagă în mod nemijlocit de dihotomia adevăr-fals, baza însăşi a gândirii şi a ştiinţei logice.

Această legătură organică, intimă, logică şi gnoseologică, între legea terţiului exclus şi problema adevărului nu îngăduie formularea unei legi supraordonate, ci cum am arătat, numai înmlădierea legii terţiului exclus.

*

În *Dialectica naturii*, Engels scrie: „Ştiinţa gândirii este, prin urmare, ca oricare alta, o ştiinţă istorică, ştiinţa dezvoltării istorice a gândirii omeneşti. Acest lucru prezintă importanţă şi pentru aplicarea practică a gândirii la domeniile experimentale. Căci, în primul rând, teoria legilor gândirii nu este căutaşi de puţin acel 'adevăr etern' stabilit o dată pentru totdeauna pe care raţiunea filistină îl leagă de termenul „logică“. Chiar logica formală a rămas de la Aristotel până astăzi un câmp de discuţii violente“[145].

Legile gândirii au preocupat în mod deosebit pe logicieni de-a lungul secolelor de la Aristotel la George Boole, Morgan şi Brouwer. Legea terţiului exclus este astăzi, cum am văzut, obiectul unor dezbateri pasionate. La începutul acestei discuţii stau sofiştii şi Aristotel (*De interpretatione*, IX) – la celălalt capăt stau intuiţionişti (Brouwer, Heyting), Gödel, Lukasiewicz şi Post.

Ştiinţa reclamă un organon dialectic. Construirea lui trebuie să înceapă prin reexaminarea şi reconstrucţia legilor logice, între care legea terţiului exclus – linie de demarcaţie între adevăr şi fals – ocupă un loc de importanţă capitală.

După părerea noastră, legile logice pot îi derivate dintr-una fundamentală, legea identităţii (concrete), între ele existând o solidaritate şi o generaţiune logică. Dacă $A = A(A- \prec A)$), urmează că A nu poate fi simultan A şi B ($\sim (p.–p)$), de unde = ceva e sau A sau B ($p \vee \bar{p}$).

Identitatea generează non-contradicţia, căci dacă $A = A$, (A nu e B), deci A e sau A sau B.

Aceasta în ordinea formal-abstractă.

Principiile sunt solidare şi constituie un tot organic.

În ordinea formal-concretă: dacă A = sigma momentelor, aspectelor şi poziţiilor sale relaţionale, $A = AB$ (plan intrapropoziţional), deci A e – cum observă Hegel şi Lenin – terţ. „Există un al treilea termen chiar în această propoziţie, însuşi A este al treilea termen, deoarece A poate fi şi $+A$ şi –A“[146].

Legile logice nu pot fi privite decât organic, suspendate de principiul identităţii concrete, *fons a quo*[147] al logicii. Logistica are dreptul să formuleze principii diverse ca

principiul comutaţiei =
$AB- \prec ba$
$A + B- \prec B = a$

principiul asociaţiei =
$(AB)C- \prec A(BC)$
$A(B = c)- \prec A + (B + C)$

principiul distribuţiei =
$A(B + C)- \prec AB + AC$
$AB + C- \prec (A + C)(B + C)$

[145] Fr. Engels, *Dialectica naturii*, E.S.P.L.P., 1954, p. 28.
[146] V. I. Lenin, Caiete filozofice, p. 107.
[147] Lat. *izvorul din care* (AB).

principiul silogismului =
$\alpha - < \beta \cdot \beta < \gamma \cdot \supset \alpha < \gamma$

principiul dublei negaţii =
$\bar{\bar{A}} = A$ - etc.

Însă această atomizare a gândirii, această disociere a principiilor logice e contrară structurii gândirii şi destramă sistemul logic; îi rupe unitatea și introduce arbitrarul. E cazul să spunem: *disjecta corporis membra*[148].

Gândirea e unitară în diversitatea ei.

Exprimând o opinie foarte răspândită în logistică, un autor afirmă că „principiile identităţii, terțiului exclus și contradicției au fost tradițional considerate ca unicele principii logice fundamentale. Aceasta e o absolută eroare. Ele nu sunt nici mai mult, nici mai puţin importante decât celelalte principii“[149].

Deşi autoarea are o atitudine comprehensivă față de logica aristotelică, socotim că opinia formulată de ea – exprimând sentimentul comun al logisticienilor – e neîntemeiată și trădează o inspiraţie pozitivist-nominalistă.

Principiile formulate în logica simbolică pot fi derivate din principiul identității (concrete sau abstracte).

Dar asupra raportului principiilor gândirii în logica aristotelică şi în logica simbolică – problemă de însemnătate fundamentală pentru orientarea cercetării logice – vom reveni cu alt prilej.

RÉSUMÉ

La pensée logique est dominée par la dichotomie du vrai et du faux, toutefois la connaissance n'est pas un processus simple, mais complexe et asymptotique.

≪ La connaissance, dit Lénine, doit être entendue non d'une façon "morte", "abstraite", non sans mouvement, SANS CONTRADICTIONS, mais dans le PROCESSUS éternel du mouvement, de la naissance des contradictions et de leur résolution ≫. La dichotomie du vrai et du faux est en devenir logique ; elle passe des vérités relatives à la vérité absolue, qui est le Σ des vérités relatives. Bien que le logique soit considérée comme essentiellement atemporel, il y a pourtant une temporalité logique qui définit le mouvement des concepts, lequel pratiquement s'accomplit au cours de l'histoire de l'humanité.

À la temporalité, en tant que processus de connaissance, répond la temporalité logique, passage de alpha à oméga et de l'aspect a, b, c d'un objet ou d'un groupe d'objets au Σ des aspects, des relations, des interdépendances et des solidarités de l'objet ou du groupe d'objets respectifs à des concepts et des propositions qui les experiment.

La temporalité et le devenir logiques limitent le principe de l'identité abstraite (A = A) et imposent le principe de l'identité concrète (A = A', A", A"', etc.; A = la multiplicité de ses aspects, formes, relations et solidarités). Le principe du tiers exclu est lui-même affecté par la temporalité logique ; par conséquent, il doit être infléchi – ce qui, dăilleurs, s'est produit dans *De interpretatione* (*de oppositionibus in futuris contingentibus*), aussi bien que dan la logique intuitionniste de Brouwer Heyting et dans les logiques plurivalentes (Lukasiewicz Post). La dichotomie est souveraine en logique. Aucune forme de néopositivisme ou de formalisme ne saurait la faire disparaître. La notion de pensée et toute logique. Elle persiste même dans la logique combinatoire. Le *truth concept* est discuté par Curry et Feys dans leur *Combinatory Logic*. Évidemment, il săgit toujours de vérité formelle, de la vérité des principes et des opérations logiques.

[148]Lat. *Membrele corpului sunt împrăștiate* (AB).
[149]L. S. Stebbing în *A Modern Introduction to Logic*, Methuen, London, 1953, note, p. 191.

Le principe du tiers exclu se rattache directement au problème du vrai et du faux.
Entre la vérité absolue ét sa négation = *tertium non datur.*
Cependant, considéré comme processus logique, le rapport săssouplit.

Entre alpha et oméga, a. b. c. i... *dantur.*

simpliciter = tertium non datur
secundum quid = tertium datur.

Lăuteur estime quîl faut maintenir fermement le principe du tiers exclu, mais quîl faut l'assouplir, afin de le rendre apte à exprimer les nuances de la pensée scientifique.

La complexité des objets et de leurs positions relationnelles, leur devenir, déterminent son assouplissement. Le maintien du principe du tiers exclu préserve la pensée de la sophistique, son assouplissement la préserve de la méthode métaphysique.

Exempli gratia, le principe du tiers exclu săssouplit et évolue en un *principium supervenientis tertii* dans les situations suivantes:

1) existence du sémantique pur sans valeur apophantique, dans le domaine des propositions interrogatives, impératives, etc;

2) existence de la polytomie vrai – faux – non-sens ;

3) dans le processus de la connaissance, des vérités relatives à la vérité absolue, ainsi que dans le reflet de la multiplicité des aspects et positions relationnelles de l'objet ;

4) l'application du tiers exclu est suspendue dans l'hypothèse des *futura contingentia* (*the sea battle tomorrow*);

5) l'application du tiers exclu est assouplie et parfois suspendue dans la mécanique des quanta ;

6) le tiers exclu est suspendu dans le cas des collections infinies (Brouwer) ;

7) il est également suspendu dans le cas des propositions indécidables (Gödel).

En conclusion, l'auteur estime que le principe du tiers exclu dérive, comme le principe de contradiction, du principe fondamental de l'identité (abstraite et concrète).

Les principes logiques sont solidaires et forment un tout organique. La logique symbolique a certainement le droit de formuler des principes divers et indépendants, tels que ceux de commutation, dăssociation, de distribution, du syllogisme, de l'identité, de la double négation, etc., mais, en dernière instance, tous ces principes logiques sont réductibles au principe dîdentité.

Les considérer comme irréductiblement indépendants est le propre d'une conception positiviste et nominaliste.

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"What If (There Would Be / Would Have Been)?" The Concept of Alternative From the Physical Domain To the Historical One

Ana BAZAC[1]

Abstract The problem of alternatives starts from the epistemological difficulties faced by humans. People have a Janus attitude towards reality and they arrive to know it starting from this bivalent position. On the one hand, they see *what is*, clearly, what is "before their eyes". Hence, alternative thinking seems absurd: dissonant with reality, illogical, not necessary, even harmful. On the other hand, they see that the existence has problems, *is contradictory*, the determinism of things is not always consistent, necessary and exact, but also vague, with random aspects, evanescent. The worrying contradictions are obvious, even if not very clearly. And from here, the thinking of alternatives seems natural, ordinary. How much and how to think alternatives depends. The weight of the two positions depends on the direct and indirect experience, so also on education.

Which face of Janus is better? Neither, but both. Both constitute a unity, although it is a unity of contraries. This paper tries to show the birth of alternatives with a logical key. Firstly, the problem of alternatives as such relates only to the human actions and decisions: including to the process of knowing that mediates the decisions to approach and imagine the inorganic determinism as well as the non-human living determinism. Therefore, *descriptions* and the *genesis of alternatives*, the differences between the *referent* and the alternatives, and between the individual and the collective referents and alternatives, the problem of *the known* and *the new*, truth and alternatives, the *question* as openness to alternatives, *counterfactual reasoning* and *hypothesis, abductive reasoning*, the *paraconsistent logical presumptions* disciplining the formation of knowledge and alternatives, the alternatives without which the *critical spirit* as such does not exist (and the various logical fallacies supported by those who oppose both the critical spirit and the alternatives), the logic of *conclusions all the way to the end* (*anticipation* and alternatives), the *epistemic* and the *logical corruption* negating both the logic of description and the logic of alternatives – are the main facets posited here.

We can finish this abstract not by mentioning the final model of *parrhesia* and

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the logical urge to not be afraid of alternatives, but by confessing that one of the reasons of this paper was and is the vastness of the *concepts–criteria* lying in the background of the explanation of alternatives, as a result of the mistakes done by both the individual and society: *the irreparable, the irreversible*. It is these concepts–criteria that generate the urgency of alternatives. At their turn, these ones can be either *ameliorative* (avoiding the necessary transformation, as we see in the present official approaches of ecological problems) and *transformative*. In the creation of both, the epistemological, psychological and social aspects intertwin. We can better understand this by responding to the challenge to make exercises of "what if?". These exercises always suppose the deeper awareness of things, the looking at this attempt from the outside, as if we were another person.

Keywords: alternative, logic, description, criteria, truth, knowledge, the new, question, what if?, critical spirit, anticipation, epistemic corruption, abductive reasoning, *parrhesia*.

Rezumat: Problema alternativelor pleacă de la dificultățile epistemologice cu care se confruntă oamenii. Oamenii au o atitudine Janus față de realitate și ajung să o cunoască pornind de la această poziție bivalentă. Pe de o parte, ei văd ce este, în mod clar, ceea ce este „în faţa ochilor lor". De aici, a gândi alternative pare absurd: disonant cu realitatea, ilogic, ne-necesar, chiar dăunător. Pe de altă parte, ei văd că existența are probleme, este *contradictorie*, determinismul lucrurilor nu este întotdeauna consecvent, necesar și exact, ci și vag, cu aspecte aleatorii, evanescent. Contradicțiile sâcâitoare sunt evidente, chiar dacă nu foarte clar. Iar de aici, gândirea alternativelor pare naturală, obișnuită. Cât și cum să gândim alternative, depinde. Ponderea celor două poziții depinde de experiența directă și indirectă, deci și de educație.

Care față a lui Janus este mai bună? Niciuna, ci amândouă. Ambele constituie o unitate, deși este o unitate a contrariilor. Acest material încearcă să arate nașterea alternativelor cu o cheie logică. Întâi, problema alternativelor ca atare se referă doar la acțiunile și deciziile umane: inclusiv la procesul de cunoaștere care mediază deciziile de abordare și imaginare a determinismului anorganic și a determinismului viu non-uman. Prin urmare, *descrierile* și *geneza alternativelor*, diferențele dintre *referențial* și alternative, și între referențialele și alternativele individuale și colective, *cunoscutul* și *noul, adevărul* și alternativele, *întrebarea* ca deschidere la alternative, *raționamentul contrafactual* și *ipoteza, raționamentul abductiv*, prezumțiile logice *paraconsistente* care disciplinează formarea cunoștințelor și alternativelor, alternativele fără de care *spiritul critic* ca atare nu există (și diferitele erori logice susținute de cei care se opun atât spiritului critic, cât și alternativelor), logica concluziilor *până la capăt* (*anticipare* și alternative), *corupția epistemică* și *corupția logică* care neagă atât logica descrierii, cât și logica alternativelor – sunt principalele fațete prezentate aici.

Putem termina acest rezumat nu menționând modelul *parhesiei* și îndemnul logic de a nu ne teme de alternative, ci mărturisind că unul dintre motivele acestei lucrări a fost și este vastitatea *conceptelor-criterii* situate în *arrière-plan*-ul explicației alternativelor, ca urmare a greșelilor făcute atât de individ, cât și de societate: *ireparabilul*, *ireversibilul*. Tocmai aceste concepte-criterii generează urgența alternativelor. La rândul lor, acestea pot fi fie *ameliorative* (evitând transformarea necesară, *așa cum vedem în abordările oficiale actuale ale problemelor ecologice*), *cât și transformative*). În crearea ambelor, aspectele epistemologice, psihologice și sociale se întrepătrund. Putem înțelege mai bine acest lucru răspunzând provocării de a face exerciții de „ce-ar fi dacă?". Aceste exerciții presupun întotdeauna conștientizarea mai profundă a lucrurilor, privirea la această încercare din exterior, ca și cum am fi o altă persoană.

Cuvinte-cheie: alternative, logică, descriere, criterii, adevăr, cunoaștere, noul, întrebare, ce-ar fi dacă?, spirit critic, anticipare, corupție epistemică, raționament abductiv, *parrhesia*.

Introduction

Captatio benevolentiae

Although the question in the title is familiar from discussions on *past* history, speculating on possible events/courses of action "if" certain x, y, z aspects/causes would not have been, it is revealing for the manner in which knowledge occurs and, even more applied, for the permanent presence of the alternative in science and technology.

Indeed, the formula of the alternative (*"if" – verb in conditional perfect mode / past perfect tense, "then" – verb in conditional perfect mode / verb in past perfect tense*) was proposed first in the reflection on history, in its multiple form, including ironical[2], belonging to Pascal. "If Cleopatra's nose had been shorter, would the entire face of the world have changed"[3]: namely, 1) "all is random, since, look, the struggle between Antonius and Cezar took place only to conquer Cleopatra and the Romans would not have wanted to remain in Egypt/the war in Egypt would not have taken place, nor the Roman Republic would have ended if . . . "; 2) "there is, therefore, disproportion between causes and effects"; 3) "accidents are more important in explaining history, therefore always some persons[4] and their game starting from their individual universe are the root. The idea of alternative is, here, only implied: in fact, the alternative seems here an *impossible possibility*, if I may use this oxymoronic wording: possibility is just a fantasy since it is not abstractions such as economic and political logic, but the reality of individuals with their personal characteristics, therefore the eventual and the unforeseen – and the unpredictable – are what explain the world. The conclusion is that there is no sense in imagining alternatives: everything is a series of eventualities "exactly as they had to be and as they must be". The historical explanation – that entails, as we know, imagination as well – is the absolute opposite and exterior to the formula "what if (there would be / would have been)".

And nevertheless, this model of judgement from the ancient historiography is invalidated from the very start even by the *process of knowledge*. People are interested in understanding the object on which they focus: they pursue the truth (always expressed by way of judgements / sentences) concerning that object, from the point of view of the position / perspective from which they view it. The example I have given on other occasions, of the primitive man in front of a bush whose leaves are moving, is very clear. The circumspect man quickly thinks about the possible cause of the leaves rustling: wind, a big or small animal, a man hiding etc. and, of course, he has already outlined his possible behaviour faced with the different variants. Then, he excludes the variants that do not reflect the current situation. Here, truth is just one. But the man in the previous example, as well as men in general knew and know that there are, in principle, also other variants, also other truths.

Introducing the hypothesis

The hypothesis proposed here is that, even though the manner of thinking[5] "what if (there would be / would have been)" is *natural* – i. e. *integrated* in the human thinking,

[2]Because the context of the formula did not refer to history.

[3]Pascal, Blaise. *Pensées* (1670), Léon Brunschvicg éditeur, 1897, Ebook Samizdat, 2010. p. 42.

[4]These persons are mostly part of the leading categories (or aim to belong to such categories). See the historical "solutions" of marriages between royal houses. But see, nowadays, the mainstream idea infused in the general spiritual atmosphere of the appearance (behaviour) of political characters as explaining the political struggles and their purpose: therefore, as giving political objectives (changing X political personage with Y etc.; but not changing the political line).

[5] *The pattern, the motif, the figure*: are as many concepts defining the manners of thinking as thought models (logical structures).

therefore in the common thinking, so that it is interconnected with its other figures, all closely interdependent – it is, however, manifesting depending on its exercise: namely also depending on the way it is formed, educated, including together with other patterns of thinking. If all these are developed, educated within the individual, they – and here the motif "what if (there would be / would have been)" is what interests us – are or become normal, simple habits. The conclusion proposed, but not developed, is that the alternative and the logic of the alternative, specific to sciences in general, are common in natural sciences and technology, however less so in some social sciences. This split – epistemologically explained by the weaker (or indirect) interposition of the social conditioning of knowledge between researchers and the matter investigated in natural sciences and technology – was also transposed into the late stage in which people consider the possibility of alternatives when solving social problems.

The outlined response to be above-mentioned hypothesis is a multi-step reasoning. It refers to the *logical structure* of thinking only in relation to its goals / functions: of adapting the human being to the world or in more clear terms, of achieving the viability of human beings into the world. And this viability means not only survival but also *human* development and control of the world.

And the logical structure is discussed in connection with the paradigm of logic as "theory / normative science of rationality", that confers "norms and criteria intervening in the assessment of validity or of the correctness of logical interferences"[6]. Of course, we all differentiate between logic as science, scholarly discipline and, on the other hand, the "logic of things". And this last phrase refers to both the objective causality of phenomena and to the manner of understanding objective interdependencies that reveal causality. Finally, interdependencies and causality are not mechanical but "play" around the processes noticed in the form of concepts of stability and change. All these processes are known, assessed and generative for knowledge with the help of / through the logical framework of thinking.

The alternative in the birth of thinking

Description

First, we must question even the first thesis (hypothetical, as we remember): is the motif "what if (there would be / would have been)" natural?

The human thinking, as we render it in one individual person or in a theoretical model, also somewhat reiterates phylogenesis: it was formed as a reaction of the organism to the environment and as a viability of this reaction. In this process, above all it is important to notice the environment to which the organism must react. In logical terms, this need for noticing was transposed into *reflection* or *reflective* thinking. Its importance is visible not only when confronted with reduced levels of attention and of noticing elements from the reality which are of interest in a discursive framework. The first action of methodical development of thinking in primary educational institutions considers the ability to *describe* things. ("What is the object like?", "What do we see in the picture?")

The description or reflection is, indeed, a *faculty*, an *ability* of thinking. It is a first manifestation of *intelligence*, namely of the ability to *connect* to things and to connect them or, in more detail, of the *composed* ability of *discerning* or *separating* between aspects and *uniting* and *connecting* them. Of course, this composed ability is formed in relation to the world or the information about the world: the more colourful, numerous

[6]Mircea Dumitru, On the Normativity of Logic, in *Normativity, Acta Philosophica Fennica, The 2019 Entretiens of Institute International de Philosophie*, Ilkka Niiniluoto & Sami Pihlstrom (ed.), 2020, pp. 51–66 (64).

and more diverse they are, the more a baby learns to consider them as a whole, the way the parts connect, the different qualities or aspects coming together as a coherent whole. And throughout this entire process, the number of words increases as does the *methodological* baggage of complex networking thereof. Mature individuals who lack a comfortable vocabulary and who lack the semantic property of words – so, using words incorrectly – were deprived precisely of the proper education to describe reality. And if description is precarious, including through a poor number of words, then their internal image concerning that reality is also superficial. That is to say, reality is a cliché for these individuals, or more realistically speaking a set of clichés which they use when they crystalise their reactions or attitudes[7],[8].

A description is not, however, perfectly synonymous with reflection. Not only because reflection is *not* a copy of reality, but a mental processing of the elements of reality and as appropriately as possible to the need to react in a sitable and efficient manner – an extremely clear idea from Kant onwards –. But also, because, even though reflection as such is *ultimately* made only through articulating the mental images, description involves language in a direct and *sine qua non* way, namely the individual self-censorship of the language or descriptive discourse. We do not refer to self-censorship involving, for example, the omission from discourse of certain known aspects, present in the mental picture. But again, and somewhat paradoxically, we refer to the fact that if an individual does not have enough words to employ logically in the description of connections, he is unable to describe these connections, and the picture described is sketchy: namely the individual is, obviously, the one using the words and forcing himself to describe what he *seems* to catch a glimpse of – what he intuits or believes he intuits – but we can also say that his diminished language is the one framing, censoring his description. As such, it is possible that the mental reflection has a richer *potentiality*[9], but if it is not *actualised*[10] in description, the result is poor. In this respect, the mental reflection remains dependent on the capacity of its development through language: judging potentiality without the criterion of actuality is meaningless, as Aristotle considered.

The generative power of description

The description is not a copy, but it must be as vivid and as adequate for reflection as possible, so that to be as correct as possible. But then description itself is less blameless in its "neutrality" of reflection because, *on the one hand*, it can create and strengthen the logical pattern of copy: "this is reality", "therefore, the respective description is the only true one", "therefore, we must judge and act only based on it".

In the scientific research, this logical pattern is transposed into the beautiful model

[7]In connection with this aspect, Hegel wrote "Wer denkt abstrakt?" (1807), G. W. F. Hegel, Werke in zwanzig Bänden, Frankfurt am Main, Surkamp Verlag, 1970, 2 Band (Jenaer Schriften – 1801-1807), pp. 575-580: people who think abstractly do not perceive connections between things, they only label them according to a chosen determination. (AB: in fact, determinations are formed by education in the broad sense of the term, namely by social messages as well as their influence).

[8]In logical terms, a cliché is a description confusing the contextual nature of the truth value of propositions (the fact that something is designated at a certain time or period of time) with the eternal or constant nature of the truth value of propositions (the fact that something is designated, irrespective of time). People who think in clichés do not indicate temporal (and spatial, and we also mention social) operators and they reduce the multiple meanings of terms related to names (therefore to the designed things of names) to some or to just one only. A cliché is, in general, a verdict.

[9]This is the aspect referred to by people who explain intuition as an "alternative" to reason: that man can know "also in another way", by intuition. Actually, and referring here only to the logical level, intuition is based on previous knowledge acquired: through emotions and rationally. Intuition is a short, synthetic (and, of course, selective) present form of previous knowledge.

[10]Therefore, we use Aristotle's terms of potentiality and actuality.

of *normal science* (Kuhn) or of the *Apollonian knowledge* in Blaga[11], and also into the ugly model of false research, of pointless amplification of articles and studies which add nothing to knowledge and only produce noise, counterproductive to knowledge, and even untrue knowledge[12].

On the other hand, a description is not neutral. Only abstract logical models, or more correctly specific models referring to precise aspects of logical thought structure abstract from the *open* nature of descriptions, that is from the richness of inaccuracies which they themselves highlight: in the form of opposites and contradictions. So that: a *description* actually *generates judgements on itself.*

This creativity of the description manifests itself multilaterally. It is easy to see that a description can be considered a thesis that, possibly together with another description (another thesis), generates a conclusion. Logic called this inference – that always leads, therefore, to a conclusion – a syllogism. At *methodological* level – that is, at the *meta* level included in the logical structuring – description conclusions can be of different types, including concomitantly, i.e. generating different types of theses or conclusions.

Some can be *prescriptions.* These are conclusions which require, oblige. (In modal logic, they work through operators such as *it is mandatory* and *it is allowed* – together with their negative variants, of course –).

Other conclusions can differentiate between reality – irrespective how we define it here[13] – and discourses on it, namely exceeding the description of reality or of the situation by *modulating description by adding the doxastic specificity.* In other words, if descriptions of the situation use (classical) propositional logic ("x is so etc.", together with invalidations and confirmations given by direct descriptive sentences with respect to the physical and logical possibility), doxastic specifying conclusions evidence that they refer to the *opinions* (*doxa*, Gr.) *about* the sentences and, basically, about the situations described by those sentences. (This type of conclusions is very Kantian but, as we can see, *on the one hand*, many people tend to ignore that in their descriptions it is always about the perspective of the person who describes or, more correctly, about a certain theory sustained in the opinion and, *on the other hand*, they tend to consider that opinions are identical to reality, that they render reality).

Also, at methodological level, some conclusions can generate *interrogations.* The main interrogation concerns the *causes* of the described situation / of the description. As such, descriptions are followed by *theories*: developments of reasoning (based on experiment in the broad sense of this word, but here we are not interested in how to substantiate reasoning) about the causes of phenomena. However, since phenomena are complex and the (noticed) causality is complex, theories themselves are *criticised*, namely *analysed* in terms of the correspondence between them and the existing information regarding the studied phenomena – or, simply put, the systems – and, therefore, from the point of view of their internal logical coherence. The criticism of theories is a form of supervision starting from their *description.*

Consequently, the descriptions of theories from these points of view can generate

[11]Both models envisage research within a paradigm: namely a general theory, concerning laws or general rules; the paradigm is a general framework for a research programme. In this framework research is fruitful, it creates n solutions/theories for n problems, proving the paradigm. But the logic of research can also lead to disproving not only certain solutions or theories but even the paradigm itself.

[12]John Ioannidis, "Why Most Published Research Findings Are False", PLOS Medicine, 2 (8), 2005, e124.

[13]Defining reality can emphasise the ontological aspect (posited by questions as "difference or overlapping between reality and existence?", "between real and virtual?") or the gnoseological aspects (as "reality is what it is noticed, interpreted and experimented by the subject"), however they are intertwined. In this text, reality is considered in its operational sense of referent of thinking. In this sense, the alternative – the hypothetical structure, the hypothetical existence (not virtual, but hypothetical) - is also a referent of thinking.

conclusions which *invalidate* the theories. Of course, there are different degrees of invalidation, but what concerns us is that descriptions can generate new or alternative *hypotheses* to the criticised theories. "There you go, according to its description it is clear that theory X is not working, therefore it is better to change it, and change is always based on another hypothesis (to be demonstrated etc.)".

In summary, we can remember that descriptions start from *questions* and take the form of *reasoning* seeking to clarify / understand a fact: that inherently is always inserted in the conditions taken into consideration. Reasoning is – no matter how limited a man's attention on a fact and its close conditions – always generating new questions; because pursuing the causes, consequences and multiple conditions of a fact evidences their always expanded and rather grey area. The epistemological condition of new questions is given by the need to color the unknown / to give it contents in this growing space of problems.

How alternatives appear

People know starting from ignorance / non-science. From an epistemological point of view, there are two aspects of the transition from ignorance to knowledge.

One is that of the already existing some knowledge. A newborn stores information about his environment. The *multiplication* of such information allows their connection and, later on, inferring within them. But the conclusions of inferences are not only mere connections of known information, because inferences as such are not made only to connect known information. In fact, their role is to *understand*[14] new things and, therefore, to reach new information. In other words, knowledge is not only the *connection* of information, but the *creation* thereof[15].

More specifically: people know starting from the known, i.e. they relate the unknown to what they already know. They *compare* the unknown to what they know, they see the

[14]The meaning is not the referent. In logic, the referent is the object which thinking refers to, of course not only as a material object. (The referent can be the idea of ..., formula ..., theory ..., music, sound, colour etc.). Meaning is the idea about the referent as it is following the understanding, namely after noticing also the mental processing of the envisaged reality. That is to say, pursuant to the connections between different aspects ("mini-ideas" or constitutive ideas in the thought process concerning the referent). In Frege (1892) there is a distinction between signification and meaning. Interpreted more freely, therefore starting from Frege but going further, signification is the particularity of the word to refer, the correspondence between the word and the referent, i.e. it refers to and is determined as a discrete unit (the correspondence of a word, or more correctly, of a name/of a denomination, with a referent); meaning is what words express, and this power of expression is given by the connections between words and arises from the correlation of the subject's intention in his relation to the world or, more precisely, to the referent, with the connections between words.

This reference to Frege is not meant to complicate things pointlessly. The idea about or the signification is precisely the meaning, the connections and the correlation of intention with signification; therefore, as we have seen, meaning does not exists unless signification exists, the correspondence with the world. (Mind you: "correspondence with the world" does not mean only the material world, but also symbols, ideal systems of relationships built in the mind).

People noticed this. When they ask the question "what is the sense of saying idea X?", idea that is untrue, namely it does not correspond to reality, they do not ask about the connection between words but about the correspondence to reality.

Meaning is dependant on signification, namely the subject's intention is always related to, and depending on the world. So that there is no sense (purpose, meaning) in believing that meaning was something so profound that it cannot be expressed: connections between discrete units can be expressed, seen, and the relationship between these connections and the subject's intention, i.e. meaning, depends on the world which the phrases refer to. If we analyse this world and the manner in which intention occurs (intention is, ultimately, of grabbing the world, of understanding it), meaning seems to be deciphered.

[15]In this respect it was said that the most important problem in logic is demonstration. See Dragoș Popescu, „Demonstrația matematică și demonstrația speculativă. Linii de orientare" ["Mathematical and speculative demonstration. Guidelines"], Probleme de logică [Logic Puzzles], volume XX, Coordinators: Alexandru Surdu, Dragoş Popescu, Ştefan-Dominic Georgescu, București, Editura Academiei Române, 2017, pp. 127-137.

similarities, differences, degrees of similarity and differentiation. The comparison activity *mediates* between the known and what must be known. As such, the unknown becomes known, familiar. And as a result, the known not only broadens, it also increasingly becomes the *basis* or the *criterion* or the *referent* depending on which the child / man knows. "Reality" is what it is known, what can be described. On a more sophisticated level, the image or the description that corresponds to the individual's knowledge (to the information known and also to the level of its connection) becomes "paradigm"; on a more colloquial level, an individual's image or his "theory" becomes a fixed idea.

More seriously, all these mean, once again, that, *on the one hand*, knowledge – namely reducing the unknown to the known – always has grounds, and the grounds always offer a first *certainty*; just as, *on the other hand*, it is possible that the grounds and the related certainty to be conceived in an absolute manner, i.e. the process of knowledge is impaired by the idiosyncrasy of the individual towards the inferential logic that can call into question the "reality" or the theory. However, the known is not a dogma in the usual sense of this word – of fix / fixed knowledge, considered in non-critical terms[16] – but it is always simply a structure of knowledge that determines its critical examination from itself, therefore, a horizon of possible changes. And a change is always a first moment when both the previous knowledge and the doubt in relation thereto coexist. [This coexistence gives the meaning of the word *dogma* in Blaga, *methodologically* signalling

- both the coexistence of different and opposing data (previous knowledge and doubt concerning it, therefore, let us say, a first negation, emotional and raw, of them) defying the binary logic of non-contradiction
- also the revolutionary quality of certain moments of knowledge where results (concepts, theories) are not clear but, rather, *a halo of possibilities*[17]]. Knowledge is an *open* process: analogous to life (living matter and consciousness).

Hence, the more man compares, and also between unrelated aspects, therefore, the more unusual the comparison is, the more the existing knowledge has the role of humus for knowledge, that is to say for the emergence of new knowledge.

The second aspect in the transition from ignorance with respect to certain new phenomena to knowledge is the *assumption*, namely either a reduction of the new to previous knowledge (the new is as the previous or as if it were the previous), or a boldness of the imagination, so a different image (we are not interested here how much, how, in what way the new image is different).

An assumption is not easily outlined. Considering the fact that a man can see / feel that, despite similarities with the old knowledge there are also new elements, relationships, details, he becomes circumspect both towards these and towards the relation between them and the entirety of the new phenomenon. After circumspection, he presumes

[16] As regards the field in question here, that of the logic of knowledge, the concept of dogma – in the above-mentioned sense, of fixed knowledge, considered in non-critical terms, e.g. considered as an axiom whose demonstration is not required (even if possible), or considered as a non-questionable basis – was used in the well-known idea of Munchhausen's trilemma: which describes three proving possibilities, all similarly unsatisfactory. The trilemma is the formulation of these proving methods, unless mentioning the methodological conditions or premises according to which we approach the demonstration/proving of any truth. If these methodological premises or conditions are absent, then some propositions/arguments end up being proven circularly (namely, ultimately by themselves), either by way of propositions which themselves must be demonstrated, in an infinite regress, either by way of dogmas.

[17] Ana Bazac, "Lucian Blaga and Thomas Kuhn: The Dogmatic Aeon and the Essential Tension", Noesis, XXXVII, 2012, pp. 23-36.

The concept of halo of possibilities is related to the concept of unclarity/vague of L.A. Zadeh (1965; but "Quantitative Fuzzy Semantics", Information Sciences, 3, 1971, pp. 159-l76: senses or meanings are vague); or to the concept of nuances of Grigore Moisil (Lecții despre logica raționamentului nuanțat [Lessons on the logic of nuanced reasoning], Bucharest, Editura Științifică și Enciclopedică, 1975).

that there is a specificity of the new phenomenon, suspecting the previous definitions or that the new could be subsumed to those previous definitions. He *doubts*, grumbles, speaks against, "gets upset" with the previous knowledge: even if it turns out that it helped him to catch a better glimpse of the new. And he even goes further: *he imagines*; by extrapolation, projection, approximation, estimation, calculation. He speculates, he guesses. The more information he has, the more used to making connections he is, the more possibilities appear before him[18].

The simple negation – if we logically connect the *previous knowledge* and the yet *new unknown* (as the negation of the old) – is no longer sufficient. Each newly observed particularity, thus different from what he had previously known, pushes him to imagine new knowledge. With each such construction of knowledge, the negation / non-contradiction applies: the new is not the old. Or in more detail: 1. the new could be like the old; 2. but the new does not overlap perfectly to the old; 3. thus, the new is not the old. And since the new has more particularities, if in connection with each one the logical law of non-contraction is applied, the *global logic of the degrees of possibility* (from non-possibility to necessity) applies to the global new. In a meta-logical approach, this is the logic that reveals the entire spectrum from non-certainty to certainty.

Such logic was named *aoristic*[19], regarding *undetermined* situations. It confronts, for examination purposes, all possibilities, i.e. all the imagined *alternatives* to know the new phenomenon. After such examination, logic selects the most plausible alternative – or even the most plausible alternatives, in an image of degrees of plausibility. Technically speaking, this logic can use *several values* (truth, false, possible, probable, impossible, improbable, undetermined[20]). Anyway, the logical inferences that transpose, in fact but philosophically speaking, the principle of sufficient reason – as Schopenhauer called the logical examination of causality in the order and knowledge of things – highlight precisely the possibilities given by the notified causes. And until the evaluation of the most probable situation, all (as possibilities) are equivalent: this is required by the rigor of the logical method.

Just the assumption involves the idea of *alternative* and the idea of using the alternative as *hypothesis*: hence as a thesis that is not (relatively) certain knowledge, but only possible and that, therefore, must be demonstrated. The intertwining and interdependence of these two ideas are constitutive in the human thinking[21]. At the level of discourse – in the mind and expressed – they are formulated with the well-known question: what if? From this point of view, any knowledge implies that "what if" question, both in relation to the present time to which both science and technology refer, but also to the past time to which their philosophy rather refers.

Alternatives to what

The idea of alternative and the logic of alternatives are related to the sensitivity of *always noticing the difference between the object concerned and the thinking about it.* In an evocative image of ancient Chinese wisdom, people notice – or should notice – the difference between the finger pointing to the moon and the moon itself. But this means that, since there are two problems to be known, the object and the theory about it, alternatives exist for both of these problems. If we do not know – or, of course, do not

[18] An interesting page on the process of imagining the future with Lucio Giuliodori, Valentina Uliumdzhieva, Elena Notina, Irina Bykova, "Thinking Beyond, Living Beyond: Futurism", Wisdom, 2 (15), 2020, pp. 176-187

[19] Alexandru Giuculescu, Order Versus Chaos or the Ghost of Indeterminacy, World Congress of Philosophy, 1998, https://www.bu.edu/wcp/Papers/Scie/ScieGiuc.htm.

[20] Thus, not only that famous included third.

[21] This paper does not discuss the continuity between pre-human and human thought.

know as much as we need to know, as much as displayed precisely by what we have already known – we must assume the degree of ignorance and, at the same time, outline alternative theories both about the object, and about the existing theory about it.

But the object as well as the theory about it raise problems and can be studied from n points of view, *i.e.* not only that there are n unknowns but also n points of view. Isn't this an image of an infinite task of leaning on determinations, too overwhelming? Can we take it?

Yes, we can. Knowledge is good for us, that is, it simplifies the object – apart from any reductionism – it shows it to us as *approachable, cognoscible*. How, why? The unknown is an unsolved puzzle, disorder that leads to cognitive resignation. Still, we have not forgotten, man knows by comparing things with what is already known. And in this process, we go step by step on the thread of connections between things. These connections are inferences. They can only describe – "all men are mortal, Socrates is man, etc." –: this is how it seems to us, that is, it seems to us that we are only describing reality. But in fact, the description is already the unfolding of *causality* ("Socrates is mortal because. . . ").

Since things are complicated, we do not easily reach the causes. And before noticing them, we grasp the close connections, the *correlations*. As stated in the epistemology of the second half of the last century, *correlation does not mean causation*. So, the fact that things are close – or at least they appear so in what we know, thus, in (at least some) discourses – does not automatically mean that some things are the causes of others. *Causation must be demonstrated*. And precisely *this demonstration is knowledge*, its core.

And in demonstration we start, as we have seen, from correlations. These draw our attention on the very problem itself and, of course, on the necessity to study them. Examples referred to in other papers – "the rooster crows, the sun rises"[22], "the bad apple spoils the bunch"[23] – show abundantly clear that close connections between things should not be ignored.

The sun does not rise because the chicken's emperor crows. The conclusion is not at all the consequence of the premise. But the premise is related to the rising of the sun, even a consequence of the rising sun: the circadian rhythm of the rooster is connected to the night – day / darkness and light alternation. The theory of the circadian rhythm was, thus, demonstrated: a theory that has nothing to do with the thesis that only saw the correlation ("the rooster crows, the sun rises"), it even invalidates this thesis, but it was constructed also pursuant to the correlation. The bad apple spoils the bunch of good apples not because of an evil principle carried by it, but because it emanates chemical signals reflecting its stage of transformation of excessive ripening into rot; and these signals are also emanated to the other apples, as if to communicate to them that it is time to become more ripen. The correlation evidenced by experience and related to the practical problem of storing apples was used to discover the causes behind the correlation.

Precautions

The ontological precaution

The idea of alternative is not absurd, that is, it does not refer to something that does not support it. From this point of view – and without detailing too much here – we should

[22]Ana Bazac, Logica și interesele de clasă [Logic and class interests], 20 April 2020, http://www.criticatac.ro/logica-si-interesele-de-clasa/.

[23]Ana Bazac, "From the Objective Information to the Information Created and Received by the Human Beings: And What Does Informatonosis Mean?", Noema, 2018, pp. 15-47.

distinguish between what the existence of alternative *allows* and *what it does not allow*. Although all ideas involve the mental processing of the data provided by the senses, so although the ideas are not simple copies of reality, they have *referential, i.e.* they depend on the intended reference, because otherwise they *do not make sense*, nor do they appear. The reference is the one that gives the criterion of distinction between those who support and those which do not support the alternatives.

Natural phenomena are a referent that does not support alternatives. In what sense can we take this sentence? Physical natural phenomena are *determined* – that is, their existence and movement have inevitable, permanent, and necessary structural *causes*, already known / cognoscible, in principle, according to the laws of nature obtained by analysing the physical, chemical, even biological processes. But the determinism of phenomena involves precise *aspects*, precise *characteristics* that have *precise* physical, chemical etc. causes. For example, the erosion of rocks over time involves physical causes (heat-cold alternation, the rhythm and intensity of this alternation; precipitations, their rhythm and intensity are also cardinal, or in general, weather phenomena such as precipitations and wind), chemical causes (type of chemical reactions between external substances depending on the type of precipitations, the rock material and catalytic physical conditions), and biological causes (type and evolution of micro-organisms and plants in relation to rocks). Determinism – knowing the causation – is never absolute because the above causes have intertwined, and time is a coagulant condition of this interweaving; and if it is, nevertheless, necessary to know the phenomenon in detail, calculations, models, projections, measurements are made. Alternatives appear, of course, in the process of *knowing* the moments, but the natural physical *causation* does not imply alternatives. No matter how complex the natural phenomena – like the ecological ones – the causes of the different *aspects* or *characteristics* are determined *each individually*, as *permanent*, *structural* to each aspect or each characteristic. From a logical point of view, the reasoning that ignores logical necessity (*as if* this logical condition would not exist) is not consistent; and the reasoning for explaining a complex natural phenomenon highlights the *"accidental"* only as a conjunction of the determining causes of the precise aspects, both in their present and past moments.

Alternatives appear only in the evaluation of *human action*. The specificity of this *referent* is that necessity or determinism in its knowing process is presented only as a *tendency*, not as a law, and that the accidental is the conjugation not only of other actions and, more broadly, events, but also of the will of the actors. But the referent is not the same as the idea of an alternative to it.

The epistemological precaution

Once again, we must distinguish between the *creative role of the knowing subject* – the fact that all ideas appear in the human mind – and, on the other hand, the referent represented by the *human action*. Alternatives appear in the *knowledge* of both, but if we deal only with the referent, then we must make another differentiation: between *individual action* and, on the other hand, *collective action* or, even if they do not overlap perfectly, *collective events*, resulting from the aggregation of n individual actions.

Logic is related precisely to these different types of referent.

The idea of an alternative to an *individual* action – as suggested by the *post* reflections with "should have been" and "could have been" – is logical only if the action *is determined exclusively by the will of the individual* and not by the totality of events or other actions among which the incriminated action took place[24]. And, of course, the

[24]Plato. Republic, in Plato in Twelve Volumes, Vols. 5 & 6 translated by Paul Shorey, Cambridge, MA, Harvard University Press; London, William Heinemann Ltd. 1969, 619c; an individual who has no

idea of alternative always appears in relation to *one* action or to certain actions, not to the totality of that individual's actions. The logic of individual action is based on *choice*, this itself being a bifurcated position between several possible courses of action for the individual. But what does choice mean from a logical point of view? It means *comparing* the possible action variants to the best model: considered by the individual or, of course, by the judging subject or subjects. And although this "the best" is clearly subjective, in fact it is a *bar* (*i.e.* an ideal) or a milestone for *evaluating* action models from highly recommended to permitted and not permitted, according to a characteristic or an advantage / disadvantage in relation to the individual making the choice[25]. Basically, to choose means to be aware of the bar and to call "'worseṭhe life that leads the soul to more injustice, and 'betterṭhe one that leads it to more justice... not to be charmed by wealth, and other such evils and not to commit numerous and insurmountable evils" as a tyrant or something similar[26]. The alternative occurs when an action that took place / did not take place is attributable to the individual, namely the alternative appears as *mandatory*: precisely because the individual could have (from a logical point of view) easily replaced his choice with this alternative if he wanted to[27].

Talking about the alternative on a collective level adds a necessary condition, time. The alternative to an individual's action seems rather for the past tense and, by translation, for the present tense and for the future, for it concerns the choice by the individual, i.e. the sole responsibility of the individual, regardless of other actions and events. The alternatives to collective actions no longer have the individual choice as a starting point, although this choice or this criterion is not missing. But the specificity of the choice in collective actions is the dependence on a large number of facts, events, actions. Therefore, the alternative (in fact, always in the plural) is not for the past, but for the present and the future. When the historical research investigates past events, it asks the question "what would be (would have been) if" only as a joke in connection to the reaction of some characters. In fact, it seeks to explain the succession and intertwining of different kinds of causes, and the result is a picture that fits into the broader picture of a wider period and trends.

If the logic of the alternative confronts choice or decision *and* the result, that requires analysis with the help of "should have", it is clear that the problem of the alternative is not for the *past* when it is *not* an individual decision but the *intertwining and corroboration of* n *facts and events*. But for the *present* and for the *future* the problem of the alternative arises because even if it is about collective facts and actions, the role of the individual decision is *constitutive, i.e.present and future facts can change depending on the individual decisions at present. The introduction of the possibility of the alternative no longer takes place with the past conditional tense but with the present conditional tense:*

the will to choose what he knows it is good from a human standpoint, has no ability to judge himself: "For he did not blame himself for his woes, but fortune and the gods and anything except himself". See also Plato, Phaedo in Plato in Twelve Volumes, Vol. 1 translated by Harold North Fowler; Introduction by W.R.M. Lamb. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd. 1966, 99a and b: "If anyone were to say that I could not have done what I thought proper if I had not bones and sinews and other things that I have, he would be right. But to say that those things are the cause of my doing what I do, and that I act with intelligence but not from the choice of what is best, would be an extremely careless way of talking. Whoever talks in that way is unable to make a distinction and to see that in reality a cause is one thing, and the thing without which the cause could never be a cause is quite another thing".

[25]For some phenomenological aspects of choice, see Ana Bazac, "Sartre and the responsibility of choice", Revue roumaine de philosophie, 1-2, 2008, pp. 173-185.

[26]Plato, Republic, 618e ("naming the worse life that which will tend to make it more unjust and the better that which will make it more just"), 619a, ("but may know how always to choose in such things the life that is seated in the mean3 and shun the excess in either direction").

[27]Charlie Dunbar Broad, "Determinism, Indeterminism, and Libertarianism" (1934), in Charlie Dunbar Broad, Ethics and the History of Philosophy, London, Routledge & Kegan Paul, 1952, pp. 195-217.

"should". The logic is fine precisely because it notices the differences in the conditions of facts and actions.

Perhaps a proof of the finesse of logic[28] *is the joke about logic, ending with the conclusion that only compliance with the form of inferences leads not only to an absurd certainty that has nothing to do with reality, but also to unfortunate consequences*[29]*. We could speculate that a subtext of the joke was the opening of logic to the integration of form and content* and, thus, to the investigation of situations that can, of course, be captured in logical formulas but that show precisely the compelling nature of these formulas and the need to overcome them by developing logic, including in the unconventional manner of proposing alternatives.

The logic of the alternative

The known and the new

Knowledge does not occur on *tabula rasa*but on an already complex basis, with n items of information and, therefore, perspectives about the world. As a result, the new is the result of an intertwining of causal chains (*the new is not the result of a single causal chain*), it involves n reverse (positive and negative) feedback, *i.e.* it appears only pursuant to such feedback that contributes to the creation of the new response and strengthens it; the new always involves the matter-information complex and the objective-subjective complex, and as a result of such a situation it is always linked to the whole of existence.

The scientific way – focused on the structures of relationships and elements, so on systems and functions – is not at all reductionist, simplifying. As mentioned above, especially through science the new is not the result of a single causal chain, it involves trans-/ inter- and multi- disciplinary perspectives plus complex teams. We do not start from the simple to reach the complex: the premises or hypotheses already have behind them a structural complexity of the studied system, and also a methodological complexity. The only reason of the metaphor "from simple to complex" is that, on the one hand, the theses from which they start are somewhat known and, on the other hand, the system resulting *pursuant* to knowing is clearer, its complexity is now clear and, inherently, greater than the complexity of the starting point. Today's disciplinary perspective is always in relation – in fact, interdependent – with the multi-, inter-, trans- disciplinary perspective. And the objective of science to reach laws / regularities does not simplify, but only gives a *criterion* for knowing complex phenomena. This knowledge is the goal of science. Thus, *science is not a myth; it does not seek to draw a static picture that would be confused with the world.*

In the common knowledge the same understanding occurs: for things are complicated, apart from information, from a "theory" about the object of interest, there is something else. Thus, *on the one hand*, people still put this much more richer reality in parentheses beyond the object of interest, because this is the practical attitude; and *on the other hand*, they either go further around the object of interest to see other information and other theories about it, or they are stopping from going further from the dominant educational messages and constraints external to their need for knowledge and their human nature.

[28] But doesn't this precisely mean the finesse of human reason?

[29] Ambrose Bierce, The Devil's Dictionary, 1911: "LOGIC, n. The art of thought and reasoning in strict compliance with the limitations and inabilities of human misunderstanding. The basis of logic is the syllogism consisting of a major, a minor premise and a conclusion – as such: Major premise: sixty men can perform a work sixty times faster than a single man / Minor premise: a man can dig a hole in sixty seconds / therefore – Conclusion: sixty men can dig a hole in one second. This can be called arithmetic syllogism, by which combining logic and mathematics we obtain a double certainty and are doubly blessed".

Of course, barriers are put in place in many ways, including by channelling thought in the directions necessary for the authors of the constraints.

From an epistemological point of view, knowledge advances in the direction of understanding complexity only if it always checks again the already existing theories. This means *concern for real falsification* (Popper), assuming the confrontation of existing theories with new or "unpleasant" data, and *the freedom of spontaneity* in choosing alternatives. Only after undergoing this process, do the new perspectives, through which we can see better the complexity of things, appear, thus the *new problems*, the new objectives of knowledge.

The alternatives respond to paradoxes, to the knowledge vacuum about an object of interest. At this level, we already see the difference between knowledge "from experience" – that does not open many alternatives – and scientific knowledge. What about that "experience"? Every man sees through the prism of his experience, therefore of his own particular. The difference is between:

- the scientific perspective or the *scientific level* – which, based on particular knowledge, with their inferences, comes to have a knowledge of what can be generalised / of the universal and, when analysing something (again, a particular) it confronts this one with the universals, i.e. it develops a theory of causality that goes beyond the particular causes of particular experiences – and

- the *particular empirical level* that does not go beyond the inference or causality related to the particular which it considers as a model or as the universal, the Truth.

The particular empirical level considers as a criterion of truth only its own "practice", its experience. But in science, practice itself, experience, are *examined*, beyond the particular, with inferences in which the causality of different causalities is confronted, so with inferences involving the universal perspective; practice and experience are not considered unquestionable axioms. The alternatives appear in this examination space[30].

What would be (would have been) if? Some cannot conceive that their example is not cannot be generalised or that it does not necessarily lead to the universal, to the valid universal conclusion. For this reason, they do not wonder what would have been; this is the mechanistic perspective: *starting from* particular examples *to* the rule that becomes the universal / the criterion/ the fixed *datum* / the reality. So, they do not imagine new hypotheses and "guess" the best theory after a small number of examples or by not even questioning the examples[31].

Others, the contemplatives, believe that inferences exclusively from universal concepts and theories lead them to new / over / else knowledge; they do not question the universals, that is, they do not corroborate them with practical examples and, of course, with practical examples that are as different as possible; their logic is *monotonic*, meaning they are not looking for new knowledge or new examples to add something and possibly to invalidate.

[30]See the extremely clarifying Jeremy Shearmur, Abusing Popper, May 2021, pp. 7-12, https://www.hpsst.com/uploads/6/2/9/3/62931075/2021may.pdf, where Popper's theory of falsification is explained as well as the philosophical context of the falsification of scientific theories.

[31]Immanuel Kant, Critique of Pure Reason (1781). Gruyer, P. A. W. Wood (Trans., Ed.). Cambridge University Press, 1998, pp. 268-69 "A physician therefore, a judge, or a statesman, can have many fine pathological, juridical, or political rules in his head, of which he can even be a thorough teacher, and yet can easily stumble in their application, either because he is lacking in natural power of judgment (though not in understanding), and to be sure understands the universal in abstracto but" cannot distinguish whether a case in concreto belongs under it, or also because he has not received adequate training for this judgment through examples and actual business. This is also the sole and great utility of examples: that they sharpen the power of judgment".

On the contrary, from a scientific perspective, every detail generates a question and therefore, one or more hypotheses, anyway, new problems[32]. A way of seeing things *differently, i.e.* of outlining a problem, is also the critique of opposite theories and, paradoxically, the assumption of both opposites in a theory that does not necessarily refer to the subject of opposite theories but benefits from elements of both. For example, from the two opposing theories on infections – germ theory and terrain theory – a new theory[33] can assemble the problem of germ targeting *but also* the problem of strengthening the immune system of organisms. Just as, the correlation of perspectives studied for a long time separately – *e.g.* biology, chemistry, the theory of knowledge – leads to the emergence of a new perspective that, in its turn, is the basis of new theories which better explain phenomena (interdependencies and actions and reactions)[34]. Likewise, theories are overcome by highlighting, in the scientific research, situations different from those that formed (on) the basis of a theory; and the result is, again, a theory that shows the coexistence of situations in the first theory and in the second theory, as a result of complex conditions of evolution of these situations[35]. And, of course, the result of the research is, above all, the verification of old theories and the highlighting of some problems that only now must be investigated[36].

In all these manners, the subtext is "what would be if?".

A moment on truth and alternative

Since the first reaction to the idea of alternative is that the existing theory is not true / the known is not (or no longer) true, let us quickly show that the relationship between truth and alternative is not so simple. And, of course, it is all the more complicated as it actually takes place through dialogue, where essentially opposite arguments take place. The logic of argumentation implies an over-approach of our problem, but which we do

[32]See à propos the current centre of interest (the pandemic, the virus etc.), rediscussing the problem of the origin of viruses (not in the political and geopolitical meaning): Robert O Young, Dismantling The Viral Theory, Jun 20, 2020, and references, evidencing the internal/from within the organism origin, from cells in the process of extinction; also see J. A. Steiner, E. Angot, P. Brundin, "A Deadly Spread: Cellular Mechanisms of α-Synuclein Transfer", Cell Death and Differentiation 18, 2011, pp. 1425-1433; R. Kakarla et al., "Apoptotic Cell-derived Exosomes: Messages from Dying Cells", Experimental & Molecular Medicine 52, 2020, 16; D. Lucchetti et al., "Detection and Characterization of Extracellular Vesicles in Exhaled Breath Condensate and Sputum of COPD and Severe Asthma Patients", European Respiratory Journal, Apr 1, 2021; 2003024; or László G. Puskás, "Nanobionts and the Size Limit of Life", Anna-Teresa Tymieniecka, Attila Grandpierre (Eds.), Astronomy and Civilization in the New Enlightenment, Springer, 2011, pp. 225-228, indicating the extra-terrestrial origin.

[33]Let us not forget, all theories are historical: they reflect the level of knowledge at a certain moment.

[34]The communication of chemical structures – [proved by cognitive biology, Ladislav Kovàč, "Life, chemistry and cognition: Conceiving life as knowledge embodied in sentient chemical systems might provide new insights into the nature of cognition", Embo Reports, 2006, June, 7 (6), pp. 562-566; and see the studies concerning molecular recognition and adaptive chemistry], also manifesting in the entities between un-alive and alive states (viruses) and in living organisms, including bacteria – is the transmission and reception of chemical signals, of chemical relations noticed as signals. See Ewen Callaway, "Do you speak virus? Phages caught sending chemical messages", Nature, 18 January 2017; Zohar Erez et al., "Communication between viruses guides lysis-lysogeny decisions", Nature, 2017 January 26; 541(7638), pp. 488–493. And the use of bacteriophages in treating bacterial infections, Alan R. Hauser, Joan Mecsas, Donald T. Moir, "Beyond Antibiotics: New Therapeutic Approaches for Bacterial Infections", Clinical Infectious Diseases, 63(1), 2016, pp. 89–95.

[35]Eric C. Keen, "Paradigms of pathogenesis: targeting the mobile genetic elements of disease", Frontiers in Cellular and Infection Microbiology, 14 December 2012.

[36]Marcin F Osuchowski et al., "The COVID-19 puzzle: deciphering pathophysiology and phenotypes of a new disease entity", The Lancet, May 6, 2021, pp. 1-20; Stephanie Seneff and Greg Nigh, "Worse than the Disease? Reviewing Some Possible Unintended Consequences of the mRNA Vaccines Against COVID-19", International Journal of Vaccine Theory, Practice, and Research, 2(1), May 10, 2021, pp. 402 443.

not deal with here[37].

First of all, the very truth of the existing theory is not – and is not considered by researchers to be – absolute and definitive. A theory is true if it answers to as many questions and counterexamples as possible for falsifying the theory, if it is empirically appropriate, and if its model is fruitful (translatable; that is, it allows predictions, as was long been said in the philosophy of science). But a theory is considered by researchers to be only a tool for tackling problems. This attitude towards the truth does not dissolve judgement milestones, the theories being such milestones. And obviously, it does not lead to relativism when valorising theories[38]. *Researchers do not confuse* the determined and contextual historical nature *of theories with* their truth value. No researcher / technician consider that the truth of the theories he works with would not matter[39].

On the contrary,

- both the research and the practical application can be done only on the basis of the theory / theories assumed to be true,
- only these theories represent the basis / premise for criticism / analysis and denial / falsification,
- but, also, on this basis we get new information, which also require new processing, and that leads to new theories,
- theories that are denied / exceeded do not coexist within the same specialised time frame (e.g. molecular biology research of problem X is based on *the latest* theories of molecular biology about problem X),
- only in the *history* of science and technology do theories coexist, including from different time frames; they are not (necessarily) alternative theories, which means that alternative / competing theories take place in science (and technology) *only within the same framework.*

Historically, theories increasingly reflecting objective reality are increasingly objective. But their evolution is based on their acquisitions which are true, i.e. they have a high degree of *internal coherence and pragmatic correspondence*[40].

In the same temporal frame and in the same field, the alternative can, therefore, be a hypothesis that does not change the paradigm – nor *Weltbild*, the representation of the world[41] – *or* it can even do so. It can be stated that the paradigmatic theories were the result – based on the examination of contradictions and problems highlighted by existing paradigms – of a construction with the subtext "what would be if?".

[37]Constantin Sălăvăstru is an accredited specialist in this field. See only "Tendances actuelles dans la théorie de l'argumentation - Essai critique et systématique", Noesis (Travaux du Comité Roumain d'Histoire et de Philosophie des Sciences), XXVII, 2002, pp. 13-45; Logique, argumentation, interprétation, Collection ≪Epistémologie et philosophie des sciences≫, Paris, Editions L'Harmattan, 2007.

[38]Here we are not discussing about value relativism in ethics.

[39]Just as no normal man believes that he can understand things, that is, to infer some things from others without the former being certain – within the temporal framework of his direct and indirect experience –. Prediction, that is considered an essential criterion of science and around which many theories about the validity of the scientific approach have been created – is integrated into the human thinking, and this integration takes place, at the level of logic, through inference. The inference involves interest for the conclusion, and the conclusion is an undetermined (future). The interest in somewhat determining the conclusion, by inference, is an interest in prediction.

[40]For clarifications on truth and content, see Ana Bazac, „Structuri de conţinut în dezvoltarea comprehensiunii" ["Content structures in the development of comprehension"], Studii de epistemologie și teoria valorilor [Studies of epistemology and value theory], Volume VI, Coordinators: Alexandru Surdu, Marius Augustin Drăghici, Gabriel Nagâț, Bucharest, Editura Academiei Române, 2020, pp. 127-154.

[41]Boris Kožnjak, "Can there be a 'scientific worldview'? A Critical Note", Filozofija i Društvo, XXIV (4), 2013, pp. 19-29.

Finally, it would be interesting to note that the truth of some reasoning / "theories" – with and without quotation marks – is, logically, the result of the *logical construction* of the proof. Construction is the inference or connections from and between proofs – that is, from premises to the conclusion. Ultimately, the internal coherence of a reasoning or knowledge consists precisely in the form, in the structure of connections in relation to the proofs. This structure must not be deprived of any step of inference, precisely so that its result be clear: easier to reject, easier to confirm.

Simply, if we consider knowledge as a relationship, we retain the *information* (data, experience) – mental and practical *processing* – the *conclusion* (that is always a *model*); the *truth* that is dynamic / plural / historical)].

An *avant la lettre* questioning of the possible truth of the new, and of the alternative as well

In the *Menon* dialogue, Plato confronted theories or arguments related to the possibility of knowing (that is always that of the new). Menon said it is impossible to know what we do not know, because we cannot see if we found it[42]. The argument is challenging for the logic of alternatives. There is no sense in asking "what if (there would be / would have been)?" because we cannot know if after thinking we also found that future. More technically, Menon referred to the fact that in inferences, *the conclusion* – if it is not known, that is, it is not clearly expressed – *can already be glimpsed*, because it is included in one of the premises ("all people are mortal / Socrates..."). Socrates answered with the famous thesis of knowledge as a recollection of the immortal soul. Of course, it is not the concrete content of the thesis that is important here, but the idea that human beings can know: and based on the logical patterns of thinking[43] and unfolding them spontaneously and creatively, unravelling the truth of things (Plato-Heidegger perspective) and creating it (Kant's perspective).

The question as an opening to the truth

Since the alternative arises from a question, we can remember – if we allow ourselves to take the Socrates-Plato perspective as a joke – that the entire knowledge is the result of questions. The description made by propositional logic (*We know that*) is, introduced with the ontological question *what is*, is developed and corroborated with the investigation of the description itself: *how is* and *why is*. Modal logic emphasises more rigorously the logical conditions of knowledge: that ontology can be possible / impossible, necessary / contingent, hypothetical or implacable (deontic), mandatory or optional, and of course that the picture is fuller when introducing temporal conditions (temporal logic is modal logic).

All variants of logical introduction of ontology[44] involve questions adequate to the conditions of *existence, property, relationship, negation, causes*. And among these latter, Aristotle's famous question about telos (for what? / what is the purpose / finality / aim?; more freely, what is the *reason for being*?) is more edifying even for the other conditions and questions. The question concerning telos restricts the conditions for which questions are asked (in this sense, it is the most economical of the questions) and, at the same time, it is decisive in the bifurcation of the trajectories given by questions. Also, if all

[42]Plato, Meno, in Plato in Twelve Volumes, Vol. 3 translated by W.R.M. Lamb. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd. 1967, 80d: "Meno: Why, on what lines will you look, Socrates, for a thing of whose nature you know nothing at all? ... Or even supposing, at the best, that you hit upon it, how will you know it is the thing you did not know?".

[43]Referring in a way to the immortal soul, if the joke is permitted.

[44]And also, of epistemology, i.e. of relating the speaking subject to the above-mentioned modes.

the questions are triggering (answer options), the *telos* allows also the *meta* perspective on all the questions.

The question about *telos* also brings us closer to the idea of alternative, because the alternative is a variant of existence. In this regard, the other questions have a limited framework (affirmation, negation, non-answer / undetermined answer), while the *telos* opens. *There is not only one alternative.*

What does "what if (there would be / would have been)" mean, from a logical point of view?

Since it is *clear that, when people want to know, they are interested in the causality behind visible things, and since causality also involves*

- *the principle in the subtext of all searches of meaning according to which there are no things without causes*,
- and the *principle of the difficulty to find them*,

people are getting closer to causes by way of *conditioned assumptions.* "If ... then". This model of reasoning, characterised as *counterfactual*, may have as unknown elements – thus possibly untrue – both the antecedent (if ...) and the consequent (then ...). The model determines the creation of several *hypotheses* and, necessarily, their demonstration and verification. The result is the confirmation or invalidation of both antecedent and consequent hypotheses[45]: thus, the formidable enrichment of new theories / ideas. In this process, the coexistence of different and even opposite situations, highlighting the plurality of causes and their probabilistic manifestation[46], more adequately describes the phenomena[47].

More specifically, the reasoning model involves *abduction*, too, *i.e.* the *choice* of the most *plausible* hypothesis, from several *probable* hypotheses, based on the assumption that both the conclusion (real situation or taken as an object of interest) and the rule of inference are known. So, in the subtext, researchers know that it is a *hypothesis* about the cause / conditioning of the conclusion, but during the processing, they consider it in the indicative mode and in the present tense and continue with demonstrations. This is where we must pay attention: researchers know that this is a *hypothesis*, while some outside commentators consider it a theory, already assumed by the community of researchers.

At the same time, abduction must be seen as a hypothetical type of reasoning but the most economical one and similar to induction, *i.e.* it starts from a case, but does not overlap with it. Because: with induction the rule of inference is true (minor premise)[48], while in abduction, that starts from the case, *the rule must also be demonstrated.* And as a result, it is possible that the entire result (including the perspective in which the conclusion / consequent has been described) is invalidated. Only in this way is the result of abduction a new theory. On this line, the abductive reasoning is *heuristic.* (Of course,

[45]Matthew Tontonoz, In a Twist, Scientists Find Cancer Drivers Hiding in RNA, Not DNA , Monday, August 27, 2018, https://www.mskcc.org/news/scientists-find-cancer-drivers-hiding-rna-not-dna.

[46]But the probabilistic manifestation is not a-deterministic.

[47]Also see Mark Parascandola, "Causation in Epidemiology", Journal of Epidemiology & Community Health, 55, 2001, pp. 905–912.

[48]The induction model: the major premise (starting from a case) – "Socrates is human" –, the minor premise providing the rule ("all humans are mortal"), the conclusion "Socrates is a mortal". (Unlike deduction, where the major premise provides the rule ("all humans are mortal"), the minor premise provides the case ("Socrates is human"), therefore the conclusion is, after all, included in the major premise ("Socrates is mortal").)

the abductive reasoning is heuristic also because the chosen hypothesis is outside the scope of "normal" theory).

However, the abductive reasoning has also a more distinctive feature: it seeks to support the hypothesis through the data that support it. In this regard, abduction is economical, *i.e.* it starts looking for hypotheses for new particular facts / data and seeks to demonstrate the most *obviously plausible* hypothesis. But again, we should pay attention: *the scientific research*, namely evaluating data, theories, the manner in which they are linked, *never uses a single type of logical reasoning*. That is, not only does the research start from the case and from the data that allowed the case / hypothesis, but it also falsifies them through questions and data that are opposite to the former. The Popperian falsification has also its say with respect to abductive reasoning.

And, moreover, *all modes of reasoning intertwine* and find their place in the knowledge of a problem; abduction is accompanied by induction that highlights the facts to test the hypothesis. Finally, the hypothesis itself can be a variant of assumption, from a fanciful one – considered as such even by its initiator – to one with a lower or higher degree of probability. But regardless its plausibility, the hypothesis is tested by facts – themselves posited into mini-theories, from the point of view of their position in the abductive reasoning regarding the hypothesis – and the result is that of *effects* and *hypothesis* (considered a premise) and *reasoning*. The result is a set of new meanings caught in a new theory. Even the logical rules are forged by the result, as we see them after practicing abduction.

In a common assertoric reasoning, the premise (either the case, or the initial condition, or the rule) is asserted as truth, aiming the understanding through an amplification of the idea of the initial *datum*. The question goes beyond this assertion, and: 1) judges and selects the assumption / hypothesis from the existing ones, so as not to waste time with unsuccessful / untrue reasoning; in this sense, abduction is *inference towards the best explanation*; and 2) determines the innovation of another hypothesis.

Ex contradictione – quodlibet

According to the logical principle that anything can follow from contradiction or any proposition can be demonstrated, we must pay attention here only to the *generative capacity of contradictions*. If we know that a logic based on contradictions is *explosive*, or that the consequences are explosive, then we should be afraid of contradictions. But people, over time, have become accustomed to judging the given, and therefore the contradictions. These ones could not have only explosive consequences, because in this way the security of thinking would not have much basis. Well, common sense determined them to consider that only *necessary* conclusions can follow from contradictions, not any conclusions. And that meant that contradictions also imply a certain coherence and a certain consistency. The necessary conclusions were called *paraconsistent* conclusions, giving the sign of the entire paraconsistent logic, of *conclusions from coherent contradictions*.

In traditional formal logic, there must be consistency (*i.e.* non-contradiction) between premises and conclusion (only in this way is the conclusion a solid, justifiable, reasonable, viable, convincing theory); so, at the level of *form*, a theory is solid if it is not contradictory, therefore it does not contain contradictory propositions, because this already vitiates the inference, consequently the solid conclusion.

At the level of *content*, it is about truth (dialetheism); but at the *formal* level there is no question of truth. However, if the truth is important, then, formally, the logic must be *paraconsistent*. Such logic delimits the contradiction so that the conclusive result is not explosive but consistent (non-contradictory), therefore, it makes the contradiction

coherent (all of its parts fit anyway). Nevertheless, the objective of paraconsistent logic is not to obtain coherent contradictions, but the non-explosive nature of conclusions.

A theory can have consistent parts, but in its entirety, it is inconsistent, namely it is contradictory[49]. In the real world, the complexity of the content accepts or supports non-triviality, *i.e.* the fact that not all propositions are parts of the theory as such, so they can be true because they refer to different aspects, although related. This is what happens in terms of content. At the level of form, that is of the logical schemes of thinking, such contradictory propositions should not be introduced in the premises of the theory, because from a contradictory situation any conclusion can result (and not only the necessary one, related to the theory itself); consequently, logic explodes. The paraconsistent principle is that the *contradiction is retained*, but "any conclusion is possible" is invalidated, so the explosion of logic is also invalidated.

More clearly: the inferences cannot be trivial, *i.e.* the *presence of contradiction does not mean that any conclusion, both true and false, would be acceptable.* So, *the classical formal logic must be followed as much as possible.* Its paraconsistent amendment does not mean by all means its annulment. Because, after all, logic – that is, inference and demonstration – appears or deviates only when there is a contradiction: that is why the *essential* principle of classical formal logic is non-contradiction. (Not the principle of identity and not that of the excluded third, because they derive; the need for non-contradiction appeared in the dialogue, identity is only a precondition of dialogue, it only named[50]).

Logically, including as the paraconsistent principle is emphasised, the conclusion must be related to the premises, to be relevant to them, therefore, to refer to them, the problem not being so much the contradiction of the premises, but the relevance of the conclusion. (Logically, the relevance occurs when the conclusion and the premises share at least one variable. In more colloquial terms, the conclusion and the premises must have something in common[51]). In this sense, paraconsistent logic is *non-trivial, i.e.* it does not consider that all contradictions are true and that anything that is true in a conclusion can be inferred from anything.

The critical spirit and the alternative

In colloquial understanding, the critical spirit is a negation or a series of negations. The critical spirit is, of course, negation, but since we know that there is no negation without affirmation, let us see what it does mean. Let us remember, in this quick manner, that precisely the relating of negation to affirmation is the criterion that separates the real critical spirit (or constructive and, as we will see, this synonym is not wrong) from the false one. From a logical point of view, the critical spirit is a two-sided attitude.

One concerns the perception of *contradictions* (or inconsistencies in man-made deeds and in the very process of their creation). We do not go into the detail that distinguishes between opposites and contradictions, neither into the theory about the excluded third and the included third. What is suffice is that the perception of inconsistencies in the realities that are objects of interest can be acute or, conversely, opaque. We immediately think about education, but logically the perception of inconsistencies is related to

[49]This idea is extremely important. And it is known. The credible lie is the one that also contains true parts. Still: a false theory is not necessarily false in every aspect of it. Logic uses the terms trivial / triviality describing the impossible ontic and epistemic situation in which all propositions / parts are true, and, at the same time, all contradictions are true. The excessively gullible persons assume such an impossible situation. Impossibility is given by the logical law of non-contradiction.

[50]Aristotle systematised logic starting from the simple, from the name. (But it is worth mentioning that the simple can appear precisely from its complex, developed form (idea demonstrated by Marx).

[51]An equally challenging example: whether or not the virus first appeared in China has nothing to do with the West's struggle against China. That fact is not an argument for such struggle.

the ability of analysis, *i.e.* of discerning and relating things and, of course, of making inferences between them. Of course, this capacity of analysis is related to the existence of things themselves – expressed in more modern terms, to the existence of information – that is, to the ontological picture as such given or revealed to people. But, looking at the same ontological picture and the same information, some make a finer analysis, but others a less detailed one. As a result, at these people the representation of things does not reveal or raise the issue of inconsistencies. Nothing is denied, but the picture becomes true. The result is that, of course, such a representation does not involve the creation of alternatives.

The other side is somehow a continuation of the former, but here occurs a differentiation between types of negation. Inadvertencies are noticed on this side, and their noticing itself is a negation. This is from where the critical spirit emerges. As it is well known, it is elegant for people today to show "critical spirit". It is "elegant" to deny but without a serious argument of denial: and this means that n denials crowd together *without any purpose*. Or, it is elegant to seem that you are excessively fault-finding, somehow analogous to Caragiale's formula, "and go on, and fight". But such a struggle is based on a *superficial* refutation that, in fact, does not deny but on the contrary, strengthens the reality against which the struggle is claimed. The above illustrations refer to *the false critical spirit that has no as real purpose the critique all the way to the end.*

The finality of criticism is always the alternative to the criticised aspect. And if this is missing, it is also because logic is lacking in anticipation. Simple naysayers do not express – and logic refers to formal thought structures as they are *expressed*, and not to ideas intuited and beliefs left in the mind – their entire reasoning of denial, i.e. the substantiation of the conclusion of denial on its prediction from theses (denials). As a result, the conclusion of denial is not even accompanied by anticipation; that is, it is a denial not only without completion, but that nullifies completion.

"Ignoratio elenchi"

The quotation marks in the above formula indicate that ignorance in arguing a problem – for or against – can be hidden by ignoring information related to the problem.

When problem A is answered by discussing problem B, an ugly tactic is used that is meant to determine the co-participant in the dialogue to resign from participating: because he should answer, and prove, that the discussion concerning problem B – when the topic was problem A – has nothing to do with the topic, and only then to possibly continue to give arguments for the topic A. So, he would waste his time and it is not certain that a discussion in such mystifying terms would be of any use.

This is the classic meaning of the formula. As the tactic is transparent, those who participate in dialogues from *positions of power* – so from positions from where *they can disregard the methodological rules of dialogue*: of respect for the topic, respect for the equal position of all participants in the dialogue, respect for the logical laws known and assumed by all participants – change the topic by *keeping quiet* about some information. Such information exists and, at least some of it is known to the other participants in the dialogue. But this information is avoided in public discourse, the only one in which knowledge is expressed: precisely because it is of data that contradict the positions of power. And then, in the absence of debate of essential information[52], the dialogue is

[52]Essential information can be the type of quantitative data, i.e. of some characteristics, and can be the methodological type. For example, the official discussion about vaccination omits information about serious adverse effects of anti-Covid vaccines (these adverse effects being limited only to immediate and, basically, only to immediate potential unpleasant consequences), just as information about the increase in the number of infections after vaccination is omitted (see Dr. Gérard Delépine, L'hécatombe post vaccinale s'étend dans le monde, 25 May 2021, https://www.mondialisation.ca/lhecatombe-post-

transformed into a system of *parallel* and, inevitably, asymmetrical monologues: and which are not fruitful for the collective clarification of the problem[53].

There is no alternative without anticipation

If we think to the cause of the reserve of many towards the idea of alternative, we can understand that, *epistemologically*, they were not used to drawing conclusions *all the way to the end*, that is, they were not used to practicing *anticipation of things resulting from their judgements* (which commonly envisage, basically, inferences in the present indicative mode). The conclusion of this limited type of inference is, of course, immediate, or short-term, immediately predictable.

Mihai Nadin highlighted the importance of differentiating between *foresight* and *anticipation*[54]. The first is related precisely to the immediate inference, *i.e.* to highlighting the consequence of the indicative premises. "If we don't tighten the screws well, the spare part will wobble (and the work will be compromised and we will have to start over)"; "If we shoot wild animals, they will no longer wreak havoc in people's farms"; "the rain makes rich harvests" / "rain makes corn, and corn makes whiskey", if we want to joke reminiscing a song from 2010. So, *logically*, the course of thinking is from the present to the future, that is, to an immediately predictable future.

Anticipation is, however, an opposite movement: from the future to the present. It involves, from the point of view of mental operations – or, if it does not sound too pretentious, of mental faculties (powers), as Kant pointed out – *imagining* the future with the help of premises of continuity / development of some characteristics of the present. "If people do not change their attitude towards nature, all systems of this nature will collapse." Leaving aside the abbreviated form, the example bases its conclusion ("all systems of nature will collapse"[55]) on imagining the situation in which the continuation of the current treatment of nature will generate a system that can no longer self-regulate.

vaccinale-setend-dans-le-monde/5656922).

[53]See also the system of overcrowding information with details which do not lead to elucidation – in fact, tiring the receiver, screening it –. Concentration of irrelevant information is an everyday tactic of mass communication and of official reports that cannot show the phenomena in their actual functioning. See the criticism of this tactic in Paul Ryder, The Pentagon Papers at 50: What's Left Out is Crucial, May 25, 2021, https://www.counterpunch.org/2021/05/25/the-pentagon-papers-at-50-whats-left-out-is-crucial/: with the aim of showing how peace was achieved in the Vietnam War, in fact following it, official documents concentrated hundreds of pages with dialogues of political figures; but they did not recall at all the fact that the war responded to the need of the power system to continue it, nor that peace would not have taken place without the social movements alternative to the power system: the resistance movement in Vietnam and the peace movement of the students, soldiers and a good part of the US population. (As regards this second movement, it showed its power a little late, after the initiative of students – who were "surrounded /excluded" – was joined by popular groups which, however, did not protest at the beginning of the aggression against Vietnam).

[54]Mihai Nadin, Anticipation: The end is where we start from, Computer Science Colloquium, University of Bremen, 11 June 2003, PDF.

[55]Indeed, the last UN Intergovernmental Panel on Climate Change (IPCC) Report 2021 is a model of anticipation methodology. It demonstrates unequivocally the consequences of the procrastinated policies after 2013 (the last IPCC Report): the aggravated parameters (some ones attaining and even surpassing the tipping points) in all the aspects of a system of imbalances of the entire physical sphere of the Earth were also modelised extrapolating them in different future time scale versions. The analysis of dozens of models of a future that is already visible – thus, from the future to the present – showed the imperiousness of the present radical decisions of transforming all policies worldwide.

And the above-mentioned imbalances are intertwining with biodiversity loss, i.e. with the imbalances in the organic and living sphere of Earth. Both types of imbalances are the result of policies, and thus these policies must change. There is no more room for prevarication. The scientific research drew attention on false "green" policies, namely, on their contradictions and inefficiency, see Nathalie Sedon et al., "Getting the message right on nature-based solutions to climate change", Global Change Biology, Volume 27, Issue 8, Feb, 2021, First published, 01 February 2021; H. O. Pörtner et al., IPBES-IPCC co-sponsored workshop report synopsis on biodiversity and climate change; IPBES and IPCC, 2021.

This imagination is the argument for the conclusion of the entire example, or more precisely, for the hypothetical thesis / condition in which people do not change their attitude towards nature.

But this means that *anticipation has* already *suggested or even outlined an alternative*, it has been proven to be a premise of the alternative. Anticipation proves to be fruitful: it does not remain a sterile mental exercise but generates new constructions of reality.

The alternative – a very serious matter

Firstly, the abductive reasoning can be better understood if we keep in mind what *hermeneutics* – interpretation – put forward: people have *rational anticipations* about one thing or another, therefore already on the basis on n previous valid reasoning, and then attempt to explain them, considering the explanation itself a demonstration of the truth / plausibility of those anticipations and reaching the conclusion that those anticipations were quick understandings (intuitions). We are not interested in intuitions here, but in the fact that the explanation / demonstration / interpretation represent knowledge that validate pre-knowledge (anticipations) *and* reveal a higher level of knowledge. *On the one hand*, the way of inferring from the explanation is based on the structure of evidence from anticipations, considered as variables. Interpretation / explanation is a tree of derivations, of inferences, because every fact in the hypothesis is recursively explained. From a perspective of intuitive mathematics but without using its symbolic language, the explanation / *construction* is both the logical movement of inference with respect to these facts *and* its *result*, *i.e.* the idea / theory at the beginning only as pre-knowledge, hypothesis. Construction is movement (from hypothesis – the facts / evidence, *i.e.* their logic in the hypothesis – to the result that is the set of facts demonstrated); the result is a confirmation of the manner of construction, hence the reinstatement of the constructed facts. Objectivity in logic is given by the structure of formal inferential relations and, of course, by the formal (syntacric and semantic) qualities of the objects placed in relations. But this means that, *on the other hand*, the evidence / object / fact itself is (defined) according to the manner of inference[56].

The material truth – that appears to us in the everyday natural language – cannot be a proof or a fact if it is not true in a formal linguistic and logical structure. Simply put, the material truth is part of *another level of existence*. The reasoning of the alternatives is no exception. For the alternative to be valid, each of the elements of the hypothesis must be valid, and then the connections between them as they appear in the hypothesis must be valid. So, the reasoning model is a tree in which the analysis (calculation) of the elements is continued with an analysis of their relations, and this analysis confirms the initial plausibility of the hypothesis, the fairness of the choice of that hypothesis.

Then, more than the other manners of reasoning, the abductive one requires the development of reasoning and presupposes the awareness of this requirement and of the abductive specificity. Neither "*if . . . then*" nor "*what if?*" do allow truncated syllogisms, in logical language *enthymemes* or *sorites*[57]; the reasoning must be very clear precisely

[56]See Jean-Michel Salanskis, Y a-t-il une Kehre de la logique?, 2004, Kehrlog.pdf, pp. 1-20.

[57]Leaving aside its logical form, sorites is argumentation – either syllogistic, or polysyllogistic – from which the intermediary moment is missing, either in the position of one of the premises or even in the position of the conclusion. Sorites is a form of polysyllogism. It is characterised by the suppression of the intermediate conclusion between the two syllogisms, so the suppression of the conclusion of the first syllogism. But in this way – and this is all the clearer in a syllogism – even the formal system of implication or relationship is vitiated. This vitiation is given by the fact that the variable that is, in fact, common to both syllogisms is missing: in the absence of the variable, the implication is less clear and can give rise to paradoxes. Abbreviation is not the sign of the acuity of reason, but "the brevity of possible reflections. . . the limitation to a mediocre expressiveness", Maryse Laurence Lewis, Le langage

because it started from a hypothesis; just as abduction does not allow rhetorical tactics that evade the problem or a concrete question and refer to another problem or an unasked question. The cause of this tactic is, of course, the inability to answer the asked question or the raised problem[58], and then the discussion is diverted to another, as if this other problem had been initially raised.

Precisely because the abductive reasoning must be clearly developed, there is a fear of alternatives in discourses and of social alternatives as objects of investigation. If most people no longer believe that "everything that is real is also rational", they are still educated to prefer the existence of the unknown and, under no circumstance, probing the way people penetrating the unknown.

And although the hypothetical nature of the starting point could characterise the whole reasoning process as adventurous, in reality the reasoning and theories related to alternatives are extremely alert to each element and reasoning related thereto; reasoning and theories related to alternatives warn that one *cannot skip* stages of thinking and judgement.

Finally, choosing alternatives is not so much guess work, as a *test* of the new. And the way to solve it is, as we have known for a long time, both from common thinking and from technology, more broadly – from practice, *trial and error*. That is, trial – error – partial fix – trial – error – another partial fix...; or even total fix etc. Everything is like: one should not treat this cycle with indifference, neither to fail in resignation faced with its difficulty. And trial and error do not refer only to the steps taken in the realisation of a theory or a product, but also to the *meta* judgement of this theory or this product in terms of their negative consequences, beyond the flawless logic of their realisation as such. The logical pattern of *trial and error* is creative beyond the realisation of a particular creation, in the very process of generating new creations, by criticising some from the perspective of new facts.

Even because it involves the logic of trial and error, the reasoning positing alternatives are *constructive*: steps towards the renewal of thinking and even towards changing the paradigms on which so much is said about.

On the difference between descriptive logic and the logic of alternatives

We must not forget that formal logic – the most everyday logic – refers to the description of facts with their relationships. As we have seen, a simple succession is not equivalent to the generation of a fact by the previous one: *post hoc ergo propter hoc* is not a valid way to deduce the causation[59]. Of course, in everyday life description is amended by the precaution of the possible or the probable, in different forms ("neutral" / objective: "it is possible" / "not possible ..."; or the involvement of the subject – in doxastic logic –: "I think that..."). As well as, during common judgements we come to prescriptions ("must" / "it is necessary"). This whole amendment is caught up in *modal* logic, as already mentioned. But there is a big difference between the *possible* and *prescriptions*. The latter already involve *the values* behind the description, and for this reason prescriptive judgements are farther from the logic of description than cautious judgements or judgements advancing doubt.

But the classic distinction between the natural sciences as sciences *about facts* and, on the other hand, the social sciences *about values and norms* is not real, *i.e.* the

et les droits humains: futilités et débats incohérents, 25 May 2021, https://www.mondialisation.ca/le-langage-et-les-droits-humains-futilites-et-debats-incoherents/5656897.

[58] That is why this tactic is also called ignoratio elenchi, ignorance in rejecting (arguments related to a problem or question).

[59] "The rooster crows...".

somewhat absolute distinction between objective description and normative prescription is (of course, historical, but) useful only didactically. Sciences about facts use models – which involve norms – and the social sciences / humanities use meticulous descriptions. So, Hume's[60] old observation about the difference between "is" and "must be" is valid for research in both types of science.

The above modal logic operators ("must" etc.) are already part of the logic of alternatives or, more precisely, of step 0 of this logic. The real is not so banal, that is, the theory that renders it is not so certain, so true that it does not require modal amendments: "yes, it is possible, but ..." / "and yet it is (seems) impossible to..."; "is it really implacable?" / "but it is not really necessary to ...". This is not the place to discuss more closely which operator is closer to the logic of alternatives. But it is clear that – always by confronting facts / situations which, at first, seem to deny the theory – they open the door to: *doubt* and *alternative*. "What if we also examined the hypothesis or hypotheses ...?". These hypotheses are required by the new situation in which the *confrontation* between theory / product and, on the other hand, consequences, new theories, maybe even new products, leads to modal amendments.

The logic of alternatives does not appear, therefore, at any time in the process of judging things. And it is not synonymous with the false alternative that would result from highlighting a characteristic or behaviour of the *object of interest* from a different point of view than the one to which the theory refers: the macro characteristics of substances or animals do not have as alternatives the molecular characteristics or organ and cell function. It is clear that this is not about alternatives but about parallel theories, about different aspects (even if these aspects are ontologically related). At the same time, this logic can refer only to the precise object of interest exactly – *e.g.* the cellular functioning – or to the *integration* of the exact object of interest into a larger whole / system according to new data (for example, about changes in the cellular function as a result of substances participating in this functioning).

Of course, the new facts / data / perspectives do not necessarily represent invalidations of the old theory, just as they do not lead only to *one* alternative[61]. As a result, we must be careful *not to stop looking for alternatives* after we reach one that is interesting *now*.

The examples and the alternative

What we call examples are the manifestation of the inductive, experimental character of thinking, but also of the unity of this inductive character with that of the general already existing following n experiments in which the mind processed everything given to it in these experiments. It can be said, in passing, that the elements known from these experiments, already kept in the form of more or less clear ideas about things in experiments, can always be brought back to the layers of memory in the form of mental experiments. These are no longer imaginaries of situations still non-existent in cognitive memory, so only then outlined – regardless of the fact that imagined situations include n aspects / cognitive elements already known – but reproductions, reminders: of course, ordered according to their intention or, more precisely, to the connection between them and the reason for recall as such; or, in other words, the ultimate goal of thinking.

The examples are forms of mental experiments. But, depending on their purpose – or their use – they are of several kinds. There are examples as simple *illustrations*

[60] David Hume, A Treatise of Human Nature, Oxford, Clarendon, 1965, p. 469.

[61] Thus, we may advance the methodological principle: as there is no one single cause of real, inherently complex phenomena, so there is never one single alternative that is possible. But obviously, the two parts of the principle do not overlap, rather their relation is an analogy.

of already clear / essentially clear assertions. These types of examples invigorate the discourse – and can bring an extra understanding because they beat the already existing understanding of assertions, i.e. they bring an extra concrete (which may possibly be the specific element or model of assertions that is most easily remembered). This addition of concrete does not mean the new, nor does it invite a deeper judgment of the assertions, so to think of possible alternatives.

There are illustrative examples in scientific knowledge and even in the scientific knowledge of the most abstract things. Assertions that link abstractions can be extremely "concrete" examples and welcome in all that is mathematical formalization. The whole development of graphs, diagrams, tables, figures in the modern science, which increased not only the intelligibility of theories and demonstrations but also included different degrees of concrete exemplification, is related to the intertwining of the abstract and the concrete in the scientific knowledge of things. But an extremely important variant of illustrative examples – or examples with the function of illustration – is that related to memorizing the steps, order and concrete content of human movements or actions in order to achieve concrete objectives. Here, imitation and repetition of steps, etc. play a key role in quickly understanding the order in which actions are taken. After mastering the movements and actions related to concrete[62] tasks much easier, people can better understand, i.e. translate into coherent articulated language the logical explanation of the action as a whole: that is, they can make theory easier. Actions and, in general, concrete theoretical systems are assumed by researchers or people involved in the acquisition of knowledge related to actions and systems. Their truth or the necessity of those actions is not in doubt: the goal now is to understand them and make them autonomous. *Illustrative* examples do not raise problems.

The illustrative examples are thus extremely important in the learning process and are, as we have seen, extremely necessary.

On the other hand, there are examples that are given the function of *proving* the truth of theories / opinions / points of view. But, as we know, examples can always be given for contrary theories. Moreover: if there is even one example that refutes the theory, then it is not the example that is to blame, not it must be erased, but the theory as such must be revised.

Indeed, what is at stake now is not learning the theory / action, but the truth or meaning of the action or theory. The examples no longer have the function of making it easier to approach the subject to the object (theory / action), but the object as such. Regardless of the number of subjects who prove or assume a theory, its truth takes into account only its coherence and consistency. As a result, if there is even one example that reveals inconsistencies and incoherence in that theory, then – precisely because only a true theory is a *theory*, that is, it is retained, it is a basis for knowledge, learning and development – the theory must be revised. And the example becomes an invitation to take into account theories opposed to that theory.

If we take the current example of the approach of the pandemic[63], it is quite clear that the demonstrative example – which is, at the same time, a demonstrative argument – is the one that raises problems. Thus, in the dominant theory – a kind of *statistical* theory – the only solution to defeat the disease is vaccination. In principle, vaccination is an easy and quick solution[64]. It substantially reduces the number of patients hospitalized and

[62]Or, expressed pompously (i.e. in scientific language), these concrete tasks or objectives are finite systems with their own objectives, their own means of accomplishment, their own criteria, their own evaluation of the phases and results.

[63]The current global official approach of the pandemic is part and parcel of the current worldwide dominant approach of health care, and emphasises its logically contradictory, and practically, malign aspects.

[64]And – especially when it is bought by governments, as they buy the armament production, as state

those who have reached the ICU, as well as deaths. But, an objection is advanced from the viewpoint of the *subject*, current American and European new types vaccines can cause extremely serious side effects, including deaths. These reactions are, however, very rare, the dominant theory continues, so there is no need to discuss them. Nevertheless, the objection does not stop, "I do not want to be among those rare cases".

This objection, which excludes any reference to external issues (conspiracies, etc.), is absolutely ignored by the official theory. This ignorance reflects the inability to always consider different / even adverse theories: here, starting from "adverse" examples.

The dominant theory and the different theory that start from the subject are not, so far, opposite: they are simply *parallel*. So, both have the same right to be taken into account.

But the ignorance of the theory of the subject by the official theory is determined by the fact that, if the theory of the subject is taken into account, then the whole dominant theory should be revised. That is: if everyone – including each subject – is interested in reducing the number of those hospitalized, etc., then prophylactic[65] and incipient treatment must be performed and strengthened. It exists – even if not in the form of one specific pill but, in any case, without side effects – and is effective[66]: so, reducing treatment, in the dominant theory, to vaccine and hospitalization medication is opposed to even the alleged official goal of reducing the number of hospitalized patients, etc. As, if the subject's theory is taken into account, then time is freed up for the improvement of vaccines, etc. Moreover, the supreme argument that the vaccine would allow milder symptoms if the vaccinated are re-infected[67] is more than shaky. Even until December 2020, when the vaccination campaign began, *most* of those infected and sick[68] had healed and / or had mild or anyway manageable symptoms; because the mortality caused by the virus is low. Why would we assume that if before the vaccination campaign most of them recovered and did not need a hospital, after the vaccination the mild symptoms would be the result of the vaccine, and not of the type of infection as such?

So, in the case of examples intended to be *confirmations*, counter-examples can always appear. And only the confirmatory examples are not enough for the truth of the theory: this one must always have the power to refute the counter-examples if it wants to be

contracts, and offer it for free to the population – it "homogenises" both the health state of the different social layers and their different health-care conditions. At any rate, the vaccine covers the difficulty of both many layers to support the eventually necessary long enough while of non-vaccine treatment, and the health-care systems' funds to offer this treatment, especially in hospitals.

[65]Prophylaxis involves a much wider approach than that of medication to directly avoid an illness.

[66]Michael Welch, Dr. Stephen Malthouse, and Dr. Peter McCullough, Doctors vs Health Authorities. Clinically Proven Drugs vs the Jab. Who will Prevail?, June 05, 2021, https://www.globalresearch.ca/doctors-vs-health-authorities-clinically-proven-drugs-vs-the-jab-who-will-prevail/5746999; here Transcript – Interview with Peter McCullough, June 1, 2021, also for general methodological frameworks of multi-drug regimens, of logic of the present type of vaccine conception and distribution, and insights of the epidemic control.

[67]However, as we know, one of the main aspects here is the prevention of infection by vaccines. This capacity of vaccines was refuted by studies on real life. See Alarmist reporting hides Covid vaccine success, August 20, 2021, https://rmc.bfmtv.com/emission/covid-19-les-vaccins-de-pfizer-et-moderna-nettement-moins-efficaces-contre-le-variant-delta-2047271.html; Dr. Peter McCullough, Study: Fully Vaccinated Healthcare Workers Carry 251 Times Viral Load, Pose Threat to Unvaccinated Patients, Co-Workers, 24 August 2021, https://www.globalresearch.ca/study-fully-vaccinated-healthcare-workers-carry-251-times-viral-load-pose-threat-unvaccinated-patients-co-workers/5753908, referring to Timothy Farinholt et al., "Transmission event of SARS-CoV-2 Delta variant reveals multiple vaccine breakthrough", medRxiv preprint; Nguyen Van Vinh Chau et al., "Transmission of SARS-CoV-2 Delta Variant Among Vaccinated Healthcare Workers, Vietnam", preprint with The Lancet, Available at SSRN: https://ssrn.com/abstract=3897733 or http://dx.doi.org/10.2139/ssrn.3897733; Fully vaccinated people who get a Covid-19 breakthrough infection can transmit the virus, CDC chief says, August 6, 2021, https://edition.cnn.com/2021/08/05/health/us-coronavirus-thursday/index.html.

[68]We are not discussing here the validity of the tests, we are only taking the official data corroborated worldwide by the corona worldometer.

true.

Epistemic corruption instead of alternatives

Although logical models of reasoning appeared above, where possible deviations, though suggested, have occupied only a very modest place in the analysis, we are all convinced that, actually, the entire effort related to "how people should think"[69] is the reaction to the violations of logic. At the level of the presentation of the *content* by logic / by the logical forms and structures, even Heraclitus pointed out[70] that, in order to present the desired content, some people use logic in a distorted way; in other words, that there is a tendency to subordinate the universal rigor of logical inferences to the subjective intentions always linked to the particular and the accidental.

The importance of content is always related to the subjects who assume it. And from this point of view, from the perspective of the subjects, one can also describe the formal aspects supported or violated by them.

Thus, the violation is seen as *corruption*, in the etymological meaning of this word. More clearly, when people – and, specifically, researchers – do not comply with *epistemic standards* (equality of persons in a dialogue, namely the critical examination of arguments regardless of their issuer, coherence and logical consistency of reasoning, critical examination of evidence), the process of obtaining the truth is vitiated and is covered by *epistemic corruption*[71].

This corruption is at the same time also a corruption of logic:

- *informal* logical fallacies (which involve the truth of arguments): *post hoc ergo propter hoc* / afterwards, therefore for this reason (the first phenomenon is considered a cause, although it is not); *cum hoc ergo propter hoc* / with this one, therefore for this reason; *ad hominem* / personal attack, with the variant *tu quoque* / revealing the hypocrisy of the previous speaker; *argumentum ad verecundiam* / out of respect towards authority; *argumentum ad misericordiam* / appeal to feelings; *counter-arguing a theory not supported by the partner but that is weaker and easier to refute*; the *false dilemma; the improbable conclusion of its own theory as an argument for itself; petitio principii* / the circular argument; the *hasty generalisation; argumentum ad ignorantia* / one's own ignorance as argument; *ignoratio elenchi* / distracting attention to an aspect because the theory cannot be refuted; *non causa pro causa* / the argument of the false cause; *ambiguity; argumentum ad populum* / the argument of the popularity of the supported point of view; *consensus gentium* / consensus as argument;

- *formal* logical fallacies (which involve the validity of arguments): *non sequitur* / arguments without connection or the conclusion does not follow from premises; *quaternio terminorum* / the fallacy of the four terms of the syllogism (instead of three); *non distributio medii* / the fallacy of the undistributed medium term neither

[69] We are not discussing here the validity of the tests, we are only taking the official data corroborated worldwide by the corona worldometer.

[70] Heraclitus, The Complete Fragments, Translation and Commentary and The Greek text – William Harris, Prof. Emeritus, Middlebury College: "2. We should let ourselves be guided by what is common to all. Yet, although the Logos is common to all, most men live as if each of them had a private intelligence of his own"

[71] Epistemic corruption does not consist only in casting doubt on a theory that is opposed to one's own image; it is not a question of methodical doubt about all theories, including one's own, but of selective doubt that ignores the rigorous development of pro and against arguments.

The concept of epistemic corruption and this meaning about it were proposed by Stephen Gardiner, A Perfect Moral Storm: The Ethical Tragedy of Climate Change, New York: Oxford University Press, 2011, p. 462, as another facet of moral corruption.

in the major, nor in the minor premise; the fallacy of *illicit processing* either of the major, or of the minor term; the fallacy of the *affirmative conclusion in one or both the negative premises* ; the fallacy of the *negative conclusion from affirmative premises*; the fallacy of *mutually excluding premises*.

There are two main causes of epistemic corruption: one is *psychological* in nature; because some cannot stand that new data about a fact contradicts their image of that fact, they "adjust" epistemic standards (ignore new data, select only information that matches their theory of fact), and do not think of rebuilding their theory. Psychologically, it can be considered that the distortion of epistemic standards is the way to avoid *cognitive dissonance* between new information and their old theory[72]. The other cause is social, more precisely, *political*: epistemic standards are distorted by those who have decision-making power and thus allow the distortion of standards in their relationships with other people.

As we have seen, epistemic corruption is the process by which a theory is supported regardless of the informal and formal costs of this support. In other words, epistemic corruption is the absolute opposite of creation of alternatives.

Abductive reasoning (with probabilities) about society

Now there is room only to outline a few ideas.

After people are shown that they judge with the help of hypothetical reasoning, these ones become familiar and, in principle, are not rejected. They can even play by always proposing – so, consciously – "what if?". Their professional approaches allow this type of reasoning[73]. At the same time, they are educated to confine themselves to "their area of expertise". In this area they can – with socially-historically determined limits – develop hypothetical reasoning; but not outside this area. And this bifurcation between the use and non-use of reasoning related to alternatives has become their habit, a pattern of thinking.

In their own area, they *can* even manifest themselves boldly; and at the same time, outside of it, "they dont have to bother". For the *past*, they may eventually accept even the question about Cleopatra's nose, as a slightly cynical joke that signals the *accidental* as a matrix for historical causality. For the *present*, they prove their spiritual height either by "realistically" criticising situations and obstacles and stopping in this moment or by escaping into metaphysical esotericism and mysterious matters where they list abundantly only abductions. For the *future*, they hide behind the infamous label of "utopia!" put on any abduction of alternatives.

This position could be perceived as a weak ability to understand *the aggregate of systems in a unitary manner and based on the same logic*: of course, as a result of their education. This education stopped the *integrative* treatment and unitary understanding of systems and causality; and the reasoning of the alternatives was limited only to strict professional preoccupations (if).

The above words may seem too harsh: especially since the common patterns of thinking are not just given but imposed. And yet, in the face of *absurd* social phenomena – destructive of individuals and of the human species, of nature – there are dominant voices in the public scientific space that insist that the development of technology is the causative factor either of evil (AB, as if the use of technology was not an option of

[72] Axel Gelfert, "Climate Scepticism, Epistemic Dissonance, and the Ethics of Uncertainty", Philosophy and Public Issues (New Series), Vol. 3, No. 1, 2013, pp. 167-208.

[73] We are not discussing here about the real social conditioning that gives the limits of the use of abductive reasoning.

social actors) or of the progress that will solve everything. And since prevention policies are weak in the face of this factor – that is, there is no globally integrated, coherent management of science, technology and their applications, and there are also "diverse motivations" due to the large number of actors and their particular social interests – there would be virtually no solution other than increasing surveillance and isolation of wrongdoers[74].

In such theories, there is no abduction, there are no alternatives: the future is the absolute structural continuation of the present, even if it is already in a state of collapse and the continuation does not improve it at all, science and technology being further transformed into competing private means for private interests.

Knowledge devoid of sensitivity to alternatives is manifesting in an extremely contradictory manner: even in *science* that generates new knowledge, knowledge deprived of the idea of alternative is determined by economic and political constraints external to science; at public level, it appears as a *false science* that offers explanations for a phenomenon based on the opinions of "experts" and does not accept alternative theories; false science uses specialised journals that do not accept to demystify scientific fraud[75], just as it uses specialised control and ethical control institutions which are subordinated to it[76].

Parrhesia

We could conclude on a philosophical note this excursion into the thinking of alternatives. If everything was explained with the help of the rational power of man, let us make a comparison[77] between the ancient and modern thinking, concerning the *current*[78] knowledge and the possibility and, especially, the need for alternatives. The comparison generates only models, inherently simplifying, and excludes the continuity of some characteristics in the two models.

In the ancient Greek thought, the truth of cognisance seems to be one of their objective features that people must *dis-cover*, as if they were copying reality, so the ultimate criterion of truth would be outside them (in Platonic ideas or in reality itself). If people know, it means that they know what is – and what is needed – so there is no longer room for any doubt about knowledge, and therefore neither for alternatives.

(Such a model was specific also to the medieval thinking. In the religious thought, the criterion of truth and the generator of indubitable evidence was the supreme extramundane being. The knowing individual could only affirm what appeared to be absolutely external to him and, obviously, absolutely certain. The responsibility of thinking somehow fell outside the knowing subject).

In the modern thinking – Bacon-Descartes – the proof of truth, certainty, are achieved: 1) by man's participation, by his examination of data, and 2) by understanding that this acquisition of truth is based on awareness of participation in obtaining truth and knowledge. On this line, in which knowledge is no longer a copy (Kant, as a continuation of the mentioned thinkers), the modern thinking is the field where Einstein's perspective of the known depending on the subject, appeared, and precisely as such conditioned certain.

[74]Nick Bostrom, "The Vulnerable World Hypothesis", Global Policy, Volume 10, Issue 4, November 2019, pp. 455-476 (here, pp. 458-459).

[75]Richard Smith, Journals, fraud, science, and misaligned incentives, July 25, 2016.

[76]Lisa Loikith, Robert Bauchwitz, "The Essential Need for Research Misconduct Allegation Audits", Science and Engineering Ethics, 22, 2016, pp. 1027–1049.

[77]The comparison is, unfortunately, Eurocentrically limited.

[78]In the sense of contemporaneous to the discussion, to the analysis.

There is another aspect common to ancient and medieval thought: the dependence of truth on the moral qualities of the knowing subject. The obtained certainty is the result of its positive moral qualities. In the modern thinking, knowledge and the dissection of the process of knowledge show that they depend exclusively on cognitive abilities, not moral ones.

But a return to origins which are not devoid of wisdom is always beneficial. Even Rabelais, at the dawn that barely announced modernity, warned: science without conscience is the ruin of the soul. Leaving the soul aside, knowledge has proven to produce, as modernity progresses to a cognitive triumph, also absolutely inadvertent results for the purpose of the process of knowledge itself. It is very difficult to decide whether the formidable acquisitions of scientific theories plus today's impressive technological applications counterbalance the phenomena of barbaric and irreparable, final destruction of human beings and of the human environment, and we rather doubt that these phenomena would be the inevitable price of the progress of science and technology. Of course, we know that this figure of Janus is determined by historical and social causes. But regardless these causes, *knowledge itself seems to require ethical conditioning.*

An ancient idea sensitive to the ethical causes was given by the concept of *parrhesia*[79]: *free* expressing of people with obvious moral qualities. Expressing is free even if what is said *triggers risks* to those persons. They know they must tell the truth – as their entire cognitive experience certifies – precisely to help the audience understand things. From the point of view of knowledge, there is an obvious relationship of asymmetry between the audience that does not know, but must know, and the speaker who knows and, at the same time, knows that he must share what it is known. Of course, if in antiquity the speaker / exhibitor was convinced that there was a perfect overlap between his opinions and the truth, we know that we must look circumspectly both at the opinions and the truth. If he believed that a critique made against some institutions was the truth (and the only truth), we know that not every kind of criticism is good "because it is critical". But if we assume these precautions, they should not silence us, that is, they should not make us only mimic the freedom of thought and expressing.

In the ancient thinking, truth was not conceived as manifesting itself in private mental experience; but only in *dialogue*, that is, in *free expression in a human collectivity.* But the late modernity – and the post-realistic euphoria of seclusion, including because of the danger of pathological natural contagion – enthusiastically glossed over the individual probing of the depths. Nowadays, *parrhesia*, free speech, seems like a retro naivety.

The ancient thinking of *parrhesia*, however, was not so refractory to the role of the subject as in the simplistic model above, mirroring the modern one. Because the bearer of *parrhesia* was a certain person: who had moral qualities not only to reach the truth with certainty but, above all, to *expose it freely.* And regarding the moral qualities, the ancient thinking was different from that of the Middle Ages: the greatest ancient "sin" of the exhibitor was *not pride / conceit,* but *insincerity*: with oneself (since the exhibitor is the one who chooses evidence, reasoning, data, because, although the truth is only transmitted, the exhibitor, himself, participates in it) and with the others, with the dialogue as such. Today, even more so as we know that the truth is not external to the subjects, sincerity should be a cardinal virtue of discussing the truth. But sincerity is categorised as naivety.

However, because in ancient thought the truth of sincere opinion was certain, the exposition did not highlight hypotheses, but theses. They intersected with the opposing theses possibly stated by the interlocutors: but this only led rather to the effort and the result of presenting them better.

[79]Michel Foucault, Discourse & Truth: The Problematization of Parrhesia - Six lectures given by Michel Foucault at the University of California at Berkeley, Oct-Nov. 1983.

Socrates was a special *parrhesiates*. He told the truth even at the risk of losing his life. At the same time, he presented the theses as hypotheses: which had to be confirmed or invalidated by collective controversy. In this controversy, the thesis-hypotheses of the opponents were *withdrawn*. That is, the examination of the arguments led to the highlighting of the truth of Socrates' hypotheses. Opponents apologised, meaning they understood that their own theses were inconsistent and that is why they were the ones who withdrew them. In his turn, Socrates shaped his hypotheses according to the ideas that appeared in the dialogue. And, although cardinal problems were raised in the middle of the discussion, if they were too radical, they were avoided or reduced to details. Inherently, Socrates' theories were completed without serious integration.

But Socrates has shown that the rhetoric by which you retell the thesis without questioning it is not enough, and that the truth always involves the confrontation of hypotheses. In subtext, any assumption of the hypothesis means the possibility to withdraw it (and to apologise for the inconsistencies that have confused the audience to no avail). And that none of this takes place outside the possibility of free expression.

Theoretically, today – especially in science and technology – these are already commonplace. *In practice*, the set of knowledge of methodology of knowledge is not as common. The space for expressing alternatives is rather exceptional, through the dominance of unique thinking over free communication. What will happen to the "field of the possible"[80], remains to be seen: although the expression of some anticipations and some alternatives raises concerns about its limitation.

In lieu of a conclusion: let us not be afraid of alternatives!

The thinking of alternatives is natural, because, both in the logic of reasoning that determine them and in their own logic, the *continuity* of the picture previous to them is shown as necessary, constitutive. Alternatives can, of course, be more radical or less radical, *i.e.* the ontic and ontological picture they present may be different from the previous one to various degrees of changes of structural representations / relations and, therefore, of some elements or characteristics of the elements participating in structures. But regardless of these degrees, the alternatives – even if they are outlined only as precise systems of structures – contain in themselves the ontic and ontological continuity that gives the *basis*, the *foundation* of change and of the alternative.

This is the first meaning of Hegel's famous term, *Aufhebung*, an overcoming that *preserves* (something of) the old state[81]. But with Hegel, things are more nuanced.

[80]The expression is from Pindar, Pythian Odes, 3 , used as a motto by Albert Camus in The Myth of Sisyphus, 1942: in the French translation, the soul must exhaust "the field of the possible". The English translation is more prosaic: "Do not crave immortal life, my soul, but use to the full the resources of what is possible", Odes. Pindar. Transl. Diane Arnson Svarlien, 1990, [60], or "Do not yearn, O my soul, for immortal life!/ Use to the utmost/ the skill that is yours", Pindar's Victory Odes, Translation by Frank J. Nisetich, Baltimore and London: Johns Hopkins UP, 1980, pp. 169-173, http://www.miscellanies.org/mythology/deities/demeter/pindar.html. Anyway, it is about the ontological possibilities created by the human being.

[81]Georg Wilhelm Friedrich Hegel, The Science of Logic (1812/1831, 1813, 1816), Edited and translated by George di Giovanni, Cambridge, Cambridge University Press, 2010, p. 33: "that what is self-contradictory does not resolve itself into a nullity, into abstract nothingness, but essentially only into the negation of its particular content"; or "such a negation is not just negation, but is the negation of the determined fact which is resolved, and is therefore determinate negation; that in the result there is therefore contained in essence that from which the result derives – a tautology indeed, since the result would otherwise be something immediate and not a result. Because the result, the negation, is a determinate negation, it has a content. It is a new concept but one higher and richer than the preceding – richer because it negates or opposes the preceding and therefore contains it, and it contains even more

Overcoming or transcending occurs when in the old state there are elements which, themselves, are negations / inferior forms of necessity: these elements or aspects are and must be overcome, precisely for the state to correspond to the universal concept that determines it. It is a question of suppressing a contradiction, not of the absolute suppression of the whole in which that contradiction exists.

But it depends on how we conceive of continuity and how we treat it. The seemingly cautious but a-historical perspective equates *the present* as we conceive it with its *continuity* (and its preservation). So, it is clear that this very conception of the present can no longer be equated with the simple copy, the simple confirmation of an existing that is legitimated at an absolutely extra-human level. Obviously, the current level of understanding of knowledge excludes such a perspective of equating the present with continuity[82]. As a result, the treatment of continuity must be critical, *i.e.* to discern between its aspects, to select them and to transform them according to their adjustment to the discontinuity already appeared in the system. However, such a critical treatment of continuity is not a loss of this continuity, but, on the contrary, an enriching and a revelation of it[83].

The second meaning of the term *Aufhebung* is that of overcoming as *suppression / abolition in essence*, in which the very preservation of the old is subordinated thereto. The contradictions of the old appear so significantly that they cannot be overcome "here and there", partially: precisely because such a partial, non-structural overcoming is contradictory exactly to continuity[84].

Continuity is not, therefore, legitimate unless it is processed and shaped as discontinuity, or simply put, unless it is transformed. But why?

The second argument against the fear of alternatives is the *purpose* of the alternative. After all, what has always been the purpose of human reason, of logic, of the *logos* as it was understood by the ancients as the ongoing mental ordering of the world[85]? The purpose of the human logic was and is to *solve the problems* that arise in the human existence and in the contemplation of existence[86] by man. And if the problems have not

than that, for it is the unity of itself and its opposite".

[82]Ionuț Tudor, „Concept şi subiect de drept. Reflecţii hegeliene" ["Legal concept and subject. Hegelian reflections"], pp. 15-25, in Emanuel Copilaș (coord.), Aventurile posibilului: două secole de filosofie politică hegeliană [Adventures of the possible: two centuries of Hegelian political philosophy], Iași, Editura Universității „Alexandru Ioan Cuza", 2021: "Present must not deceive us, it was not there from the beginning, it became as such at certain historical moments and due to specific historical coordinates" (p. 24).

[83]Karl Marx, Economic and Philosophical Manuscripts of 1844, "Communism as the positive transcendence of private property as human self-estrangement, and therefore as the real appropriation of the human essence by and for man; communism therefore as the complete return of man to himself as a social (i.e., human) being – a return accomplished consciously and embracing the entire wealth of previous development (Aufhebung)".

[84]Tony Andréani, Misère du réformisme. A propos de L'esprit de la révolution. Aufhebung, Marx, Hegel et l'abolition, de Patrick Theuret, http://denis-collin.viabloga.com/news/misere-du-reformisme.

[85]As it is known, the human logos was conceived by the ancients as a pendant of the logos of the world, that is, of the ability and, at the same time, of the world's characteristic of order. This correspondence of the human logos with that of the universe or the given existence precisely signalled the ability of reason to capture the order of the world, therefore, to put in order the disordered appearance of things.

[86]Problem solving is not synonymous with the theoretical teleological perspective in which the final goal and form would already be caught in the starting forms and moments. Such a perspective appears in a simplistic image of linear dialectical logic in which the existence of negation already implies the contradiction which, in its turn, automatically gives rise to the new thesis that denies negation.

Actually, in dialectical logic, the result is only a (possible) consequence of the contradiction; and its characteristic of "reason to be" of the entire reasoning (and process) – in which after the accumulation of the determinations highlighted by theses, contradictions (antitheses) appear and they logically require their overcoming (synthesis) – does not imply at all that overcoming (the famous denial of negation) be an absolute negation of the antithesis and take place only in the individual affirmative form. More clearly: if Hegel gave us the logic in which "the contradiction of statements made by the consciousness

been solved by the logical ordering of human existence as it is given or is considered as given, then the only solution is to question the datum itself and, inherently, to think alternatives. The alternatives are not meant to destroy the constructive peace necessary for human balance. On the contrary, they make a decisive contribution to this peace: when it becomes rarer and when it is necessary to re-stimulate it. The concern for continuity is, thus, congruent with the concern to conceive alternatives: always on time.

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on different levels of its development" appears (Dragoș Popescu, Logică naturală şi ştiinţa logicii în filosofia lui Hegel [Natural logic and the science of logic in Hegel's philosophy], Giurgiu, Pelican, 2009, p. 241), Marx's dialectical logic involves the realistic evolution of though in which modal situations and the pluralism of theses regarding determinations also exist. So, speaking of Marx's dialectical logic we do not reduce it to the application of logical schemes to real life, but we remain at the level of the formal science of thought structures; although in Marx such a science appears rather indirectly, from its applications in real life or as a result of observing the ways of thinking in real life.

Speaking about the teleological perspective: the telos as ab initio triggering cause appears in Aristotle. In Hegel, telos is not an ab initio cause, but appears in connection with thinking and resolving contradictions. In Marx, telos is, on the one hand, only thought and, on the other hand, only possible. In other words, even for the same reasoning / argument, there is not a single telos. And no, objective logic and subjective logic do not remain indifferent to each other (as Dragoș Popescu considers, ibidem, p. 233). If thinking – by which several teloi are confronted – fails to see better the type and extent of the determinations as theses and the type and extent of the contradictions they support, then the result, the synthesis, does not contain at all the telos that was initially considered as a premise of the entire reasoning. Or, of course, the result supports a different telos. The result is a possible consequence and, possibly, not even the best/most logical.

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EPISTEMOLOGIE / EPISTEMOLOGY
Problema transpunerii practice a cunoașterii științifice și tehnice
/
The problem of the practical transposition of scientific and technological knowledge

Knowledge – Science – Math Under the IT Rule and the Rise of the *Fourth World*

Gheorghe M. ŞTEFAN[1]

Abstract The tradition of the last few centuries allows mathematicians to reveal purely formal meanings, science to add to them meanings acquired through experiment formally supported by mathematics, and to them knowledge adds purely experimentally accessed meanings. Information technology, IT, manages, in the last few decades, to change the hierarchical balance established between sense, significance and syntax in the trio formed by knowledge, science and mathematics. By relating to IT, the relationships between the latter change, primarily because their nature is strongly influenced by the new actor on the scene of the interaction of the human mind with existence. The relationship with IT of each form of access to the meanings of existence becomes dominant, and the interaction between these forms is increasingly intensified through information media. The central and mediating position that TI acquires induces more complex and nuanced relationships in the knowledge - science - mathematics trio, which will hopefully allow access to a wider range of meanings. In the IT-dominated context, we highlight the emergence of a fourth world of unstructured and/or unreliable information.

Keywords: information technologies, meanings, sense, signification, the fourth world.

Introduction

Understanding is a mental behavior organized hierarchically on the following three main levels:

- mathematics, which provide rigorously organized formal meanings related to forms imagined or suggested by the real world
- science, adds meanings acquired from organized experiments formally supported by the mathematical approach
- knowledge, completes the mental image of existence by purely experiential facts when the phenomenal behavior can not be reduced to forms.

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In the XVII-th century starts the process of disenchantment by imposing the previous hierarchy which starts with the simplest representations provided by the mathematical approach and ends in the non-formal phenomenological realm of representations. Knowledge includes science, and, in turn, scientific knowledge includes the mathematic understanding. It is about inclusion, not subordination.

Pre-informational age

In the transition period of Baroque (1600-1750), Francis Bacon (1561-1626) and René Descartes (1596-1650) started to struggle to overcome the tradition coming from Plato and Aristotle but also from the humanistic tradition of Renaissance. The ancient tradition was scientifically obsolete, while the Renaissance humanistic heritage was full of mystic, magic, hermetic, cabalistic, alchemic influences. The experimental approach (Tycho Brahe (1546-1601), Galileo Galilei (1564-1642), Johannes Kepler (1571-1630)) and the mathematical support it used (René Descartes, Blaise Pascal (1623-1662), Isaac Newton (1643-1727), Gottfried Wilhelm von Leibniz (1646-1716)) shaped the transition to the modern understanding of existence in the pre-informational age.

It is common to talk about science based on math or scientific knowledge, but very rarely about mathematical knowledge, because the interdependencies between the three levels of understanding are predominantly "linear", in the sense that the connections between mathematics and science and science and knowledge were strong, while between mathematics and knowledge they were week (see Fig. 1). This situation is due to the fact that:

mathematics : build abstract systems governed by the syntactic order of forms partially inspired by the real world and partially due to the creative imagination of mathematicians

science : reveals forms in the real world by reducing real phenomena to rigorously manageable forms using mathematics as a supportive tool

knowledge : appropriates additional useful meanings as evocative senses considering real phenomena, where the scientific reduction mathematically supported doesnț work

while the connection between mathematics and deep phenomenological knowledge was somehow compromised by the numerological "techniques" practiced during the Middle Ages.

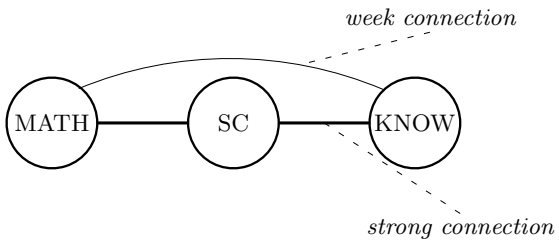

Figure 1: How are connected in the pre-informational age mathematics, science and knowledge.

The period of Enlightenment, besides the liberty without responsibility and profane without sacred, promoted a pure rational approach based almost exclusively on quantity[2]. The relation between mathematics and sciences strengthens, with a very positive effects on the development of sciences, but the knowledge starts to be limited to the scientific approach. The simple[3] and purely quantitative[4] approach is exclusively imposed. The evolution was so spectacular that, towards the end of the 19th century, there were voices that considered necessary to be specified only few details in order to complete the process of knowledge in our universe. But, in a short time, this optimistic mood was disturbed by unpredictable developments: some coming from new openings in the Western world and some coming from the Eastern space.

New openings in the Western type of understanding

The end of the nineteenth century and the beginning of the twentieth century come with fundamental reconsiderations of the basic elements of knowledge. David Hilbert (1862-1943), Max Planck (1858-1947) Albert Einstein (1879-1955) and Sigmund Freud (1856-1939) in the middle of this period, around 1900, challenged the scientific community with new openings, openings that the twentieth century has not yet managed to completely exhaust.

Mathematical decision

2500 years after the Cretan Epimenides provoked Western rationality with his famous undecidable sentence, David Hilbert's communication at the Congress of Mathematicians in Paris in 1900 paved the way for a solution through reformulations that will be clarified by rigorously defining the problem of decision [13]. In 1928, Hilbert finally formulated the *decision problem* (*Entscheidungsproblem* as it is known in German) in a book published with Ackermann [14]. As a consequence, in 1931 the logician Kurt Gödel (1906-1978) formulated the most important negative result in the history of mathematics in the form of his incompleteness theorem [10].

Gödel's fundamental work triggers the emergence of information technologies. Five years later, four mathematicians, Alonzo Church (1903-1995) [3], Stephen Kleene (1909-1994) [15], Emil Post (1897-1954) [18], Alan Turing (1912-1954) [20], they published their works starting the computing era.

Quantum & relativistic mechanics

When in the second half of the 19th century it was considered that there were only a few aspects of detail that needed to be clarified in physics, the scientific world is set in motion by two fundamental reconsiderations related to *continuity* and *absolute*. Quantum and relativistic mechanics force the scientific community, through the seminal works of Max Planck [16] and Albert Einstein [7, 8], to restart the engines of the process of knowledge at unprecedented speeds.

The models proposed by physicists used the continuity hypothesis and absolute reference systems. Planck and Einstein force the rethinking of physical processes in a discontinuous context and based on relative references. If formal/mathematical and

[2]How well Wolfgang Amadeus Mozart and Lorenzo da Ponte caught this effect in their *Don Giovanni*! See by turn *Viva la liberta*, *O statua gentilissima*, and *Madamina* from Mozart's *Don Giovanni* opera [19].

[3]Carrel's, *Man, The Unknown* [1]

[4]Eventually, maybe too late, René Guénon in his 1945 book [12] warned those willing to listen about the destructive effect of the pure quantitative approach.

experimental support strongly supported these new approaches, direct perception was shocked. Feynman's famous sentence *"Shut up and calculate"* is one of the consequences of the quantum-relativistic revolution. Thus a closer connection than ever was made between mathematics and science.

Unconscious mind

In 1900 Sigmund Freud published his most important work: *The Interpretation of Dreams* [9]. Man ceases to be fundamentally and exclusively a conscious being, who can share with others his entire mental experience. The revelation of the beyond of consciousness in the human mind has opened new avenues for understanding what man and existence might be. The multiplicity of states of consciousness, as an experimental fact, provided the context of much enriched approaches to man's relationship with existence.

These three events, produced in completely distinct fields – mathematics, physics and psychology – will have consequences that will converge, in the second half of the twentieth century, towards fundamental reconsiderations, in the process of assimilation and integral capitalization for knowledge. This is the reason why the process of knowledge coexists today, perfectly justified, with a parallel process of philosophical interpretation. The philosophical approach is mandatory because the historical "moment" seems to be an integrative one, in which its knowledge and interpretation are accommodated in a relationship of causal synchronicity.

The influence of the East on Western thought

The first notorious Buddhist in Western culture was Arthur Schopenhauer (1788-1860). He had a statue of Buddha on his desk. One of the important ideas in Buddhism is that the world is an illusion, which leads to distorted representations that we can form on realities. The rationalism of the Enlightenment is thus called into question by considering additional forms of knowledge made from a subjective perspective.

But only in the second half of the 19th century did the West pay more attention to Eastern spirituality, considering it primarily from an exotic perspective. Thus, in the second half of the nineteenth century, Eastern ways of understanding began to provoke some Western minds with two main results.

A first effect of the Orient was manifested by the esotericisms induced by the theosophical movement of Helena Petrovna Blavatsky (1831-1891), extended in the anthroposophical movement of Rudolf Steiner (1861-1925), to name only the least irrational currents.

A second effect was that of reconsidering various Western esotericisms. Personalities such as Eliphas Lévi (1810–1875) and Papus (1865–1916) triggered currents that were continued by René Guénon (1886–1951), Julius Evola (1898–1974) and Frithjof Schuon (1907–1998). It is very difficult to position Carl Gustav Jung (1875-1961) in this context through his essential contributions, following the approach started by Freud, through which he realizes a well-founded bridge between Eastern and Western thought.

Relaunching the Western project

The reactions and counter-reactions that appear in the confrontation between East and West, between subjective and objective, between imaginary and rational, give a specific color to the first half of the 20th century.

One of the most significant reactions is the formation of the Vienna Circle of Logical Empiricism, a group of philosophers and scientists in the fields of natural sciences, social sciences, logic and mathematics, which met regularly between 1924 and 1936 at the University of Vienna, under the leadership of Moritz Schlick (1882-1936). The major influence of the concerns of this group was manifested in the field of analytical philosophy and philosophy of science. The main contributions were of some participants, in a way marginal to the activity of the circle: Ludwig Wittgenstein (1889 -1951) [22, 23] and Kurt Gödel [10].

We can also exemplify the diversification of interpretive currents by the Copenhagen Interpretation which is an expression of the meanings of quantum mechanics that was largely conceived from 1925 to 1927 by Niels Bohr (1885 -1962) and his close collaborator Werner Heisenberg (1901- 1976) and which remains one of the most accepted interpretations of quantum mechanics.

We cannot neglect the effect that World War II had through a new and surprising synthesis between mathematics and its implications in the emergence of computer science and technology.

We can highlight the three significant processes that took place in this period of transition to an era in which information will begin to dominate the relationship we are discussing between knowledge, science and mathematics.

Quantum mechanics and the fullness of existence

The internal and external coherence of the formalism of quantum mechanics has always been doubled by the most controversial interpretations. Among them, the imposition of the non-locality principle is the source of some spectacular speculations. The locality, characteristic of classical physics, allows the structural approach, an approach that is seriously questioned when the non-locality is taken into account.

We have become accustomed to the fact that the form corresponds to the essence. The Platonic tradition, fixed by the Christian mentality, confuses the abstract form with the absolute essence. It seems that it is not a big mistake at the level of classical, conventional understanding. However, it proves to be a serious error when the approach of knowledge approaches the depths of existence.

How can two fundamentally distinct (somewhat contradictory) forms consistently refer to the same essence? How can we model correctly both through particles and waves?

The interpretation given by a classical, structurally truncated mentality, to a plenary reality can only be inconsistent. The interpretive, philosophical framework must be broadened to fit a science in which non-locality is principled and in which the dogma of identity between (abstract) form and (absolute) essence is no longer accepted.

Psychology and trans-personal development

Freud‘s discovery, extended and deepened by Karl Gustav Jung (even against the will of the discoverer of the unconscious), brings psychological thinking to a level from which, starting with syntheses with other fields to be possible and useful.

If Freud discovered the unconscious, it was Jung who revealed its magnitude (too limited by Freud to sexual aspects). Jung was also the one who understood the viable and complementary alternative offered by Oriental thinking for understanding the psychology of the unconscious.

The collective unconscious postulated by Jung provides the strongest basis for understanding the spiritual unity of humanity and ultimately provides a path to the deep connection of the mind with existence in all its fullness.

The most tangible result of this evolution is transpersonal psychology, in which the tradition of spiritual practices in the East and the West is combined with the most advanced achievements of modern psychology. The birth certificate of transpersonal psychology is the founding in 1969 of the journal Transpersonal Psychology by Abraham Maslow (1908-1970) and Antony Sutich (1907-1976).

From here to the AUC (altered state of consciousness), proposed for study by Charles Tart (n. 1936), or the hierarchy of levels of consciousness proposed by Ken Wilber (n. 1949) (sometimes accompanied by an exaggeratedly unjust critique of Jung‘s contribution) was only a step .

The mind as a physical device with a functionality that cannot be completely described formally appears to psychologists coupled with the fullness of existence at various levels of depth. Consequently, the understanding of the mind can no longer be separated from the understanding of existence at all these levels.

Integrative philosophies

More than ever in the modern history of science, researchers have been involved in general, interdisciplinary or philosophical debates. Paradoxically, the better the concordances with the theoretical predictions, or the more obvious the formal rigor of the demonstrations, the more precarious the possibility of interpreting the theoretical options. No one questions Schrödinger‘s equation or Gödel‘s theorem, but most researchers debate the significance of their meaning without being able to fully agree.

Science is progressing, but the conceptual tools for interpreting its progress are proving increasingly powerless. And no one can know if, at some point, the real progress of knowledge will be limited by the precariousness of the tools of integrating science into a unitary vision.

Thus, the concern of researchers for the philosophical integration of knowledge results becomes common. Without considering the activity of "professional" philosophers (such as Edmund Husserl (1859-1938), Alfred North Whitehead (1861-1947), Sri Aurobindo (1872-1950), Karl Popper (1902-1994) or Ludwig Wittgenstein) unimportant, we still comment on major philosophical contributions, "from within", made by researchers with a solid scientific background. We refer in this sense to philosophical contributions that bring to our attention the *implicate order* of David Bohm (1917-1992) [2], the *structural-phenomenology* of Mihai Drăgănescu (1929-2010) [5], or the integration of the *levels of consciousness* proposed by Ken Wilber [21].

The relations between mathematics, science and knowledge will change under the pressure of the evolutions that take place in each of these fields. The firmness of the results based on the rationality of the forms is questioned when the decision on the validity becomes questionable. When the results of scientific experiments become relative and depend on the intentionality of experimenters, the (subjective) interpretation casts shadows on the objectivity of the scientific approach. To all this is added a mind that is perceived as manifesting itself on several levels of understanding, which further complicates the understanding of what mathematics and science are able to offer.

And if all this was not enough to increase the complexity of the relationship between mathematics, science and knowledge, in the second half of the century emerges with exponential intensity science and information technology.

Informational age

It all started with the approach of mathematicians who translated Godel's result from the field of logic to that of mathematics. It was a successful attempt to assess the effect that logical incompleteness can affect mathematical rigor. The effect of the incompleteness of the formal approach was thus rigorously delimited.

Surprisingly, the emergence of a new scientific field with associated technology has resulted. Serendipitous coincidences or implacable causality led Alan Turing to be involved in the world's second conflagration at Government Code and Cypher School at Bletchley Park, or the ENIAC computer to be built for the purpose of calculating artillery-firing tables. It is difficult for us to separate external causalities, such as defense policies, from internal causalities inherent in the developments in the three areas investigated.

A dramatic change happens when a new actor enters the scene. It is about ***information technology*** (IT). By its main functions:

- modeling: allows the description of realities that cannot be (simply) captured through analytical forms.
- simulation: offers solutions where solving systems of differential equations is not analytically possible.
- designing: based on modeling and simulation the design process can efficiently and quickly address topics of an otherwise inconceivable complexity
- interconnection: through communication systems, IoT, and the like, complex connections are made with effects that can be more or less positive
- sensing: involves connecting to the complex reality offered by both the natural environment and the artificial or social
- learning: through artificial intelligence (AI) techniques information systems can learn by detecting subtle patterns that the human mind is not able to identify
- securing: by providing communication systems that allow the transmission of data so encrypted that only the recipient has access to them
- acting: based on the previous characteristics, the computer systems can act autonomously in favor or against the environment in which they were implemented.

IT increases the complexity of our approach and provides another way mathematics, science and knowledge are interconnected (see Figure 2).

In this new context:

mathematics acquires experimental instruments borrowed from science mediated by information technologies (provides approximate solutions for hard problems); thus the term *experimental mathematics* is found more and more in the specialized literature

science acquires new tools allowing the discovering by complex and intense simulation (how proteins fold) or for investigating hidden realities using complex data processing (looking for oil fields)

knowledge by adding subtle knowledge using appropriate learning mechanisms (experimenting on real data using artificial intelligence technologies)

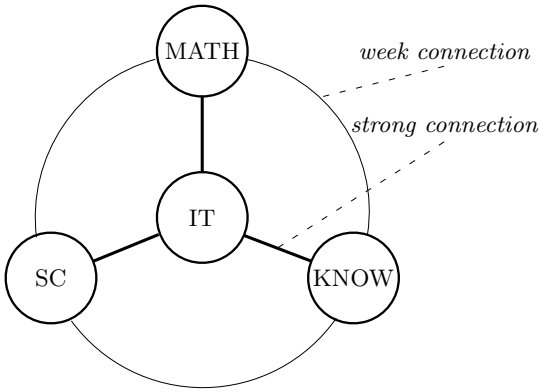

Figure 2: In the information age mathematics, science and knowledge are strongly mediated by information technologies.

so that TI becomes a dominant mediator between the three areas considered.

Scientists are increasingly using mathematical concepts in an IT-mediated way. Indeed, integration through a program (written in MathLab or Mathematica) is increasingly used. We accumulate informal knowledge primarily through computer systems of communication and connection to reality, to the detriment of a direct contact or mediated by the scientific understanding of the phenomena.

In a somewhat paradoxical way, TI ensures a closer connection doubled by a disconnection accentuated by a too "authoritarian" mediation of the IT environment. The balance between these two contradictory tendencies can only be made by the good discernment of IT users.

The relationship between exposure and concealment acquires nuances and possibilities impossible in the pre-informational era. Always, a third world product had to be subjected to a very fine dosage of revelation and wrapping.

The fourth world: an unstructured and unreliable data layer

With the emergence of IT, a clear differentiation is required between the field of information and that of data. More rigorous definitions are needed for these two notions.

Starting from the definition of the information given by Mihai Drăgănescu [6], we will note the difference between information and data.

Definition 0.1 *Information is a structure with an internal syntactic order that has an associated meaning through which it acts in the system in which it is integrated.*

◇

In a computer system the information is represented by the programs that process data. In this sense, the data, represented similarly to the information, are distinguished by the fact that their meaning is not manifested at the level of the computer system.

Definition 0.2 *Data are syntactic structures with a meaning that act, if they do, outside the system in which they are integrated.*

◇

If in the pre-informational age the third world highlighted by Karl Popper has emerged (see Figure 3.a), in the information age we are isolated from the authentic products of the third world by a "thick" unstructured layer that seems to form a fourth world that isolates us from reality (see Figure 3.b). The image of the world is distorted by this new world of signs which acts not by syntactic order, nor by the associated meanings[5], but by messages in which the sense is hidden behind misleading significance.

In this context, a buffer of un-structured and un-reliable data emerged between the real world and the traditional semiotic world. The natural semiotic space is thus isolated from the real world trough the unstructured and unreliable data, or, worse, manipulated data. This intermediate layer belongs unfortunately to the information domain because it acts, rarely for the good, but especially for the evil of the human world.

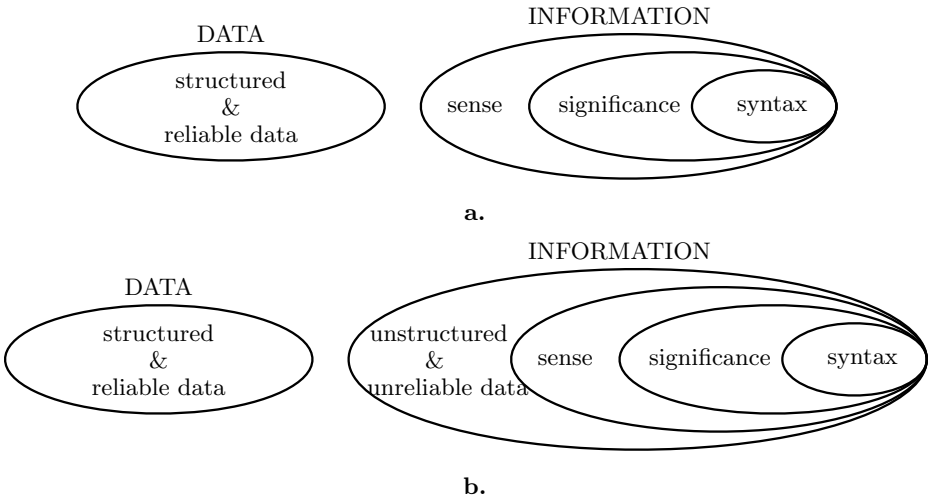

Figure 3: **a.** In the pre-informational age, the Popperian *third world* [17] of structured data is part of our world we access according to our own will. **b.** In the information age, a thick layer of ***unstructured data*** mediates imperatively our access to the world blocking our direct access to the real world.

The new symbolic layer of data wrapped around traditional layers, represented by syntactic order, significance and sense (see Figure 3.b), disrupts the human being's interaction with existence, especially due to the fact that there are no mental protection mechanisms configured in the Darwinian evolutionary process for this new, parasitic entity. Information technologies aggressively "promote" the components of this fourth world in a space where there are no educational processes that protect us against it.

The development of the fourth world tends to fundamentally change the relationships, re-established in the computer age between knowledge, science and mathematics (see Figure 2). IT makes its mark on the relationships it establishes and through the

[5]We consider the meaning under the two aspects through manifestation: significance and sense. Significance (of reference or of context) associates with a formal structure, subject to a syntactic order, a reality to which it refers or considers it in a certain factual context. The sense evokes sending the thought into a complex of meanings through which the univocity of the association is replaced by a more or less extended field of possible meanings.

components of the fourth world, a world of unstructured or non-transparently structured information.

If unstructured information can usually have benign effects, non-transparent structured information can spoil the harmony between knowledge, science and mathematics.

What do we mean by the non-transparent structuring of information from the fourth world? An ordered syntactic structure can associate meanings in a process in which intentionality is manifested explicitly. But since the intentionality that acts in a process of signification is not expounded or is deliberately hidden, then the meaning that emanates is not transparent. It is non-transparent, because it derives from occulted meanings.

Knowledge is the most disadvantaged by the manifestations of the fourth world. Unstructured and/or manipulated information disrupts with maximum effect the ensemble of representations on the world that benefit from the rigor of form or the cervix of the experiment.

It is enough to discuss the proliferation of the transformation of publishing houses into printing houses in spaces where the freedom acquired in the last three decades has also suspended natural restrictions that gave coherence to the third world. The unlimited space for the disposition of expressing opinions and beliefs uncensored by scientific control and formal rigor has led to the proliferation of a space that is grotesque and vicious. Freedom without responsibility gives birth to the monstrous construction of the fourth world.

But the fourth world of unstructured or unreliable information can prove useful if it is subjected to filtering and organizing processes based on advanced IT tools. For example, the hidden significations that lead to dysfunctional senses can be revealed by artificial intelligence (AI) techniques that are able to highlight subtle patterns that escape analysis by traditional methods. But surprisingly, useful content can be extracted from it that is compatible with the third world, which it can substantially enrich.

Mathematical tools that require a particularly intense computing have developed and continue to develop. The use of these computer tools has consequences on the three actors: mathematics, science and knowledge. Mathematics acquires increasingly used experimental components, science has access to reality on demand through traditional methods of research has no access, and knowledge is enriched by methods and knowledge gained informally and/or beyond repeatable experiences.

We will have to learn to expose ourselves to the more or less deterministic chaos of the fourth world. Confronting him, if made from competent and honest positions, can bring substantial gains to man‘s position in his world. It all depends on how the top-down actions are complemented, if any, by the bottom-up actions. Can the IT-based information environment be a space where the inconsistencies between the world of forms, the world of repeatable community experiments or the world of unrepeatable individual experiences can be reconciled? If so, then abstract forms, community and individual practices have a chance to harmonize to form the full man that humanists of all times have dreamed of.

Concluding remarks

The information age brings with it two major events. First, the change in the way the knowing mind manifests itself in the three areas: mathematics, science, knowledge. Secondly, the emergence of what we call the fourth world of unstructured and / or unreliable computer products with both negative and positive effects.

IT is established in a central position mediating dominantly the relationship between mathematics, science and knowledge.

In the space that TI establishes, they allow the appearance of the fourth world, which can also become the source of major dysfunctions or the solution for many of the problems of the human world.

Once again it is proven that the human being externalizes [11] functions that are limited by exercising at the level of the individual mind. The exteriorization is done this time in the IT space. Man‘s limited ability to participate constructively and effectively in the progress of his own world requires this externalization in the IT world with the acceptance of all associated positive and negative effects.

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Knowledge as a Public Good and Knowledge as a Commodity

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Abstract In order to shed some light on the issue of public knowledge, particularly scientific and technological knowledge, I will first examine the thesis that increment in the sense of new knowledge is rarely found in the public domain. Additional knowledge mainly produced in the scientific community and by research outside of science tends to be treated as a commodity. The restriction of a wide distribution of new knowledge may be based on a number of factors. I will concentrate on contemporary legal restrictions, especially, modern patenting laws. The second part of my observations deals with some of the complexities linked to the thesis that knowledge is a public good. I conclude with remarks about the link between the ownership of knowledge and social inequality.

Keywords: knowledge as private property, knowledge as common and as public good, patenting, knowledge monopolies, social inequality

Rezumat: Pentru a face lumină asupra problemei cunoașterii publice, în special a cunoștințelor științifice și tehnologice, voi examina mai întâi teza conform căreia creșterea în sensul noilor cunoștințe este rar întâlnită în domeniul public. Cunoștințele suplimentare produse în principal în comunitatea științifică și prin cercetări în afara științei tind să fie tratate ca o marfă. Restricționarea unei largi distribuții de noi cunoștințe se poate baza pe o serie de factori. Mă voi concentra asupra restricțiilor legale contemporane, în special a legilor moderne de brevetare. A doua parte a observațiilor mele se referă la unele dintre complexitățile legate de teza conform căreia cunoașterea este un bun public. Închei cu remarci despre legătura dintre proprietatea asupra cunoașterii și inegalitatea socială.

Cuvinte cheie: cunoaștere ca proprietate privată, cunoaștere ca bun comun și ca bun public, brevetare, monopoluri ale cunoașterii, inegalitate socială

Introduction

It would appear to be almost self-evident that in a society in which knowledge becomes the dominant productive force, it – or at least certain types of knowledge – turns into a commodity and can be appropriated, recognized, treated and traded as property. Of course, any effort to understand knowledge as a commodity is influenced or possibly hindered by the fact that knowledge has both market-relevant attributes and non-marketable

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values that do not disappear by treating knowledge as a commodity and having an exchange value.

In order to shed some light on the issue of public knowledge, particularly scientific and technological knowledge, I will first examine the thesis that *increment* in the sense of new knowledge is rarely found in the public domain. Additional knowledge is mainly produced in the scientific community and by research outside of science tends to be treated as a commodity. The restriction of a wide distribution of new knowledge may be based on a number of factors. I will concentrate on contemporary legal restrictions, especially, modern patenting laws. A further limit much older was identified by the economist Kenneth Arrow. Contrary to the optimistic assessment of the World Bank (1991:1), "knowledge is like light. Weightless and intangible, it can easily travel the world, enlightening the lives of people everywhere," Arrow notes (in Stiglitz and Greenwald, 2014:507; my emphasis) that although "knowledge is a free good. The biggest cost in its transmission is not in the production or distribution of knowledge, but in its *assimilation*." Georg Simmel's ([1917] 1970:44; English p. 491)[2] sober observation – "what is common to all can only be the possession of who possesses less than anyone else" – about the minimum commonality of human attributes across collectivities, refers in addition to a kind of marginal law of knowledge distribution, that is, the last individual who still shares a specific knowledge determines the common world of knowledge in a population. It is not the middle or the average, but the lower limit of any "participation" that determines the degree of the dissemination of knowledge. The second part of my observations deals with some of the complexities linked to the thesis that knowledge is a public good. I conclude with remarks about the link between the ownership of knowledge and social inequality.

Knowledge as a commodity

It is a mistake to consider the question of knowledge as a commodity and knowledge as a public good to be a modern question. In fact, the suspicion that knowledge is traded as a commodity has played a role in the 18th century. Exemplary for this are Adam Smith's in a preliminary work of his classic *The Wealth of Nations*. Smith refers to the following context:

> Let any ordinary person make a fair review of all the knowledge which he possesses [...] he will find that almost everything he knows has been acquired at second hand, from books, from the literary instructions which he may have received in his youth, or from the occasional conversations which he may have had with men of learning. A very small part of it only, he will find, has been the produce of his own observations or reflections. All the rest has been purchased, in the same manner as his shoes or his stockings, from those whose business is to make up and prepare for the market that particular species of goods.

The acquisition of knowledge, in the end, does not differ according to Adam Smith from buying any other product; as "with the trade of material goods, there are individuals whose particular task is to create knowledge and prepare it for the market" (Valenza, 2009:11). Not only can knowledge become a commodity, but there is a parallel intellectual "division of labour" between producers and consumers of knowledge.

Knowledge has always had its price and was never available in an unlimited supply, that is, knowledge has been, not unlike other commodities, scarce, and in order to utilize it, one had to sometimes buy it. However, what precisely determines the value of

[2] „Was allen gemeinsam ist, kann nur der Besitz des amwenigsten Besitzenden sein."

knowledge is by no means self-evident. The value of knowledge depends, for example, not merely on the utility it may represent to some individual or firm but is linked to the ability or inability of others actors, for example competitors, to utilize and exploit it to their advantage as well.

In the context of traditional economic discourse, knowledge is treated in a peculiar and often less than plausible fashion ranging from assuming "perfect" knowledge of market participants to treating knowledge merely as an exogenous dimension to efforts to argue that knowledge can be treated in a reductionist manner, that is, as a conventional economic category to which orthodox concepts such as utility, fixed and variable costs apply with benefit and without restriction[3].

It would seem that economists tend to prefer a conception of the value of knowledge which closely resembles their conception of value of any other commodity, namely, value derives from the utility of the "product" knowledge (use-value), although there remains a considerable range of interdeminacy when it comes to the expected value of knowledge.

For a significant part, the service sector of society lives off selling knowledge. The educational system employs millions who make a living by disseminating socially necessary knowledge. The control of the free circulation of knowledge cannot only be hampered by limited access to the pre-conditions for its acquisition but also, in a legal way, by assigning property right to it. One only has to refer to patent and copyright laws. In many countries, patent and copyright laws are no longer confined to technical artifacts and processes but include intellectual ownership in art, music, literature, and increasingly, scientific inventions.

Since the 1980s, the policy for legal protection of intellectual property (patents, trademarks, copyrights) has changed radically, and lawsuits for violations of patent law have increased (for example, the patent dispute between Apple and Samsung over smartphone design). With the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) as part of the constitution of the World Trade Organization (WHO), signed in Marrakesh in April 1994 as the conclusion of the so-called Uruguay Round, new binding obligations were put into effect for all WHO members with regard to their national policies for the protection of intellectual property. More than one hundred countries signed the treaty. Developing countries signed TRIPS in return for the promise of liberalizing world trade. In spite of the broad assent to the TRIPS rules, the standards continue to remain controversial. Critics from peripheral states, for example, complain that the special economic and political interests of the developed world and its multinational corporations are protected rather than global health and economic prosperity[4]. Important to note is in addition that the TRIPS agreement extends the life of a patent over what many countries stipulated; the patent protection is granted for 20 years.

Depending on the patented resource and in terms of economic impact it may have,

[3]In an effort to arrive at ways of determining the value of information as an economic good, Bates (1988:80), for example, argues that there is an inherent imbalance in the fixed cost and variable cost component of producing (and re-producing), information. The production of information has an exceptionally high component of fixed and a very low, even nonexistent variable cost component (the costs associated with the replication of the information), because information is infinitely reproducible and consumes all other resources. Such a treatment of "information", of course, is only plausible as long as one is convinced that reproduction is virtually unproblematic (e.g. transcends the initial conditions of production including the costs associated with it), and can be repeated at will because production is definitive and does not require any intermediaries or subsequent interpretation.

[4]Writing on the history of intellectual property laws, Hannes Siegrist (2019:32) notes, that the "concept of intellectual property emerges from the formative periods of modern culture, science and economics. It was developed in the eighteenth and nineteenth centuries in American and European culture-producing states with the objective of protecting the individual creative and commercial work of certain groups of the affluent and educated middle classes and protecting their special entitlements and special position during the transition from traditional aristocratic and profession-based society to modern class society."

(1) patents on knowledge capacities confer market power, and

(2) patents can impede the ability to produce new knowledge by effectively blocking market access by protecting relevant, needed knowledge with patents (see Drahos and Braithwaite, 2002);

(3) Patents can influence the labor market of a company up to the possibility of monopolies, i.e., only one buyer for certain special knowledge emerges. The power over the labor market has a number of economic and social consequences, which can range from determining the income of employees to consequences for the educational system;

(4) Patents can increase the degree of market concentration and encourage a lack of competition for access to the market;

(5) Patents have an impact on the economic cycle (see Pagano, 2014:1416-1420);

(6) Their market power influences the risk behavior and investment in research and development of these companies;

(7) Patents increase the differentiation of individual earnings and, as generally observed,

(8) Internationally sanctioned patents help co-determine the income and wealth inequality of modern society through unearned income. The wealthy classes of society earn a substantial part of their income not as a result of their work, but as a function of their assets.

The protection of intellectual property in the sense of intellectual property law (copyright and related rights; Intellectual Property Rights, IPR) should, if this is indeed the case, create incentives for innovation (Stiglitz and Greenwald, 2014: 429-456). The counterpart to copyright-protected intellectual property is the *public* domain, intellectual property as common property or, the *global community of knowledge*. Concerning this community of knowledge, there is a not unjustified suspicion or even fears in companies that patent laws promote exactly the opposite (see also Stiglitz, 2002:245), namely the increased monopolization of knowledge progress. This suspicion is reinforced by the fact that the most important resource of present and future inventions is knowledge (Henry and Stiglitz, 2010:240). Restrictive patenting leads to knowledge monopoly capitalism (Stehr, forthcoming). The essential difference between knowledge monopoly capitalism and monopoly capitalism is the fact that the monopolistic position is not primarily due to the market power of a company, but to the legally secured cross-border control over knowledge.

Knowledge as a public good

As we have seen, the fact that knowledge is treated as a commodity and is traded is not a new phenomenon. However, some observers would assert that we are witnessing, as a result of technological rather than the legal transformations, especially in conjunction with the proliferation of information-processing machines, a radical "exteriorization" of knowledge with respect to the "knower". With it, the relationship of the "suppliers and users of knowledge to the knowledge they supply and use [...] will increasingly tend to assume the form already taken by the relationship of commodity producers and consumers to the commodities they produce and consume – that is, the form of value. Knowledge is and will be produced in order to be sold, it is and will be consumed in order to be valorized in a new production: in both cases the goal is exchange" (Lyotard, [1979] 1984:4). What counts according to Lyotard, therefore, is the exchange and not so much the use value of knowledge. Nonetheless, there is still not an economic theory of knowledge in analogy to a theory of location for land as a factor of production, for capital or labor. Economists have treated knowledge, as have most of their fellow social

scientists, in a taken for granted manner and often introduced it as an exogenous or external factor.

If there is answer to the question whether there can be a just price for knowledge, this answer should be: The lack of a price tag for knowledge as a public resource may be the best indication of a just price for knowledge. In order to escape the possibility that any stratified access to knowledge offers huge advantages to those with such privileged opportunities and therefore enhances social inequality formation in society not only through its role as an economic resource but also as a foundation for social power and authority, *knowledge should be without a price*. In other words, the rewards that accrue to the use of knowledge should be impartially distributed throughout society while the benefits that follow from the discovery of knowledge might be dispersed according to contribution or merit[5]. Joseph Stiglitz (1999a) enlarges the thesis that knowledge is a public good in a dual sense. He describes why knowledge is not merely a public good but a *global public good*. In addition, Stiglitz designates human rights, political, economic and environmental goals as public goods[6].

Most if not all discussions about knowledge as a public good are normative or political in nature. Economists tend to strongly defend either the idea that knowledge should be available to all (for different reasons, obviously) or the idea that knowledge, for example additional knowledge, needs to be protected and hence carry a price tag (again for different reasons but mainly to ensure that the propensity to generate additional knowledge is not discouraged).

But first, we need to inquire in more detail into what exactly a public good is and why the idea of a public good is related to the issue of the price of knowledge. As we have already seen in the case of the definition of a public good by Joseph Stiglitz, public goods can refer to rather diverse phenomena. Economists consider products, knowledge, services, ideas, and information that are produced or available in a society to be public goods if *access to them is not regulated and can in principle be shared by all members of a community*. In other terms, public goods are goods which nonpaying people cannot be kept from using: Street names, social trust or safety are public goods. Public goods, therefore, emerge as a result of certain social norms (such as, for instance, peace, civic order, environmental safety and good governance) or are physical phenomena (such as, for instance, carbon-absorbing forests, algae or air).

Environmentalists prefer to distinguish public goods from "commons" / common goods (*Gemeingüter*). The difference between public goods and common resources is considered to be significant with respect to access to and governance of goods. As a rule, *common* goods are not freely accessible and available for use (Hess and Ostrom, 2007). Common goods, for example, solar energy co-operatives or the lobster fishing industry in Maine (can be made) subject to rules and formal and cultural norms negotiated freely among the individuals who use these goods collectively (user communities; cf. Acheson, 2003). In a "constructed commons" much of the value pertains to embedded knowledge and information such as patented discoveries.

However, neither the extent, nor the nature or the value of knowledge and information in constructed common goods are readily transparent and available. The focus of

[5]For, as John Maynard Keynes argues, a just price is a matter of equity not equality. Just prices "are those which correctly reward talents and efforts" (see Skidelsky, 2010: 145–146).

[6]Joseph Stiglitz (1995) specifically identifies a total of five global public goods: "international economic stability, international security (political stability), the international environment, international humanitarian assistance and knowledge." A definition of global public good that is not merely confined to listing examples of global public goods but also considers their *availability* concludes that "global public goods might usefully be defined as those goods (including policies and infrastructure) that are systematically underprovided by private market forces and for which such under-provision has important international externality effects" (Maskus and Reichman, 2004:284).

constructed commons analysis has focused on the social organization of such associations rather than the value constructed by such communities. The intellectual interest in carrying out these studies was, after all, driven by the desire to promote the establishment of commons communities, for example, in contrast, and opposition to the institution of private property (Madison, Frischmann and Strandberg, 2010).

The price of *private* in contrast to public goods is negotiated in the market place. Market places are also seen as the most efficient context for furthering the propensity to produce private goods. The propensity to produce is further secured by conditions extraneous to the market, for example, property or intellectual rights; but producers for markets rely also on public goods or non-market goods such as the air to breathe, the climate, national defense, a tax system or gravity.

Public goods are freely available by definition, they are not subject to property rights, and their burdens or benefits cannot be restricted to an individual or a collectivity. As far as their use or utility is concerned, public goods are non-excludable. Moreover, the consumption of a public good is non-excludable if unauthorized actors (free-riders) cannot be prevented from enjoying the benefits or incurring the costs of being exposed to it. The non-excludability of a good, a service or an environmental condition is a contingent matter; for example, "it is easier to exclude individuals from the use of a bike than it is from national defense" (Drahos, 2004:324).

If many individuals and organizations can enjoy a public good without depleting it and if its consumption or enjoyment does not come at another person's expense, a public good is *non-rival*. From an individual perspective, the consumption of public goods carries no restrictions. A mathematical theorem "satisfies both attributes: if I teach you the theorem, I continue to enjoy the knowledge of the theorem at the same time that you do" (Stiglitz, 1999b:308). Once the theorem is published, no one can be excluded, anyone can utilize it.

Joseph Stiglitz (1999b:309) also makes the point that the nonrivalrousness of knowledge implies, for example, that there is zero marginal cost for an additional individual or organization that benefits from available knowledge. Even if it would be possible to prevent someone from taking such knowledge on board, it would be undesirable to impose restrictions since there are no marginal costs associated with sharing the benefits that come with the knowledge in question.

Conflating knowledge and information, Stiglitz (1999b: 309) argues that "if information is to be efficiently utilized, it cannot be privately provided because efficiency implies charging a price of zero – the marginal cost of another individual enjoying the knowledge." However, as Stiglitz is quick to add, "at zero price only knowledge that can be produced at zero cost will be produced." In this case, private markets "would not provide them at all or would do so at deficient levels relative to those demanded by citizens" (Maskus and Reichman, 2004:284). Hence, the probability that additional knowledge will be generated is also close to zero. If additional knowledge is without price, the supply of new knowledge will dry up. The idea that the acquisition of new knowledge comes at no cost of course describes an ideal typical condition. After all, the actual transmission and acquisition of additional knowledge requires some resources, however small or significant.

Nonexcludability also has implications for the price of knowledge. Since such knowledge is available to everyone, the price would approach zero. We have already discussed patents and IPR as ways of restricting the number of users. Depending on the legal frame of patenting, the patent application makes a considerable "amount" of the relevant innovation publicly accessible. Whether this knowledge can in fact be appropriated is not dependent on its mere availability, however.

The probability of fabricating *incremental* knowledge and enjoying the economic advantages that flow from such knowledge is, of course, a stratified and contingent process.

Within technological regimes, techno-economic networks (cf. Freeman, 1991; Callon, 1992) or theoretical "paradigms," the advantage goes to those who already have produced, and therefore command, significant elements of incremental knowledge. Technological regimes or paradigms may be embedded within a company or in a network of firms, research institutes, etc. In analogy to Robert Merton's (1995) observations about the operation of the Matthew effect in the process of accumulating standing and prestige in science, it is possible to stipulate a similar principle for the stratification of incremental knowledge. Generating incremental knowledge is likely to be easier for those who can disproportionately benefit from what they already know; for example, due to the capacity of combining local and global knowledge (cf. Stiglitz, 1999: 317–318).

The competitive advantages that may accrue to individuals or firms which generate and manage to control incremental knowledge is, without question, limited in terms of time, especially but not only due to the time limits of the protection granted by patents or copyrights. Thus, such companies must continuously strive to stay ahead in the fabrication of knowledge: "Once their intellectual advantages are imitated and their outputs standardized, then there are downward wage and employment pressures" (Storper, 1996: 257) as well as a decline in profitability.

In contrast to incremental knowledge, the general, mundane and routinized stock of knowledge consists mostly of knowledge that is non-rival as well as non-excludable; that is, these forms of knowledge may very well constitute public goods[7]. But even the general mundane stock of knowledge is hardly ever completely excludable or without rivalry. Such protection may be based either on legal norms or on some other apparatus in which knowledge may be inscribed, preventing its use by others. Once a certain capacity to act has been discovered, it usually can be used again and again and at relatively low transaction cost, if any. From a collective point of view, for example from the perspective of all consumers or a community, the use of public goods, as noted early (see Hume, [1739] 1961; Hardin, 1968), may give rise to the free-rider problem.

It might be useful to distinguish between pure public goods and *quasi-public* or *impure* public goods. Quasi-public goods would refer to conditions of action, for example, from which a consumer or an employer benefits even though he has not incurred any of the cost of the discovery and the explication of the intangible asset. The publicly accessible infrastructure of a country would be an example, or an employee's training and education that is not entirely paid for by the employer but nonetheless of great benefit to the corporation.

As Inge Kaul, Isabelle Grunberg and Marc Stern (1999:xx) point out, financial stability has "public good qualities. A bank or financial institution can generate much profit through risky lending. All it stands to lose is its capital if fails. But in a complex and interdependent financial system, the cost of a single institution defaulting is much higher – often a multiple – because one default can lead to more failures and defaults." Technically, such a possibility is known as a case of negative externalities. But it is better known as a way of socializing costs. In the case of what is seen as global public goods, the risks, costs and benefits, the externalities, are shared or borne across the world.

[7]These characteristics of knowledge allow for a decoupling of the "cost" of the fabrication of knowledge from the benefits that accrue to those who use it. As a result, the non-rival and non-excludable attributes of knowledge constitute a disincentive to invest in the production of knowledge (see Dosi, 1996: 83). Geroski (1995: 94–100) discusses various strategies that might be instrumental in overcoming the appropriability problem of incremental knowledge.

Conclusion

To what extent is, can – and maybe even should – knowledge generally be accessible around the world? Is knowledge a public good whose opportunities for example in the field of health care can be *equitably* and globally exploited? Is knowledge universal? One of the implications of the universality of knowledge assertion is the apparently close affinity of this thesis and the idea of the unrelenting globalization process in the modern world. The economic implication of perfect mobility of knowledge would be a gradual but persistent trend toward full equality of knowledge capacities and human capital across countries. As Thomas Piketty ([2013] 2014:70) remarks: "no small assumption". Thus, regarding the convergence in the economic growth among countries, the "principal mechanism for convergence at the international as well as domestic levels is the diffusion of knowledge." However, successful convergence of knowledge depends on many factors; it does not occur more or less automatically transcending all social, economic, legal and political hurdles. The most pertinent barrier, as I have attempted to indicate, are modern patenting laws that impede access to new knowledge and the benefits associated with incremental knowledge.

The assertion of a natural "*laissez faire*" global world of knowledge is also diametrically opposed to the observation that knowledge is tacit and sticky. Knowledge is "reluctant" to travel because it clings to the knower. Knowledge is produced locally and remains local without efforts to overcome its parochial nature. The opinion that it should be otherwise is perhaps largely nourished by the ease with which data and information are believed to circulate. Nonetheless, knowledge as non-rival good does leave its origins for obvious reasons; the producer desires that its creation departs, and not merely as "fugitive knowledge" but at times as a rival commodity. But if this is not the case, that is, if new knowledge is fenced in, it will have significant consequences for social inequality within and across nations.

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Environmental Aspects of the Use of Oil and Oil Components

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Abstract The article discusses the environmental aspects of the use of oil and oil components. It is shown that for the most complete solution of applied problems in oil and gas production, taking into account the preservation of ecological biodiversity (meaning a decrease in anthropogenic environmental pollution), it is important to know the qualitative composition of the used hydrocarbon raw materials.

Keywords: high molecular weight compounds of oils, resins and asphaltenes, inhibiting properties, microelements, catalytic poisons, waste production.

Rezumat: Articolul discută utilizarea petrolului și a componentelor petrolului în relație cu mediul. Se arată că pentru cea mai completă soluție a problemelor aplicate în producția de petrol și gaze, și pentru a ține seama de conservarea biodiversității ecologice (ceea ce înseamnă o scădere a poluării antropogene a mediului), este important să se cunoască compoziția calitativă a materiilor prime de hidrocarburi.

Cuvinte cheie: compuși cu greutate moleculară ridicată a petrolului, rășinilor și asfalturilor, proprietăți inhibitoare, microelemente, otrăvuri catalitice, producerea deșeurilor.

Introduction

The article shows that the problem of chemical processing and rational use of heavy oil residues is currently acute. Resinous-Asphaltene Substances (RAS), which make up a significant proportion (up to 40%) in oils and even more in oil components, are the main reserve for deepening oil refining and increasing the degree of qualified use of petroleum raw materials. Scientific information on the chemical composition of the RAS will contribute to the qualitative identification of sources of environmental pollution, especially if we consider the effect of oil properties on the pollution of the atmosphere, soil and water surface in the region of deposits.

Main part

The oil industry of Azerbaijan is one of the main sources of pollution of the environment with toxic substances, and the air is polluted not only by various gas emissions generated in the process of oil refining, but also by gaseous oil products. If we consider oil in three aspects - as a natural resource, a product of production and an environmental pollutant,

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then it is obvious that it is necessary to organize a comprehensive analysis of the impact of the properties of oil and its components on the environment. The solution to this issue is extremely important in the context of the future ecologinizing of oil producing industries.

At oil refineries, which are today industrial complexes with a high degree of mechanization and automation of production processes, raw materials are not fully used, by-products are formed, and so far not completely captured. This reduces the technological performance of production processes and sharply degrades the environment. A significant part of oil and gas emissions (carbon oxides, sulfur, nitrogen, hydrocarbon vapors, metal oxides, carcinogenic substances, dust) are highly toxic. When the atmosphere is polluted, there is an accelerated destruction of metal and reinforced concrete structures, ancient monuments, soil acidification, poisoning and death of flora and fauna, and also a negative impact on human health.

Therefore, the technological perfection of oil processing methods must be assessed not only by production and economic indicators, but also by their environmental friendliness. Sources of gaseous hydrocarbons (natural and associated petroleum gases, some synthetic gases obtained during thermal and thermocatalytic processing of oil and oil products) make a certain "contribution" to the pollution of the external environment, including the air basin.

At present, a lot of attention is paid to the complex study of High Molecular Weight compounds (HMW), since they contain significant amounts of heteroatomic compounds that adversely affect the catalytic processes of oil refining and petro chemistry. The main part of all microelements is concentrated in the highest boiling fractions of oils (resins and asphaltenes), which allows us to consider them as the main catalytic poisons of many oil refining processes.

For example, the presence of asphaltenes in the feed reduces the hydrogenation rate by $2 \div 4$ times and increases the rate of catalyst deactivation by several times. The RAS, which remained in the oil products, have an extremely negative effect on their operational properties[2],[3].

Since there is a continuous exchange of microelements between oil, rocks, formation waters, oilfield and refinery equipment, the RAS can be a link through which the relationship between the oil system and the environment is carried out.

We have found that the highest concentrations in the RAS of Azerbaijani oils contain elements of the iron group and heavy halogens, especially iodine[4]. For example, it was found that the highest concentration of iodine among the oils of Azerbaijan belongs to the oil of the Gunashli field. And halogens in all cases are concentrated mainly in the resinous components of oils.

The chemical nature of the halogenated components of oils has not yet been finally established and the relatively high content of bromine and iodine in Azerbaijani oils indicates that these oils, especially the oil from the Gunashli field, are promising objects for scientific research. Interest in petroleum microelements increased significantly when it was discovered that the amount of certain metals (in particular, vanadium and nickel) could be comparable to their content in ores. It is characteristic that the study of metals in oils was previously mainly by geochemists, but after it became known about the harmful effects of metals on the processing technology and operational properties of fuels, they began to be dealt with by chemists-technologists and ecologists. From an

[2] Мир-Бабаев М.Ф., 1998. Высокомолекулярные соединения нефтей Азербайджана // Химия и технология топлив и масел, №5, с.44-45.

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environmental point of view, the study of the microelement composition of refined oils is important in order to identify sources of environmental pollution with oil.

The presence of halogen-containing compounds in low-boiling oil fractions is apparently associated with the decomposition of high-molecular halogen-containing components during the distillation process, which leads to increased corrosion of oil refining equipment. That is, the purpose of the ongoing research of petroleum metal-containing compounds is not only the rational extraction of microelements from petroleum feedstock, but also the fight against corrosion[5],[6].

So, when burning boiler fuel containing increased amounts of heavy metals, intensive destruction of refractory masonry occurs in furnaces, with vanadium being the most aggressive component. Vanadium pentoxide and vanadium salts present in the ash are low melting compounds. Together with sulfur-containing substances, they form dense deposits that cause metal corrosion. The amount of vanadium pentoxide emitted annually with the smoke of modern power plants is measured in hundreds and even thousands of kilograms. Organic vanadium compounds have a negative effect on the performance of petroleum products, and vanadyl porphyrins present in oils are effective stabilizers of petroleum emulsions that impede their destruction. Vanadium in oils, which is a part of non-porphyrin complexes, is also associated with sulfur, which leads to atmospheric pollution and sulfur oxides.

It is known that ashes of heating oil are rich sources of valuable metals (vanadium and nickel etc.), which can be effectively leached under weakly acidic reducing conditions. With the help of synchrotron radiation, arsenic in the form of pentoxide was detected in oil fly ash emitted into the atmosphere, in addition to vanadium and nickel[7].

When using fuel oil (which is to some extent a concentrate of petroleum RAS), and, therefore, microelements) as boiler fuels, the environment is polluted with significant amounts of metal oxides. According to calculations[8],[9], during the combustion of 1 ton of liquid fuel in power plants and industrial facilities, $1kg \div 2kg$ of metal oxides, mainly iron and vanadium, enter the atmosphere.

Knowing the microelement's composition of oils, it is possible to identify the sources of oil pollution of the environment, since trace elements are present in all oil fractions, starting with gasoline, and their amount, as a rule, increases with increasing boiling point of the fraction, reaching a maximum in the residues[10].

For the qualitative extraction of metals from oils and petroleum components, we used neutron-activation analysis, which is universal in relation to a very large number of elements and does not require preliminary preparation of samples (ashing)[11],[12]. The application of this analysis made it possible to establish about 20 different microelements in characteristic oils of Azerbaijan, including lanthanides, which were not determined

[5] Мир-Бабаев М.Ф., 1996. Нефтяные смолисто-асфальтеновые вещества // Химия и технология топлив и масел, №6, с.43-46.Мир-Бабаев М.Ф., 1997. Микроэлементный состав нефтей по данным нейтронно-активационного анализа // Химия и технология топлив и масел, №5, с.46-47.

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[11] *Idem.*

[12] Самедова Ф.И., Мир-Бабаев М.Ф., 1992. Высокомолекулярные гетероатомные соединения нефтей. - Баку: Нефис, 135 с.

earlier (La, Eu, Yb, Ce). The type of elements contained in all Azerbaijani (low-sulfur) oils, or in the overwhelming majority of them, are Fe, Ni, Cr, V, Co, Zn, Au, Sb, Se, I, Br. These microelements (in particular, Ni, V, Cr, and Co) isolated from crude oil can be used for micro alloying steels, which is very important.

Some words about the practical application of oil components[13],[14].

Petroleum RAS are natural inhibitors; they exhibit a certain inhibitory activity in reactions with a free radical chain mechanism. The total concentration of natural inhibitors in asphaltenes can reach 0.28 mol / kg of oil. They are present in high effective concentrations $(0.66 \div 0.79) mol/kg$ in RAS extracted from oil of the Banka Darwin field. Natural inhibitors contained in the RAS of characteristic (low-sulfur) oils of Azerbaijan are in most cases not inferior to synthetic antioxidants in their inhibitory effect, and resins from Gunashli oilfield are comparable in "strength" of action with the most effective synthetic antioxidants: naphthol and topanol[15].

The concentration and activity of inhibiting centers in the RAS naturally depend on the chemical type and the degree of metamorphic transformation of oil, which in turn determines the role of RAS as preservatives that stabilize the reservoir oil system and thereby ensure the preservation of oil in the bowels during geological time.

Oil residues (high-boiling oil fractions) are one of the raw material sources for the production of oil stabilizer concentrates. In particular, tar deasphalting asphalt, containing active antioxidants, is comparable in its inhibitory effect with common synthetic phenolic and naphthylamine antioxidants. The simplicity and low production cost, as well as the relatively high antioxidant properties of petroleum concentrates, consisting mainly of RAS, contribute to a more rational use of petroleum feedstock (in particular, production waste).

Various substances that have valuable practical applications in industry can be obtained from petroleum RAS by chemical modification using sulfonating, amination, chloromethylation, condensation, phosphorylation, and thermolysis reactions. The introduction of a significant number of active functional groups into molecules of RAS leads to the production of materials with anion and cation exchange properties.

We found[16], that the concentration and activity of inhibiting centers in low-sulfur Azerbaijani oils decrease with an increase in the depth of the deposits, that is, catagenic transformations lead to a decrease, and hypergene transformations lead to an increase in the inhibitory ability of oil components, in particular resins and asphaltenes. Inhibitors, concentrated mainly in RAS, are represented by heteroatomic compounds, and up to 10% of inhibitors are also contained in heavy residual products of oil refining (asphaltenes, tar and pitches). Therefore, it is of interest to use the residual products of oil refining as an inhibitor of the oxidation of fuels and oils instead of expensive additives. This will effectively solve the problem of maximum use of secondary resources.

The practical use of petroleum CAS as stabilizers for various polymeric materials is also conditioned by their inhibiting properties.

For example, chloromethylated asphaltites are accelerators in the chemical curing of epoxy resins and reagents for sulfurless vulcanization of rubbers. When rubber mixtures are filled with asphalt, more elastic rubber is obtained than when filled with soot. Asphalting concentrates increase the thermal-oxidative stability of epoxy compositions, and petroleum asphaltenes are emulsion stabilizers: their small additives (up to 1%) reduce

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the hydraulic resistance during the movement of oils in wells by $20\% \div 40\%$. Asphaltene concentrates are also used as antifriction fillers for lubricating compositions instead of graphite.

The main carriers of the biological activity of Azerbaijani oils from the Balakhani, Naftalan and Surakhani fields are naphthenic hydrocarbons with high cyclicity and optical activity; they are associated with the structures of biologically active compounds - the most important relict hydrocarbons related to steranes and triterpanes. Due to their clear association with biological products, these hydrocarbons are called biological tags. The concentration of steranic and triterpanic hydrocarbons in Azerbaijani oils does not exceed $0.3\% \div 0.5\%$. The predominant amount of steranes and triterpanes is contained in oil from the Balakhani field, which determines the use of high-boiling fractions of this oil for the production of medical and perfume oils[17].

The main carriers of the optical activity of Azerbaijani oils are also naphthenic hydrocarbons (their highly annular representatives). The most optically active oils and their fractions were discovered from the Azeri, Balakhani and Jafarli fields. Optical activity is an important property of oils and their components, as it makes it possible to solve the problem of the genesis of oil and determine its age.

At present, the use of luminophores based on petroleum fractions (components) is widely developed. Among the studied samples of Azerbaijani oils from the Oil Rocks and the Banka Darwin fields, aromatic hydrocarbons isolated from the residues (fractions above 350 degrees Celsius), which have an intense yellow glow, are of greatest interest. This creates a good opportunity to use these aromatic hydrocarbons in capillary luminescent flaw detection as a luminescent component of an indicator liquid.

Conclusion

The presented brief review on the environmental aspects of the use of oil and oil components has shown the practical value of these substances. The range of application of petroleum components is very wide, and their potentialities are far from being exhausted, since only the chemical transformations of RAS already make it possible to obtain a number of compounds with valuable properties necessary for solving the problem of developing a technology for the non-residual use of oil. When planning the rational use of oil and its components in the future, it is possible to identify sources of oil (anthropogenic) pollution of the environment and thereby significantly reduce emissions of pollution into the atmosphere, which will generally contribute to an improvement in the environmental situation. And this is one of the measures to conserve global biodiversity.

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ISTORIE / HISTORY ...
a aplicării cunoașterii științifice
/
of application of scientific knowledge

Cifre vechi în Transilvania[1]

MIHOLCSA Gyula[2]

Abstract We use numbers daily, not only mathematicians, but everybody. We have been using them so much that we have forgotten what a big discovery numerals have been for humanity. Some people consider that this was the biggest discovery of humanity for the last 2000 years. Roman numerals have spread throughout Europe because of the Roman empire, for almost one and half millennia. But it was very difficult to perform calculations with these early numerals, people used the abacus instead. When Hungarians came into Europe (896 A.D.), they had their own runic writing. But when St.Stephan I. converted Hungarians to Christianity (about 1000 A.D.), they began to use the Roman numerals. Today we use the Hindu-Arabic numerals. These were introduced into Europe by Fibonacci (by 1200 A.D.), because it was much easier to do calculations with these ones, than with the Roman numerals. It took about 200 300 years before Europe became convinced of the usefulness of Hindu-Arabic numerals. From where, how and when did these numerals spread in Transylvania? This article aims to answer these questions, by examining old books and paintings, coins, old churches, church bells and baptismal fonts.

Keywords: numbers, Roman numerals, Hindu-Arabic numerals, Transylvania.

Rezumat: Folosim numerele zilnic, nu doar matematicienii, ci toată lumea. Le-am folosit atât de mult încât am uitat ce descoperire mare au fost pentru umanitate. Unii oameni consideră că aceasta a fost cea mai mare descoperire a umanității din ultimii 2000 de ani. Numerele romane s-au răspândit în toată Europa din cauza Imperiului Roman, de aproape un mileniu și jumătate. Dar a fost foarte dificil să se facă calcule cu aceste numere timpurii, oamenii au folosit în schimb abacul. Când ungurii au venit în Europa (896 d. Hr.), aveau propria lor scriere runică. Dar când Sf. Ștefan I. a convertit ungurii la creștinism (aproximativ 1000 d.Hr.), au început să folosească numerele romane. Astăzi folosim cifrele indo-arabe. Acestea au fost introduse în Europa de Fibonacci (prin 1200 d. Hr.), deoarece era mult mai ușor să faci calcule cu ele, decât cu numerele romane. A durat aproximativ 200-300 de ani până când Europa s-a convins de utilitatea cifrelor indo-arabe. De unde, cum și când s-au răspândit aceste cifre în Transilvania? Acest articol își propune să răspundă la aceste întrebări, examinând cărți și picturi vechi, monede, biserici vechi, clopote ale bisericii și fonturi de botez.

Cuvinte cheie: numere, cifre romane, cifre indo-arabe, Transilvania.

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Introducere

Zilnic utilizăm cifrele, nu doar matematicienii, o facem cu toții. Ne-am obișnuit atât de mult cu ele, încât am și uitat deja ce invenție mare au însemnat cifrele pe vremea lor, pentru omenire.

Ce a fost înainte de cifrele de azi? De unde, când, și cum au ajuns în Transilvania aceste cifre? Căutăm răspunsuri la aceste întrebări în manuscrise, cărți, pe clădiri și biserici vechi.

Cifre romane

În Europa, la începutul primului mileniu Imperiul Roman a introdus administrația publică și justiția (pe înțelesul de azi al termenilor) în rândul popoarelor cucerite, care aveau culturi diferite. Astfel s-au răspândit pe tot cuprinsul Europei cifrele romane utilizate de cuceritori.

Sistemul de numărare roman este unul aditiv, ceea ce înseamnă că obținem valoarea unui număr prin adunarea valorilor cifrelor ei. De exemplu, MDCCCLXVII reprezintă un număr care se obține din adunarea elementelor (cifrelor) lui: o mie (M), plus cinci sute (D), plus de trei ori o sută (C, C, C), plus cinci zeci (L), plus zece (X), plus cinci (V), plus de doi ori unu (I, I), adică o mie opt sute șaizeci și șapte (1867).

Cifre romane în Europa medievală

Tot la începutul primului mileniu, în Orientul Apropiat a apărut creștinismul, care apoi s-a răspândit în toată Europa, până la urmă chiar cu ajutorul Imperiului Roman. Limba oficială a Bisericii Creștine a devenit latina, și împreună cu limba, s-au preluat și cifrele romane. După destrămarea Imperiului Roman, cifrele romane au rămas în folosință în întreaga lume creștină, aproape un mileniu și jumătate.

Cu cifrele romane însă, se puteau efectua greu operațiile matematice. Să încercăm doar să înmulțim două numere scrise cu cifre romane!

Aceste operații – de care aveau în primul rând nevoie perceptorii de taxe și comercianții – se făceau fie în cap, fie folosind degetele. Găsim descrierea uner reguli vechi de înmulțire în „Tudományos Gyűjtemény/Colecția Științifică” din 1820:

> *Prin folosirea degetelor de la mână, oamenii au început să facă și calcule, așa cum o fac și azi, cei care nu se pricep destul, fac calcule pe degete.*

Cum se puteau face calcule pe degete ? Cu ajutorul așa-zisei ≪Regula PIGRI≫:

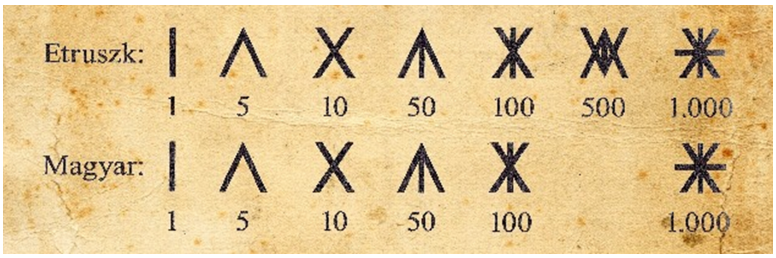
> *Cel care cunoaște înmulțirea de la* 2×2 *până la* 5×5*, poate efectua ușor restul înmulțirilor pe degete. De exemplu, vreau să aflu cât face* 6×8 *? Procedez în felul următor: pe una dintre mâini, număr pe degete 6, pe cealaltă 8; încep numărarea de la 8. Pentru ca 5 să devină 6, e nevoie de 1, iar pentru ca să devină 8, e nevoie de 3. Înmulțesc degetele rămasa îndoite între ele: de 4 ori 2 este 8. Degetele ridicate înseamnă fiecare numărul 10, astfel, din degetele ridicate rezultă 40. Adăugând la acesta 8-ul de dinainte, rezultă 48, adică* 6×8 *este egal cu 48.*

Matematica grecilor n-a ajutat prea mult această situație, căci ea era dezvoltată mai ales în domeniul geometriei. Grecii au redus chiar și calculele matematice la metode geometrice, rezolvându-le astfel.

Dat fiind că operațiile matematice nu puteau fi realizate cu cifrele romane, comercianții, perceptorii de taxe și schimbătorii de valută utilizau abacul.

Cifre cuneiforme în Transilvania

Maghiarii, veniți din orient și stabiliți în Bazinul Carpatic (deci și Transilvania) la sfârșitul primului mileniu, au adus cu ei o scrierea cuneiformă proprie („rovásírás"). Cifrele erau de asemenea scrise în acest mod. Logica acestei scrieri era că semnele se puteau grava ușor pe un băț, de la dreapta la stânga (pentru ca mâna stângă care ține bățul, să nu acopere ceea ce s-a scris). În Transilvania s-au descoperit zeci de relicve scrise cu această scrierea cuneiformă[3]. Este interesant că aceste cifre se aseamănă foarte mult mult cu cifrele etruscilor, scrise tot aditiv, ca și sistemul roman. De fapt, și cifrele romane au avut la bază cifrele etruscilor, pe care apoi le-au modificat.



Atunci când Regele SF. ȘTEFAN al Ungariei a convertit maghiarii la creștinism, a renunțat totodată și la scrierea „păgână" (cuneiformă), preluând alfabetul latin. Potrivit decretului regal din A.D. 1000, luna octombrie, ziua a 9-a:

> *„În urma povățuirii papei SILVESTRU al II-lea, s-a hotărât: maghiarii, secuii, hunii, precum și vechile litere folosite de preoția maghiară păgână, scrierea de la dreapta la stânga, scrierea cuneiformă, vor înceta! În locul lor, se vor folosi litere latine. Scrierile predate vor fi mistuite în foc, astfel încât, prin nimicirea lor, orice amintire și dorință de revenire la religia păgână să dispară."*[4]

Acest decret regal este controversat; potrivit unora, este un fals. Realitatea este totuși că aparatul de stat și instituțiile bisericești au trecut toate la alfabetul latin și cifrele romane. Urmele acestora le descoperim în prezent în Ardeal.

Cifre romane în Transilvania

În continuare vom căuta numere scrise cu cifre romane, dar nu cele scrise de romani în timpul ocupatiei între 106 şi 271, ci cele folosite și scrise de transilvăneni, adică acelea care s-au încetățenit în viața de zi cu zi a Transilvaniei.

Luncani (jud. Cluj). Cele mai timpurii numere scrise cu cifre romane din Transilvania datează de la finele anilor 1200. Pe locul actualei biserici reformate din Luncani, pe vremuri se ridica o biserică mai mică. Aici, găsim gravat pe zidul porticului, pe o mică plachetă de piatră, anul construcției bisericii de azi, cu cifre romane: „*Anno D[omi]ni* ***M CC XC nono***", adică 1299.

Înanite de această biserică era aici o mică capelă sub formă de pătrat, care astăzi este sanctuarul. Preotul ȘTEFAN a construit o sacristie la acesta, iar deasupra ușii de

[3]RÁDULY János: *Titkok a rovásírásban* (Secrete în scrierea cuneiformă), Editura Erdélyi Gondolat, Odorheiu Secuiesc, 2004.

[4]CSALLÁNY Dezső: *Rovásírásos emlékek a Kárpát-medencében* (Scrieri runice în bazinul carpatic) in A NYÍREGYHÁZI JÓSA ANDRÁS MÚZEUM ÉVKÖNYVE 1969-1971, Budapest, 1972, p. 135.

Figure 1: Luncani (jud. Cluj). Inscripția de pe biserica reformată - 1290.

intrare la sacristie a gravat anul construirii: „*Istam cameram edificavit Stephas sacerdoss anno domini* ***MCCXC***"[5], deci 1290! **M** se află la capătul rândului doi (sub forma Φ), jos în stânga **CC**, jos pe dreapta **XC**. Este foarte posibil ca aceasta să fie cea mai veche cifră cioplită în piatră, pe care o putem găsi pe o clădire ardeleană (Fig. 1).

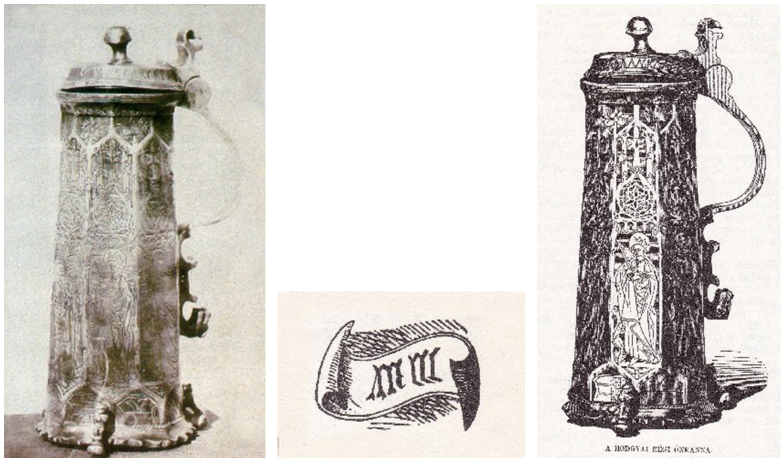


Figure 2: Hoghia (jud. Harghita), pocalul de staniu - 1300.

Hoghia (jud. Harghita). O altă inscripție de an s-a păstrat cioplit în staniu. În

[5]Această cameră a fost construită de preotul Ștefan în Anul Domnului MCCXC.

biserica din Hoghia a existat un pocal vechi. ORBÁN Balázs l-a fotografiat (imaginea din stânga) și pe baza fotografiei l-a desenat (imaginea din dreapta). În cartea sa în 6 volume *Descrierea tărâmului secuiesc* (1868), unde publică desenul pocalului, ORBÁN menționează că pe acesta se găsește inscripționat anul: „*MCCC*", adică 1300 (Fig. 2, la mijloc). Pocalul nu mai există, a fost distrus în al Doilea Război Mondial.

Alțâna (jud. Sibiu). Alțâna se găsește la 35 de km de Sibiu, pe cursul râului Hârtibaciu. Biserica săsească a localității a fost construită în sec. al XIII-lea, la începuturi fiind o bazilică romanică cu 3 naosuri, ulterior a fost reconstruită în stil gotic. Pe cristelniță a fost trecută anul realizării ei: „*Anno · domini* · ***millesimo · cccc · iiii · tempore · regis · sigissmundi***", adică 1404. Interesant este că cifra 400 nu a fost trecută în conformitate cu metoda obișnuită romană de scădere 500-100, adică „CD", ci s-a folosit metoda adunării: 4 cifre de 100 scrise consecutiv, adică CCCC. La fel și cifra 4. Din păcate cristelnița nu mai există, a fost furată în anul 1998.

Cetatea de Baltă (jud. Alba). O altă inscripție de an foarte timpurie, se află pe clopotul bisericii reformate din Cetatea de Baltă. Este vorba de fapt de cel mai vechi clopot inscripționat cu anul de producție, din Transilvania. Pe el se vede trecut: „✠ *o* ✠ *rex* ✠ *glorie* ✠ *veni* ✠ *cum* ✠ *paie* ✠ *anno* ✠ *domini* ✠ ***millesi[mo]***° ✠ ***cccc***° ✠ ***xvii***°", deci 1417. Și aici 400 este scris în același mod, prin adunare.

Figure 3: Cetatea de Baltă (jud. Alba). Clopotul bisericii reformate - 1417.

Atia (jud. Harghita). În Ținutul Sării se găsește Atia, un sat cu populație catolică. Clopotul bisericii a fost distrus în incendiul din 1867. ORBÁN Balázs a vizitat cu câțiva ani înainte biserica catolică și a publicat inscripția de pe clopot în cartea sa, căci chiar și pe atunci era considerat foarte vechi: „*anno domini* ***millesimo cccc***° ***xxx vii***", adică 1437. Cifra de o mie nu este reprezentată prin litera „M", ci este scrisă complet: „*millesimo*"

Figure 4: Atia (jud. Harghita). Inscripția de pe fostul clopot al bisericii catolice - 1437.

Sighișoara (jud. Mureș). În sec. al XIII-lea, în cetatea Sighișoarei s-a stabilit ordinul dominicanilor. Biserica construită lângă mănăstire a fost finalizată în 1551. În

Figure 5: Sighișoara (jud. Mureș), cristelnița bisericii evanghelice - 1437.

această biserică găsim o cristelniță adusă de altundeva. Literatura de specialitate scrie despre aceasta că a fost turnată în 1440. Pe cristelniță, pe al doilea rând se vede: „*Iacobi fusor[i]s ca[m] panaru[m] sub anno d[omi]ni M° CCCC° X I°*", adică 1411. Însă, dacă considerăm că un mic unghi proeminent de la baza literei „I" n-ar fi o decorație, ci talpa literei „L" mic, atunci această literă va avea valoarea 50, iar „xl", va însemna 40, deci am avea într-adevăr 1440. Și chiar acesta este adevărul, deoarece – din fericire – pe clopot este însemnat și numele meșterului care a turnat clopotul, IACOB, iar acesta a lucrat la Sighișoara (locul unde a fost turnat clopotul) doar începînd din anii 1430.

Figure 6: Cluj (jud. Cluj). Cadranul solar de pe biserica catolică „Calvaria" - 1449.

Cluj (jud. Cluj). Mănăștur aparține în prezent de Cluj. Vechea sa biserică „Calvaria" a fost de multe ori reconstruită, până și-a atins forma actuală. Pe peretele sudic se află un cadran solar vechi, cu cifre romane. După „*Antonius*" (preotul din anii 1440) urmează anul, care este foarte greu de descifrat (sus, partea dreaptă), probabil este și sub formă abreviată. Potrivit specialiștilor, este vorba de 1449, astfel că acesta poate fi considerat cel mai vechi ceas solar funcțional – deci nu aflat într un muzeu – din Ardeal.

Figure 7: Teiuș (jud. Alba). Intrarea la biserica catolică - 1449.

Teiuș (jud. Alba). Construirea bisericii catolice din Teiuș a fost finanțată de Iancu DE HUNEDOARA, din tezaurul capturat de la turci după bătălia de la Sibiu (25 martie 1442). Lucrările de contrucție au fost conduse de meșterul CONRAD din Brașov. Deasupra porții de intrare în biserică este gravat anul construirii ei: „*an dm · m · cccc · xxxx · viiii johannes de hunyad rgn. hungr. gubr.*", adică 1449. Este interesant faptul că cifra 9 nu a fost scrisă în conformitate cu metoda obișnuită de scădere 10-1, adică „IX", ci s-a folosit metoda adunării: 5, apoi 4 cifre de 1 scrise consecutiv, adică VIIII (Fig. 7).

Gornești (jud. Mureș). Clopotul bisericii reformate din Gornești provine din sec XV. Inscripția de pe clopot este: „*in nomi[n]e ih[es]u o[m]ne genv flectatur celestivm et in terestivm //infernoru[m] an[n]o do[min]i* ***m° cccc° l vi°***", adică 1456. Este anul în care papa CALIXTUS al III-lea a emis bula papală referitoare la trasul clopotelor la ora prânzului.

Vingard (jud. Alba). Biserica evanghelică din Vingard este construită în stil gotic târziu. Pe fațada vestică se află cioplit în piatră un blazon nobiliar al familiei regelui Ioan Zápolya (1487-1540), ultimul rege ai Ungariei medievale, în jurul căruia, pe o panglică cioplită este scris anul construirii bisericii (dreapta sus): „***m cccc lxi***", adică 1461.

Figure 8: Vingard (jud. Alba). Stema de pe biserica evanghelică - 1461.

Sighișoara (jud. Mureș). Biserica evanghelică din Sighișoara se află pe vârful unui deal, din acest motiv, este des numită „Biserica din deal". Înăuntru găsim expus vechiul clopot al acestei biserici, care a fost adus din turn. Pe acest clopot vedem inscripționat anul turnării în cifre romane: „***m cccc lxxxvi***", adică 1486 (Fig. 9).

Figure 9: Sighișoara (jud. Mureș), clopotul bisericii evanghelice „Din deal" - 1486.

Tomești (jud. Harghita). Biserica romano-catolică din Tomești a fost construită în 1725 în stil baroc, în locul unei biserici mai vechi. Cel mai vechi clopot al bisericii provine din 1495: „*Anno do[m]ini* ***m*** ° ✠ ***cccc lxxxx v yar***". Clopotul a fost turnat la Brașov, și este interesantă inscripția numărului „90", care a fost scrisă nu prin metoda scăderii (XC), ci prin adunare: după cifra 50 urmează patru de 10.

Este interesant că în multe locuri din Ardeal, chiar și după apariția cărților tipărite, care utilizau și răspândeau cifrele arabe, în multe locuri s-au folosit în continuare cifrele romane.

În Țara Românească și în Moldova cifrele romane încep să fie folosite pe scară largă mai târziu, din două motive: 1. aceste țări n-au căzut în zona de influență a Imperiului Roman, apoi a bisericii romano-catolice, deci a scrierii latine; 2. în aceste țări era deja în uz un alt sistem de numerație, cel chirilic[6]. Cifrele romane apar în primul rând în actele

[6] Acesta își avea originile în sistemul grec de scriere a cifrelor, și anume cu ajutorul literelor alfabetului.

și documentele care se referă la legăturile (comerciale, vamale, politice, etc.) acestor țări cu Transilvania.

Cifre indo-arabe

În timp ce în Europa se foloseau cifrele romane, în Asia s-a dezvoltat un cu totul alt sistem numeric, cu alte cifre. Cel mai devreme chinezii, apoi, în jurul anului 200 și hindușii au inventat un nou sistem numeric. Datorită viziunii lor asupra lumii, la hinduși apăreau de multe ori cifre foarte mari, care trebuiau și scrise cumva. De exemplu, potrivit hindușilor, lumea nu are câteva mii de ani vechime, așa cum se considera în sfera de cultură iudeo-creștină, ci mai multe miliarde, așa cum susține în prezent și știința (!). Erau la modă pe atunci și diferite concursuri de genul „Cine știe să scrie numere cât mai mari?".

Bhillamala (India). În jurul anului 300, hindușii au fuzionat cifrele Brahmi și sistemul de numerație pozițional, cu sistemul numeric zecimal[7]. Acest sistem s-a finalizat în secolele VI-VII. Matematicianul și astronomul indian BRAHMAGUPTA (598-668) le-a sintetizat în anul 628 în cartea sa, *Brāhmasphutasiddhānta*, care era de fapt un almanah de astronomie. Sistem de numerație pozițional a mai fost folosit înaintea lor și de către maiașii din America de Sud, dar acesta a avut baza 20, și de asemeni de babilonieni, unde baza de numerație era 60.

De exemplu, în cazul numărului 1867: 7 reprezintă ordinul unităților, 6 - ordinul zecilor, deci 60, 8 - ordinul sutelor, acesta însemnând 800, iar la final, cifra 1 reprezintă ordinul miilor, deci 1000. În total obținem: 1867. Cu alte cuvinte, fiecare cifră din număr poartă două informații: valoarea ei (ca și la cifrele romane), dar și poziția ei - asta a fost noutatea sistemului pozițional. Deci poziția din număr îi conferă cifrei respective o a doua valoare (asociată acelei poziții), și anume valorile din sistemul de numerație zece, date de exponenții lui zece (zece la puterea poziției unde este cifra): 10^0, 10^1, 10^2, 10^3, etc. Avantajul acestui sistem de numerație este că se pot scrie cu ușurință numere foarte mari, de asemenea și operațiile cu ele sunt mai ușor de efectuat.

Bagdad (Irak). Prin anii 770 matematicianul arab Muhammad AL-FAZARI (746 - 796? sau 806?) a tradus din limba hindusă în arabă cartea lui BRAHMAGUPTA (*Brāhmasphutasiddhānta*), în care erau folosite cifrele hinduse. Această traducere i-a familiarizat pe arabi cu sistemul hindus, care în jurul anului 800 au și preluat sietemul de numerație hindus. Prin anii 820, inspirat de aceste cărți hinduse de matematică, Muhammad ibn Musa AL-KHWARIZMI (780-847) matematician persan a adunat la un loc cunoștințele matematice de până atunci și a publicat faimoasa lui carte Al-Kit$\bar{a}$b al-mukhtaṣar f$\bar{i}$ ḥis$\bar{a}$b al-jabr wal-muq$\bar{a}$bala -gebr, manualul fundamental al algebrei de azi. În această carte apar pentru prima dată notate numerele necunoscute cu litere. Din cuvântul „al-jabr" a rezultat cuvântul „algebră" de azi. Ba mai mult, din pronunția numelui lui AL-KHWARIZMI, s-a format cuvântul „algoritm", care în prezent înseamnă o procedură de calcul.

Cifre indo-arabe vechi în Europa

Acest sistem de scriere a numerelor a ajuns în Europa prin mediere arabă, mai exact pe calea maurilor din Maroc și Spania, în secolele X-XI. Datorită acestei medieri arabe, noi le numim astăzi – în mod eronat – cifre arabe; corect ar fi cifre indo-arabe, căci la origini au fost hinduse.

După pustiirile migrațiilor Evului Mediu, la începutul mileniului al II-lea au început să se formeze orașele europene, care au reunit artizani și comercianți, s-au înființat

[7]Până atunci folosiseră sistemul numeric hexazecimal (cu baza 60) al babilonienilor.

universități. Producția, schimburile de mărfuri și noile forme ale economiei pe bază de bani, au condus vrând-nevrând la dezvoltarea matematicii. Cartea lui AL-KHWARIZMI a fost tradusă în latină.

Albelda (Spania). În colecția de texte *Codex Vigilianus*, scrisă de trei călugări (VIGILA, SERRACINO și GARCIA) în anul 976, apar pentru prima dată cifrele arabe în Europa.

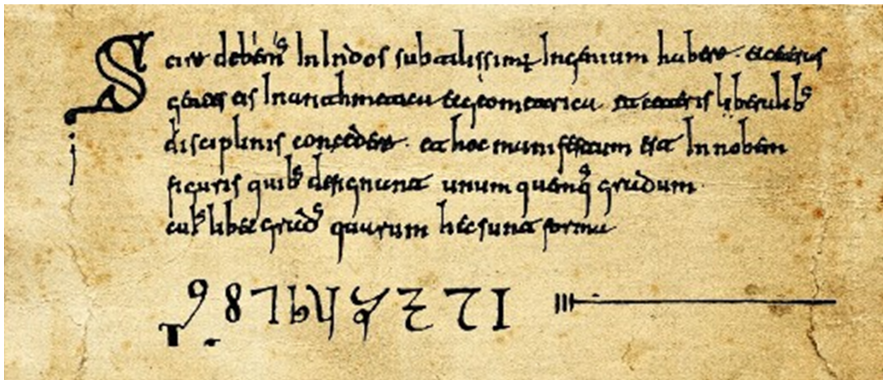


Figure 10: Fragment cu cifrele indo-arabe din *Codex Vigilianus* - 976.

Fès (Maroc) Primul promotor european al acestui sistem numeric indo-arab a fost călugărul benedictin francez GERBERT de Aurillac (946-1003), mai târziu, papa SILVESTRU al II-lea, care, pe vremea călugăriei, a studiat timp de 4 ani la universitatea marocană din orașul Fes, ce a aparținut civilizației arabe. Printre altele, a studiat acolo matematică și astronomie.

Figure 11: Ilustrație din *Chronicon pontificum et imperatorum* (pagina 428) - 1460.

Reims (Franța). După întoarcerea în Franța, mult cultivatul călugăr-matematician

GERBERT a încercat să popularizeze cifrele indo-arabe, începând cu anii 980. Între timp a construit un nou tip de abac (ce folosea nu cifre romane, ci tocmai pe cele indo-arabe, cu care calculele se puteau face mult mai rapid). Pe lângă mai multe articole despre matematică a scris și o carte de geometrie. În 999 devine papă sub numele de SILVESTRU al II-lea. Nu știm cât succes a avut efortul său de a populariza sistemul de numerație indo-arab, căci după ce moartea sa prematură i-a întrerupt domnia (1003), s-a răspândit despre pontiful matematician că ar fi colaborat cu diavolul (Fig.11), deoarece în ochii contemporanilor săi un om nu putea poseda atâtea cunoștințe precum dânsul, fără să fi fost ajutat de diavol.

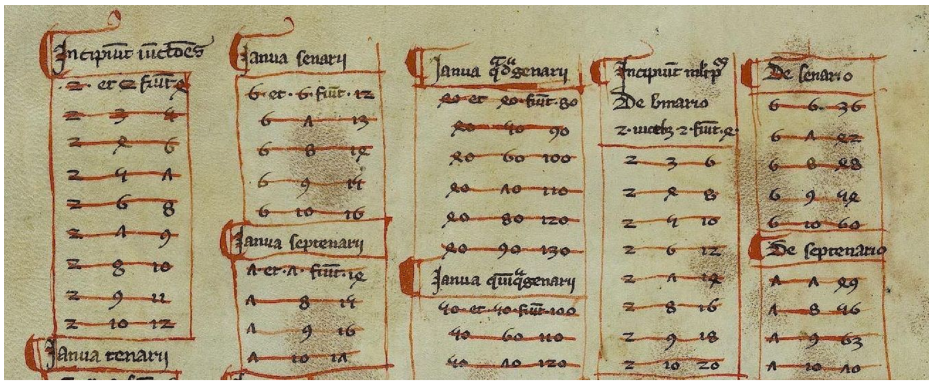


Figure 12: Pagina 12 din cartea Liber Abaci - copie din 1343.

Pisa (Italia). Ceva mai mult succes a avut un alt fiu al Europei, un matematician italian, dar crescut tot în cultura arabă. Și el a realizat imensul avantaj față de sistemul roman, atotputernic la vremea aceea, în care nu se puteau realiza operații matematice și nu se cunoștea cifra 0. LEONARDO da Pisa (1175 1250), mai cunoscut sub numele de FIBONACCI (adică fiul lui BONACCI), a crescut în Algeria ocupată de mauri (orașul Bugia/Bejaia), dat fiind că tatăl său a fost reprezentantul comercial al orașului Pisa în lumea arabă. FIBONACCI a învățat calculul indo-arab de la profesorii săi arabi. După ce în 1200 s-a întors în Italia, în orașul natal Pisa, a încercat să popularizeze metoda de calcul a arabilor, mult mai eficientă, cu care deja se puteau rezolva chiar şi ecuații.

Lucrarea sa cea mai cunoscută, *Liber Abaci* (Fig. 12) adică „Cartea despre abac", a apărut în 1202. În această carte, el folosește exclusiv cifrele indo-arabe, și prezintă avantajele calculului cu numere arabe, față de cel făcut cu abacul.

Paris (Franța). Cam tot pe atunci, un călugăr Augustin englez, Johannes de SACRO-BOSCO (sau, John of HOLLYWOOD) (1195-1256), a scos un manuscris cu titlul *Tractatus de arte numerandi* (∼1225), în care și el încerca să popularizeze cifrele și sistemul numeric indo-arab. Acest manuscris s-a răspândit prin copiere manuală la mănăstiri, chiar în mănăstiri din Ungaria. Începând din 1221, SACROBOSCO a predat astronomie și matematică la universitatea din Paris, printre altele și sistemul de numerație indo-arab. Carte lui de matematica a fost tipărită prima dată în 1488.

Toledo (Spania). În 1272 a apărut la Toledo *Tabelele Alfonsine*, care erau primele tabele astronomice concepute în Europa. Ele cuprindeau cele mai precise date ale vremii despre poziția Soarelui, a Lunii și a celor cinci planete cunoscute atunci, raportate la stelele fixe. Pozițiile erau exprimate cu cifre, în toată cartea fiind folosite cifre arabe (Fig. 13).

Pe vremea aceea nu existau tipografii, cărțile erau răspândite doar pe baza copierii manuale. Cu toate acestea, aceste cărți (și în special cartea lui FIBONACCI) au tulburat

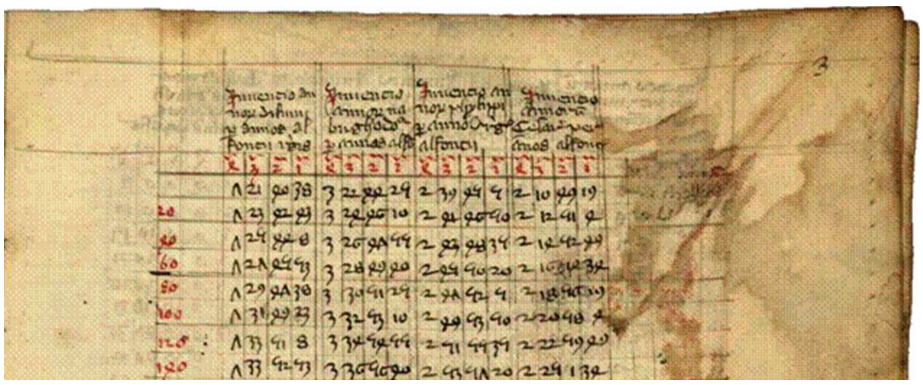


Figure 13: Prima pagină a traducerii în latina a *Tabelelor Alfonsine* - copie de prin 1320.

serios apele pe tot cuprinsul Europei. Unii s-au opus, alții au realizat că este mult mai ușor să operezi calcule în noul sistem numeric, astfel că l-au protejat și susținut. În mod ciudat, tocmai comercianții și perceptorii de taxe, adică cei cărora le-ar fi ușurat cel mai mult munca, au fost cei care s-au opus cel mai vehement introducerii cifrelor arabe în locul cifrelor romane. Motivul invocat a fost că registrele comerciale – scrise de mână pe vremea aceea – puteau fi mai ușor de falsificat, în cazul în care se scriu cu cifre arabe, căci era nevoie doar de adăugarea unui 0 la finalul unei cifre, astfel valoarea numărului devenea de 10 ori mai mare. În cazul cifrelor romane, așa ceva nu era posibil.

Florența (Italia). Conflictul dintre adepții celor două sisteme numerice a fost atât de intens, încât, de exemplu la Florența, centrul financiar al Europei, în 1299 a fost interzisă complet folosirea cifrelor arabe! Astfel, în pofida avantajelor practice evidente, timp de două secole, a ajuns în impas introducerea cifrelor arabe în Europa. Odată cu aceasta, a ajuns în impas și dezvoltarea științei.

Mainz (Germania). Inventarea tiparului în 1439 de aurarul german Johannes GUTENBERG (1400-1468) a fost ceea ce a pus din nou lucrurile în mișcare. Invenția lui GUTENBERG a permis multiplicarea manuscriselor. În topul produselor tipografice s-a aflat pe primul loc Biblia, urmată apoi de calendare. Pe locul trei s-au aflat cărțile de calcul ce explicau noul sistem de numerație și efectuarea calculelor. Tot mai mulți au făcut cunoștință cu cifrele indo-arabe și au descoperit avantajele acestora față de cifrele romane. Cărțile de calcul au soluționat o nevoie devenită deja arzătoare: cerințele progresului orașelor, breslelor artizanale și universităților, aflate în plină dezvoltare, după Renaștere și prima revoluție tehnologică.

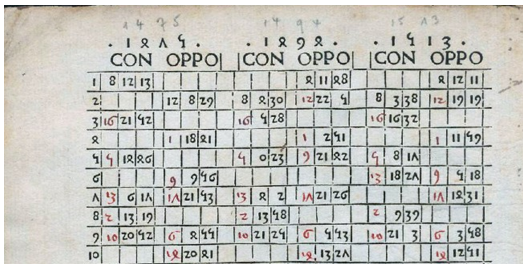


Figure 14: *Calendarium*, primul calendar tipărit - 1474.

Nürnberg (Germania). În 1474, matematicianul și astronomul german Johannes Müller VON KÖNIGSBERG (1436-1476), pe numele mai cunoacut REGIOMONTANUS, a publicat primul calendar tipărit, *Calendarium*. Aici deja a utilizat cifrele indo-arabe. După acest model, s-au realizat mai multe calendare. Având în vedere că după inventarea tiparului, la topul tipăriturilor calendarele au fost pe locul doi (după Biblie), ele au contribuit foarte mult la răspândirea noilor cifre în toată Europa.

Veneția (Italia). În 1483 se reeditează la Veneția *Tabelele Alfonsine*, de astă dată cu tiparul, ceea ce duce la accelerarea răspândirii cifrelor indo-arabe.

Freiburg (Germania). Astfel, în sec. XV, cifrele arabe au început încet să înlocuiască cifrele romane. Acest proces este reprezentat alegoric de zeița medievală Arithmetica din cartea *Margarita Philosophica* de Gregor REISCH (1467-1525), apărută la Freiburg în 1503. Pe desen se compară metoda de calcul a abacului, cu aceea a cifrelor arabe. Decorațiunile de pe veșmintele zeiței anticipează rezultatul comparației (Fig. 15).

Figure 15: Zeița „Arithmetica” din *Margarita Philosophica* (pag. 158) - 1503.

A fost așadar nevoie de 500 de ani, pentru ca Europa să accepte cifrele arabe cu sistemul de numerație zecimal, pozițional, în locul celor romane.

Cifre indo-arabe vechi în Transilvania

Acest proces de pătrundere a cifrelor indo-arabe poate fi recunoscut și urmărit de asemenea în Transilvania. Ele au început să intre aici în secolul al XV-lea, cam atunci când aceste cifre au început să se răspândească și prin toată Europa. Și aici, dezvoltarea meșteșugurilor și a comerțului a fost aceea care a decis schimbarea. Putem spune că în

general, relansarea vieții civile pornite după Renaștere a asigurat terenul propice, dar și necesitatea unui sistem de numerație mai eficient ca cel roman. Apariția universităților occidentale a atras mulți tineri ardeleni, care după încheierea studiilor la aceste universități s-au întors acasă și au predat noile metode de numărare învățate în Occident, ca profesori. La răspândirea acestor cifre au ajutat și cărțile aduse din Europa de Vest (căci nu au existat tipografii în Transilvania până în anul 1529).

În Transilvania, din cauza vicisitudinilor istoriei, războaielor dese, pustiirii și incendiilor, nu prea s-au păstrat documente din perioada arpadiană (sec. X-XIII); s-a distrus aproape tot ce a fost scris pe hârtie. S-au păstrat mai degrabă lucrurile mai greu de distrus, inscripțiile cioplite în piatră sau turnate în metal.

În Moldova și în Țara Românească cifrele arabe au pătruns mult mai târziu, deoarece acolo era deja în uz un alt sistem de numerație, cel chirilic. Cifrele arabe încep să apară în documentele românești scrise cu litere chirilice începând din mijlocul secolului al XVII-lea[8].

Cifre indo-arabe vechi combinate cu cifre romane

Cifrele arabe au fost folosite la început timid, intercalate cu cele romane.

Sibiu (jud. Sibiu). Cea mai veche astfel de scriere mixtă se găsește la Muzeul Brukenthal din Sibiu (manuscrisul 89 h), unde este trecut anul 1418: „*Finit[us] e[st] lib[er] i[st]e* ***mill***^{emo} ***cccc***^{mo} ***18***^{no}”, deci 1418. Tot aici găsim anul într-un alt manuscris, anul 1429, inscripționat similar: „Anno d[o]m[ini] Millesi[m]o cccc° 29°”.

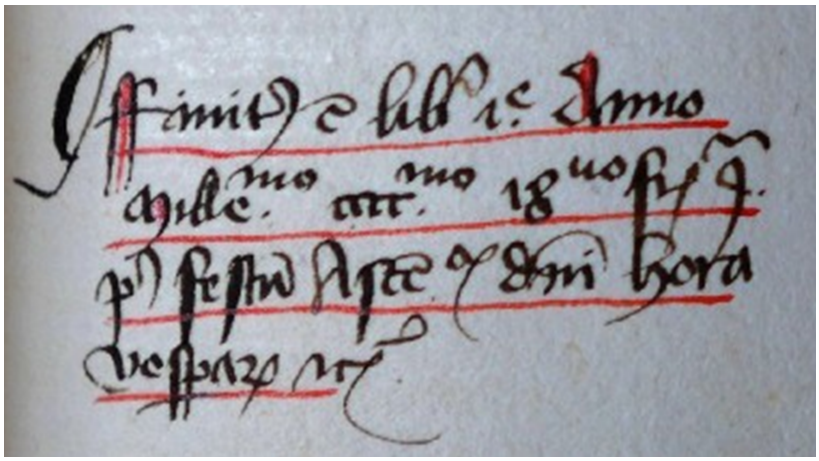


Figure 16: Fragment din manuscrisul 89h, *De quattuor instinctibus* - 1418.

Pe vremea aceea, încă nu se foloseau cifrele arabe actuale, căci în Europa nu exista un mod unitar de scriere al cifrelor. Forme mai vechi ale cifrelor arabe s-au folosit și în Ardeal.

Văleni (jud. Cluj). Poate una dintre cele mai vechi astfel de cifre, se găsește pe zidul bisericii reformate din Văleni. Biserica a fost la origine o clădire din perioada romanică. În sec. al XV-lea, sanctuarul în stil romanic a fost transformat într-un sanctuar gotic, cu arhitectură ogivală. Data acestei mari transformări este semnalată prin inscripția pe un contraforte: „***1 V II***”.

[8]Cel mai vechi găsit până în 1972 [TÓTH, 1972: 83] este un din anul 1642.

Figure 17: Văleni (jud. Cluj). Inscripția de pe contrafortul bisericii reformate - 1452.

Unii[9] o citesc drept „1407". În locul cifrei pentru o mie, se vede un „1" arab, apoi un 4 vechi arab (asemănător unui 8 trunchiat la bază), precum și cifrele romane „V" și „II". Din acest motiv este citit drept „7". Între aceste cifre este un semn despărțitor (un fel de cratimă, fig. 17), ceea ce sugerează că cifrele trebuiesc interpretate separat. Dat fiind că cifrele arabe „1" și „4" au și valoare poziționlă și înseamnă 1000, respectiv 400, rezultă ceva - care de altfel este unic -, faptul că și cifrei romane „V" i-a fost dată și o valoare poziționlă, însemnând nu numai 5, ci 50. Așadar, este vorba de 1000 + 400 + 50 + 2, adică 1452, și nu 1407. Dovada acestui lucru sunt alte documente referitoare la istoria bisericii, care atestă că în anul 1452 micuța capelă a fost extinsă în sanctuarul de azi cu contraforturi, de către familia VALKAI, astfel inscripția de pe contrafort imortalizează anul acestei extinderi.

Figure 18: Sâncraiu (jud. Cluj). Inscripția anului turnării clopotului bisericii reformate - 1481.

Sâncraiu (jud. Cluj). Clopotele bisericii reformate din Sâncraiu s-au topit la marea

[9][TOTH 1972: 77], [FILEP, BEREZNAI 1982: 119], [MAURER 2004: 92], [VARGA 2012: 230].

pustiire din 1848. În 1916, guvernul Ungariei a oferit un clopot vechi bisericii, dintre cele predate pentru a fi turnate în tunuri. În 1951 s-a crăpat și a fost turnat din nou, păstrând forma și decorațiunile vechi. Aici se poate vedea un ecuson de pelerin: silueta Sf. Maria cu Pruncul Isus în brațe, deci un fel de Pietà. Deasupra se deslușește minunat inscripția anului, făcută cu scriere mixtă: „*hoc ✝ opus ✝ f[ieri] f[ecit] a[d] h[onorem] s[ancti] n[icolai?] co[nfessoris] ✝ a[nno] d[omini]* ***m·cccc°·8·1***”, adică 1481.

Luna de Sus (jud. Cluj). Situația este asemănătoare și la Luna de Sus. Clopotul bisericii reformate nu mai există, a fost topit și turnat din nou în 1958. Dar inscripția a fost desenată de DEBRECENI László, încă în anii 1930. După cum vedem, o singură cifră arabă cu valoare poziționalăs-a strecurat printre cifrele romane: „*xpvs rex venit in pace devs homo factus est · a · d ·* ***m· cccc 8 ii***”, adică 1482.

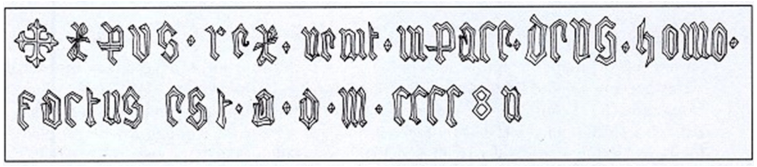


Figure 19: Luna de Sus (jud. Cluj). Desenul inscripției de pe clopotul bisericii reformate - 1482.

Figure 20: Movile (jud. Sibiu). Inscripția anului de pe clopotul bisericii evanghelice - 1482.

Movile (jud. Sibiu). Clopotul cel mic al bisericii evanghelice din Movile a fost turnat tot în 1482: „*s(an)cte • michael • ora • pro nobis • ad dominvm • anno • d(omini)* ***1 8 II***”. Aici primele trei cifre sunt scrise cu cifre arabe: 1, , 8.

Rupea (jud. Brașov). Rupea este un vechi oraș săsesc. Clopotul bisericii evanghelice a fost turnat în 1488 la Sibiu, iar pe acesta este inscripția: „*sancti spiritvs assit nobis gracia ano d[omi]ni* ***mi° cccc° 8° viii°***”, adică 1488.

Dipșa (jud. Bistrița-Năsăud). Este foarte interesant ceasul solar de la Dipșa. Biserica gotică, utilizată în prezent de ortodocși, a fost construită de sași, fiind finalizată în 1489. Probabil atunci a fost amplasat și cadranul solar, căci cifrele lui reflectă tocmai acea perioadă de tranziție. Pe cadran vedem orele, scrise cu cifrele arabe (fig. 21): 7, 8, 9, dar și cu cifre romane: X, XI (aceasta din urmă este greșită, a fost scrisă invers, ca IX). Urmează din nou cifrele arabe 12, 1 și 2 (sub forma literei „Z”), apoi din nou cifre romane, III și IIII: „Λ **8 9 X IX 1Z 1 Z III IIII**”.

Figure 21: Dipșa (jud. Bistrița-Năsăud). Cadranul solar de pe biserica evanghelică - 1489.

La cifra 4 romană nu s-a folosit metoda scăderii, „IV", ci s-a folosit mult mai simpla adunare: patru de „I", poate tocmai pentru ca pictorul să nu greșească, așa cum s-a întâmplat la cifra 11, sau poate ca omul simplu de la țară, să poată citi cu ușurință ora, să nu se încurce cu scăderea.

Sînmartin (jud. Harghita). Este deosebit de interesant clopotul de la biserica catolică din Sînmartin. Biserica a fost construită în 1814 în stil baroc, în locul unei biserici mai vechi, demolate în 1802. Clopotul vechi, turnat la Brașov, este din 1495. Anului turnării apare pe clopot în modul următor: „*Anno domi[ni]* ***1 cccc lxxxx v*** *gar*" , adică 1495. Interesant și unic este faptul că pe prima poziție nu apare Millesimo, nici M, ci aici apare cifra 1. Nu e clar dacă e unu arab (1) sau unu roman (I), dar este cert că are valoare poziționlă, căci în datarea turnării reprezintă 1000. Deci a apărut logica indo-arabă a scrierii numerelor, chiar și la unele scrise cu cifre romane.

Chilieni (jud. Covasna). Biserica din Chilieni a fost reconstruită și înălțată după cutremurul din 1473. Lucrările au fost finalizate în 1497. La intrarea în stil gotic a bisericii devenite ulterior unitarian, există o inscripție mixtă a anului renovării: „***m 9***Λ" (Fig.22). Aici găsim deja mai multe cifre arabe: o mie este reprezentat încă prin litera romană „m", dar „497" este deja scris cu cifre arabe, evident, fiind vorba de cifre arabe mai vechi. În unele locuri este interpretat drept „1427", a treia cifră este considerată „2". Totuși, aceasta este mai degrabă un „9" cu decorațiune, căci pe vremea aceea, cifra „2" nu era atât de rotunjită, semăna mai degrabă cu litera „Z". Este interesantă şi cifra veche „7", care seamănă cu un cort.

Figure 22: Chilieni (jud. Covasna). Detaliu de pe poarta de intrare al bisericii unitariene - 1489.

Ighiu (jud. Alba). Biserica barocă din Ighiu a fost construită în 1781. Clopotul

vechi a fost distrus în Primul Război Mondial. Anul turnării ei, „***M5Z3***", inscripționat cu cifre mixte, a supraviețuit doar în cărți („M"-ul este o mie roman, „Z" înseamnă 2): 1523.

Chinteni (jud. Cluj). Exact același an, scris în același mod „***M5Z3***", îl întâlnim și pe un alt clopot, la Chinteni. Clopotul a fost de fapt găsit la Feiurdeni, în anii 1890, îngropat în pământ. În 2010, a fost dus la Chinteni din motive de siguranță.

Cifre indo-arabe vechi

La începutul anilor 1500, cifrele romane au început să fie complet înlocuite cu cifrele arabe. În Transilvania, putem găsi deja ani care sunt scriși exclusiv cu cifre arabe. Dar acest proces începuse deja mai de mult.

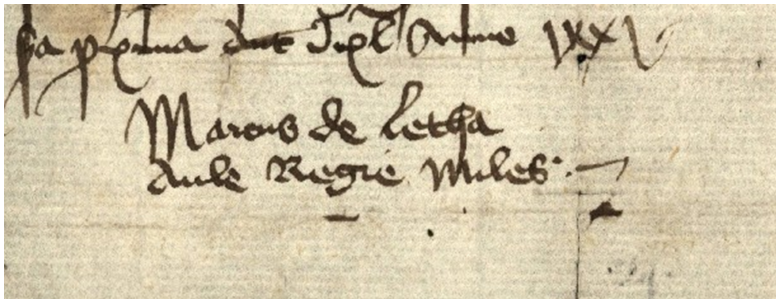


Figure 23: Brașov. Detaliu din scrisoarea din Măieruș - 1441.

Brașov (jud. Brașov). Cel mai vechi an scris exclusiv cu cifre arabe descoperit în Transilvania[10], este o scrisoare în limba latină din 1441, al unui ostaş al regelui, MARCUS de Letha, emisă la Monioros/Măieruș (jud. Brașov), adresată brașovenilor (scrisoarea este păstrată la Arhivele Naţionale din Brașov, colecția STENNER, Seria II, nr. 6). Anul menționat se vede la sfârșitul primului rând (Fig. 23).

Figure 24: Turda (jud. Cluj). Piatră zidită în peretele intrării la parohia catolică - 1452.

[10]TÓTH, 1972: 81.

Turda (jud. Cluj). În Turda, vizavi de Biserica Catolică, se află parohia catolică. O piatră foarte veche, ornamentată se află la poarta de intrare, pe care se vede inscripția: 1 Γ Z, adică 1452.

Cluj (jud. Cluj). În a doua jumătate a secolului al XV-lea, numerele romane au început să fie folosite din ce în ce mai rar în Transilvania. Existau două turnuri de poartă în Cluj, care au fost demolate cu ocazia extinderii orașului în secolul al XIX-lea. Unul a fost poarta străzii Mănăşturului, construită în 1476 de breasla cojocarilor și demolată în 1843, celălalt este bastionul porții de pe strada Podului, care a fost construit în 1477 de breasla lăcătușilor și a fost demolat în 1868. Dar înainte de asta, din fericire, au fost copiate inscripțiile de pe ele. Bastionul porții de pe strada Podului a fost fotografiat de VERESS Ferenc, un fotograf din Cluj, în anul 1865, astfel s-a păstrat imaginea. În Istoria Clujului, publicată de JAKAB Elek în anul 1870, pe bastionul podului se putea deslușI anul „—bf *1* ΛΛ", adică 1477, iar pe poarta străzii Mănăştur: „***1*** **Λ6**", adică 1476.

Tășnad (jud. Satu Mare). Cea mai veche și impresionantă clădire din Tășnad este Biserica Reformată. Biserica a fost construită în secolul al XIII-lea. Forma gotică actuală a căpătat-o în anul 1476. Acest an este înscris pe piatra de la talpa arcadei din sanctuarul bisericii (fig. 25), renovat recent: „***1*** Λ ***6***", adică 1476.

Figure 25: Tășnad (jud. Satu Mare). Piatră zidită în peretele bisericii reformate - 1476.

Șeica Mică (jud. Sibiu). Saşii au folosit în general cifrele romane pe clopote, dar și pe cristelnițe. Totuși, la Șeica Mică, în biserica construită în sec. al XIV-lea, se păstrează o cristelniță foarte veche, pe care anul este scris cu cifre arabe: „***1*** ΛΛ",. A fost turnată la Sibiu, în anul 1477.

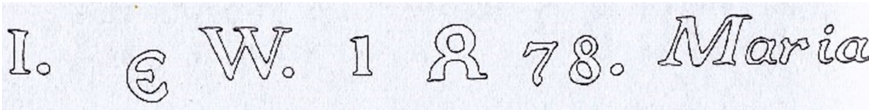


Figure 26: Oradea (jud. Bihor). Desenul inscripției de pe clopotul catedralei - 1478.

Oradea (jud. Bihor). Clopotul de la Catedrala din Oradea, care a fost turnat în anul 1478, nu mai există. Conform scriselor lui MISKOLCZY István din 1601, anul turnării de pe clopot era: „1 78", adică 1478 (Fig.26).

Cehețel (jud. Harghita) este un sat mic din Ținutul Sării, aflat la poalele Muntelui Firtoș. Clopotul bisericii unitariene a dispărut, doar desenul lui ORBÁN Balázs păstrează amintirea acestuia: „—bf *1* —bf *81*", adică 1481.

Cornești (jud. Mureș) este un sat de-a lungul pârâului Niraj. Clopotul bisericii reformate a fost turnat din nou în anul 1958, iar anul original este scris cu noile cifre arabe, folosite în zilele noastre. Conform desenului lui ORBÁN Balázs, care văzuse la vremea respectivă clopotul original, anul turnării, 1482, era scris cu vechile cifre arabe: „*o rex glorie veni cum pace* ***1 8Z***", adică 1482.

Figure 27: Cornești (jud. Mureș). Copia inscripției de pe clopotul bisericii reformate - 1482.

Figure 28: Sighișoara (jud. Mureș). Picturi pe peretele bisericii evanghelice - 1483, 1488.

În **Sighișoara** (jud. Mureș), pe biserica evanghelică din deal regăsim mai mulți ani scriși cu cifre arabe. Pe unul dintre aceștia îl găsim în textul explicativ al picturii de la intrare: „***1 88***", adică 1488. Acest număr surprinde anul finalizării construcțiilor.

Celălalt se află în partea din interior al cercevelei: „***1 83***”, adică 1483 (Fig. 28). Aceasta se referă la progresul lucrărilor de la începerea construcției, din anul 1480.

Porumbeni (jud. Mureș). Dar clopotul vechi al Bisericii Reformate din Porumbeni, care a fost turnat în 1487 la Sibiu, s-a păstrat, și se vede foarte bine anul turnării: „***1 8***Λ”, adică 1487.

Figure 29: Porumbeni (jud. Mureș). Anul turnării clopotului din biserica reformată - 1487.

În **Vișt**ea (jud. Cluj), biserica gotică nu are turn, însă are o clopotniță veche lângă biserică. Aici se află un clopot vechi, de asemenea, din 1487. Atât numărul ”4”, cât și ”7” sunt scrise cu cifre arabe vechi.

Dipșa (jud. Bistrița-Năsăud). Am mai vizitat satul Dipșa atunci când am observat cifrele mixte ale cadranului solar. Am spus atunci, construcția bisericii a fost finalizată în 1489. De unde știm sigur acest lucru? Anul este indicat pe partea superioară a unuia dintre piloni, scris exclusiv cu cifre arabe: „***1 8 9***” (Fig. 30).

Figure 30: Dipșa (jud. Bistrița-Năsăud). Anul de pe contrafortul bisericii evanghelice - 1489.

Coșeni (jud. Covasna). Merită să menționăm inscripția „*O REX GLORIE VENI CVM PACE* ***1 96***”, de pe clopotul Bisericii Reformate din Coșeni, deoarece în unele

lucrări este menționat ca datând din 1426[11].

Figure 31: Coșeni (jud. Covasna). Anul de pe clopotul bisericii reformate - 1496.

Într-adevăr, a treia cifră seamănă mai mult cu un „2" folosit azi. Dar acesta nu este de fapt un „2" , ci este un „9", care are o codiță ca ornament (Fig. 31, ca și „9" din figurile 21, 22, 30). Această cifră nu poate fi un doi, pentru că la momentul respectiv, cifra 2 nu era ca cel de azi, ci era sub forma literei „Z".

La **Gănești** (jud. Mureș), în biserica reformată există de asemenea, un clopot la fel de vechi: „***1 96***". Acesta a fost turnat la Sibiu, și a scăpat de retopire în timpul războiului: în 1918, fiind considerat o valoare istorică, la propunerea Comitetului Național al Monumentelor din Budapesta a fost returnat de la centrul de colectare Mediaș, înapoi la Gănești.

Crăciunel (jud. Harghita). Biserica romanică din satul Crăciunel a fost extinsă în 1496 și i s-a construit un turn. Anul extinderii este gravat în piatră deasupra intrării, cu cifrele arabe utilizate în acea perioadă: „***1 96***". Este interesant faptul că ORBÁN Balázs (care publică desenul anului în cartea sa), citește acest an ca 1495.

Sântana de Mureș (jud. Mureș). Există, de asemenea, un clopot foarte vechi în biserica reformată din Sântana de Mureș, care a fost turnat în 1497, cu inscripția: „*O rex · glo[r]ie · veni · cum · pace · ih[e]s[us] · n[azarenus] · r[ex] · i[udeorum] · i ·* ***1*** • • ***9*** • Λ •.". Între cifre regăsim și ornamentul folosit pentru delimitarea lor (Fig. 32).

Figure 32: Sântana de Mureș (jud. Mureș). Anul de pe clopotul bisericii reformate - 1497.

[11][KISGYÖRGY 2010: 31]

La *Racoș* (jud. Brașov), actuala biserică a fost construită în anul 1827. Nu se știe care a fost soarta clopotul ei vechi, poate că a fost topit în noul clopot în 1865. Însă ORBÁN Balázs l-a văzut, a surprins inscripția: „*ad honorem sancte margarethe virginis et martiris* ***1 98***", adică 1498.

În **Sânvăsii** (jud. Mureș) există o veche biserică unitariană. Aici, însă, s-a păstrat clopotul vechi, tot din 1498, anul fiind scris cu vechile cifre arabe: „*o rex glorie veni cum pace ihesus nazarenvs rex ivdeorvm* ***1 9 8***" (1498).

Figure 33: Viștea (jud. Cluj). Anul de la intersecția arcadelor bisericii reformate - 1498.

Viștea (jud. Cluj). La Viștea am mai văzut clopotul vechi, realizat în anul 1487. Anul reconstrucţei bisericii reformate gotice a fost înscris în piatră. La punctul de întâlnire al arcadelor sanctuarului gotic, în cheia de boltă regăsim clar cifrele anului 1498, scrise cu cifre arabe: „***1 98***".

În **Ungaria** (deci și **Transilvania** de atunci), chiar și pe cele mai vechi monede apărute după 1500, cifra 4 arabă e scrisă sub forma veche. De exemplu, pe dinarul emis în „***150*** " (1504), dar și pe cel din „***151*** " (1514, fig. 34). Mărite, micile monede de argint arată în mod clar anul emiterii.

Figure 34: Dinarii din anii 1504 și 1514.

La **Rugănești** (jud. Harghita), vechiul clopot al bisericii reformate nu mai există, a fost distrus în timpul Primului Război Mondial. Acesta a fost original turnat la Sibiu în

anul 1512. Cunoaştem azi inscripția datorită lui ORBÁN Balázs: „*sancta katerina ora pro nobis devm* ***151Z***". Pe clopot, „2"–ul vechi în forma literei „Z" a fost din greşeală scris invers.

Lopadea Nouă (jud. Alba). Clopotul Bisericii Reformate din Lopadea Nouă a fost turnat la Brașov în 1514. Aici putem vedea inscripția „*Sancta maria ora pro nobis p m* ***151*** ,", însemnând „Fecioară Maria, roagă-te pentru noi, 1514".

Figure 35: Desen ilustrând execuția lui Gheorghe DOJA - 1514.

Transilvania. 1514 este anul răscoalei conduse de Gheorghe Doja. Răscoala a fost înăbușită de armata condusă de Szapolyai, sau ZÁPOLYA János. Au fost păstrate mai multe desene înfățișând execuția crudă a lui Gheorghe DOJA, dintre care una conține și anul, scris cu litere arabe vechi: „***151*** ", adică 1514 (Fig. 35).

Cifre indo-arabe noi

Odată cu răspândirea tipografiei, a devenit necesară standardizarea cifrelor în Europa. De exemplu cifra 5 avea diferite forme, care uneori sunt și azi greu de descifrat (Fig. 24, 44, 47). Tipografii au preferat cifrele pe care Albrecht DÜRER le-a folosit pe picturile și gravurile lui. Acestea s-au răspândit, ele au devenit forma finală a cifrelor indo-arabe, acestea sunt cele folosite și astăzi.

Cifre indo-arabe noi în Europa

Nürnberg (Germania). Anul 1514 este o piatră de hotar în apariția noilor cifre arabe. Părinții pictorului renascentist Albrecht DÜRER (1471-1528) au plecat în Germania din satul Ajtós de lângă orașul Gyula din Ungaria. El s-a născut deja în Nürnberg. În 1514, Albrecht DÜRER a realizat gravura de cupru, intitulată *Melancholia*. Aceasta înfățișează

o femeie, probabil întruchiparea melancoliei, și în jurul ei putem vedea diverse obiecte simbolice, al căror sens nu este în mod clar descifrat nici astăzi. Deasupra capului femeii, vedem și un pătrat magic cu cifre, de la 1 la 16. Cifrele sunt poziționate astfel încât, citite pe orice direcție dreaptă, suma celor patru numere este 34. Mai mult decât atât, suma perechilor de numere simetrice faţă de centrul pătratului dă 17 în orice direcție. În mijloc, jos, putem vedea în două pătrățele datarea gravurii: 1514.

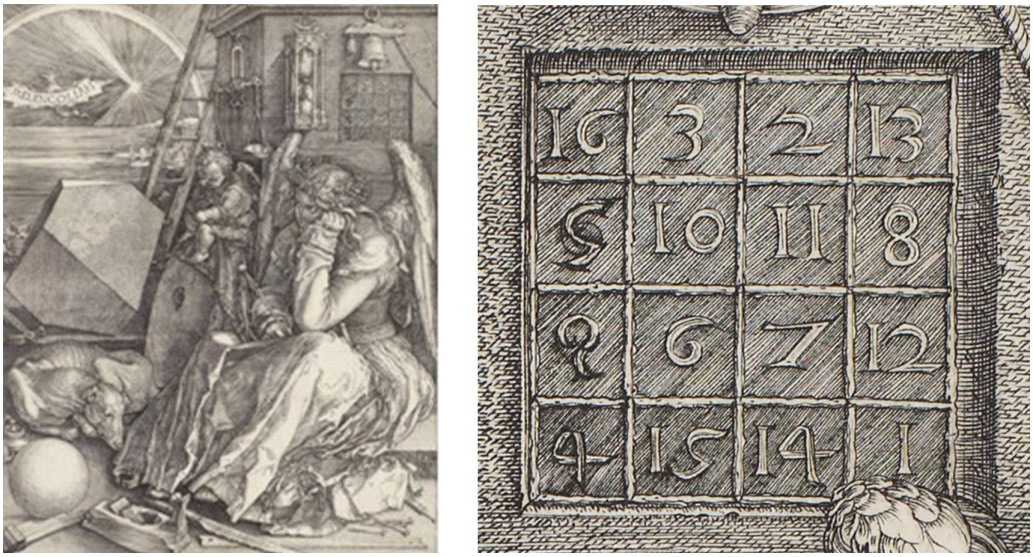


Figure 36: „*Melancholia*” lui Albrecht Dürer, și fragment - 1514.

Într-o lucrare anterioară a lui DÜRER realizată în 1504, gravura intitulată Adam și Eva, putem urmări modul în care artistul a modelat forma veche a cifrei arabe „ ” în forma pe care o folosim și astăzi „4”: el a înclinat ușor la stânga cifra veche și apoi a transformat bucla într-un triunghi.

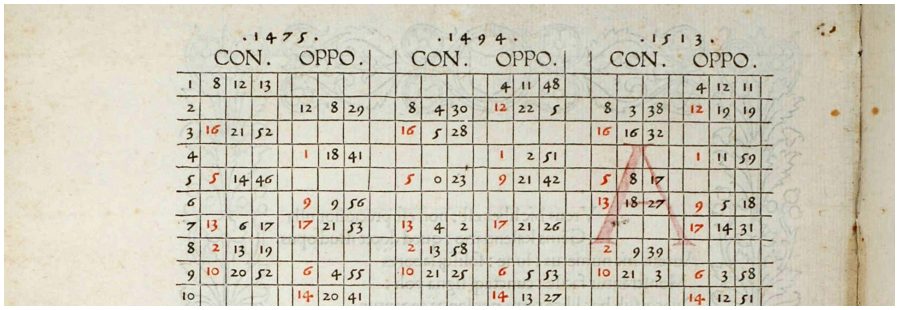


Figure 37: „*Calendarium*”, al doilea calendar al lui REGIOMONTANUS - 1475.

Nürnberg (Germania). DÜRER nu este singurul care a folosit cifrele arabe pe care le cunoaștem azi. Calendarul lui REGIOMONTANUS, realizat în 1474, e scris cu vechile cifre arabe (fig. 14). În anul următor, în 1475, se pot vedea cele mai noi cifre arabe, care sunt foarte asemănătoare cu cele de astăzi (fig. 37).

Figure 38: Guldinerul austriac - 1486.

Austria. În vestul Europei, guldinerul a fost realizat cu noile cifre arabe încă din anul 1486.

Cifre indo-arabe noi în Transilvania

Și în Transilvania s-a început trecerea la noile cifre arabe „standardizate". Dar ca și în Europa, această trecere s-a desfășurat în paralel cu vechile cifre arabe, care au fost înlăturate încet.

Figure 39: Movile (jud. Sibiu). Inscripția de pe clopotul bisericii evanghelice - 1496.

Movile (jud. Sibiu). Cel mai devreme regăsim noile cifre arabe în Transilvania la biserica evanghelică din Movile, aparținând de comuna Iacobeni. Ea a fost construită în secolul al XIII-lea, iar în sec. al XV-lea și-a căpătat forma finală. Pe clopot este inscripționat anul turnării: „*O rex · glorie · veni · cum · pace ·* ***1496***". Putem vedea că „4"-ul este deja scris precum astăzi (Fig. 39).

Turnul de clopot al acestei biserici ne mai arată cât de rapidă a fost trecerea dintre vechiul și actualul „4". La doar câțiva metri de clopotul prezentat anterior găsim un alt clopot, mai mic, pe care este scris anul „1 8 II", cu „4" vechi. Un alt lucru interesant este faptul că la acest clopot din urmă s-au folosit cifre diferite : „4" și „8" sunt numere arabe, însă „2"-ul este roman. Revenind la clopotul din 1496, acesta a fost probabil

turnat la Sibiu, asemeni clopotului din Gănești, la care însă găsim cifra „4” scrisă sub forma veche.

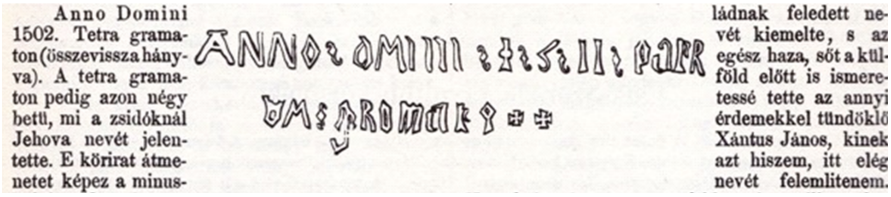

Anno Domini 1502. Tetra gramaton (összevissza hányva). A tetra gramaton pedig azon négy betű, mi a zsidóknál Jehova nevét jelentette. E körirat átmenetet képez a minus- ládnak feledett nevét kiemelte, s az egész haza, sőt a külföld előtt is ismeretessé tette az annyi érdemekkel tündöklő Xántus János, kinek azt hiszem, itt elég nevét felemlitenem.

Figure 40: Leliceni (jud. Harghita). Copia inscripției de pe clopotul bisericii catolice - 1511.

Leliceni (jud. Harghita). Clopotul vechi al Bisericii Catolice din Leliceni a fost turnat la Brașov. Anul turnării a fost scris cu noile cifre arabe chiar înainte de „Melancolia” lui DÜRER: 1511. Știm acest lucru din cartea lui ORBÁN Balázs, deoarece clopotul acela a dispărut (a fost turnat din nou în 1989).

Figure 41: Mănăstireni (jud. Cluj). Piatra zidită în peretele bisericii reformate - 1536.

Mănăstireni (jud. Cluj). În interiorul bisericii reformate din Mănăstireni se află o arcadă, în a cărei compoziție este inclusă și o piatră veche, pe care se află gravat anul „**1536**”, cu cifre arabe noi (fig. 41).

Ungaria / Transilvania. Și emiterea monedelor a contribuit la răspândirea cifrelor arabe. După pacea de la Oradea (1538), în 1540, regelui Ungariei Ioan ZAPOLYA i s-a născut un fiu, de la soția IZABELLA (prințesa Poloniei), fapt care a rezolvat problema independenței Transilvaniei. Cu această ocazie s-au emis monede de aur, pe o parte

Figure 42: Forintul de aur - 1540.

fiind Madonna și stema familiei ZAPOLYA (fig. 42, prima imagine, în centru jos), și cu inscripția „*Ioannes D[ei] G[ratia] - R[ex] Hungariae*", iar pe cealalaltă regele Sfântul LADISLAU în armură (protectorul Transilvaniei), precum și anul emiterii forintului de aur: „**1540**", cu cifre arabe noi. [HUSZÁR 1996: 12]

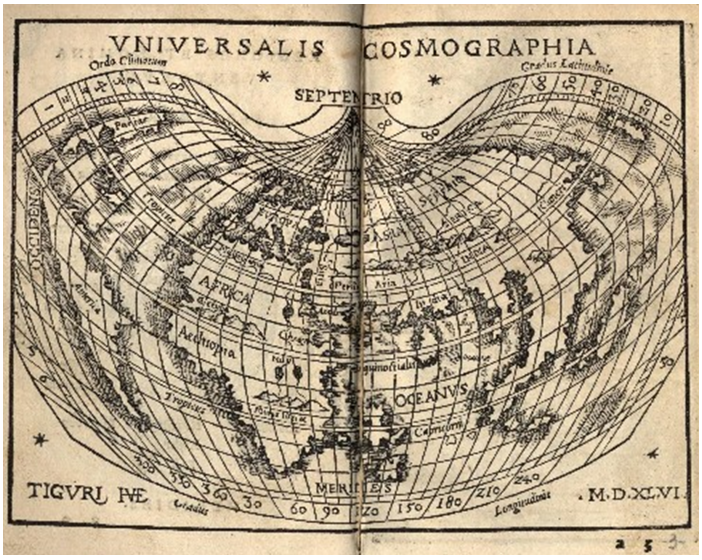


Figure 43: Brașov (jud. Brașov). Harta lumii din cartea Rudimenta Cosmographica - 1546.

Brașov. Johannes HONTERUS (1498-1549) reformatorul Brașovului a scris în 1530 o carte pentru școlari, *Rudimenta Cosmographica*. Cartea cuprinde o serie de cunoștințe elementare, printre altele și de geografice. Honterus a desenat mai multe hărți pentru această carte, devenind astfel unul din primii cartografi ai Transilvaniei. Pe harta lumii (fig. 43), începând cel puțin cu ediția din 1546, cifrele ce numerotează latitudinile și longitudinile sunt scrise cu cifre arabe noi. Dar observăm și faptul că cifrele romane au rămas la modă, ele fiind folosite pentru scrierea anului ediției respective (colțul dreapta jos).

Rămăşiţe de cifre indo-arabe vechi în Transilvania

Evident, tranziția la cifrele noi indo-arabe nu a fost bruscă, ci a avut loc în decursul mai multor decenii, aproape într-un secol. Astfel găsim cifre arabe vechi și după *Melancolia* lui DÜRER, deci după 1514, deși din ce în ce mai rar.

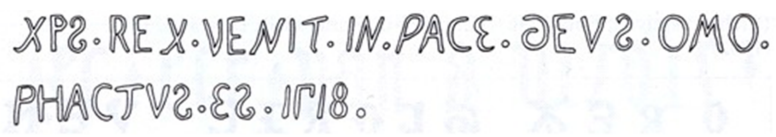


Figure 44: Slimnic (jud. Sibiu). Copia inscripției clopotului cetății - 1518.

Slimnic (jud. Sibiu) se află la marginea de nord a Pământului Crăiesc. Cetatea a fost construită în secolul al XIV-lea pentru a apăra drumul spre Sibiu. Și aici era un clopot vechi, turnat în 1518, dar a fost distrus în Primul Război Mondial. Nu știm unde a fost turnat clopotul.

Pelișor (jud. Sibiu). Similară este și inscripția anului de pe clopotul Bisericii Evanghelice din Pelișor. Biserica fără turn a fost construită în secolul al XV-lea, clopotul se afla în turnul de sud al zidului de protecție. Clopotul, cântărind 1,5 chintale, a fost confiscat în Primul Război Mondial, în 1918 și transportat la centrul de colectare din Mediaș pentru a fi topit și folosit ca ghiulea. Datorită vechimii sale, Comitetul Național al Monumentelor din Budapesta a recomandat scutirea clopotului, astfel și noi putem vedea inscripția cifrelor arabe: „*Ad honorem sancte michahelis archangeli* ***1Γ18***" (1518).

Avea 400 de ani când a scăpat de topire. Totuşi, nu-l putem vedea, deoarece nu se poate urca în turn din motive se siguranță. Dar există o fotografie mai veche despre clopot, pe care „5"-ul arab vechi este încă vizibil [BENKŐ 2002: 295].

Figure 45: Hărănglab (jud. Mureș). Clopotul bisericii unitariene - 1527.

Hărănglab (jud. Mureș). La Hărănglab, clopotul bisericii unitariene a fost turnat la Brașov și datează din: „***1ΓZ7***", adică 1527. Recunoaștem vechiul „5"-ul în formă de „Γ", precum și „2"-ul în formă de „Z", dar care a fost scris din greșeală invers (fig. 45, a doua imagine).

Onuca (jud. Mureș) este o localitate mică, nu departe de Reghin. Biserica medievală (azi reformată) a fost reconstruită în 1933. Clopotul vechi, turnat la Bisitrița, a scăpat de asemenea, de a fi topit în timpul războiului, și în 1918 a fost readus la biserică. Pe clopot este gravat doar anul turnării, scris cu cifre arabe vechi: „***1ΓZ9***", adică 1529.

Figure 46: Lăzarea (jud. Harghita). Inscripția pictată pe peretele de la intrare - 1532.

Lăzarea (jud. Harghita). Pe locul castelului de astăzi din Lăzarea, în zona centrală, unde este intrarea, a existat mai înainte o clădire cu etaj, construită în 1532. Când LÁZÁR István a construit castelul în 1631 în stil renascentist (patru turnuri la colțuri și zidul între ele), a încorporat această clădire veche. Pe peretele ei, la intrarea în castel se găsește anul contrucției acestei părți: „*Anno **153Z** Do[m]ini*", adică 1532 (fig. 46).

Figure 47: Teiuș (jud. Alba). Cadranele solare de pe contraforturi - 1535.

Teiuș (jud. Alba). Pe biserica catolică din Teiuș, construită de Iancu DE HUNEDOARA, se află două cadrane solare. Ele sunt încrustate pe doi piloni alăturați. Pe unul dintre ele (Fig. 47, stânga), vedem orele scrise cu cifre vechi arabe. Aici putem vedea vechiul „7" asemeni unui acoperiș. De asemenea, vedem și „3"-ul folosit și astăzi, un „4", și un „5" vechi. Pe celălalt pilon vedem și o datare, tot cu cifre arabe vechi. Acest număr ciudat se poate descifra foarte ușor, folosind cifrele primului cadran solar, deoarece acolo este foarte clar care cifră corespunde cărei ore: 1535.

Cireșoaia (jud. Bistrița Năsăud). Clopotul Bisericii Reformate din Cireșoaia a fost turnat la Bistrița, în 1534. Cele patru cifre înfășoară complet clopotul: „***1*** $\Gamma \sum$ ", adică

1, 5, 3 (care este scris invers), și apare vechiul 4, deci 1534.

Figure 48: Armășeni (jud. Harghita). Clopotul bisericii catolice - 1542.

La **Armășeni** (jud. Harghita) clopotul vechi din biserica catolică a fost turnat la Brașov, și are inscripșia: „*O REX • GLORIE • VENI • IN PACE • 1* · Γ · · Z". Acesta conține încă cifrele arabe vechi „5", „4" și „2" (care este întoarsă din greșeală, fig. 48), deci 1542.

Noșlac (jud. Alba). Din câte cunoaştem, ultimul an inscripționat, în care au fost folosite vechile cifre arabe, îl găsim pe un cadran solar. Cadranul solar, care se afla pe pilonul Bisericii Reformate din Noșlac, a dispărut deja, – deși ar putea fi încă sub tencuială. ORBÁN Balázs a văzut acest cadran solar la vremea respectivă și a și publicat în cartea sa desenul cadranului și al anului de datare aflat sub cadran (fig. 49).

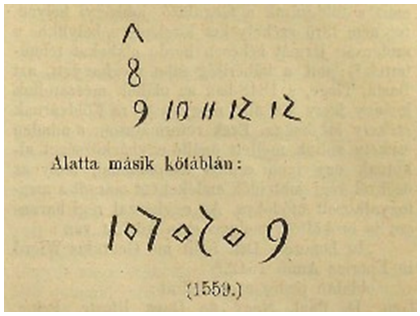


Figure 49: Noșlac (jud. Alba). Copia inscripției de pe contrafortul bisericii reformate - 1559.

În acei ani funcționau deja 3 tipografii în Ardeal: din 1529 la Sibiu, din 1538 în Brașov și din 1550 în Cluj. Astfel, nu numai produsele de tipografie europene au răspândit noile cifre arabe în Transilvania, ci și cărțile tipărite în Ardeal, deoarece tipografiile erau de obicei importate din străinătate, împreună cu literele și cifrele folosite acolo.

După cadranul de la Noșlac găsim foarte rar, ici și colo, câte o cifră arabă veche. Întâlnim cel mai des „2"-ul în formă de „Z", uneori chiar și cu secole mai târziu.

La **Cricău** (jud. Alba), pe turnul bisericii renovate recent putem observa anul „***157Z***", cu vechiul „2" în formă de „Z", deci 1572.

Figure 50: Târgu Secuiesc (jud. Covasna). Piua din muzeu cu anul datării - 1623.

Târgu Secuiesc (jud. Covasna). Printre exponatele Muzeului Colecțiilor din Târgu Secuiesc există o piuă realizată cu o jumătate de secol mai târziu. Pe ea este gravat anul datării: „16Z3". Pe poziția a treia vedem liter „Z", care este probabil „2", deci este anul 1623.

Figure 51: Ghelnița (jud. Covasna). Casetele pictate pe plafonul bisericii catolice - 1628.

Ghelnița (jud. Covasna). Pe plafonul casetat al bisericii catolice din Ghelința, pe una dintre casete observăm anul realizării acesteia: 1628, tot cu vechea cifră arabă, „2" în formă de „Z".

Biserica reformată din **Mănăstireni** (jud. Cluj), a fost inițial o biserică benedictiană cu două turnuri. Unul dintre turnurile s-a prăbușit și se presupune că anul gravat pe

Figure 52: Mănăstireni (jud. Cluj). Casetele pictate pe plafonul bisericii catolice - 1642.

colțul clădirii din acel loc surprinde anul prăbușirii: „164Z", adică 1642 (și nu 1647, așa cum este interpretat în unele locuri).

Transilvania. „2" în formă de „Z" îl găsim și pe monezi. Pe talerul emis la Baia Mare de principele transilvan RÁKÓCZY György al II-lea, se află anul emiterii: „*PAR REG HUN DOM ET SIC COM* ***165Z***", adică 1652 (fig. 53).

Figure 53: Talerul principelui RÁKÓCZY György al II-lea - 1652.

Începând cu talerul principelui APAFI Mihály din 1662, pe monezi s-a încetățenit cifra „2", nu mai găsim forma ei veche „Z". Dar numai pe monezi. Deoarece o mai găsim și în secolul următor, al XVIII-lea.

Chilieni (jud. Covasna). Avem exemple pentru vechiul „2" în formă de „Z" chiar din secolul al XVIII-lea. Deasupra intrării bisericii reformate din Chilieni putem vedea gravat anul „***17Z8***", care reprezintă 1728. Interesant este faptul că aici și „8"-ul este

Figure 54: Anul de la intrarea în biserica reformată din Chilieni - 1728.

asemeni vechiului „4”, însă inversat.

Turda (jud. Cluj). În încheiere prezentăm o altă curiozitate. Pe coridorul de intrare al salinei din Turda se poate vedea o expoziție interesantă a planurilor vechi ale minei. Pe una din ele, pe un proiect în limba germană, este un an scris în stil și mai vechi, cu cifre arabe amestecate cu cele romane: „***m854***”, unde „m” reprezintă 1000, deci anul este 1854.

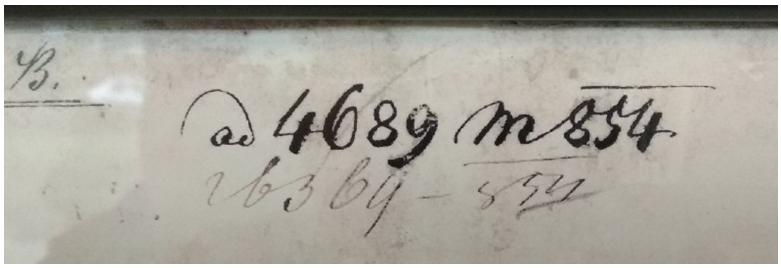


Figure 55: Anul de pe o hartă veche a salinei din Turda - 1854.

Concluzii

Toate aceste „rămășițe” de cifre arabe vechi au fost mai mult excepții, curiozități. În concluzie putem spune că în primele decenii ale anilor 1500, noile cifre arabe erau deja cunoscute și folosite peste tot în Transilvania.

După ce în Europa s-a statornicit sistemul de numeraţie zecimal-poziţional cu cifre indo-arabe, s-a deschis o mare oportunitate pentru matematică: s-au putut face calcule complicate. Iar asta a dus la apariția și dezvoltarea ştiinței, în sensul de azi al cuvântului, începând cu Galileo GALILEI (1564-1642).

În 2000, în pragul mileniului al III-lea, 100 de oameni de știință și profesori de renume mondial, inclusiv laureați al Premiului Nobel, au fost întrebați care sunt după părerea lor cele mai importante invenții ale omenirii din ultimele două milenii? Trei dintre aceștia (John D. BARROW, Keith DEVLIN, și V. S. RAMACHANDRAN) au numit sistemul

numeric indo-arab[12].

Putem să ne dăm seama și noi de acest lucru: nu există o zi în care să nu utilizăm cifrele indo-arabe. Cu toate acestea, cifrele romane nu au ieșit din uz, nu au dispărut total. Le mai putem găsi fie în ceea ce priveşte datarea (anul ediției unei cărți, uneori chiar numerotarea paginilor introducerii), fie în numerotarea lunilor, a rândurilor sau coloanelor, ori pentru a marca orele pe ceasuri. Asta a devenit deja o tradiție, poate modă, și nu o necesitate.

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[12][BROCKMAN, 2001: 37, 108, 94]

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La Fondation Berliet – Un modèle de centre de préservation de la mémoire technique et technologique

Monique CHAPELLE[1]

Abstract L'article présente l'histoire de la Fondation de l'Automobile Marius Berliet. Créée en 1982 par la famille Berliet et Renault Véhicules Industriels, la Fondation Berliet a pour objectif de sauvegarder et de valoriser l'histoire de l'automobile lyonnaise et du véhicule industriel français de toutes marques. Les étapes de mise en place de la collection de véhicules, des archives et du centre de documentation, ainsi que les activités menées depuis près de 40 ans, brièvement décrites, font de cette fondation un modèle de centre de préservation de la mémoire technique et technologique.

Mots clés: mémoire technique et technologique, Fondation Berliet, l'histoire de la préservation des camions, valorisation.

Rezumat: Articolul prezintă istoria Fundației de automobile Marius Berliet. Creată în 1982 de familia Berliet și de Renault Vehicles Industriels, Fundația Berliet își propune să protejeze și să valorifice istoria automobilelor din Lyon și a vehiculelor industriale franceze de toate mărcile. Etapele de constituire a colecţiei de vehicule, a arhivelor și a centrului de documentare, precum și activitățile desfășurate aproape 40 de ani,descrise pe scurt, fac din această fundație un model de centru pentru păstrarea memoriei tehnice și tehnologice.

Cuvinte cheie: memorie tehnică şi tehnologică, Fundaţia Berliet, istoria prezervării camioanelor, valorificare.

Introduction

≪*Rendre à la technique et à l'industrie la place qu'elles avaient perdue dansles esprits comme dans les faits*≫, c'est la motivation qui a conduit **Paul Berliet**, à l'aube des années 1980, à créer la Fondation de l'Automobile Marius Berliet. Pendant un quart de siècle à la tête de la S. A. Automobiles M. Berliet que les Pouvoirs Publics rattachèrent à la Régie Nationale des Usines Renault en 1975 et qui devint Renault Véhicules Industriels, il a mis en œuvre cette initiative après que la marque Berliet et Saviem ont été gommées par la RNUR et qu'il a dû surmonter de graves ennuis de santé.

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Reconnue d'utilité publique dès sa création en 1982 par la famille Berliet et Renault Véhicules Industriels, la Fondation Berliet a pour objet la sauvegarde et la valorisation de l'histoire de l'automobile lyonnaise et du véhicule industriel français toutes marques, «*la mémoire métallique et la mémoire immatérielle*» selon l'expression de Jean Favier, soit de produits manufacturés véhicules et organes ainsi que d'archives et de documentation. Cette alliance paraissait indispensable au fondateur pour permettre aux historiens académiques et autodidactes de comprendre non seulement le fonctionnement des matériels mais le contexte de l'activité des constructeurs.

Siège social à Lyon dans la maison Art Nouveau de Marius Berliet édifiée en 1911, inscrite à l'Inventaire Supplémentaire des Monuments Historiques en 1989, où est aussi installé le centre d'archives et de documentation tandis que la collection de véhicules est abritée dans la France profonde à 35 km au nord de Lyon dans des bâtiments de 7000 m2 construits entre 1982 et 2011, soit 30 ans.

Comment s'est constituée la Mémoire Métallique?

Multiple actions ont conduit à la formation de la mémoire technique Berliet:

- par l'apport dans la dotation initiale de 75 véhicules – pour l'essentiel des voitures et camions de marque Berliet et quelques matériels Renault et Saviem;
- par la recherche immédiate de produits de marques françaises de véhicules industriels disparues selon des critères historique, technique, d'usage: les premiers interlocuteurs contactés furent « casseurs » qui s'appellent maintenant négociants en métaux, les descendants des constructeurs, anciens concessionnaires, garagistes, transporteurs, corps de sapeurs-pompiers, en bref les professionnels de la chaîne du transport routier;
- par les contacts personnels lors de manifestations spécialisées et le bouche à oreille.

Le résultat fut un rendement très inégal. Pourtant, soit par acquisition et surtout par don, la collection compte, en 2020, 326 véhicules de 30 marques, l'important accroissement étant intervenu dans les années 1980 / 1990. L'effort a surtout porté sur les véhicules industriels car leur sauvegarde suscitait peu d'intérêt il y a 40 ans!

La quête d'organes – moteurs, boîtes de vitesses, carburateurs, pompes d'injection – n'était pas prioritaire; néanmoins, une collection de 140 moteurs à essence, diesel, électriques ou à vapeur d'une douzaine de marques, visualisé l'évolution technique.

Aux côtés de véhicules qui attendent 30 ans d'âge pour être labellisés véhicules de collection, d'autres plus anciens, selon leur état, connaîtront une restauration ou un destin de banque d'organes et sont en réserve. Le choix des matériels à restaurer repose sur des critères de marque, d'ancienneté, de financement et d'opportunité. Ainsi, la célébration du 70^{eme} anniversaire de la bataille de Verdun en 1986 en partenariat avec le Secrétariat d'Etat aux Anciens Combattants a été la raison essentielle de la restauration, aux côtés de CBA Berliet, de camions Barron-Vialle, Dewald, Latil, Peugeot, Renault, Saurer.

Opportunité aussi, la découverte en 1987, dans une casse en Corse, d'un châssis-mécanique portant sa plaque d'identité, type M 1910; le rapprochement de ses organes avec la documentation technique a permis de conclure au caractère authentique de cet ensemble complet; doté de sa carrosserie bois reconstruite à l'identique, il fut, en France, le premier camion classé Monument Historique en novembre 1988 «*en qualité de représentant de la première génération de camion*»

Quant aux travaux de restauration, deux professionnels expérimentés salariés, qui travaillent dans un espace mis à disposition par notre co-fondateur, pilotent les chantiers,

confient à des spécialistes extérieurs des tâches dont ils contrôlent la qualité, effectuent les opérations les plus délicates.

Et comment s'est constituée la Mémoire Immatérielle?

Il y a eu un effort continu pour former la mémoire immatérielle de la Fondation Berliet:

- des fonds d'archives polymorphes, quoique parcellaires à des degrés différents sur plusieurs centaines de constructeurs, représentant 800 mètres linéaires;
- une documentation concernant des fiches techniques, catalogues, manuels d'entretien, imprimés publicitaires, publications liés aux activités des constructeurs ainsi que des périodiques, soit 1200 mètres linéaires ;
- une bibliothèque d'ouvrages sur les techniques, sur les marques, sur la vie politique et économique, soit 6000 volumes du milieu du 19ème siècle à nos jours;
- une photothèque de 80000 unités et 730 supports d'images animées.

A part des pans d'archives d'Automobiles M. Berliet, parfois laborieusement sauvés de la destruction, les éléments d'archives d'autres marques ont été acquis au fil des années par achat, don et prêt pour reproduction.

La Fondation a commencé avecune archiviste-documentaliste en 1982, puis deux et actuellement trois. Elles traitent les fonds et classent la documentation. La numérisation a été introduite dans les années 1990; elle a d'abord concerné le bordereau du contenu de chaque boîte d'archives, la fiche de lecture des ouvrages et publications. Depuis peu, nous entreprenons la numérisation de chaque photographie.

Parallèlement, ces spécialistes répondent aux questions très diverses et d'ampleur variable extrêmement variée qui émanent d'amateurs et restaurateurs de véhicules, de chercheurs académiques et autodidactes, de journalistes, d'organisateurs d'expositions, etc.

Une cinquantaine de mémoires de maîtrise ont été réalisés dans plusieurs disciplines: histoire sociale, histoire de l'art, géographie, génie industriel, urbanisme et le plus récent en histoire de l'architecture.

La Mission de Valorisation

Notre Conservatoire de Véhicules, agréé Etablissement Recevant du Public (ERP) n'a pas le statut de musée; il est pourtant tout-à-fait possible à des groupes de le visiter sur demande 8 mois sur 12. Ils sont accueillis et accompagnés par des guides bénévoles, compétents et passionnés, souvent issus des secteurs de l'industrie et des transports. La typologie de ces groupes: des Clubs de Véhicules, des Entreprises de Transports, des Lycées Professionnels, des Associations de Patrimoine ou d'Histoire Régionale ou tout simplement des familles ou des groupes amicaux. En outre, une fois l'an – exception faite de 2020 – les membres des « Amis de la Fondation Berliet », association loi de 1901, créée en même temps que la Fondation Berliet, sont invités et chacun peut se faire accompagner de trois personnes. Mobilisation générale de tous les bénévoles pour accueillir, ce jour-là, deux milliers de visiteurs.

Pour aller au-devant de publics plus larges, nous participons à des salons de type professionnel tel que SOLUTRANS à Lyon ou spécialisé comme les classiques **RÉTROMOBILE** à Paris en février et **EPOQU'AUTO** à Lyon en novembre. Au-delà de l'objectif d'exposer un véhicule ou plusieurs comme à **EPOQU'AUTO**, de conter

son histoire et de le replacer dans son contexte au moyen de panneaux ou vidéos, nous nous efforçons d'accueillir chaque visiteur, de répondre à sa curiosité personnelle, voire de la provoquer.

Au Musée de la Grande Guerre du Pays de Meaux, au Musée des Confluences à Lyon, au Mémorial de Verdun, nous avons répondu favorablement à la demande de prêt de longue durée de véhicules-phares pour leurs présentations permanentes. Nous prêtons aussi des véhicules pour des manifestations professionnelles qui peuvent être de courte durée, mais nous sommes plus réservés à l'égard d'organisateurs d'événements où la considération portée au véhicule est purement anecdotique et où les conditions de sécurité ne sont pas leur priorité.

Au tournant du 21ème siècle, plusieurs documentaires, édités ensuite en CD, ont été réalisés sur plusieurs chaînes télévisées mêlant des interviews, des séquences du Conservatoire et des documents d'archives.

Aux côtés d'une *Lettre d'Information de la Fondation Berliet* diffusée tous les deux mois aux membres de l'Association et à des personnalités, des communiqués adressés aux médias réunis une fois l'an à **RÉTROMOBILE**, des entretiens personnalisés avec des journalistes européens au Conservatoire ou à la Villa, le site internet www.fondationberliet.org, plusieurs fois réactualisé, offre des vastes ressources sur la mémoire métallique et sur les fonds archivistique et documentaire. Sa fréquentation est en augmentation régulière et atteint quelque 8000 visites mensuelles. Nous constatons que les internautes sont plus friands des rubriques concernant les véhicules que celles relatives aux articles et documents!

Notre présence sur les réseaux sociaux, Facebook et Instagram, est plus récente et nous veillons à les alimenter régulièrement: au 26.01.20, Facebook abonnés: 11400 dont 10727 j'aime contre 10437 abonnés et 9896 j'aime au 21.09.20. Instagram: 1547 contre 1 441.

Dès l'origine, notre président-fondateur voulu jouer collectif pour apprendre de ceux qui étaient déjà sensibilisés au patrimoine industriel. Nous avons très vite rejoint des associations française et internationales: le CILAC (Comité d'Information et de Liaison pourl'Archéologie Industrielle), l'ICOHTEC (International Committee of the History of Technology), le TICCIH (The International Committee of Industrial Heritage), l'IATM (International Association of Transport and Communication Museums), la SAH (Society Automotive Historians). Les communications que nous avons pu faire à leur congrès périodiqueont élargi à l'international l'audience des conférences prononcées à l'échelon régional et national.

Conclusion

En conclusion, la Fondation Berliet peut être un modèle pour la mise en place de centres de préservation de la mémoire technique et technologique non seulement en France mais aussi dans dăutres pays, où existent des témoignages de progrès scientifique et technique et qui méritent d'être collectés, sélectionnés et muséifiés.

Quelques photos à la Fondation Berlier

Crédit photos: Fondation Marius Berliet / Lyon-France.

Figure 1: Conservatoire des véhicules anciens de la Fondation Marius Berliet - Hall 1.

Figure 2: Conservatoire des véhicules anciens de la Fondation Marius Berliet - Hall 5.

Figure 3: Fête des Amis au Conservatoire de la Fondation Marius Berliet - la foule des invités dans le Hall 1.

Figure 4: Exposé au Salon Rétromobile 2019 à Paris, le Berliet T100 n°2 de 1958 entouré de la foule des visiteurs.

Figure 5: *Lettre d'Information de la Fondation Berliet* - Couverture du numéro 1 de 2021.

REVIEW

Georges Chapouthier, *Sauver l'homme par l'animal: retrouver nos émotions animales*,

Paris, Odile Jacob, 2020. (Ana Bazac)

The title is already suggestive: if the present humans will regain their ancestral instincts and animal emotions they will improve their mood and attitudes towards the world. But is the book a simple plaid for considering animal emotions, seen somewhat differently from either the traditional picture of emotionless beings thus naturally considered with indifference – except the pets used as necessary company – or with the traditional prejudice of inherent and necessary cruelty?

Actually, the explicit scientific part of the book, describing the feelings of animals manifested as amazing behaviours, is the substantiation of an important philosophical interpretation. It is about the *continuity* and *discontinuity* or *similarity* and *difference* between man and animals and, on this basis, a meta look about the meanings of this unity for both man and the animal world; and even for the natural world, if this enlargement is not considered excessive. Indeed, the implicit purpose of the book is the imperious necessity to change the entire attitude of humans towards nature in its entirety.

As the book underscored, its premises are not new. The topics of ethology are well-deciphered, and the history of ideas about animals is a definite part of the history of ideas as such. However, the book changes the methodological view: the, say, well-known facts are considered, and in a new way.

A first aspect of this methodological turn concerns the problem of superiority of humans towards the animal[1] kingdom. Chapouthier mentioned that from Darwin on there is a difference between the *biological success of access to life/success of survival and, on the other hand, the morally construed success of access to life*. The first is the same at all the existent living species, i.e., it depends on the natural relationships between species and their organic and inorganic environment. The second certainly depends on the intellectual ability of man, of his *sapientia*: but not only on that.

Accordingly, the second aspect condenses the many proofs of immorality, cruelty and savagery of man towards animals – and, in the background, towards nature – in order to rather give proofs of both the fact that "animals have souls", if we can use the motif of "souls of animals" ardently debated in the old Christian texts, and that it is possible and necessary to change the attitude of man towards animals.

The passionate pleading of the book for the existence of incredible emotions in animals – and thus, of their intelligence, if intelligence assures firstly the biological success of life – must not make us to forget that man's ability of superior intelligence is not tantamount to his morality. Although man was called *animal morabile* – having capacity for moral,

[1]The examples given in the book do not concern only vertebrate animals, and the logic of the book – the attitudes of humans towards animals – uses a general meaning, that is an animal "is a multicellular living being that in order to feed itself consumes other living beings as plants or other animals", Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, p. 17.

meaning that he "is called to be moral" and "must develop one's moral capacity"[2] – we already know that this moral ability is not only the result of intelligence but also of the historical social conditions of man's milieu. The ideas about animals and the attitudes towards them (and towards nature, do not forget) were always forged according to the social relationships in society and between society and the non-human environment. In this respect, we may well assume that the historical cruelty towards animals – and, as general irrationality, towards nature – revealed the inter-human cruelty. Or, conversely – as the book insists – the human civilisations in their history can be evaluated according to their attitude towards animals. This "correspondence" was and is historical (meaning historically and socially determined) but it reflected and reflects also the level of knowledge about animals and nature. And the level of knowledge also involves the level of morals. From this standpoint, can we not transfer the Kantian *categorical imperative* for humans[3] in the attitude of people towards animals and nature? Obviously, the animals and nature are not persons having the conscience of their ends, but they can be treated as if their existence and intertwining, giving the necessary equilibrium of life – so, of the planet's environment – would be conscious ends in themselves.

Clearer: the animals and nature are, obviously, means for the existence of humans; as the other persons are for an individual. But Kant explained that, apart from the characteristic – or function – of *means* for others, the humans always must be treated *also* as *ends in themselves*. Because every human life is unique and unrepeatable – it is saint, if we can use this metaphor – and thus the value of every human life is equal with the value of any other human life. This equality does not send to a simple golden rule of reciprocity – treat others as you would like others to treat you[4] – but to the care for the *contents* of every and all human lives: if every human life must be considered also as an end in itself, then it is not indifferent which conditions as social relations people do create for beautiful contents of life, such contents so that each individual can manifest his/her creativity. If so, then animals and nature can be treated: 1) not only without cruelty but also preventing their harms, because they constitute irreplaceable *means* for the human existence. And 2) this function of being means must be considered not so much/only in the sense of particular usefulness but also/at the same time as global significance of their whole existence and balance. This whole existence and balance constitute "ends in themselves". They must be defended so as not to vanish: and with them, the human ends in themselves, too.

This ethical standpoint can be understood without any demonstration of biological continuity and discontinuity of animals and humans. But the biological demonstration is necessary in order to emphasise the biological ground of both the human and animal development.

Therefore, the book starts with the review of some models of human attitudes towards animals. These models concern the lack of empathy towards the suffering of animals and the absolute reduction of animals to means for humans (the scientific Greek tradition, the Jewish tradition, the animal-object (or machine) in the modern scientific tradition, the continuity of this tradition in the Western civilisation) but also the compassionate treatment of animals in Hinduism, Buddhism and Jainism. Today, "the only scientific

[2]Otfried Höffe, *Can Virtue Make Us Happy?: The Art of Living and Morality*, p. 41.

[3]We must insist that the categorical imperative – being part of meta-ethics/ meta-deontology – is not abstract, it does not transcend the concrete conditions but substantiate them: in any conditions, humans must not treat the others only as means; but how to do this, it is the task of conditioned /hypothetical imperative (which must never violate the categorical imperative); thus, the two types of imperative are not equal, and the hypothetical imperative must never be the only ethical principle. If this happens, the moral is reduced to the order given by any selfish interest.

[4]See Ana Bazac, The Enlightenment Epistemology and its Warning against the Instrumentalisation of Science, *Noema*.

standpoint is to transfer the Cartesian identity between the body of the animal and the body of man to all the evolutionary processes, as Darwin did, and to the psychical processes, as the neurosciences do". Because on this basis there is no longer difference of nature between animals and man, that would substantiate the treatment of animals only as objects[5].

The second chapter emphasises the "continuity", or more correctly, the precedence of animal intelligence that substantiates the similarities between man and animals. With a comprising recent bibliography about the intelligence and emotions ability of animals, the book shows an entire animal *culture* of intelligence and emotions. The author selected from the defining traits of the concept of culture, the *behavioural features transmitted through imitation and learning, horizontally and vertically, but apart from genetic heredity*[6]. The animal culture was demonstrated at vertebrates – as use of tools, communication, language, moral norms and aesthetic choices. At the level of invertebrates, intra-generational learning was well demonstrated.

All of these rose – again and inevitably – the big problem of the consciousness of animals. But the consciousness itself is a unity of two facets:

- that of *access* to the external world, answering appropriately to the environment[7]; here, the consciousness is an efficient intra-somatic tool allowing the living being to understand the world in order to respond to it in the least wasteful manner and in the form of the most adequate *actions*; consciousness cannot be separated from actions; it is a means to acting, as the actions are steps and means of the consciousness; but the access is not immediately perceived by the subject (animal or man)[8];

- that of *self-consciousness*.

Before discussing the latter, let's mention that there is also an intermediary kind of consciousness, the *phenomenal* one, consisting in the feelings experienced in the process of access to the world. It is – as the book shows, but without naming it as an intermediary kind of consciousness – a development of *nociception*[9], ability to recognise the exterior threats.

Philosophically, since every living being has *conatus*, the will to self-preservation, then every living being has a more or less developed ability to recognise the exterior threats. This feature is common to all living beings. What begins to differentiate them is the adding of *emotions* (as *pain*) and *perception of the nociception* (as *suffering*)[10].

There are many experiments about the emotions[11] of vertebrates and cephalopod

[5]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, p. 34.

[6]Ibidem, p. 38. See also the amazing Heather N. Cornell, John M. Marzluff and Shannon Pecoraro, Social learning spreads knowledge about dangerous humans among American crows; also A. M. P. von Bayern, S. Danel, A. M. I. Auersperg, B. Mioduszewska & A. Kacelnik, Compound tool construction by New Caledonian crows; and the fascinating Barbara C. Klump, John M. Martin et al., Innovation and geographic spread of a complex foraging culture in urban parrot.

[7]An important manifestation of the access consciousness is the numerical ability (recognition of numbers / detection of number change and estimation of quantities bigger than 3.

See Sarah Benson-Amram, Virginia K. Heinen, Sean L. Dryer, Kay E. Holekamp, Numerical assessment and individual call discrimination by wild spotted hyaenas, Crocuta crocuta; Jennifer Vonk, Michael J. Beran, Bears 'count' too: quantity estimation and comparison in black bears, Ursus americanus; Maria Bortot et al., Honeybees use absolute rather than relative numerosity in number discrimination; Martin Giurfa, An Insect's Sense of Number.

[8]Thomas Natsoulas, The Sciousness Hypothesis. I.

[9]From Lat. *noceo –ere* etc., to harm; *inceptio –onis*, beginning.

[10]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, p. 71.

[11]Darwin's 1872 book – *The Expression of the Emotions in Man and Animals* – was a forerunner. As well as *The Descent of Man and Selection in Relation to Sex*, 1874; see also Mark Bekoff, Animal Emo-

molluscs[12]. These experiments are doubled with the specification of the brain structures controlling the emotions[13] and the proof that they are common to all the vertebrates (including man). Anyway, the researchers have discovered that the experiments must take into account the different sense organs as channels of transmission of the external stimuli and that the degree of access and phenomenal consciousness depend also on the different sense organs of animals, so that it is not legitimate to consider them only through the lens of one model[14]. Regarding the cephalopods, there are changes in colour etc. of their body in front of different stimuli, but there are only suppositions about emotions.

What is important from a methodological standpoint is that the intertwining and interdependence of all kinds of consciousness are demonstrated not only in man but also in animals[15]. The *phenomenal* consciousness of the feelings experienced by animals would only help the access consciousness, in fact, they are intertwined. While the *learning* process of animals[16] – from other members of the species, but also in their relation with their environment – shows that the *meta* look on the access to the world is a way of developing the self consciousness. But it is, obviously, a manner of access conscience or of deepening of the knowledge about the world[17].

And although this phrase sounds anthropomorphic, we know that this knowledge is both unconscious, instinctual – which means the transposition and fixation of epigenetic and behavioural information[18] within the genetic one – and present: at individual level and, if it is the case, at the level of animal / animal communities. Both the access consciousness – once more, related to conatus – and the phenomenal consciousness have unconscious parts[19] and, at any rate, in primates, even conscious parts. And we should think more carefully if the experiment of recognition in mirror[20] can already attest self-consciousness or only a step to it, since the mirror and the perceived image in it is only an aspect of the milieu, requiring reactions. The papers of Thomas Natsoulas[21] related to the human consciousness's many orders (revealed by theories about consciousness) or "stream of consciousness" (William James, 1910) – the *preconscious*, the *unconscious* psychical processes (both not having intentionality)[22], *perceptual and reflective direct*

tions: Exploring Passionate Natures: Current interdisciplinary research provides compelling evidence that many animals experience such emotions as joy, fear, love, despair, and grief—we are not alone. The tendency to reduce the criteria to a type of experiment with animals in order to prove their degree of consciousness is similar to the reduction of criteria of human intelligence to the IQ experiment.

[12]See also Peter Godfrey-Smith, *Other Minds: The Octopus, the Sea, and the Deep Origins of Consciousness.*

[13]John M. Marzluff, Robert Miyaoka, Satoshi Minoshima, and Donna J. Cross, *Brain imaging reveals neuronal circuitry underlying the crow's perception of human faces.*

[14]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, pp. 67, 87.

[15]See a methodological premise – that of measurement of physiology in free-living animals in order to quantify the emotional arousal – Claudia A.F. Wascher, Heart rate as a measure of emotional arousal in evolutionary biology; before, Claudia A.F. Wascher, Isabella B.R. Scheiber, and Kurt Kotrschal, Heart rate modulation in bystanding geese watching social and non-social events.

[16]Georges Chapouthier, *Sauver l'homme par l'animal: Retrouver nos émotions animales*, p. 86. We insert here the high ability of learning in artificial environments controlled by man (in circus and research); see Annika Stefanie Reinhold, Juan Ignacio Sanguinetti et al., Behavioral and neural correlates of hide-and-seek in rats; Candace C. Croney and Sarah T. Boysen, Acquisition of a Joystick-Operated Video Task by Pigs (Sus scrofa).

[17]See Jennifer Ackerman, *The Genius of Birds*

[18]As schemes of action or, larger, steps to answering to stimuli.

[19]Shundong Bi, Romain Amiot, Claire Peyre de Fabrègues et al., An oviraptorid preserved atop an embryo-beating egg clutch sheds light on the reproductive biology of non-avialan theropod dinosaurs, *Science Bulletin*, showing an extremely old instinctive parental care (the dinosaur was found sitting on eggs in a nest) during incubation; but this concrete instinct is inevitably followed by parental care after incubation: and this allowed transmission of learned behaviour, which allowed greater flexibility and adaptability to environment.

[20]Joshua M. Plotnik, Frans B. M. de Waal, and Diana Reiss, Self-recognition in an Asian elephant.

[21]See only Consciousness, *American Psychologist*; *States of Consciousness: The Pulses of Experience.*

[22]For a philosophical analysis of intentionality, based on recent neuroscience research, see Ana Bazac,

consciousness/ direct awareness of something, (theory of the inner consciousness (inner eye, perception like account), *awareness of the subject's own acts and affections*[23] */ the recognition of the mental instances* (that is different from or includes the consciousness of the self); so, the "double consciousness" according to situations and including both the consciousness of personal unity between the self and his/her mental states, and the awareness of these mental stats in front of the milieu – help us to understand the animal consciousness.

In this framework, the behaviour criterion to emphasise emotions shows also strong similarity between the mental pathologies of man and animals. Anxiety and depression are the common reactions of animals to threats and they are proved by experiments, showing both the loss of pleasure and the resignation manifested in human depressions. Also: the neurosis (of which the humans are relatively aware) and psychosis (of which they are not), alcoholism and substitutive actions in case of frustration[24]. In all of these situations, acute, recurrent, and chronic stressors and trauma on animals were emphasised[25]. In all of these situations, cognitive biases were demonstrated when the previous experience of animals was either happy/balanced or unpleasant: as in the actions of optimistic or pessimistic humans on the basis of their previous situations[26].

Further, the individual personality or variability of animals is common to them and humans[27]. But also, the transition from emotions – as individual feelings related only to the individual – to empathy[28], ability to feel the emotions of others[29]. The book discusses the positive emphatic feeling, altruism[30]. Why that? Because: its intention is to show the pre-human origin of positive feelings as a basis of human development as such. This development was and is not only / not so much the result of cruel struggle for existence, but of mutual aid and cooperation, found also at animals. And since realism requires to avoiding both extreme conceptions of "man is good by nature" and "man is evil by nature", the same realism implies the rejection of the cliché of "man is as stupid and bad as animals". Indeed, this is neither true for animals nor for man[31].

The intentionality of the consciousness: from phenomenology to neurosciences and back. The attitude of Evanghelos Moutsopoulos towards the phenomenology of the consciousnes, also in Romanian, as a postface to the translation into Romanian of E. Moutsopoulos, *La conscience intentionnée*.

[23]For example, as feeling that the subject knows, see Asher Koriat, The Feeling of Knowing: Some Metatheoretical Implications for Consciousness and Control. And yes, if we consider the stressors of animals, why do we not mention between them the ignorance of the milieu – that is not the familiar one – and the ignorance of appropriate reactions in this new milieu?

[24]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, pp.73-83.

[25]Hope Ferdowsian, Debra Merskin, Parallels in Sources of Trauma, Pain, Distress, and Suffering in Humans and Nonhuman Animals.

[26]Keith M. Kendrick, Ana P. da Costa, Andrea E. Leigh et al., Sheep donț forget a face; I. Veissier, A. Boissy, L. Désiré, L. Greiveldinger, Animals'emotions: studies in sheep using appraisal theories; Christian Nawroth, Mirjam Ebersbach, Eberhard von Borell, Are juvenile domestic pigs (Sus scrofa domestica) sensitive to the attentive states of humans?–The impact of impulsivity on choice behaviour; Véronique Deiss, Frédéric Lévy, Ludovic Calandreau, et. al., Chronic stress induces pessimistic-like judgment and learning deficits in sheep; Franziska Knolle, Rita P. Goncalves, and A. Jennifer Morton,"Sheep recognize familiar and unfamiliar human faces from two-dimensional images; Piglets vocally indicate preference for their piglet friends over human conspecifics, *phys.org*, December 10, 2020.

[27]Georges Chapouthier, *Sauver l'homme par l'animal: Retrouver nos émotions animales*, pp. 88-92.

[28]*Ibidem*, pp. 95-99.

[29]See only Marco Iacoboni, Istvan Molnár-Szakács, Vittorio Gallese et al. Grasping the intentions of others with one's own mirror neuron system; Martin Schmelz, Josep Call, Michael Tomasello. Chimpanzees know that others make inferences; Frans B.M. de Waal, Pier Francesco Ferrari. Towards a bottom-up perspective on animal and human cognition; Maxim I. Stamenov, Vittorio Gallese. (Eds.) *Mirror Neurons and the Evolution of Brain and Language*.

[30]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, pp. 99-101. See also Elliott Sober, David Sloan Wilson, *Unto others: the evolution and psychology of unselfish behavior*.

[31]See also Samuel Anthony Barnett, *Biology and Freedom: An Essay on the Implications of Human Ethology*.

The mirror function of molecules and cells in the brain has developed at social animals / in the process of social interactions of animals[32]. It was necessary for better grasping the intentions of other animals and they transposed into emotions, both individual and transposed from other animals[33] as *emotional contagion*. The emotional contagion is a primitive form of empathy and, in its turn, influences the social relations between animals. The emotional contagion is preceded by /includes the communication of experience of pain through vocal and facial expressions, but also through neurological basis[34]. This neurological basis, including the mirror function, as well as the hormonal basis, supported not only empathy but also self-recognition as an element of self-awareness: and not only in primates, but also in phylogenetically distant taxa[35].

Therefore, the emotions of animals are not their simple anthropomorfisation, but, as in humans, are – and they developed as – ways of cognition: in order to better accessing the world[36]. Without emotions, the meanings of the world and of the access to it are absolutely insufficiently grasped[37]. The reduction and deviation of performance in knowledge and behaviour was demonstrated at lambs separated from mother sheep[38].

The strong interdependence of intelligence and sociality[39], common to animals and man, is based on the same evolutionary architecture, in mosaic, framed by the principles of juxtaposition of similar elements and *integration* of structures resulted from juxtaposition into larger structures. This architecture of living beings, forged in relation with the environment, led to functional abilities of even the simples structures (as viruses) or living organisms[40]. But the mosaic architecture is all the more clear in social insects, in cephalopod molluscs and in vertebrates. The animal intelligence in social insects is group intelligence and does not develop as consciousness[41]. In vertebrates – and, as we know it for now, in cephalopod molluscs – intelligence develops as culture, as individual consciousness, with memory and emotional feelings[42].

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The differences appear in humans, as superior (vertebrate) animals. They prove their animal ancestry in the anatomical rule (demonstrated till in the intrauterine life) of

[32]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, p. 100.

[33]See not only the geese measured in 2008 (note 14), but also Maki Katayama et al., Emotional Contagion From Humans to Dogs Is Facilitated by Duration of Ownership. (Here, the heart rate variability was measured, too).

[34]Caroline M. Hostetler, Mary M. Heinricher, and Andrey E. Ryabinin, Pain is more than a physical process – now a study in mice suggests it may even be socially transferable.

[35]Paolo Baragli, Chiara Scopa, Veronica Maglieri and Elisabetta Palagi, If horses had toes: demonstrating mirror self recognition at group level in *Equus caballus*.

[36]We may speculate about the development of emotions when the instinctive ability to mislead predators or prey is not successful.

[37]Rick Anthony Furtak, Emotional Knowing: the Role of Embodied Feelings in Affective Cognition.

[38]Fabio Napolitano, Giuseppe De Rosa, Agostino Sevi, Welfare implications of artificial rearing and early weaning in sheep

[39]See an unexpected proof, Christopher M. Jernigan, Natalie C. Zaba, Michael J. Sheehan, "Age and social experience induced plasticity across brain regions of the paper wasp *Polistes fuscatus*

[40]Mirna Kramar and Karen Alim, Encoding memory in tube diameter hierarchy of living flow network, *PNAS*, showing that the slime molds' organisms changed (evolved) in order to encode past food locations, so information about food locations. The mold has no nervous system, but the information is stored by the morphology of the entire organism when a part is in contact with food and secretes a substance enlarging some tubes which "remember"; the mold moves alongside these "memory tubes", and not alongside the narrower tubes not storing information about food.

[41]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, p. 121.

[42]See the mosaic architecture of culture, Georges Chapouthier, ≪Le mosaïc des traits culturels≫. Also, Alexandra K. Schnell, Nicola S. Clayton, Roger T. Hanlon, and Christelle Jozet-Alves, Episodic-like memory is preserved with age in cuttlefish.

ontogeny repeating phylogeny; but this rule does not apply to behaviours[43], since these ones reflect qualitatively new experience and meanings of the environment, and reactions.

Anyway, man is "a very intelligent ape", distinguishing from his cousins by a powerful brain – able to *externalise his memory* and thus thousand times increase his performance[44] – and a youthful appearance. This youthful appearance, neoteny, is always accompanied by the youthful activity *par excellence*, play. And play is that which characterises the two pets closest to humans, the dog and the cat. By the way and interesting to show the similarity animals – humans, there are also animals which "domesticate" other animals[45].

But, despite his intelligence that transforms his entire environment, man is a "moral disaster"[46]. Concerning the fact that the animal is a "victim of man", there are five main domains raising the problem of man – animal relations: the treatment of pets, breeding of so-called "cash" domestic animals, slaughter and meet consumption, treatment of wild animals, biomedical experimenting on living animals and the "cruel games" where man mistreats the animals for simple amusement[47]. How can all the abominable attitudes – so, not only towards animals – coexist with the good ones? The book reviews the main causes of this coexistence, always insisting on the biological basis of the construction of man. Thus, there are *reality disguise* concerning the actions of man, beautifying them, even transforming them into valuable moral actions or, certainly ignoring them, silencing them. Also, there are reality disguise of the treatment of animals. All of these forms of disguise, transferring imagination into ideologies strongly influencing the behaviours, cause them to lag behind at an unimaginable wild, uncivilised level.

What are the solutions? Obviously mentioning the social relations and education, as well as the moral theories, the book emphasises the role of affective and empathy formation of humans: not in a vague meaning, but as *emotional intelligence* controlled by reason or ability of mind to control its emotions[48]. The biological basis is the complex of right and left hemispheres of the brain, which are complementary to each other but, the author considers, they are absolutely asymmetrically promoted by the Western education: the right hemisphere, developing emotions and sensitivity in a holistic and synthetic manner, is neglected in favour of the left hemisphere's analytical sharpness fit for the present technophile society.

Actually, at first the author "biologises" a problem generated by non-biological, but social, political choices. The old formula of Rabelais, *science sans conscience c'est la ruine de l'âme*, as well as J. J. Rousseau's paper winning an award in 1750, about the high level of science but the low level of morals, were invented when education still was marked by the right hemisphere's abilities. Therefore, just the values transmitted by culture, in order to being imprinted (Lorenz), generate the capacity of humans as symbolic animals to transpose the direct empathy to abstract kinship, beyond genetic relationship[49].

But then, it is clearly shown that one could not infer from the idea of a better ecolog-

[43] Gerhard Medicus, The Inapplicability of the Biogenetic Rule to Behavioral Development.

[44] Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, p. 125. Bernard Stiegler spoke about *exosomatisation*, creation by the human species, through science and technology, of a "second" *soma* for each member of the species: an exosomatisation / "exosomatic organogenesis", Bernard Stiegler, *The Neganthropocene*, Edited, translated and with an introduction by Daniel Ross, London, Open Humanities Press, 2018, p. 117 (borrowing the concept from Alfred Lotka, "The Law of Evolution as a Maximal Principle", *Human Biology*, 17, 1945, pp. 167–94 – "exosomatic evolution").

[45] Georges Chapouthier, *Sauver l'homme par l'animal: Retrouver nos émotions animales*, pp. 131-133.

[46] *Ibidem*, p.138.

[47] *Ibidem*, pp. 141-151.

[48] *Ibidem*, p. 164.

[49] Ladislav Kováč, Biopedagogy.

ical situation through a return to nature / natural balances, the idea that by returning to animality man would have a better moral situation. Because: the animal level of being must not be idealised; the similarity between animal closed groups and the closed traditional villages, where the interests of groups can clash with the interests of larger human communities, and the empathy of individuals within the same species/group, but involving at the same time a bitter struggle for life between species/groups[50], demonstrate a dialectic of contradictory features[51], that gives the point of the book: *the possible empathy between animals* as a model for humans is rather a *metaphor* of a direction of its evolution[52].

This metaphor is fruitful: just the emotions make the difference between man and its special cognitive devices, the robots[53]. And we can add that, besides intelligence, just the emotions make the difference between man and animals: the symbolic characteristic of the human animal manifests as depth and infinite meanings of emotions, never tantamount to the emotions of animals. It was said that "humans are mythophilic animals, driven by a need to find a complete explanation for events in terms of intentions and purposes"[54]. Just the quest for explanation generated – and neurology certifies – the symbolic world of values giving extraordinary meanings to emotions.

Well, the metaphor ends as a sketch of moral based not only on reasons, but also on emotions and, especially, on empathy[55]. These two slopes of moral balance each other, and allow both the reasonable control of emotions and the control of abstract thinking by the affective norms[56]. Concretely, by recognising the animal side of humans, they can change their behaviour towards animals.

Georges Chapouthier is an old and long lasting promoter of this rigorous sciemtific and humanist perspective on animals and man. Methodologically, he assumed the holistic and dialectic view about evolution, refusing the reductionism that haunted biology but also the human ontology[57].

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The book has a practical last part related to the respects towards animals, the face to face positing of rights of man and rights of animals and the declaration of the rights of animals. We do not insist on them. But we end this review by drawing attention on three important practical aspects highlighting the fertility of the perspective provided by this approach.

[50]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, pp. 171-176.

[51]Struggle for life inter-species/ inter groups *and* empathy within the species/group but generating /related to group closure.

[52]Let's not forget the primitive humans instinct of partaining to the same species, that stopped the fatal aggression (Konrad Lorenz, On Aggression (1963), Translated by Marjorie Kerr Wilson, With a foreword by Julian Huxley, London and New York, Routledge, (1966/2002) 2005, p. 208). That instinct, continuing the animal instinct, was related to the fact that the individuals looked each other directly in the eye, without being removed from the weapons that separated the fighters.

[53]Georges Chapouthier, *Sauver l'homme par l'animal : Retrouver nos émotions animales*, pp. 177-182.

[54]Ladislav Kováč, Darwin and Dostoyevsky: Twins.

[55]By insisting on empathy, the author assumes his appurtenance to an ancient and valuable range of researchers questioning the human moral. Between them, Schopenhauer considered compassion/lack of compassion as the main philosophical concept explaining the contradictory and malign behaviours of man. See Ana Bazac, Arthur Schopenhauer's mirror: the will, the suffering, the compassion as philosophical challenges.

[56]Georges Chapouthier, *Sauver l'homme par l'animal: Retrouver nos émotions animales*, p. 183.

[57]Other three refusals of reductionism/ simplicity, in: John Maynard Smith and Eörs Szathmáry, *The Major Transitions in Evolution*; Ladislav Kovàč, Unended knightstournaments; Eva Jablonka, Marion J. Lamb, *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life*.

One is that of the image people have about "the soul". As it was grasped even indirectly from this book, the soul is the consciousness of the *self*[58] , involving both the consciousness of the environment as always related to the *self*, and the awareness of one's own existence and thoughts. This awareness is an absolute subjective, inner experience, accessible by the individual trough introspection and communicable through the symbolism of non-verbal and verbal languages. Beyond *qualia* – the elementary subjective peculiarities of the individual perceptions – the awareness of the self can be objectified, including by the inner language used by humans. Phylogenetically, this second versant of consciousness evolved from the first only in man. Only in man the two versants of the consciousness are interdependent. But if so, we can understand that a main feature of the human consciousness is *responsibility*. Animals have no responsibility; they have only instincts and ability to grasp the environment, including the emotions of other animals. The humans have responsibility or rather the ability to view the world, including the emotions of other fellows, through the lens of values related to the meanings of their actions and thoughts and of the world as such. The values and meanings are constructed by humans, and their contents are the key of their responsibility.

The other aspect is that of "surrogacy arrangement or surrogacy agreement", transforming the women carrying of a pregnancy for others into bodies without emotions. The maternal feelings are the oldest and deepest feelings, transposed even at the genetic level of living beings; but the absurd value of "right to have children on account of the annulment of the right of others" absolutely ignores the maternal feelings and the psyche of the women hired to carry pregnancy. The payment for this service would annul all the torments, would it? This example better shows the meanings and generosity of the book's point to "return to our old animal emotions". One of the most important common features of animals and man is *adaptability*. This main trait was shown by evolution, and its surprises never end[59] and are discovered at both animals and plants. But to what values should man "adapt" in order to survive and to survive humanly?

The last aspect here is that of scientific possibilities for a radical transformation of man-animal relations (and man-nature relations). Science is that which provides the fuel for all the urges to respecting animals, to animal and food ethics etc. *And nowadays this fuel is given.* It is possible to make food from air – and it's not about genetically modified food – with the same flavour as the better meat[60]. It is possible to make good and natural food for everyone on the Earth by a non-industrial, natural farming[61]. This does not mean to return to primitive agriculture consuming the creative power of farmers by toiling the whole day for subsistence. But this means to change the concrete values of subsistence[62], and self-esteem and power[63] of man. It is, again, a question of substituting the narrow, selfish *telos* of having with the *telos* of *being*: human. Or: a question of substituting life as such – the reduction of the human life to simple survival, or to the access consciousness – with the *human meanings* of life[64], beyond the simple biological survival, with the life *per se/für sich*: this substitution is the real victory of

[58]The *self* is here the unique subjective centre of power, unifying and organising the subjective experience of the individual. It is because the individual is *aware of it*, and the individual is aware of it because the powers of consciousness were gradually organized into a single center of power (we certainly do not elaborate about the triune model of Freud).

[59]Huw J. Griffiths, Paul Anker, Katrin Linse et al., Breaking All the Rules: The First Recorded Hard Substrate Sessile Benthic Community Far Beneath an Antarctic Ice Shelf.

[60]Solar Foods, *Breaking Free from the Vicious Circle of Protein Production.*

Solar Foods receives world's most prestigious design award, 06/09/2019.

[61]Vandana Shiva et al., *The Future of Food: Farming with Nature, Cultivating the Future*; Adrian Muller et al., Strategies for feeding the world more sustainably with organic agriculture.

[62]Janet Ranganathan et al., *Shifting Diets for a Sustainable Food Future.*

[63]Gyorgy Scrinis, Ultra-processed foods and the corporate capture of nutrition.

[64]See the beautiful Giorgio Agamben, *The Open: Man and Animal* (2002). It is worth to read it.

the consciousness of the (human) self.

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A Methodological Remark Starting from Stephen Budiansky's *Journey to the Edge of Reason: The Life of Kurt Gödel*,

New York, W. W. Norton & Company, 2021. (Ana Bazac)

A popular book about a scientist is always interesting, for it concerns remarkable deeds which improved the human knowledge and thus, the telos, the reason-to-be of the human being and its civilisation. Accordingly, the life as such of the scientist, narrated by the popular book, is of absolutely secondary relevance since it does not explain the logic and uniqueness of the scientific construction. As already it is well-known, once created, a work has its own "life", i.e., its own internal causes and significances. And since it's about a scientist, just the life of his creation deserves to be displayed.

The honest, exact and beautiful documentary[1] of the life of Kurt Gödel, made by Stephen Budiansky, is nevertheless part of the tradition of books about the "romanticised life of...", even in the form of non-fictional literature. But a scientist is not "Queen X". To mix n details of the life of the scientist with some elements of his exploits is not useful for the average reader: neither from the standpoint of a deeper understanding of the social and psychological context of the activity of the scientist and nor from the viewpoint of this activity as such, or rather of the results of this activity. By speaking about "the life of...", the writer transmits not only his analytical / critical cleverness but also various ideological values; consciously or directly pursued by the writer, but also showing through from the described tableaux as such. And although a strong tradition in the conceiving of the popular books is to create a fashion (or even a "market") for the explicit and implicit ideological messages they promote, the profound reason of the popular books which flourished as a consequence of the Enlightenment movement in the Europe and America undergoing modernisation was just the propagation of knowledge by making it accessible to the general public. In this regard, the good popular books do not lower /reduce the quality of knowledge they "vulgarise", they only make it accessible: and this requires a big technical expertise of writers.

The impressive documentation and ability to select the most significant aspects of the life of Kurt Gödel gives, however, a feeling of "incompleteness" and at the same time, of a "summary" of many issues that the reader would have liked to deepen.

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Every life is unique and has historical relevance, even if it is "happy". We overthrow Hegel's well-known opinion in his Lectures on the Philosophy of History. Every life

[1] With an impressive bibliography.

is plenty meaningful for us; we can grasp significances of every action / non-action, behaviour and their general structuring.

Every life is interesting; or it is not: for the understanding of the work. Kurt Gödel grew up as a curious child in a loving middle class family, he likened to learn, obtained his doctor in philosophy degree with a thesis in mathematics, had friends, a girlfriend he married; but also became psychologically ill – with paranoid delusions and psychosis, anxiety, obsessive compulsive disorders, phobias and schizophrenic manifestations. In a specialised popularising book, Pierre Cassou-Noguès, Les Démons de Gödel: Logique et folie, Paris, Seuil, 2007 proposed certain conjectures concerning the "unity" of Gödel's logic, philosophy and "madness": as a psychical background for his logic and philosophy. However, Gödel's logic was developed – in his young years – independently of his philosophical perplexities and influences and especially independently of his not yet serious health and psychical problems: because it concerned a special realm, mathematics, always realised in formal frameworks. Accordingly, we may conclude that the psychology (and even the ideology) of a certain author is not important when it is about scientific creations and works: because we know that there were different and opposed psychologies (and ideologies) of exceptional scientists working in the same period in the same domain. A psychological research of the hero, without discussing his scientific works but only labelling/classifying them according to the scientific opinions, is then a better outcome. And the description of the role of the imaginary in the work of scientists is already a specialised popularising book.

Stephen Budiansky is a historian, and thus he gave beautiful pages about the Gödel family's history and – something which is completely or partially missing from the other books about Gödel's life – the social contexts[2]. But even these could have been separate works, arousing the readers' interest precisely for the special problems treated in them. Or, in its current form, all of these aspects are truncated.

Gödel had reactions towards social ideologies and policies – like religion, racial discrimination, authoritarianism – and not only towards individual relationships.

And because the social ideologies and policies were too complicated, too far away from the logic of reason and too unknown, Gödel chose to be restrained from problems outside his field, he indubitably having democratic views. On the one hand, he assumed that all of these extra field problems did not have a priori legitimating, but they needed a thorough scientific investigation. On the other hand, what could he do but be silent, since he did not see – and he was not trained to see – logical solutions to complex social problems and since the offers of "specialized" interpretations of so many philosophers, sociologists and political scientists did not answer these problems than through unilateral criticism and never logically carried to the end?

During his stay in Europe, the dominant human model was that of the disciplined middle class and bureaucracy (see Heinrich Mann, Der Untertan, 1912/1918) towards which the liberal democrats seemed nec plus ultra. But even the close mathematician friends in the Vienna Circle, no matter how democrats and pacifists (and Gödel shared these views) were confused: because they lived in the triumphant era of capitalist economic modernisation and development – a kind of passive revolution, if we are allowed to use Gramsci's formula – and because they mixed theoretical liberal and utopian images

[2]I can'n stop mentioning that – unlike the other books about the "life" – Budiansky's book has described not only Vienna's and the Austro-Hungarian Empire's civilisation and cultural splendour seen from the perspective of the well-off middle class, but also its coexistence with its reverse in the conditions of life of the working class. See Stephen Budiansky, *Journey to the Edge of Reason*, pp. 39, 75, 76

But – for we are in a year of Olympiad – he did not mention the 1931 Workers' Olympiad in Vienna; see Gabriel Kuhn, Georg Spitaler, *These Stunning Photos Show How Workers Held Their Own Olympics*, 07.23.2021, `https://jacobinmag.com/2021/07/photography-socialist-workers-sports-international-red-vienna-olympiad`

about society; not practical images related to the ardent needs of the working people, because their benevolent middle class humanism could not reach that. Their political impotency contributed to the final slip of Europe to the extreme right and could concretise only in their evasion (emigration) for survival. The (European) Belle Époque led to the WWI and later, the inertia of democratic protests did not stop the WWII[3]: because the evil did not consist only in racial discrimination, as some ones thought and still think[4].

In America, Gödel could manifest his – in Europe, social democratic, in the New World, liberal – interest for the American politics, but the mixture of hope and logical examination did not constitute a stimulus for his psychical balance, and concretised in the reduction of the discipline of creation. As many of his high intellectual friends, he was confused, choosing always the lesser evil: but within the logic of status quo.

The unity of the work and the state of mind of exceptionally endowed persons is a strong theme from Romanticism onwards. Nowadays we know that this relation is more complicated, and that people's philosophy or Weltanschauungen relate not only to their psychical state but also to the educational conditions suitable to absorb and understand philosophy. Gödel's confuse expression and metaphorical belief in angels and daemons has perhaps a link with his psychical troubles, but certainly it illustrates a confuse philosophy, based on an undisciplined philosophical training to judge criteria and outcomes. And in this respect, we should accept – and it's difficult not so much relating to past thinkers, but to present, living persons – that not everything a creator does is extraordinary and that, on the one hand, Gödel's philosophy remained at the level of suggestions – which imply n interpretations –[5], but that on the other hand, some of these suggestions prove to be fruitful.

The objective existence of mathematical truths – as Popper's "world 3" – and that this objectivity does not oppose their construction, was emphasised by Gödel[6]. Also: the fact that mathematical formalism is not the only source of mathematical validity[7]. Also: the fact that only the human reason can find new axioms, of a new kind, different from the old ones. However, somehow in the spirit of time – not in mathematics that was and is an "a priori science", but in philosophy and, generally, in ideology – he considered that with introspective ways and with phenomenology, we can grasp "other basic concepts hitherto unknown to us"[8]. Anyway, and letting aside phenomenology, "in the systematic establishment of the axioms of mathematics, new axioms, which do not follow by formal logic from those previously established, again and again become evident"; and that these axioms "are logically independent from the earlier ones": and, pay attention, just for this reason, "a machine cannot imitate"[9].

Gödel reflected both the ideological constraints of philosophy and its backward level from the standpoint of a clear language and expression, remaining at the level of metaphors and suggestions. His notes reflected both the influence and assumption of

[3]We can see a relative comparison in David Rosen, *A New Progressive Era?* July 8, 2021, `https://www.counterpunch.org/2021/07/08/a-new-progressive-era/`

[4]This type of reduction corresponds to the present liberal reduction of social problems to gender identity and sexual orientation. Philosophically, this reductionism – covered by its practice to mixing it with antiracism, in order to induce the confusion of their equivalence – promotes particularism and opposes the universalism of human reason. They are absolutely anti-Kantian.

[5]This philosophy was not scientific, as that of Carnap (who needed psychiatric services).

[6]See Kurt Gödel, "The modern development of the foundations of Mathematics in the light of Philosophy", (1961?), *Collected Works*, Volume III, Eds. Solomon Feferman, John W. Dawson, Jr., Warren Goldfarb, Charles Parsons, Robert M. Solovay, New York, Oxford, Oxford University Press, 1995, pp. 375-387.

[7]*Ibidem*, p. 381: "for reasonably comprehensive axioms of mathematics, it is impossible to carry out a proof of consistency merely by reflecting on the concrete combinations of symbols, without introducing more abstract elements".

[8]*Ibidem*, p. 383.

[9]*Ibidem*, p. 385.

idealism and the tendency to legitimate the "rightward philosophy" by the special situation of mathematics. His representation of objective existence of concepts and axioms can be likened to the vague, idealist, contradictory holism of the time. And the simplified views about materialism – considered to being opaque to freedom of randomness and to consciousness[10] – and idealism, did not allow seeing their unity. Also, his image about a valuable metaphysics demonstrating the objectivity of the world from some "primitive entities" analogous to the mathematical analysis of systems does not denote a deep philosophical understanding[11]: because philosophy is not reducible to the objectivity thesis and is historical, something that is different from mathematics. Finally, he had a simplified – and false – image about philosophy, or more exactly about its reason to be and its capacity. The deep intuition does not give the highest concepts and theories, and the logic and meanings of the world can be well emphasized even on the basis of rationalist demonstrations about the material intertwining.

Nevertheless, Gödel's philosophical insights were more subtle and less fit for rapid labelling than they were thought to be in different selective readings: he considered that "the middle" or the combination of materialism and idealism is the better answer[12] and that even in mathematics the certainty "is to be secured not by proving certain properties by a projection onto material systems – namely, the manipulation of physical symbols – but rather by cultivating (deepening) knowledge of the abstract concepts themselves which lead to the setting up of these mechanical systems, and further by seeking, according to the same procedures, to gain insights into the solvability, and the actual methods for the solutions, of all meaningful mathematical problems"[13]. And just because his starting point was mathematics, he considered that the process of understanding does not consist of giving explicit definitions for concepts, "since for that one obviously needs other undefinable abstract concepts and axioms holding for them", but of "a clarification of meaning"[14]. The necessity to use the phenomenological method and to understand Kant correctly was, for him, the important way to clarify the meaning of concepts: but for us this doesn't exclude to go further.

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Because Kurt Gödel's performance concerns logic and mathematics[15] (and especially mathematical logic[16]), the interest of the average reader is, obviously, to understand them: what formalism does mean, what a formal system does mean, what is the difference between the logical calculus[17] and the mathematical one, what the syntactic and semantic aspects of formal systems – and of their analysis – mean, what do mathematical truth, consistency[18], completeness[19] and incompleteness mean, what do proof and

[10] But do not forget: he wrote in a period when the "cold war" type dogmatism of both philosophical schools was strong.

[11] Gödel quoted in Budiansky, p. 270.

[12] Gödel, "The modern development of the foundations of Mathematics in the light of Philosophy", p. 381.

[13] *Ibidem*, p. 383.

[14] *Ibidem*.

[15] Certainly, Gödel had other mathematical contributions, besides his famous incompleteness theorems: in recursion theory, in the mathematical problem of intuitionism, and in set theory (independence results).

[16] Gödel's theorems belong to *mathematical logic*, because they applied logic to mathematics or, more precisely, they considered logic from a mathematical point of view, pursuing to understand the foundations of mathematics. And this made him a great logician.

[17] The calculus in a formal system supposes that there is always an algorithm of this calculus.

[18] Consistency means that the formal system in its complex structure is not contradictory and the deduction of results from this system does not lead to logical contradictions; simpler, that from the formal system one cannot deduce both a result and its opposite.

[19] Completeness depends on specific mathematical theories and refer to/reflects these specific con-

provability mean, and certainly what were Gödel's achievements, and not only through his famous theorems, what is the significance of constitution of new mathematical disciplines (as mathematical logic, but not only), what is the import of Gödel's theorems in the context of subsequent development of theorems solving the problems of consistency etc. And certainly, all of these can and is worth be related to the philosophical picture that preceded and evolved during the logical and mathematical endeavours. A "philosophy" of mathematical logic, namely, an explanation of its goals and tenets is much more interesting for the average reader[20]. Do not forget: it is about a popular book. Not the students in mathematics and logic are the target of a book about the life of Kurt Gödel[21], but just the non-expert readers. To give them truncated information, no matter how correct, about both the social and psychological context and the work[22] is not very beneficial.

For we speak about a popular book (or books) about scientists, the domain where they have created must be explained, no matter how rapidly. For example, the fact that in mathematics not only the rules of calculus, as it is in the common lay understanding, give the reason or correctness and efficacy of this discipline but also their foundations,

ditions, and Gödel Goedel has established (in his dissertation, 1929) the completeness of first-order predicate calculus, where, if every formula having a certain property can be derived in the system (using a theorem of the system), every true sentence in a model is provable; sentences are logically valid because they correspond to the model and are deduced on the basis of a finite formal deduction specific to it. Gödel considered that, since all the logically valid sentences are proven / provable, this system is complete.

About his completeness theorem, Gödel said: "The completeness theorem is indeed an almost trivial consequence of [*Skolem 1923b*]. However, the fact is that, at that time, nobody (including Skolem himself) drew this conclusion (neither from [*Skolem 1923b*] nor, as I did, from similar considerations of his own). . . . This blindness. . . of logicians is indeed surprising. But I think the explanation is not hard to find. It lies in a widespread lack, at that time, of the required epistemological attitude toward metamathematics and toward non-finitary reasoning. . . . The aforementioned easy inference from [*Skolem 1923b*] is definitely non-finitary, and so is any other completeness proof for the predicate calculus. Therefore these things escaped notice or were disregarded[135]", quoted in John W. Dawson Jr., *Logical Dilemmas: The Life and Work of Kurt Gödel*, Wellesley, MA, A. K. Peters, 1997, p. 58. The square brackets refer to Skolem's "Einige Bemerkungen zur axiomatischen Begründung der Mengenlehre". In *Matematiker kongressen i Helsingfors 4–7 Juli 1922*, Den femte skandinaviska matematikerkongressen, Redogörelse, 217–232. Helsinki: Akademiska Bokhandlen [A few remarks on the axiomatic justification of set theory].

[20]There already are such books. But after Hao Wang's *Popular Lectures on Mathematical Logic*. New York, Van Nostrand, 1981, other popular lectures covering the forty years after would have been useful.

[21]There already are such books, either insisting on specified aspects – like Hao Wang, *A Logical Journey. From Gödel to Philosophy*, Cambridge and London, The MIT Press, 1996; or Torkel Franzén, *Gödel's Theorem: An Incomplete Guide to Its Use and Abuse*, Wellesley, MA., A K Peters, 2005, whose clarity is once more emphasised by the mention of the life on only three pages; or the most recent and very undestandable Maria Hämeen-Anttila, *Gödel on Intuitionism and Constructive Foundations of Mathematics*, Doctoral Dissertation, Faculty of Arts, University of Helsinki, Unigrafia, 2020 – or developing chronologically, in "life" context, the professional accomplishments, like the very clear Dawson John W. Jr., *Logical Dilemmas: The Life and Work of Kurt Gödel*, Wellesley, MA, A. K. Peters, 1997. See also the review of Francisco Rodríguez-Consuegra, "Philosophy in Hao Wang's Conversations with Gödel. Review of Hao Wang, A Logical Journey. From Gödel to Philosophy", *Modern Logic*, Volume 8, Number 3 & 4 (May 2000–October 2001), pp. 137–152.

[22]Technical shortcomings can be found in Budiansky and Rebecca Goldstein, *Incompleteness: The Proof and Paradox of Kurt Gödel*, New York, London, W.W. Norton & Co, 2005. Goldstein's explanations contained mistakes as already shown by Solomon Feferman, "Provenly Unprovable", Review of *Incompleteness* by Rebecca Goldstein, *London Review of Books*, February 9, 2006, and Juliette Kennedy, Review, February 5, 2006, juliettekennedy2.pdf.

the axioms[23] - giving the frame of the formal systems[24] and their formalism (rules of inference) and underlying principles (or properties of mathematical objects) considered as the most general or productive – was a main concern of its professionals cannot be overlooked. Indeed, the great problem, more and more obvious in the second half of the 19th century was finding such axioms[25], and then, their checking in the "real life" of formal systems and rules of deduction, their verification including by confronting them with logical and theoretical paradoxes.

In this process, the need to understand and prove the correctness of formal systems and calculus following the given axioms, their consistency and the provability of their coherence led to the development of both mathematical logic and meta-mathematics. The first developed the reasoning from within the formal systems, while the second analyses mathematics from without, posing the problems of properties of mathematical objects, axioms and systems. Logic was a main tool in the axiomatisation of different mathematical disciplines, allowing inherent conjectures of mathematical theories and the speculation to reduce to one single axiom the foundation of a system of theorems. But logic was, too, a terrain where not only "the relation of mathematics to logic"', but also "fundamental questions of methodology, such as how quantifiers were to be construed, to what extent, if at all, non-constructive methods were justified, and whether there were important connections or distinctions to be made between syntactic and semantic notions"[26] were disputed. Actually, just this terrain favoured the constitution of meta-mathematics.

Is the above claim too pretentious? I think it is not. To supply the general public with highly accurate and readable information (about logic and mathematics, and especially about mathematical logic) means to leave behind the general traditional " life of..." and to substitute it with readable syntheses of high scientific theories. There are so many aspects which can and must be displayed[27] in order to increase the knowledge and scientific tools and worldviews of ordinary people that it is a pity to remain in old

[23]In mathematics, the axioms are considered intuitively *true*, and thus *truth* is given by the axioms and the necessary results of a solid calculus in agreement with axioms and a set of rules: or, philosophically speaking, with criteria that constitute the landmarks of research and theories developed within it. But in science, "truth" is provability, therefore the existence of proofs of the assumed theories.

Coherence proves the correspondence of the deductive steps evolved in the frame of the system with the axioms and sets of rules (of a certain formal system); differently put, the axioms and sets of rules are proven by this coherence of the deductive steps.

[24]Formal systems are *sets of axioms and rules of inference, allowing the generation of theorems*, thus sets of mathematical objects. The formal framework or the language of (formal) systems is given by languages with their alphabet and grammar, axioms, rules of inferences, theorems.

[25]If we want to explain philosophically: if the axioms are not contradictory to each other and do not lead to both true and non-true sentences, or to contradictory statements, the system has limits or is incomplete. In other words, Gödel's deployment of proofs always related to concrete formal systems, here to Peano's Arithmetic consistency – revealed the *limits* of systems of axioms: thus, and for both the alternative proving in other formal systems and the further progress of mathematics and mathematical logic, the axioms must be developed; this giving alternative systems which can prove with other means the consistency of Peano's Arithmetic.

More specifically: the *first* incompleteness theorem (1931) showed that, in the same consistent theory/formal system of Peano Arithmetic, there can be sentences which are neither provable nor disprovable; this would not meaning that the sentences cannot be proved in other formal systems. On the contrary, in principle they can / there are formal systems where these sentences can be proved. Nevertheless, Gödel showed that some arithmetical theorems cannot be proven within the *existent* formal systems containing Peano Arithmetic formalism. Therefore, it is always about the *limits of systems of axioms*, they are those which must be developed; not about the metaphysical impossibility to prove some truths. And the *second* incompleteness theorem demonstrated that the consistency of a certain type of formal system cannot be established with the means of the same formal system.

[26]John W. Dawson Jr., p. 48.

[27]See the beautiful Matthew Inglis, Andrew Aberdein, "Beauty Is Not Simplicity: An Analysis of Mathematicians' Proof Appraisals", *Philosophia Mathematica*, Vol. 23, Issue 1, 2014, pp. 87-109.

publishing clichés[28]. The general public has no time to address specialised scientific journals. Let's help them by bringing them closer to high quality scientific papers.

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We finish this review by mentioning some philosophical aspects related to mathematics, pointed out by the book or missing.

The ultimate philosophical nature of Gödel's famous theorems means that the idea of ultimate proof of a system as lying outside the system is valid because it is logical. People could see this logic many times and the philosophers could synthesise this common sense conclusion. But the point is to not remain at the level of intuitions or everyday proofs: it is to thoroughly demonstrate this idea.

The philosophical meanings of Gödel's exploits concern many aspects of their logic as such. The mathematical construction, its peculiarity towards the epistemological constructivism, the mathematical imagination and the criteria of analysis, the formal strictness of definitions, the limits of (formal) systems and any type of formalisation[29], involve logic[30]. Mathematical constructivism is the mathematical paradigm that considers the process of proving of the existence of mathematical objects, obviously as a result of working formalism in coherent systems And, while objectively, logic is the order of things, grasped by reason, as a discipline it is the normative science of reason, inherently simplifying it in ideal forms and giving criteria and norms to evaluate the validity and correctness of inferences. Just through the use of logic could mathematics pursuing the understanding of its foundations show that without the rigorous, inherently formal demonstration, the idea that in any system of transposing reality into a code of signs and significations, the last stage explanation is outside the respective theoretical system cannot be supported only at the level of philosophical (and common) intuitions.

However, Gödel's incompleteness theory was not conceived of as a proof of the finitude and limits of science / mathematics. The fact that a formal system – and the mathematical formal system can be a model for a scientific theory – does not arrive to its ultimate provability within its own boundaries is only an invitation to consider the expansion and nesting of systems (the systems of systems) and to scientific optimism. This scientific / mathematic optimism was promoted by David Hilbert and Hans Hahn[31], and was the life-long credo of Gödel. And though Gödel's idea about his theory and achievements was – in a lucid self-scrutiny – that "All of his contributions, he sadly observed, were of a negative kind—proving that something cannot be done, not what can be done"[32], actually they were methodological[33] and generated openness.

Not only that the "cannot" is fruitful (and science advances only through the excluding or negative proofs), but the theory drew attention at the same time on the fertility and the limits of (systems of) axioms (of truth sentences) in self-referential systems and

[28]These clichés issued in the era of the first industrial revolution, when first such books responded to the needs of the middle class and latter even to those of the lower classes. They popularised cognisance about the process of creation, about famous works, about the interdependence of social, psychological, philosophical and scientific sides of the human reality, even messaging to the readers that by hard-working every one can be a creator, something more important than to be a member of the haves. Anyway, these non-fiction biographies have – as we see today (but certainly I do not speak about Budiansky's book) – also the function to transmit dominant ideological meanings.

[29]Gödel's first theorem of incompleteness referred to the impossibility of proving the completeness of a certain particular system of axioms (Peano's formal theory of natural numbers qua elementary number theory), while the second theorem referred to the fact that the consistency of arithmetic cannot be established within the boundaries of the arithmetic system itself).

[30]But do not forget: logic applies to any knowledge.

[31]Stephen Budiansky, pp. 91, 95.

[32]*Idem*, p. 15.

[33]Is meta-mathematics not a kind of methodology?

the possibility / provability of necessary truths in modal logic, distinguishing them from contingent truths. Modal logic is related to mathematical induction in the sense that its operators help the constitution of finite chains of reasoning about expressible variables and quantifying sets and relations of natural numbers. However, "although mathematical induction is fully expressible in second-order arithmetic, the trouble is that the underlying logic (second-order logic) is not axiomatizable"[34].

There always are other systems – solving other problems (related to the intentions) – which have proven (internal) consistency but which, at their turn, are not complete. In a non-mathematical formulation that I don't know if appropriate, Gödel's demonstration that every axiomatizable consistent system in which all true sentences are provable is incomplete[35], is rather a proof of the historical trend of mutually generated mathematical theories and, obviously, of the union of mathematics and modal logic. Because, as Gödel observed, "that switching to higher-order systems of logic not only made it possible to prove propositions that are undecidable in a lower-order system, but also often dramatically shortened the length of the proof even for propositions that could be proved in the lower order system"[36].

Today we understand better the stakes of the former scientific theories without which, however, we cannot go on. The incompleteness theorem was considered too narrow because of its proof limited to a finite system[37]. Of course: but just this was its end, and by showing that "a static fixed FAS (finite axiomatic system) cannot work"[38], it suggested just the possibility to use the theorem in new, even opposed ways.

In his work, Gödel has developed some philosophical conclusions. First, they concerned the nature of mathematical truths that proved to be double: there are objective mathematical truths, not depending on 'any further hypothesis' and on any proof (whether this proof is possible or not), and subjective truths, as "humanly demonstrable" and conditioned by the axioms. Thus, even the system of axioms is not complete, but it contains both provable and unprovable truths. Then, they concerned the possibility to solve mathematical problems beyond the algorithmic procedures[39].

Other revealing philosophical conclusion was that formulated in a 1934 paper: in Menger's words, "that the consistency of each preceding system is provable in the successive systems; furthermore, that at every level there exist undecidable sentences that become decidable at higher levels", or otherwise put "in transition to logics of higher order, not only do previously unprovable propositions become provable, but many proofs already available become greatly abbreviated "[40].

Other philosophical conclusion is related to a speculative supposition of a complete set of axioms for the entire mathematics: if a system of axioms cannot prove all the true

[34]Raymond M. Smullyan, *Gödel's Incompleteness Theorems*, New York, Oxford, Oxford University Press, 1992, p. 113.

[35]But if, in other words, a system that is consistent cannot prove its own consistency is sound in a dialectic philosophy, in mathematics it is not. Because, as Gödel observed, a system/result is true when it is deduced from consistent axioms by consistent rules of inference. And if this is the case, there is no longer the need to prove it.

[36]In the words of Budiansky, p. 185.

[37]Gregory Chaitin, *Meta Math!: The Quest for Omega*, 2004, p. 23.

[38]*Ibidem.*

[39]Solomon Feferman, "Are There Absolutely Unsolvable Problems? Gödel's Dichotomy", *Philosophia Mathematica* Volume 14, Issue 2, 2006, pp. 1-19. A quote from Gödel (p. 12) is significant: "Turing gives an argument which is supposed to show that mental procedures cannot go beyond mechanical procedures. However, this argument is inconclusive. What Turing disregards completely is the fact that *mind, in its use, is not static, but constantly developing, i.e.*, we understand abstract terms more and more precisely as we go on using them . . . though at each stage the number and precision of the abstract terms at our disposal may be *finite*, both . . . may converge toward *infinity*".

[40]Karl Menger, *Reminiscences of the Vienna Circle and the Mathematical Colloquium*, Edited by Louise Golland, Brian McGuinness, and Abe Sklar. Dordrecht, Netherlands: Kluwer, 1994, p. 212.

sentences deduced within the system, would the construction of a complete set of axioms for the entire mathematics be possible? The problem is similar to the quest for a "theory of everything" in physics. The incompleteness of such a system and the impossibility to create it was explained by Chaitin: "for math to progress it would have to evolve over time, adding new concepts and new fundamental principles (axioms or postulates)"[41]. "The fundamental philosophical questions like the continuous versus the discrete or the limits of knowledge are never definitively solved"[42].

A fine philosophical conclusion resulted from strong relationship between mathematical formalism and its constraints and, on the other hand, the non-formal expression of the truth of principles or of "the significance of symbolic expressions"[43] as premises of the entire mathematical endeavour. If we consider these principles valid, there is no reason to not accept all the mathematical truths and proofs based on them. A kind of reciprocal is the understanding of the limits of mathematical[44] concepts: for instance, consistency as the key or most important proof/basis of the truthfulness of the mathematical objects and theories. However, the consistency as such is not enough to attest any theory / rather one cannot attest any theory only on the basis of consistency of the formal system[45].

What is interesting is that Gödel tried to mix and at the same time to surpass the divergences between the schools of mathematical foundation whose friendly and unfriendly dialogue led to so many relevant discoveries in the mathematical field in the first half of the 20th century. He did not reject formalism, even in its constructive form, while showing that logic helps to understand that the mathematical constructions and truths are not aleatory. They are necessary, thus objective. Beyond the discussion about Gödel's Platonism, it is about the avant la lettre assumption of the "world 3" of Popper[46]: the human theories etc., once created by man, become a world distinct from him, and that can be treated and judged independently of its constructors[47]. The truth of theories, for-

[41]Gregory Chaitin, in *It's not All in the Numbers: Gregory Chaitin Explains Gödel's mathematical Complexities*, 2012, `https://www.simplycharly.com/read/interviews/its-all-in-the-numbers-gregory-chaitin-explains-kurt-godel-mathematical-complexities/`

[42]Gregory Chaitin, *Meta Math!: The Quest for Omega*, 2004, p. 10.

[43]L. Susan Stebbing, Postulational Systems and *Principia Mathematica*, originally published as Appendix in *A Modern Introduction to Logic* (1931), Third edition, Methuen, 1942.

[44]For a lay person like me, all of these aspects of mathematics send to questions related to science and knowledge.

[45]Torkel Franzén, "The Popular Impact of Gödel's Incompleteness Theorem", *Notices of the AMS*, Vol. 53, Number 4, 2006, pp. 440-443 (443).

[46]This idea that the logic of the created spiritual things is that which gives them legitimacy and not the fact that they were conceived of by the human mind, appeared in Benedictus de Spinoza, *Ethics* (Ethics Demonstrated in Geometric Order...), (1677), in *The Collected Works of Spinoza*, Edited and Translated by Edwin Curley, Volume I, Princeton, New Jersey: Princeton University Press, 1985, V, 23, Note to proof, p. 608. In Latin, "Mentis enim oculi quibus res videt observatque, sunt ipsæ demonstrationes", `https://la.wikisource.org/wiki/Ethica/Pars_quinta_-_De_potentia_intellectus_seu_de_libertate_humana`

[47]Letting aside Gödel's image of the objectivity of spiritual creations as if they would prove the omnipotence of a trans-mundane being, his view was, nevertheless, consistent. His Platonism was simply a manner to express the objectivity of spiritual creations.

"He maintained, for example, that because a mathematician cannot 'create the validity of . . . theorems . . .at his will,' mathematical activity 'shows very little of the freedom a creator should enjoy.' On the contrary, he argued, 'what any theorem does is . . . to restrict [that] freedom,' and whatever restricts the freedom of creation "must evidently exist independently' of it... He agreed that 'a mathematical proposition says nothing about the physical or psychical reality existing in space and time, because it is true already owing to the meaning of the terms occurring in it.' But he rejected the contention that 'the meaning of th[ose] terms . . . [is] something man-made, consisting merely in semantical conventions.' Instead, he reaffirmed his Platonistic view that 'concepts form an objective reality of their own, which we cannot create or change, but only perceive and describe.' The meaning of mathematical statements thus inheres in what they say about relations among concepts", John W. Dawson Jr., p. 199.

malism, conjectures and developments of infinite values does depend only on the internal logic or consistency of the theoretical constructions. But on this line, truth is necessary even for the demonstrations of formalist consistency.

Logic and mathematics are distinct, but they are intertwining and their history – at least, in the 20th century – is a race where the relay was taken over conjointly by mathematicians and logicians. Gödel was an exponent of this race and the development of fundamental positions and theories in both sciences was very clearly emphasised in the book of Dawson Jr, but less clear in Budiansky's book. (Both Budiansky and Goldstein leaned only on the famous incompleteness theorems). Gödel's exploits in the founding of mathematical logic can be understood only in concert with the whole of other discoveries before and after them, just because they were answers to the problems debated in the community of mathematicians.

I think that just this concert and logic of creations should be the main topic of general books about scientists. And: much less the overwhelming life details and the details of personal professional relations. In Budiansky and the books cited until now these details show a careful reading of mathematical papers and deciphering of the shorthanded manuscripts. Nevertheless, the chronological story of details of personal professional relations is not always welcome in order to transmit the logic of creation. Perhaps a future chronological analysis of all manuscripts of Gödel will better show both the richness of his professional endeavour and the philosophical confusion that has not impaired his mathematical and logical depth, but is interesting to know from a didactic standpoint.

Popularising mathematics and logic is important. It's not the place here to elaborate, but it's certainly necessary to say that the popularisation of mathematics is difficult. It depends on the level reached in the mathematical and logical research, or from which the popularizer of these disciplines starts. Thus, it must follow Hilbert's advice: "A mathematical theory is not to be considered complete until you have made it so clear that you can explain it to the first man whom you meet on the street"[48]. For this reason, on the one hand, to be a popularizer of math without being a mathematician is hard. On the other hand, for a mathematician to transpose into lay explications, rather using words than formulas, is not very comfortable. When explaining clearly, people clarify also their thoughts: by speaking, transposing into words some intuitions or unfolding some not so clear reasoning, they arrive to know. But a mathematician already knows: thus he doesn't feel the need to say by words that which he not only understands very well but is better explained in the specific mathematical language. So, only those mathematicians who consider popularising their discipline a duty, do it. From this standpoint, both the books of Budiansky and Goldstein have shortcomings.

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SIGNAL

Landscapes in Logic Vol. I. Contemporary Logic and Computing,

Adrian Rezuş, editor; College Publications, London, 2020.

(Cristian Calude[1])

This volume aims to illustrate the interplay between the contemporary work in logic and computing and the mainstream mathematics[2]. It is divided into two parts: Selected Topics in Contemporary Logic and Advances in Computing[3].

The first part includes eight chapters

The chapter "The Development of Decidability Proofs" by K. Bimbó presents the evolution of decidability proofs for various propositional logics based on sequent calculi, from the first one – for intuitionist logic – to some of the latest results. The common thread is the essential use the Curry Kripke technique.

"Non-Distributive Logics: From Semantics To Meaning" by W. Conradie, A. Palmigiano, C. Robinson and N. Wijnberg discusses a line of research in the relational (non topological) semantics of non-distributive logics.

The chapter "Bounded Functional Interpretation with an Abstract Type" by P. Engrácia and F. Ferreira presents, in a classical framework, the bounded functional interpretation with an abstract type and its main result.

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[2]Project, Adrian Rezuş (ed.) ≪Contemporary Logic and Computing Science≫, College Publications, London 2020. Goal: The book consists of invited and contributed papers illustrating recent research trends in logic and computing science, edited by me during the period September 2019 - June 2020. It is focussed on the following topics: A) Proof theory, lambda calculus, type-theory, and constructive mathematics, B) Recursion theory, computability, computational complexity, and applications of logic in computer science, C) Current research on classical and non-classical logics, D) Philosophy of mathematics. The Project is part of a larger editorial enterprise, currently in progress at College Publications, London. Date: 1 September 2018 - 1 July 2020. https://www.researchgate.net/project/Adrian-Rezus-ed-Contemporary-Logic-and-Computing-Science-College-Publications-London-2020.

[3]The division of the volume in two sections – topics in 'logic' vs topics in 'computing' – is more or less conventional. Some contributions are focussed on historical and technical details meant to put in perspective the impact of the work of some outstanding mathematicians and philosophers on the contemporary research in logic and computing science. Some other papers, also with a historical flavour, were supposed to evidentiate punctual methods of research and specific concepts or topics, as, e.g., decidability, computability, randomness, and computational or descriptive complexity. In general, the papers were intended as specific surveys of results. Other volumes – to be issued subsequently in the same series – will hopefully delineate aspects of the contemporary logic landscape that have not been illustrated here. The intended audience of the book includes graduate students in mathematical logic, foundations of matematics, and computing science, as well as philosophers, mathematicians, and, possibly, other scientists interested in the recent research on logic and computing. July 2020, 978-1-84890-340-1. https://www.collegepublications.co.uk/LiL/?00001

L. Humberstone discusses in "Twins in Logic – Identical and Otherwise" what Łukasiewicz metaphorically calls twins connectives in some logic, that is, when they behave 'in the same way' according to that logic. The presentation includes looser and stricter ways to read this metaphor.

A. Iorgulescu presents a detailed view of a world of twenty two algebras of logic in "Algebras of Logic vs. Algebras"

"Relevant Logics: From Semantics To Proof Systems" by H. Kurokawa and S. Negri presents in a uniform manner axiomatic presentations of a wide family of relevant logics as well as their Routley-Meyer semantics (based on ternary accessibility relations).

"Sobociński's Nachlaß" by V. F. Rickey presents unpublished results on Leśniewski's systems in B. Sobociński's papers. Items that the author was unable to place chronologically are listed at the end of the paper.

W. Veldman's paper "Treading in Brouwer's footsteps" presents the work that has been done in intuitionistic mathematics by J. J. de Iongh and some of his students in the period 1963–1985. The paper briefly treats the philosophy of intuitionistic mathematics, and then continues with some results concerning the continuity of real functions, Dedekind-infinite sets, the continuum hypothesis, the perfect set theorem, and the completeness of predicate logic, descriptive set theory and Ramsey's Theorem.

The second part on Advances in Computing includes thirteen chapters

A. Böhm, M. Böhm, E. Böhm, M. Dezani-Ciancaglini, F. Manfredini, N. P. Böhm present in "Corrado Böhm. The λ-adventure" a glimpse of Corrado Böhm, "scientific genius, but also [the] man".

C. T. Chong discusses in "The Reverse Mathematics of Ramsey's Theorem for Pairs" the combinatorial principle RT^2_2 derived from Ramsey's Theorem for pairs and presents its proof-theoretic strength within the framework of reverse mathematics.

The chapter "Ramsey Theory on Infinite Structures and the Method of Strong Coding Trees" by N. Dobrinen discusses some recent trends in Ramsey theory on infinite structures and possible future directions for applications.

R. Downey chapter "Randomness and Computation" presents a selection of results in Algorithmic Information Theory, an area which uses computational methods to define and study randomness of individual objects. Interactions with computability theory and applications in information theory, effective dimension, randomness amplification, and analysis and ergodic theory are covered, but not the relevance to quantum theory and computing.

O. Finkel and D. Lecomte chapter "Descriptive Set Theory and Ω-Powers of Finitary Languages" surveys some recent results that link Descriptive Set Theory and ω-powers.

W. Gasarch's chapter'Low, Superlow, and Superduperlow Sets" ("Exposition of a Known But Not Well-Known Result") presents the beautiful "proofs of Jockusch and Stephan" for the existence of these strange mathematical objects. And, indeed, they look beautiful even for the reviewer who is not a fan of this exoteric chapter of incomputability.

W. Gasarch, E. Metz, Y. Shen, Z. Xu, S. Zbarsky present an intriguing result about the size of the smallest non-deterministic finite automaton recognising cofinite unary languages and related open questions in "Small NFA's for Cofinite Unary Languages".

C. Gassner's "An introduction to a model of abstract computation: the BSS-RAM model" gives a detailed presentation of BSS RAM's for the sequential computation over first-order structures, including important properties like universality.

N. Greenberg's chapter "Two applications of admissible computability" presents two applications of admissible computability in the formalisms of Kripke and Platek to higher

randomness and computability of uncountable structures.

H. Ishihara in "The constructive Hahn-Banach theorem, revisited" presents a new proof of an approximate version of the separation theorem by using the Baire category theorem, and a proof of an approximate version of the (1-dimensional) dominated extension theorem in the framework of Bishop constructive mathematics. K. Meer's chapter entitled "Metafinite model theory and real number computations" surveys research done in the area of descriptive complexity theory in relation with the Blum-Shub-Smale model of real number computations.

D. Skordev surveys some technical results in neat computability in his chapter titled "Moschovakis extension of multi-represented spaces". M. I. Soskova's chapter reviews results in "The theory of the enumeration degrees, definability, and automorphisms".

The papers, written by experts in their subjects, are surveys on various topics, some focussed on historical or philosophical topics, others, in fact most, on mathematical results. The technical parts are presented in rigorous manner and are written for an educated reader in their specific topics; they are less inviting to a more generally educated public or students. The relevance to main stream mathematics, one of the objectives of the book, is weak, with two notable exceptions: the articles by Downey and Ishihara.

Ioan Biriş, *Lucian Blaga - Conceptele dogmatice*,

Cluj-Napoca, Editura Școala Ardeleană, 2020. (Ana Bazac)

Volumul este o interpretare a operei filosofice a lui Lucian Blaga din punct de vedere epistemologic. Iar această interpretare este consonantă cu dorința clar exprimată de Blaga însuși de a-i privi teoria care cuprinde și leagă trilogiile sale drept o perspectivă nouă asupra cunoașterii. În siajul paradigmei kantiene de precedență a explicării procesului de creare a cunoștințelor asupra ontologiei care le sintetizează savant în chip de concepte ordonatoare ale înțelegerii lumii, Lucian Blaga a avansat o structură coerentă de idei. Firește, el a rezonat puternic cu accentul asupra sub-, in-, de fapt, infra-conștientului pus de gândirea europeană mai ales de la începutul secolului al XX lea și cu predominanța paradigmei religioase (creștine) în ideologia românească a timpului. În acest sens, am putea conchide că filosoful Lucian Blaga a căutat să dea o legitimitate epistemologică acestei paradigme, iar în această întreprindere a integrat atât infra-conștientul cât și analiza științifică modernă: pe care a transpus-o mai degrabă în mod metaforic.

Ioan Biriș a evidențiat o parte din logica acestui demers blagian în care, chiar dacă punctul declanșator a fost cultura și factorii săi stilistici[1], cerința de a le fundamenta a generat teoria filosofului clujean în care descrierea filosofică a cunoașterii îndeplinește rolul de structurare coerentă a concepției generale metafizice despre lume. În principiu, întreaga concepție blagiană despre dogme are în vedere nu doar teologia și știința, ci, în primul rând metafizica. Principiile metafizice generatoare – Marele Anonim, misterul – sunt cele care sunt explicate în modul dogmatic blagian.

Perspectiva asumată clar de autorul exegezei de față este „filosofia conceptului", adică relevarea acestei concepții prin discutarea modului în care Blaga a propus calitățile conceptelor în raportarea acestora la obiectele intenționate.

Introducerea dă cadrul: accentul asupra infra-conștientului în filosofia europeană – de la Leibniz – și traducerea de către Blaga prin:

1. specificul omului de a exista nu doar ca ființă animală în orizontul concret al lumii transmis prin simțuri, ci și ca ființă ce sondează și revelă misterul (necunoscutul);

2. iar această capacitate se face nu atât prin cunoaștere cu ajutorul categoriilor date prin analiza conștientă ce este inerent legată de simțuri ci prin cunoaștere cu ajutorul categoriilor abisale, constituite în bună parte la nivel infra-conștient și conferind cadrul stilistic în care se realizează întreaga cunoaștere și care astfel este capabilă să pătrundă în adâncimea misterelor.

Într-o formulare mai aplicată, Blaga distinge între cunoașterea conștientă care este logică, iar intelectul își folosește pe deplin abilitățile logice, fiind en-static, specific cunoașterii conștiente, paradisiace (în care obiectul este pe deplin clarificabil), și, pe de altă parte, cunoașterea ce include și maniera subconștientului, atunci când intelectul

[1] La Blaga, stilul ține de inconștient.

iese din funcționarea normală, el devenind ex-static, specific cunoașterii luciferice în care obiectul are și o parte ce se ascunde, misterul; dar acesta este deschis, poate fi atenuat sau, dimpotrivă, întețit.

Dar când simte intelectul nevoia să evadeze din starea normală? Atunci când se confruntă cu situații contradictorii ce nu mai pot fi explicate cu teoriile logice existente. În fața paradoxurilor, rațiunea se descurcă prin teorii „dogmatice": termenul are la Blaga un sens diferit de cel din teologie. În teologie, dogma este „învățătura", ansamblul de aserțiuni avansate ca absolut adevărate, fixe și date o dată pentru totdeauna: dogma este infailibilă. Ca urmare, filosofia critică (de la Kant începând), a opus dogmei ideea cunoștințelor adeverite prin demonstrații, prin probe, susținute logic: orice ofertă de cunoștință infailibilă fiind suspectă epistemologic, de nesusținut. Dar Blaga nu preia nici sensul filosofic analitic al conceptului de dogmă, deoarece vrea să depășească simpla opoziție dintre dogma primară, teologică și cunoașterea rațională. Dimpotrivă, el consideră că, uneori gândirea are în față situații contradictorii mai complicate decât cele care, în mod normal, sunt rezolvate acceptând adevărul uneia dintre aspectele contradicției, potrivit principiului logic fundamental tertium non datur. Situațiile mai complicate arată „crize ale intelectului" și sunt rezolvate prin teorii dogmatice. Acestea sunt teoriile ce pleacă de la confruntarea deschisă a paradoxurilor și de la punerea lor drept premise, reținând sau acceptând ambele lor părți /contradicțiile, dând unității lor semnificații neobișnuite față de teoriile normale de până atunci. În știință, chiar ideea schimbării revoluționare a teoriilor normale până atunci, deci chiar ideea schimbării paradigmelor (evidențiată mai târziu de Thomas Kuhn) a inclus ideea că noua paradigmă acceptă și situațiile contradictorii inadvertente cu teoriile normale de până atunci dar le interpretează în mod nou. În acest sens s-a putut face o apropiere între conceptul de dogmă la Blaga și teoria dinamicii științei la Kuhn[2].

Dar Blaga a fost sfâșiat între două tendințe opuse de a face filosofie: de a fundamenta înțelegerea lumii în mod metafizic, adică la nivelul principiilor ontologice generatoare (Marele Anonim cu puterile și frânele sale transcendente), și de a o fundamenta epistemologic. El a ales împletirea celor două tendințe – nu asta este poziția „dogmatică"?, dacă este permisă gluma – adică, în ultimă instanță, susținerea imaginii metafizice prin referință la cunoaștere. De aceea și astăzi este dominantă interpretarea filosofiei lui Blaga într-o cheie excesiv metafizică ce anulează, în fond, caracterul deschis al misterului la filosoful din Lancrăm și îl reduce mai degrabă la permanența funcției sale de frână a penetrabilității lumii de către spiritul uman: posibilă și astăzi. În sfârșit, întreaga argumentare blagiană este tributară perspectivei metafizice de reducere la O cauză. Totuși, acestea nu anulează caracterul interesant al filosofiei lui Blaga: chiar prin teoria sa metafizică[3]. Iar acest caracter interesant trebuie văzut și în cadrul temporal al creației sale și din punctul de vedere al atitudinii filosofice de astăzi față de filosofia lui Blaga.

Dincolo de această observație, volumul semnalat se ocupă de ideea de dogmă sau de conceptele dogmatice la Lucian Blaga. După cum și precizează autorul, volumul nu este o povestire a filosofiei blagiene a dogmei, așa cum a apărut și s-a dezvoltat de-a lungul operelor lui Blaga, ceea ce este, cred, o scădere a cărții din punct de vedere informațional, ci: a) o notare a semnificațiilor dogmei așa cum au apărut acestea în teologia creștină la Philon din Alexandria și menționate ca atare de către Blaga; explicarea conceptelor dogmatice religioase ocupă chiar un loc important în economia cărții, pe baza importanței date de Blaga teoriei emanației a lui Philon și deja discutată de Hegel; b) o evidențiere

[2]Vezi Ana Bazac, "Lucian Blaga and Thomas Kuhn: The Dogmatic Aeon and the Essential Tension", *Noesis*, **37**:23-36, 2012.

[3]Dar să nu uităm: toate teoriile filosofice au caracter istoric, determinate de contexte complexe și astfel, cu o valabilitate ce este încadrabilă spațio-temporal și evaluabilă și potrivit acestui cadru și potrivit reperelor prezentului din perspectiva căruia se analizează.

a metodologiei prin care se poate constitui perspectiva dogmatică în știință.

Acest din urmă aspect este mai interesant, deoarece, după descrierea modului în care este concepută analogia de către Blaga referindu-se la transcendent și la capacitatea științei de a include „analogiile secrete" în ceea ce este / pare absolut diferit, se discută:

1. din punct de vedere logic – și pe baza modelelor logice din matematică (Leibniz, Boole, Neurath etc.) pentru ca limbajul metaforic utilizat de Blaga să devină mai clar – principiul identității și teoria prin care Blaga atenuează și ajustează acest principiu ca urmare a observării fenomenelor și teoriilor din știința modernă;

2. conceptele calitative (Aristotel) și conceptele relaționale moderne, dar și reliefarea de către Blaga a conceptelor-imagini (Urphänomen-ul lui Goethe[4]) care, în perspectivă dogmatică, amplifică și, în același timp, transcend empiria;

3. conceptele numerice. În mod deosebit aici, față de celelalte capitole ale cărții, Ioan Biriș a dorit să să legitimeze concepția lui Blaga adeverind-o. Dar trebuie să observăm: ideea că matematica și logica sunt discipline diferite nu este echivalentă cu ideea că matematica este superioară logicii, cum a considerat Blaga, iar cartea nu a precizat niciodată că ideile – și, concret, ideea superiorității matematicii asupra logicii – sunt disputabile. Desigur, Blaga, și interpretarea lui Ioan Biriș o susține, a avut nevoie de această idee – sau, mai degrabă, a ajuns la ea – deoarece matematica, și concret, definirea numerelor, i-a părut mult mai complexă decât logica. Adică Blaga a considerat, aceasta a fost ideea relevată de carte, că definirea numerelor este de resortul antropologiei, calitatea lor de a fi obiective și/sau subiective fiind nedecidabilă. Excursul autorului, inerent redus, prin istoria modernă a definirii numerelor (Gottlob Frege, Bertrand Russell, Wittgenstein, necunoscuți lui Blaga[5], Wundt, Poincaré și Cassirer, pe care s-a bazat –) a fost interesant, dar nu neapărat necesar, deoarece teoriile logiciste, convenționaliste, formaliste/constructiviste, empiriste (și, subliniez, inclusiv antropologice) despre număr reies din constructivismul epistemologic kantian și ar fi putut fi sintetizate, tocmai pentru a lăsa spațiu discutării concepției lui Blaga, mult prea săracă și expediată. Pentru a arăta că teoria factorilor stilistici ca manifestări ale perspectivei antropologice se înrudește cu teoria formelor simbolice a lui Cassirer nu era necesară discutarea unor aspecte interesante în sine dar care nu au adus nimic nou temei care nu trebuie uitată: teoria blagiană a dogmei, adică aici, cum/dacă/în ce măsură conceptele numerice au fost socotite și relevate de către Blaga ca dogmatice. Acest aspect nu apare, capitolul ilustrând mai degrabă incontestabila expertiză epistemologică a autorului în teoria conceptului, despre care a scris o carte importantă[6];

4. problema expansiunii logice a conceptelor. Aici autorul a expus ideile lui Frege despre identitate și delimitarea conceptelor, ale lui Carnap despre dinamica conceptelor și a evidențiat dependența principiului logic al identității de pluralitatea condițiilor și calităților obiectului. Tocmai pentru a depăși antinomiile rezultate din această confruntare, Blaga a propus identități parțiale sau elastice și includerea în logică a categoriilor dogmatice, iar capitolul a exemplificat și clarificat încă o dată

[4]Vezi explicarea acestui concept în Ana Bazac: The approach of space and an inter-war anthropological model, *Analele Universităţii din Craiova, Seria Filosofie*, nr. 33, (2/2014), pp. 127-161; Daimon, creativity and science (transdisciplinary flight), *Noema*, **14**:203-256, 2015.

[5]Blaga a vorbit exclusiv de raportul între subiect și predicat. După Frege, care introdusese deja calculul propozițional bazat pe funcții și argumente, între care funcția de adevăr, Cassirer nu putea decât să considere primatul conceptului de funcție asupra conceptului de obiect. Este vorba aici de o continuitate între idei din logică și matematică și, pe de altă parte, filosofie.

[6]Vezi Ana Bazac, Ioan Biriş: Conceptele ştiinţei (2010), *Noema*, **11**:535-539, 2012.

teoria emanației philoniene în conceptele creștine de Dumnezeu (Tatăl/Logos-ul), de trans-substanțializare și de trinitate.

Obiectivul de fundal al volumului a fost explicarea sau legitimarea teoriei dogmatice (Philon – Blaga) prin referința la teoriile despre concepte în știința modernă și mai ales în matematică. Blaga însuși a legat teoria lui Philon de teoria mulțimilor transfinite a lui Cantor. Iar această premisă i-a permis autorului să demonstreze și el, prin modele matematice, teoria, după cum întreaga logică dogmatică de stabilire a antinomiei din cupluri conceptuale și de transfigurare a antinomiei prin scindarea conceptelor a fost precedată de punctări tehnice ale unor teorii moderne. Cred că modelarea matematică și referința la teoriile despre concepte în știința modernă dau punctul de interes al cărții.

Este o lectură epistemologică specială (repetăm: potrivit filosofiei conceptului) a unei teorii metafizice – realizate apăsat metaforic – ce, pe de o parte, poate să fie o sclipire, un truc (dogma blagiană fiind, în clara definire a lui Ioan Biriș, „o formulă intelectuală, dar una intenționat contradictorie, structural paradoxală, cu menirea de cuprinde transcendentul" (p. 246)); dar pe de altă parte, teoria lui Blaga (în esență, în Eonul dogmatic (1931)) include o frumoasă (și rară, în filosofia românească) analiză a științei celei mai noi din vremea sa și cu referințele cele mai noi. Exemplele (teoria relativității, teoria cuantelor – din fizică – și teoria entelehială din biologie) sunt folosite de Blaga pentru a releva posibilitatea unei direcții noi, capabile de un spor imprevizibil, cum spunea el, în cunoașterea lumii. Aceasta este direcția dogmatică, de depășire a teoriilor științifice logice și acreditate, iar aceeași doctă menționare a teoriilor filosofice folosite în interpretarea lor face din lectura directă a lui Blaga o extrem de atrăgătoare preocupare pentru cititori și o extrem de necesară incursiune directă în logica gândirii românești interbelice.

Am putea încheia această scurtă recenzie la o carte interesantă – și necesară în filosofia românească actuală – printr-o întrebare referitoare la originalitatea lui Blaga în conturarea teoriei sale a dogmei. În principiu, originalitatea constă în legarea unor aspecte (în fenomene și teorii) care nu au fost legate înainte. Blaga s-a referit la oameni de știință și la filosofi care au semnalat și chiar dezvoltat modul „dogmatic" – adică, în limbajul nostru, holist, integrativ – de cunoaștere. Iar analiza lui Philon de către Hegel în Prelegerile de istorie a filosofiei a dat întreaga schemă a teoriei blagiene. După cum, legitimări ale conceptelor religioase prin referirea la știință au existat și ele. Dar teoria lui Blaga este o frumoasă abordare epistemologică a legării științei, conceptelor religioase și filosofice: care, încă o dată, merită să fie cunoscută și direct. În acest sens, și inclusiv cu ajutorul unor cărți de analiză ca aceasta a lui Ioan Biriș, cititorii pot și trebuie să depășească mesajul ce reduce complexitatea cognitivă (și) a lui Blaga la aceea de a fi exclusiv în serviciul teologiei sau infra-conștientului. După cum, ei își pot pune problema contextului intern și internațional în care teoria lui Blaga nu a fost singura, iar „aerul de familie" (ca să preluăm formula lui Wittgenstein pentru concepte) al atâtor teorii „dogmatice" și abisale este o dată mai mult producător de lumină.

BOOK

The Secret of Geniality (V)

Robert DJIDJIAN[1]

Instead of abstract:

We continue to publish, in a series, the book THE SECRET OF GENIALITY (Yerevan, Armenia, Noyan Tapan Printing House, 2002) by our colleague Robert Djidjian, not only because we all must know the philosophical research and creation (in our domain of epistemology and philosophy of science and technology) from a wider geographic area than that provided by the established fashion in virtue of both extra-scientific reasons and a yet obsolete manner to communicate and value the research; but also because the book as such is living, challenging and very instructive.

The title of the book is suggestive enough to make us to focus on an old problem: the dialectic of the insight, of the discovery – its psychology moving between flashes of intuitions and knowledge stored in memory – and its logic of composition of knowledge from hypotheses to their demonstration and verification. The realm of science is most conducive to the understanding of this dialectic and the constitution of the ideas which are the proofs of what is the most certain for humans: the "world 3", as Popper called the kingdom of human results of their intellection, and though transient and perishable in both their uniqueness and cosmic fate, the only certain proof of the reason to be of *homo sapiens* in the frame of multiversal existence. Therefore, the power to create is the secret of the human geniality, and how to create science is a main part of this secret.

Ana Bazac

În loc de rezumat:

Continuăm să publicăm, în serial, cartea SECRETUL GENIALITĂȚII (Erevan, Armenia, Tipografia Noyan Tapan, 2002) de colegul nostru Robert Djidjian, nu numai pentru că toți trebuie să cunoaștem cercetarea și creația filosofică (în domeniul nostru de epistemologia și filosofia științei și tehnologiei) dintr-o zonă geografică mai largă decât aceea oferită de moda consacrată atât din motive extra-științifice cât și dintr-o manieră încă învechită de a comunica și a valorifica cercetarea; dar și pentru că volumul ca atare este viu, provocator și foarte instructiv.

Titlul cărții este suficient de sugestiv pentru a ne face să ne concentrăm asupra unei probleme vechi: dialectica intuiției, a descoperirii – psihologia ei mișcându-se între sclipiri de intuiții și cunoștințe stocate în memorie – și logica compunerii cunoștințelor din ipoteze, și pe de altă parte, demonstrarea și verificarea lor. Tărâmul științei este cel mai favorabil pentru înțelegerea acestei dialectici și constituirea ideilor care sunt dovada a ceea ce este cel mai sigur pentru oameni: „lumea 3", cum a numit Popper regatul rezultatelor umane ale intelecției lor și, deși trecătoare și perisabilă atât în unicitatea, cât și în soarta lor cosmică, totuși singura dovadă

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certă a raţiunii de a fi a lui *homo sapiens* în cadrul existenţei multiversale. Aşadar, puterea de a crea este secretul genialităţii umane, iar modul de a crea ştiinţă este o parte principală a acestui secret.

Step 12. WHEN DO SCIENTISTS ALLUDE TO INTUITIVE THINKING?

"There is no logical path to these laws; only intuition, resting on sympathetic understanding of experience, can reach them."

Albert Einstein

We never can be sure of our understanding of the ways of great discoveries unless we are able to explicate the conception of intuitive thinking. One may constantly doubt with good reason whether had not geniuses of science made their great discoveries just with the help of their immense power of intuition. The latter position is laconically expressed in Poincaré's statement, "*Intuition* is the instrument of invention". So 1et us examine what is assumed by the term "intuitive thinking".[2]

The most apparent feature of the use of the term *intuition* is its striking ambivalence. In one of the recent investigations of the subject the situation is characterized as a "semantic jungle". No surprise that some authors admit that intuition is little understood though highly treasured and sought after.

Yet in one point all writers on intuition are unanimous. They all account just to intuition discoveries and inventions as well as other forms of intellectual insight.[3] Quite naturally, many writers strongly believe that intuition, whatever it might be, is the highest capacity of human mind. Some thinkers go further and insist that reason is only the "*servant*" of intuition. Scientists usually avoid this kind hurting expressions though they would readily agree with Poincaré's general assessment: "It is by logic that we prove; it is by intuition that we discover".

There are three main approaches to the phenomena labeled as intuitive. The oldest tradition is the mystical. Its followers use the term "*intuition*" to indicate intellectual

[2]Though one can trace almost all theoretical conceptions of human cognition back to Aristotle it comes out that he never used the term "intuitive thinking" in his theory of cognition and knowledge. But in the Nicomachean Ethics there is a certain admission of intuitive reasoning. "The intuitive reason, "explained Aristotle, "deals with ultimates at both ends of the mental process; for both the first and the last terms, that is both first principles and particular facts, are intuitively and not logically perceived... As universals then are reached by way of particulars, these facts must be grasped by perception, in other words, by intuitive reason." But one should not take this remark as an assumption of a special type of human cognition. Aristotle had clearly stated in the *Analytics* that the first principles and universals are reached through induction. Since particular facts are grasped by perception, and this is qualified as reached "by intuitive reason", it must be concluded that Aristotle's "intuitive reason" is identical to sense perception.

[3]It must be mentioned here that some writers like to propagate a romantic vision that Einstein created his theory of special relativity just by pure intuition, in complete isolation from the problems of theoretical physics and achievements of his predecessors. For instance, Jeremy Bernstein insisted that "in the creative work of a great physicist, "intuition" – a feeling of how the universe should be – plays a more important role in formulating this axiomatic structure than the results of any given experiment". (Jeremy Bernstein, *Einstein*. New York, Penguin Books, 1973, p.52.) To prove his position, he quoted Albert Einstein's remark on the Michelson-Morley experiment in an interview with a historian of physics a year before his death: "In my development Michelson's result has not had a considerable influence. I even do not remember if I knew of it at all when I wrote my first paper on the subject". But historians of physics and Einstein's biographers are not sure whether did the aging sage recollect the relations of the past correctly. Einstein himself had mentioned that he studied thoroughly Lorentz classical work on electrodynamics. And just in that book Lorentz presented in detail the famous hypothesis of relativistic contraction to overcome the principle difficulty, which arose from the negative result of the Michelson-Morley experiment.

phenomena regarded as extra-sensual, supernatural or even magical. Very close to this position stand writers who consider intuition among other alleged demonstrations of instinctive or unexplainable activities of human intellect. One can include into this group also those conceptions that consider religious experience as a phenomenon going beyond reason and unreachable for human limited powers of rational cognition. At present this approach to intuition is characteristic to writings propagating Eastern mystical teachings like Yoga and Zen Buddhism.

The second tradition comes from philosophers. To build a complete theory of knowledge, philosophers often have to struggle with the problem of "direct" cognition. To overcome related difficulties, some thinkers eventually introduce into epistemology the assumption of the knowledge gained directly by insight or intuition.

The third line of approach to intuition is presented by the conception of unconscious (or subconscious) creative thinking. It was first proposed by Henri Poincaré and soon became the prevailing conception of intuition and insight in the twentieth century psychology.

The most strange general feature of the above approaches is the fact that the mystical approach to intuition is quite logical, in its way, while the Poincaré conception seems lacking logic and reason in its essence. The mystical approach considers intuitive thinking as supernatural and magical. So it is quite reasonable that the proponents of mystical conception regard intuition as a power that cannot be understood. Poincaré tried to propose a rational conception of the process of scientific discoveries. But the main principle of his conception is the statement that scientific discoveries emerge out of unconscious or subconscious activity of human intellect. How can one hope to develop a rational theory of phenomena that are declared being out of reach of consciousness?

Returning to the problem of intuitive thinking we again have to deal with the main difficulty of its study. The phenomenon of intuition remained for many centuries elusive and puzzling mainly because the term was used in different and often incompatible meanings. Modern investigators of intuition were forced to develop special strategy to tackle this state of matters. They start their research by a systematic review of all meanings in which the term intuition is used. And then investigators try to build a theoretical-psychological model of the process of intuitive thinking that could be accounted for all fixed meanings of the term.[4]

Building this kind of "*totalitarian*" conception of intuitive thinking appears to me an impractical task. In fact, this book does not need an all-embracing theory. I will be completely satisfied if I reach a conception of intuition successfully explaining the main features of its demonstration in the process of scientific discoveries. So my research of intuition I limit with cases when scientists feel themselves forced to use the term intuition. As you will see, this approach of self-restriction helps to develop a completely rational conception of intuition that can be called "*the theory of scientific intuition*".

So, when does scientist allude to intuition? First of all, a scientist is driven to use the concept "intuition" when he is asked a straightforward question, "How did you come to your great discovery?" In the long history of science, no scientist was ever able to tell the successive steps of his thought that eventually brought him to his great idea. As a rule, the answer to this seemingly simple question is as follows: "*I made my discovery*

[4]One should posses an unlimited optimism if he is going to build a model explaining all meanings of the term intuition. The Oxford Dictionary tells of twenty different properties of intuition and insight, many of which appear completely incompatible with each other. Webster's New International Dictionary suggests a more limited set of characteristic features of intuition: "Revelation by insight or innate knowledge, a form of knowing that is akin to instinct or a divining empathy and gives direct insight. Quick and ready insight. The act or process of coming to direct knowledge or certainty without reasoning or inferring." But even this limited set involves a striking variety of notions like insight and innate knowledge, instinct and divine empathy, quick processing and ready answers, direct knowledge and complete certainty.

intuitively".

Trying to explain to the readers of *The Evolution of Physics* the phenomenon of sudden intuitive illumination, Albert Einstein found it most appropriate to refer to the experience of Conan Doyle's famous hero. So how did Sherlock Holmes found out solutions of numerous mysteries? The apparent answer is as follows, "*He plays his violin, or lounges in his armchair enjoying a pipe, when suddenly, by Jove, he has it!*".[5]

Of course, by telling that discoveries were made by intuition scientists did not unveil the way that led them to their striking success. Most probably, it is objectively impossible to reconstruct the successive steps that had eventually brought to any given great discovery. "*All rising to great place is by a winding stair*", believed Francis Bacon. Yet scientists never appeared capable to account for the steps by which they climbed by this legendary stair. The main reason is that actually there were not successive steps by which the scientist came to his discovery. In the process of his research, a scientist tries so many approaches, suggests and rejects so many ideas, spends so many days and weeks in the full darkness of the labyrinths of the tantalizing problem that there could be few traces of the successive steps of its solution. At least, all writers on intuition agree that when a scientist arrives at his great idea there is little if any awareness of the process by which he reached it. Jurgen Rehm and Volker Gadenne find this point of absence of clear awareness so essential that they define intuition as "judgments with no awareness about the rules for inference".[6] In his original characteristic of intuitive thoughts B. Clynche pointed out, "*I think we mean that we know something without knowing how we came to know it and without being able to prove it*".[7]

Subjectively, no great scientist is ready to admit how many fruitless approaches he had tried and what kind of apparently wrong ideas he had considered on the way to his discovery. Post factum, when the problem is solved, many people can clearly see the direct and wide road that led to the discovery. So it is very hard and painful for an explorer to tell people the real zigzag path of his research that often went in curious and even apparently wrong directions one could hardly expect from a great thinker.[8]

[5] Albert Einstein and Leopold Infeld, *The Evolution of Physics*. New York, Simon and Schuster, 1961, p.4.

[6] Jurgen T. Rehm and Volker Gadenne, *Intuitive Predictions and Professional Forecasts*. New York, Pergamon Press, 1990, p.7.

[7] Quoted in Tony Bastick, *Intuition. How we think and act*. New York, John Wiley & Sons, 1982, p.52.

[8] Only Max Wertheimer claimed that he had succeeded to clear out the details and "concrete events of thought" that brought Albert Einstein to the discovery of the theory of relativity. He was well aware that Einstein's famous papers and more popular lectures give only the final results and did not tell "the story of his thinking". So when in 1916 there appeared a lucky chance to talk with the great genius, Wertheimer tried hard to learn the most exciting point – the steps of thought that brought to the revolutionary discovery. Unfortunately, Wertheimer's account, which was first published in 1945, does not contain any single detail of the presentation of the theory of relativity that had not been widely known by that time. Moreover, Wertheimer insisted that during his talks with Einstein he understood that Michelson's experiments appeared to Einstein as "crucial" ones, very important and even "decisive". (Max Wertheimer, *Productive Thinking*. New York, Enlarged edition 1959, (First edition 1945), pp.213, 217.)

In fact, by 1916, Einstein did not explicitly mention Michelson's results in none of his numerous papers on relativity. For this same reason, one cannot be completely sure also in details of Professor Ishiwara's notes of Albert Einstein's lecture on relativity given in Kyoto in December 1922. According to these notes, Einstein's account of his early research of the problem of relativity was as follows: "While I cannot say exactly where that thought came from, I am certain that it was contained in the problem of the optical properties of moving bodies. When I first thought about this problem, I did not doubt the existence of the ether or the motion of the Earth through it.

"While I was thinking of this problem in my student years, I came to know the strange result of Michelson's experiment. Soon I came to the conclusion that our idea about the motion of the Earth with respect to the ether is incorrect, if we admit Michelson's null result as a fact. This was the first path which led me to the special theory of relativity. (Albert Einstein, *How I created the Theory of Relativity*.

In short, when scientists use the term "intuition" to account for ways that brought them to their great discoveries, in actuality, they just conceal the objective impossibility and subjective inability to reconstruct the successive steps on the way to their discoveries. Bernard Cohen pointed out that Albert Einstein strongly believed that scientists have no certain idea about the process of their discoveries.[9]

Admitting explicitly or implicitly that there were no successive steps leading to revolutionary ideas, many methodologists conclude that intuitive thinking to which they account great discoveries should be non-logical. So it sounds quite convincing when adherents of this viewpoint define intuition as "conscious awareness without logical reason". In the Middle Ages scholars made strict distinction between the logical power of *ratio* and the *intellect*, the latter interpreted as the power of direct insight. Some authors even believed that intuitive thinking is illogical.

The characteristics of the activity of an exploring mind as of non-logical process can be accepted only in some special sense. One just should bear in mind that by the term "non-logical thinking" here is understood the fact that for this kind of thinking there are no strict formal rules. But the absence of a rigorous logic of discoveries does not mean that there is no logic in the process of scientific research. We have proved above that any discovery is made with the help of method of hypotheses, its main phases being the analysis of the problem and idea generation by analogy. Of course, the method of hypotheses does not guarantee solutions of research problems. In that sense, the ways of an exploring mind are non-logical. But the hypothetical-deductive methodology provides the optimal organization of the undertaken research. Analytic-synthetic procedures are the real logic of research and discovery. So if the intuitive thinking is to be accounted for great discoveries, it would be totally wrong to characterize it as non-logical, and least of all, illogical.

Another type of situation inclining people to accept the idea of intuitive thinking is related to the well-known ability of outstanding professionals to solve complex problems almost instantaneously. Many famous physicians were able to diagnose momentarily cases of illnesses that appeared to their colleagues perplexing and puzzling. Talented mathematicians instantly find out solutions of problems that turned on as being very difficult and practically insurmountable for ordinary investigators.[10]

The impression from such instantaneous solutions is that scientists break the complex problems from the first sight, just at the very moment of their presentation. There is, apparently, no time spent for the analysis of the given problem and search of prototype problems, for idea generation and checking of solutions. In the case of such "*instantaneous*" solutions, scientists are again in difficulty to account the intermediate steps of the process of solution. They believe that the true solution was revealed to them momentarily. Naturally, only intuition could be supposed as the mental mechanism of such an insight.

In: History of Physics. Readings from Physics Today. New York, American Institute of Physics, 1985, p.244.)

It should be noticed here that Albert Einstein had never checked the correctness of details of Professor Ishiwara's notes since they were published in 1923 in Japanese only.

[9] "Einstein said most emphatically," recalled Bernard Cohen, "that he thought the worst person to document any ideas about how discoveries are made is the discoverer." (Bernard Cohen, *Einstein and Newton*. In: Einstein. A Centenary Volume. Ed. by A. P. French. Cambridge, Harvard University Press, 1979, p. 40.)

[10] There is an excellent example concerning Richard Feynman. In 1967, James Bjorken carried on complex theoretical calculations of high-energy electron-proton collisions that were studied experimentally at the Stanford Linear Accelerator. Learning accidentally the main feature of the experimental data and some of Bjorken's results, Feynman succeeded to interpret the data with the help of his own model of elementary particle interactions. And it took Feynman only an evening of calculations. (John and Mary Gribbin. *Richard Feynman. A Life in Science*, p.198.)

But let us not hurry with conclusions. First, let us clear up which type of problems are solved momentarily? An instantaneous correct diagnosis of the illness of a given patient can suggest only an experienced physician who met in his practice many similar cases of diseased people. Similarly, a mathematician is able to see momentarily only solutions of familiar problems that previously did demand a good deal of time and effort.

In general, momentarily solutions are characteristic only for people who have sufficient experience of dealing with a given type of problem. Experts in the given field solve familiar problems quickly and correctly. We can admit they have a significantly strong intuition in their field of activity. But if they are suggested an unfamiliar type of problem, it will take them significant time to reach the solution. Their strong intuition is helpless dealing with unfamiliar problems. So we can now see that momentarily solutions do not require a special type of thinking or some unordinary ability. Simply, in the case of familiar problems, the analysis of a given problem takes place almost momentarily while the prototypes for idea generation are always at hand.[11]

The third source of the assumption of the existence of intuitive thinking is related to the well-established fact of discoveries made in the moment of insight. "*The single ¡right¿ answer comes in a flash of knowing*", believe D. J. Schallcross and D. A. Sisk.[12]

The flash of insight often takes place in circumstances when the explorer had put his research problem aside and was busy with some activity that had nothing in common with his previous research. The explorer himself is usually sure that at the moment of such an insight he had not made any conscious effort to solve his research problem. On the other hand, the solution itself came to the explorer as a momentarily vision of the true idea. George Polya describes the moment of illumination and insight as follows: "*After brooding over the problem for a long time without apparent progress, we suddenly conceive a bright idea, we see daylight, we have a flash of inspiration*".[13] So it is quite natural that people were inclined to explain such a spontaneous vision of the true solution as a clear evidence of cooperation of divine forces. Mathematicians like to quote Gauss' account of one of his discoveries, "*I succeeded not on account of mine painful efforts, but by the Grace of God. Like a flash of lightning the riddle happened to be solved*".[14]

But from the beginning of the twentieth century, almost all psychologists and methodologists explain the phenomenon of spontaneous insight with the help of conception of subconscious creative thinking. Since it is the predominant conception in this field, I will discuss it in the chapter that follows.

[11]Suppose we suggest a brilliant scientist to solve a chess problem. It is quite clear that if the scientist has not sufficient experience in solving chess problems, he will face serious difficulties. Even simple problems, if unusual, will take him a good deal of time and serious effort. But if a problem is an ordinary one and very familiar, its analysis and solution take place almost instantaneously. Considering these cases of fast solutions Mario Bunge pointed out, "Intuition is very fast reasoning, so fast that the process is not appreciated as reasoning".

[12]Doris J. Schallcross and Dorothy A. Sisk, *Intuition. An Inner Way of Knowing.* Buffalo, New York, Bearly Limited, 1989, p.6.

[13]George Polya, *Mathematical Discovery. On Understanding, Learning, and Teaching Problem Solving*, vol.2. New York, John Wiley & Sons, 1965, p.54.

[14]Quoted in W. H. Leatherdale, *The Role of Analogy, Model and Metaphor in Science.* Amsterdam, North-Holland Publishing Company, 1974, p.13.

Step 13. THE HYPOTHESIS OF SUBCONSCIOUS THINKING

"Alas! How easily things go wrong!."

B. Dowling

There can be no doubt that people keep reasoning and proving by conscious effort. Already from the fourth century B. C., educated people learned from Aristotle's Analytics the strict rules of deduction and the principles of rational proof. But modern world's attitude to deductive reasoning, especially to its scholastic theory, was that of a dull and unproductive kind of human thinking. What seemed much more attractive was the process of idea generation, especially the mechanisms of discoveries and inventions.

Rene Descartes believed that the ability to solve scientific problems should be determined by some inborn factor. This ability was considered, by contrast to formal-logical thinking, as belonging to a higher level of cognition that could provide productive and creative forms of thinking. "*The human mind*", wrote the French thinker, "*has within it a sort of spark of the divine, in which the first seeds of useful ways of thinking are sown, seeds which, however neglected and stifled by studies which impede them, often bear fruit of their own accord*".[15]

It was quite clear that just theoretical discoveries present the most important instances of creative thinking. So, psychologists were eager to question famous scientists on their personal experience concerning the subtle phenomenon of high level cognition as well as of the special state of mind in the process of great discoveries.

Henry Poincaré, the prominent French mathematician and physicist, was one of the most famous scientists by the end of the nineteenth century.[16] Quite naturally, the Society of French psychologists asked him to tell some facts and details of his own personal experience in regard of state of mind in which his theoretical discoveries had been made. Poincaré himself liked to speculate upon general philosophical and methodological aspects of science and scientific knowledge. So he readily agreed to the suggestion of French psychologists. Moreover, Poincaré not only recollected some startling facts concerning his own scientific explorations, but also suggested a possible theoretical explanation for them.

The most remarkable fact accounted by Poincaré was about the circumstances in which one of his mathematical discoveries had been made. For several weeks Poincaré was absorbed in the research of a difficult problem in the theory of functions. The investigation advanced very slowly. Feeling himself exhausted by unproductive attempts of solution, Poincaré put aside the stubborn problem and left Paris for a short rest. Poincaré made no attempt to return to his research problem at his vacation. But one beautiful day, during a sight seeing trip, just amidst a talk with his friend, he suddenly realized the solution of the abandoned problem.[17]

[15]René Descartes, *Rules for the Direction of the Mind.* – In: The Philosophical Writings of Descartes, vol. 1. New York, Cambridge University Press, 1985, p.17.

[16]In Donald Davis' assessment, Poincare was "one of the most famous mathematicians of the time". (Donald M. Davis, *The Nature and Power of Mathematics.* Princeton, New Jersey, Princeton University Press, 1993, p.68.)

[17]Since Poincaré's account is the most significant factual basis of all modern conceptions of the psychology of creative thinking, I would like to quote it in more detail. Here is Poincare's story of his study of the so-called Fuchsian functions: "I wanted to represent these functions by the quotient of two series; this idea was perfectly conscious and deliberate; the analogy with elliptic functions guided me. I asked myself what properties these series must have if they existed and succeeded without difficulty in forming the series I have called thetafuchsian. "Just at this time. I left Caen, where I was living, to go on a geologic excursion under the auspices of the School of Mines. The incidents of the travel made me forget my mathematical work. Having reached Coutances, we entered an omnibus to go to some place or other.

To explain this fact of his own creative biography, Poincaré first considered the most probable factor, namely, the positive effect of having a good rest. After the exhausting weeks of research, his tired mind apparently got a good deal of rest. So, returning to his research problem, Poincaré could tackle it with a renewed mental power and consider it from a fresh viewpoint, a circumstance that always appeared very essential in problem solving.

But this reasonable explanation was unacceptable for Poincaré. He was completely sure that he did not attempt to examine the problem during his above-mentioned trip. Poincaré remembered well that the moment the solution flashed his mind he was involved in an interesting discussion with his friend.

The cardinal feature of the accounted phenomenon was that the discovery came all of a sudden, without any conscious effort. So Poincaré concluded that any acceptable explanation should assume some mechanism of unconscious thinking. "*Most striking at first is this appearance of sudden illumination, a manifest sign of long, unconscious prior work. The role of this unconscious work in mathematical invention appears to me incontestable*", summed up his personal observations the French prominent explorer.[18]

This line of argumentation eventually brought to the hypothesis of subconscious mechanism of creative thinking. Along with the conscious work of mind, there should be at work some yet unknown subconscious level. Moreover, the subconscious mind should work continuously, even while the conscious mind was at rest. And the moment when an idea of solution eventually appeared on the subconscious level, this idea would be pushed up to the surface to the conscious level where it would be perceived as a spontaneous solution coming from nowhere.

If one agrees that scientists, taking rest after a hard research, completely abandon their research problem, then Poincaré's account and many similar cases of sudden insight could be explained only assuming the existence of the subconscious level of creative thinking. Possibly that was the reason why psychologists and scientists accepted Poincaré's conception of subconscious thinking almost unanimously.

In actuality, the hypothesis of subconscious thinking meets insurmountable difficulties. Poincaré himself realized some of them. As an experienced scientist he knew well that there might be no insight into the solution of a research problem if it had not been consciously analyzed beforehand. No theoretical problem can be solved without previous conscious efforts to understand it. In face of this undeniable truth, Poincaré had to admit that sudden inspiration and insight "*never happen except for some days of voluntary effort*". Jaques Hadamard, a devoted follower of the conception of subconscious creative thinking, had to st ate clearly: "*Discovery necessarily depends on preliminary and more or less intense action of the conscious*".[19]

Another essential weakness of the conception of subconscious creative thinking is linked to the fact that it neglected at large the phases and steps of the process of problem solving. From all these essential and complex processes only one point was considered, namely, the combination of ideas. At the start of investigation, there are plenty combinations of ideas that can be regarded as useful for the solution of the problem under research. In fact, most of them appear to be of no help for the undertaken research. But the conscious mind perceives only "*fruitful*" combinations or some of those that could be fruitful. How can the conscious mind avoid considering the huge amount of fruitless

At the moment when I put my foot on the step, the idea came to me, without anything in my former thoughts seeming to have paved the ways to it, that transformations I had used to define the Fuchsian functions were identical with those of non-Euclidean geometry." (Quoted in Jacques Hadamard, *An Essay on the Psychology of Invention in the Mathematical Field.* New York, Dover Publications, 1954, p.12.)

[18] Jaques Hadamard, *op. cit.*, p.14.

[19] Jacques Hadamard, *op. cit.*, p.44

combinations? Being completely isolated from the logic of problem solving, Poincaré and his followers failed to realize the role of the analysis of the problem as of the most effective means to cut off all the irrelevant information and possible combinations. For this reason, they could suppose only the possible help coming again from the hypothetical unconscious.[20]

Returning back to the main obstacle of the conception of subconscious thinking. It is almost unanimously accepted that there could be no solution of a serious scientific problem if it is not thoroughly analyzed at the conscious level. To save his hypothesis of subconscious thinking, Poincaré had to add a new assumption: the subconscious creative thinking should be "*triggered*" on by the conscious analysis of the problem under research. The conscious efforts to reach the solution "*set going the unconscious machine*". Without preliminary conscious work over the given problem, explained Poincaré, the unconscious machine "*would not have moved and would have produced nothing*".[21] This artificial ad hoc assumption cannot be properly defended. No one can answer what can prevent the subconscious thinking to begin on its own the investigation and solution of research problems. Especially if one bears in mind that the subconscious mind was supposed to be able to solve problems that appeared unsolvable during intensive conscious research.

Another serious difficulty arises in regard of the phase of "*incubation*". When the problem under research is supposed to be processed on the subconscious level, the period of time during which the solution is found out Poincaré characterized as the phase of "*incubation*". But it is well known that many discoveries have been made in result of the conscious investigation of the research problem just "*sitting at the desk*". So Poincaré was forced to make another additional assumption according to which creative thinking can proceed in two parallel lines – one conscious, the other – subconscious.[22]

If psychologists were not so much fascinated by the romantic hypothesis of subconscious creative thinking, they could easily deny the conception of "*incubation*" experimentally. Suppose a group of students is given a problem of medium difficulty. After a short conscious analysis the students are told, according to the plan of the experiment, to sweep aside the problem till the next meeting. According to the conception of unconscious thinking, in these conditions of the experiment the given problem would be transferred to the phase of subconscious "*incubation*". But if the next meeting with the students of this experimental group were scheduled to take place after several weeks or

[20] "It is obvious that invention or discovery, be it in mathematics or anywhere else, takes place by combining ideas," asserted Jacques Hadamard the principle position of his great forerunner. But being isolated from the theory of problem solving, he could hardly see any other way but that of assuming the unconscious construction of possible combinations of ideas and choosing the fruitful ones among them, again on the level of unconscious thinking. Moreover, forgetting that this assumption itself needs a proof, Hadamard made from it far reaching conclusions on the nature of the subconscious thinking. "This shows us again," insisted Hadamard, "the manifold character of the unconscious, which is necessary to construct those numerous combinations and to compare them with each other." (Jacques Hadamard, *op. cit.*, p.29.)

[21] Some psychologists prefer to speak of the complementarity of the conscious logical investigation and the subconscious intuitive thinking. "Intuition is not opposed to reason, but works with it in a complementary fashion," wrote Frances Vaughan. Yet he, like many other psychologists, believed that the rational and conscious part of research "would, in fact, be useless if it were not complemented by the intuition that gives scientists new insights and makes them creative". (Frances E. Vaughan, *Awakening Intuition.* New York, Anchor Books, 1979, p.150.)

[22] There is plenty of evidence that "the Eureka experience" and insight come after a certain interval of delay time, which sometimes can take weeks, months, and even years. But do these facts prove that during these periods of delay the unsolved problems had undergone the process of "incubation"? Of course, the idea of incubation can be evaluated as a very hypothetical assumption only. "The incubation period," points out Tony Bastick, "has given writers the idea that the subconscious mind has been somehow "reasoning" or working on the information in the same way as the conscious mind would reason, and when the answer is reached it pops into consciousness. Hence they wrongly infer that intuition is the same type of process as analytic reasoning but at a preconscious level." (Tony Bastick, *Intuition. How We Think and Act.* New York, John Wiley & Sons, 1982, p.147.)

months, it would come clear that most of the students had just forgotten the problem, at least its many significant parameters. That would prove that there is neither a process of "*incubation*" nor the hypothetical subconscious level of creative thinking.

There is another insurmountable difficulty for Poincaré's conception also. Ideas produced by a spontaneous insight and illumination are of a very general nature. Insight and illumination give birth to a general scheme of solution only. Moreover, Poincaré was aware that the subconscious is unable to accomplish simplest calculations. But what kind of intellectual capacities are needed for simple calculations? These are the abilities to identify and compare, which, in turn, suppose some minimal memory. Since it is evident that the hypothetical subconscious mind is unable to accomplish even the simplest calculations, it must be admitted that the subconscious intellect is lacking at least one of the above mentioned intellectual abilities. But if subconscious mind has not a minimal memory or is unable either to identify or compare, it never can function as an effective cognitive instrument. That means that if the subconscious level of thinking even existed, it would be absolutely unable to solve any research problem.

Step 14. THE LAW OF CONSTANT ALERTNESS

"True insight is a divine reward for the never-resting mind."

Anonymous

We have revealed above the characteristic situations where referring to intuitive thinking seems necessary or at least useful. First, it is when famous scientists are unable to recall the successive steps of their great discoveries. Second, distinguished professionals often demonstrate their ability to solve problems in their field of activity almost instantly and effortlessly. The third and most impressive case is that of a sudden insight and spontaneous solution of a difficult research problem. But in all these cases the term intuition just helps to conceal the inability to explain rationally the said startling phenomena.

Now I will show how convincingly one can build the rational conception of intuition and insight on the ground of the above outlined analytic-synthetic conception of the logic of research and discoveries. According to this conception, any research problem is solved by the successive cycles of analysis, synthesis, and verification. Idea generation is always accomplished by an analogy with the solution of some similar problem. Regarding the case of great discoveries, one has to look for very remote prototype problems that often seem to be so irrelevant to the problem under research that only crazy people may consider them seriously.

This is the real logic of great discoveries. But this logic never assumes a sequence of successive steps that can *guarantee* the solution of the research problems. In fact, the logic of scientific discoveries is a kind of logic of *search*, which makes it only probable that the solution of the problem under research will eventually be revealed. On the other hand, this logic provides the optimal way for the search of the solution of a given problem. The analytic-synthetic conception does not make an over-ambitious claim, but it provides the true method of effective research.

Bearing in mind this specificity of the logic of great discoveries, one can easily understand why is it so difficult for famous scientists to tell the sequence of thoughts that actually have brought them to their discoveries. The main point is that there never existed a logical sequence of steps on the way to a great discovery. All was achieved by an unceasing search, by climbing and falling, retreating and sidestepping.

Now let us consider the second case when the term "*intuition*" denotes the ability of outstanding professionals to solve the problems of their field of activity almost without

any effort. Let us ask three simple questions. Can a professional effectively solve problems of his field of activity if he is not endowed by sufficient level of intellectual capacities? The negative answer is entirely clear. So we conclude that the first necessary component of intuition is the sufficient level of intellectual capacities, namely the abilities of problem analysis and idea generation.

The second question is the following: *Can a professional effectively solve problems of his field if he has not sufficient knowledge concerning the subject of research?* It is evident that he cannot. So the second necessary component of intuition is the sufficient amount and level of relevant knowledge.

Now the third question.*Can a new-comer have a strong intuition in the given field of activity?* Surely, he cannot. Simplest research problems can puzzle a newcomer. One cannot seriously speak about the intuition of an inexperienced newcomer in a given field. Only the intensive personal research experience brings to the formation of strong intuition. As E. Fishbein had underlined, "*Intuitions base themselves on mental habits*". Only systematic activity and experience form habits. Without personal experience any theoretical knowledge remains a kind of abstract speculation. Only experience provides effective use of general knowledge. Life constantly confirms the wise saying that one thorn of experience is worth a whole wilderness of warning.

With the help of these three questions we have uncovered the *necessary* components of intuition, namely, intellectual capacities, knowledge, and experience. But, perhaps, these three components are also *sufficient* for the formation of intuition? In fact, they are. Consider a professional having high intellectual capacities, deep knowledge of the field of his investigation, and rich personal research experience in the given field. It is quite evident that such a scientist will solve problems of his field most effectively, often without a notable effort. We would have a good reason to say that this scientist has developed strong intuition.

Thus, one must accept that the intellectual capacities of a person together with his knowledge and experience are the necessary and sufficient components for the formation of scientific intuition.[23]

But how can one explain from this viewpoint the really startling cases of spontaneous solutions of difficult problems usually accounted to the activity of the mysterious insight and intuition? If we assume for a moment that shifting aside the problem under research the investigator totally forgets about it, then the assumption of the existence of subconscious creative thinking would seem unavoidable. But in the above discussion we have convincingly demonstrated that the assumption of subconscious creative thinking is completely fruitless.

So let us consider again the situation when a scientist puts aside an important problem he has not succeeded to solve. Does his mind *totally* forget about the unsolved problem the moment the problem is shifted aside? Of course, it does not. Such a problem is just shifted from scientist's short-term operative memory into the general memory. More than that, the stubborn problem has, for many reasons, a very special standing for its investigators conscious mind. First, the problem is evidently very important to him since he has explored the problem to the level of self-exhaustion. Second, the failure to solve a significant problem hurts investigator's pride and self-esteem. These two factors do not permit the scientist to forget the abandoned problem. "*You cannot get rid of your problem, it follows you everywhere*", noticed George Polya. Even putting the stubborn problem aside, the investigator remains continually aware of its existence. "*A number of pioneering studies carried out during the early years of the century showed that people are surprisingly good at focusing their attention upon a given task and ignoring irrelevant*

[23]I have presented my conception of intuition first in my book —em The Methodological Analysis of the Process of Discoveries and Inventions, Yerevan, 1984 (in Russian).

events in their immediate surroundings," pointed out James Reason.[24] When asked by friends how he succeeded to make his great discovery of the law of universal gravitation, Newton revealed his secret, "*I continually kept thinking about it*".

My hypothesis is that in the case of spontaneous insight this awareness is of an extreme level. In regard of the abandoned important problem the mind of a scientist seems to be in a state of constant alert. The important problem, even put aside and apparently abandoned, remains for its investigator actually the problem no.1. Each new piece of information, each new association is processed in the light of this dominant task. In Leibnitz' words, scientist's "*spying attention catches whatever seems relevant*". Such a constant readiness to hit the target brings, sooner or later, to an analogy, to some remote prototype problem that gives birth to the idea of solution. A biographer mentioned on Newton, "*What he thought, he thought on continually*". Newton himself described his attitude as follows: "*I keep the subject constantly before me and wait until the first dawnings open slowly, by little and little, into a full and clear light*".[25]

To prove further my hypothesis of the state of constant alertness, I would like to examine what kinds of ideas are produced by spontaneous insight. Any discovery is started by insight, but no discovery is born as a complete creation. A discovery first comes to light only as a general idea, as the main principle of solution. The moment of insight illuminates just the general idea, the main pattern. Only further examination reveals the complete structure and provides detailed proof of the new theoretical conception. Characterizing solutions brought to light by momentary insight, Poincaré himself mentioned that the only thing that the subconscious creative mind is able to uncover is the general idea of solution. This kind of insight or illumination is the departure point for further complete theoretical elaboration by the investigator.

Being in the state of constant alert, the mind of an investigator conceives all new information as a hint or possible way that can lead to the solution of the problem he was forced to shift aside. So when investigator's searching mind meets such an information and realizes that the long awaited idea is finally found out, there arises a feeling of illumination, of a sudden clear vision of the truth. Naturally, the investigator perceives this momentary vision of the true path as some divine insight, as an instance of heavenly illumination. In actuality, it was just the moment when some new information or momentarily association helped the investigator to realize that the problem under research could be solved by analogy with a certain prototype problem.

It is interesting that the insight, which helped Poincaré to build his conception of subconscious thinking, was just a case when an investigator succeeded to see a remote analogy leading to the solution of his research problem. In his paper, Poincaré recalled that he, in the moment of sudden illumination, had realized that there was an analogy between the particular problem of the theory of functions he was unsuccessfully exploring and the non-Euclidean geometry, which he knew quite well.[26]

[24] James Reason, *Human Error.* Cambridge, Cambridge University Press, 1990, p.27.

[25] Quoted in Richard S. Westfall, *Never at Rest. A Biography of Isaac Newton.* Cambridge, Cambridge University Press, 1980, p.174.

[26] In face of the importance of my claim that insight and illumination are just the moments when a scientist realizes the existence of an analogy between the problem he intended to solve and some problem already solved, I would like to present a direct evidence from Poincaré's famous story. "At the moment when I put my foot on the step," tells Poincare, "the idea came to me, without anything in my former thoughts seeming to have paved the way to it, that transformations I had used to define the Fuchsian functions were identical with those of non-Euclidean geometry." You see, all the illumination was the realization of the analogy (or identity, in Poincare's terms) between the Fuchsian functions and non-Euclidean geometry. In the second important case of Poincaré's story, the insight again revealed an analogy. Here is Poincare's own evidence. "One morning," recalled Poincaré, " walking on the bluff, the idea came to me, with just the same characteristics of brevity, suddenness and immediate certainty, that the arithmetic transformations of indefinite ternary quadratic forms were identical with those of non-Euclidean geometry". (Quoted in Jacques Hadamard, *An Essay on the Psychology of Invention in*

That the exciting moment of illumination is just the moment when an explorer realizes some helpful analogy can be clearly traced also in Paul Dirac's recollection of the circumstances of his discovery of the method of matrix commutation in quantum mechanics.[27]

It is widely accepted that analogy is the most usual means of idea generation during normal conscious research. I am sure, if people read more carefully the essay of Poincaré and noted that his psychological interpretations concerned just a case of analogy, they would be less inclined to adopt the romantic and mysterious conception of subconscious thinking.[28]

It should be realized also that the flash of insight more readily illuminates the mind of a man who has sufficient level of the necessary components of intuition – analytic-synthetic abilities, knowledge and personal experience – and has carried on sufficient amount of preparatory conscious research of the problem. An ingenious idea takes its sudden birth when two remote pieces of information (that of the problem under research and of the prototype problem) meet each other spontaneously. But to realize the historic meeting, one has to have the necessary abilities and, what is even more important, one must be on constant alert. "*Hunches, global grasps, and other forms of intuition*", explained Mario Bunge, "*occur as a result of the careful analysis of problems, as a reward for patient and often obsessive preoccupation with them*".[29] E. W. Sinnot even insisted on the necessity to be "*immersed' in the subject of the undertaken research: "*Such inspirations, it is well recognized, rarely come unless an individual has immersed himself in a subject. He must have a rich background of knowledge and experience in it... without this flash the creative process might never have been able to get started*".*[30]

A good theory is the most practical thing. Conversely, a bad theory can be very damaging. Consider the conception of subconscious creative thinking. If one strongly believes that discoveries are made on the level of subconscious mental processes, then it will be quite reasonable to suppose that any conscious effort to solve the problem under research is directly hindering the process of subconscious discovery. Advocates of such an extreme viewpoint advice scientists:" Let the subconscious to do the work".[31] A similar advice you can meet in the works of writers propagating the mystical interpretation of intuition. They teach to rely fully on intuition and inner feelings. "*Intuition can and does cut through confusion to show you what is true*", declares Frances Vaughan. But

the Mathematical Field. New York, Dover Publications, 1954.)

[27]Paul Dirac, yet an unknown young physicist, intensively worked over his problem for several weeks, day after day. Only on Sundays he put aside his research and went out of town, wandering in surrounding hills. Yet he could not get himself completely free of his research problem even during these outings. Dirac did not consider his research problem consciously, but he felt its presence at the periphery of his mind. And all of a sudden, during a routine walk, there came the insight that the problem of the commutation of Hiesenberg matrixes has a direct analogy with so-called Poisson-bracket. (Paul Dirac, *Recollections of an Exciting Era. – In: History of Twentieth Century Physics*. Proceedings of the International School of Physics "Enrico Fermi". Course LVII. New York, Academic Press, 1977, p.121.)

There are so many recollections of prominent scientists on their discoveries made occasionally during a regular quiet walk that one has to consider seriously whether was not Nietzsche right when he declared, "Only ideas won by walking have any value".

[28]W. H. Leatherdale noticed the connection of the flash of insight and a corresponding analogy. He explained that the feeling of irrelevance of the insight and preceding conscious efforts is an illusion. (W. H. Leatherdale, *The Role of Analogy, Model and Metaphor in Science*. Amsterdam, North-Holland Publishing Company, 1974, p.20.)

Close to this position came also Philip Johnson-Liard in his paper on the role of analogies in creative problem solving. (Philip N. Johnson-Liard, Analogy and the Exercise of Creativity. In: *Similarity and Analogical Reasoning*. Edited by Stella Vosniadou and Andrew Ortony. Cambridge, Cambridge University Press, 1989, p.313.)

[29]Mario Bunge, *Intuition and Science*. Englewood Cliffs, NJ, Prentice Hall, 1962, p.117.

[30]Quoted Tony Bastick, *Intuition. How We Think and Act*. New York, Wiley & Sons, 1982, p.27.

[31]See, for instance, D. E. H. Jones. *Let Your Unconscious Do the Thinking*. – "New Scientist". L., 1979, vol. 83, No. 1171, p.722 – 723.

such an advice is entirely misleading. Without conscious analysis no theoretical problem can be solved. There would be no discovery if one formulates the problem and then puts it aside hoping naively that the subconscious creative forces of his intellect would solve the problem.[32]

I would like to mention that rejecting the idea that besides the conscious thinking there exists also a special kind of subconscious thinking, I am in no way denying the existence of unconscious mental processes. I fully accept Wilhelm Wundt's remark that human consciousness realizes only the results of mental processes. All the mental processes going on in the brain are out of reach of human senses, and just in this sens they can be qualified as being unconscious.

Some finishing notes. I have proved above that intuition is the entity of problem solving capacities, knowledge and experience. So, every one has an intuition, but *just corresponding to the level of his intellectual capacities, knowledge and experience in the given field of activity.* Intuition is not alien to ordinary people and ordinary research. Just different people have different level of intuition, and different problems require different power of insight. "*All of us*", prove Tony Bastick, "*have this ability. In various degrees they [intuitions] pervade everything we do. They vary from the scientific awesome moments of creative inspiration to the day-to-day hunches and "*feelings*" which guide our common actions*".[33]

Actually, we use the term "*intuition*" only in cases of its strong and impressive demonstrations. There is no need to speak of intuition when every one sees the way to the prototype problem and to the solution itself. But when the helping analogy is so remote that there is no logical way to it or when only rich personal experience is helpful to find it out, people are inclined to account the solution to some unknown factor, calling it by mysterious term "*intuition*".

Step 15. THE LAW OF GREAT AMBITIONS

"Fortune helps the brave."

Terence

Again we return to the central question of our investigation. How it happened that the real geniuses of science, far from being endowed with outstanding intellectual abilities of talents, still succeeded to make their great discoveries?

Since it is extremely difficult to propose any satisfactory general answer to the question, let us consider the cases of each one of the real geniuses separately.

Michael Faraday carried out over 16,000 experiments to discover the laws of electromagnetic phenomena. So there can naturally arise the question if were not these 16,000 experiments enough for any scientist to discover the same laws?

Charles Darwin kept gathering new evidence on the evolution of species for almost 23 years after his return from the voyage of the *Beagle* until being pressed by the discovery of Alfred Wallace. One can agree with Loren Eiseley that without Darwin's *A Naturalist's Voyage around the World* there might have been no Wallace. But not less

[32]Strictly following the conception of unconscious thinking one can land finally at a position neglecting knowledge and experience. Reason and knowledge might appear superficial and unnecessary. Instead, students should follow T.S. Elliot's advice, "In order to arrive at what you do not know, you must go by a way which is the way of ignorance". (See, for instance, Frances E. Vaughan, *Awakening Intuition.* New York, Anchor Books, 1979.)

[33]Tony Bastick, Intuition. How We Think and Act. New York, John Wiley & Sons, 1982, p.2.

legitimate seems the assumption that Darwin, without the stimulus of Wallace, would hardly discover the mechanism of evolution.[34]

Gregor Mendel made his great discovery experimenting with peas, which appeared to be extremely helpful for genetic analysis. But Mendel failed to corroborate the laws of genetics in his following experiments. So it can be supposed that Mendel's discovery was determined mainly by the lucky choice of the experimental plant. (It is well known that a lucky circumstance, in general, had always been an important factor in empiric discoveries.)

There remains only Albert Einstein's creative biography to help us to reveal the secret of geniality. So what is the secret that helped Einstein to make his great discoveries?

To find out the answer we have to consider scrupulously the ways and steps through which Einstein made his discoveries. As it was mentioned above, an explorer meets unsurpassable obstacles when he tries to reconstruct the real path that brought them to the given discovery. To solve a serious scientific problem one has to try a huge number of different ideas and hypotheses, the predominant part of them having little to do with the final solution. So when an idea comes out to be the successful solution of the problem under research scientists cannot, as a rule, recall the strict sequence of thoughts by which the idea was born. Moreover, Paul Dirac insisted that a scientist readily forgets the way he made his discovery. Especially in view of the fact that explorers come to their discoveries by confused and winding ways, often following wrong directions of thought, while after the discovery is made it appears so clear what a simple and direct way could bring to it.[35]

Einstein's *Autobiographical Notes* contain no single sentence about the steps and ways of his discoveries. Except of few pages dealing with different aspects of his intellectual development, the remaining content of the notes is devoted to the discussion of the general aspects of the theory of relativity. In addition, Einstein himself reminded the reader that "*every reminiscence is colored by today's being what it is*". So he concluded that what he had said in these autobiographical notes were true "*only within a certain sense*". I would like to mention also the story of the first wonder he experienced in his life when at the age of four he watched the striking behavior of the needle of a magnetic compass. Einstein begins this story with the words: "*I can remember – or at least believe I can remember*".

In regard of the steps which led Einstein to his great discoveries, the most reliable source are the letters Einstein wrote those days. We will see in the following discussions how much instructive these letters are. Anyhow one should not have too big expectations. If Einstein's letters contained a clear-cut presentation of the paths, which led him to his historical discoveries, his biographers would long ago reveal the secret of his genius.[36]

Explorers find only things they are looking for. Hints are useful only when the explorer is ready to conceive them. The important evidence contained in Einstein's letters can be functional only in the case if we have a heuristic conception, a hypothetical expectation of the "*secret intellectual weapon*" of the real geniuses of science. Hence, to reach an adequate understanding, we have to consider the problem, first of all, theoretically.

So I formulate the central question of my discussion: "*What is the most necessary condition for an explorer to make a fundamental theoretical discovery?*"

[34] "In fact, the more one examines the relationship of the two men the more one is impressed with the likelihood that without the stimulus of Darwin, there might have been no Wallace, just as, without the stimulus of Wallace, Darwin might never have got around to formal publication," sums up his position Loren Eiseley. (See Loren Eiseley, *Darwin's Century. Evolution and the Men Who Discovered It.* New York, Anchor Books, 1961, p. 157.)

[35] Paul Dirac, *Recollections of an Exciting Era.* in: History of Twentieth Century Physics, p.109.

[36] In actuality, the predominant number of books on Einstein's life and scientific heritage had been written before the publication of his letters in the *Collected Papers of Albert Einstein.*

I am going to prove that the answer to this principle question is as follows: To make a fundamental theoretical discovery, one has to be, first of all, *ambitious*. I mean, one has to have a strong inner conviction that he is able to solve the most fundamental problems of science, this conviction being supported by strong determination to solve them.

Consider a scientist satisfied with the routine of solving *ordinary* research problems, publishing numerous papers and discussing them with his colleagues. He will soon become a good professional and can eventually make some positive contribution to the advancement of science. But such an investigator has practically no chance to make a great discovery. Einstein once mentioned that he should be glad that he failed to enter the scientific ranks immediately after graduating from Zurich Polytechnic Institute. An academic career, explained Einstein, compels a young man to immediate scientific production, which is easy to accomplish dealing with second rate problems.

If a scientist has no ambitions, if he does not attempt to reveal the basic laws of nature, if he is not in a constant search of answers to the fundamental questions of science, then no great idea would come to his mind. Moreover, even confronted face to face with a great idea, he would not be able to recognize its real value and see its basic importance for the building of a new revolutionary theory.

Only basic questions give birth to great ideas. "*Great deeds demand great obstacles,*" underlined Loren Eisley. If a fundamental question did not strike the mind of a scientist, and if it did not catch his attention, then he will never make any great discovery. Not being involved in basic analysis of a fundamental problem, a scientist will miss its solution even observing closely the particular idea that could lead to a revolutionary theory.

Loren Eiseley revealed a really striking case concerning Sir Charles Lyell whose *Principles of Geology* had immensely influenced young Charles Darwin. The point, which amazed Eiseley, is really exceptional. In the second volume of *Principles of Geology* where many important topics of biology were discussed Lyell formulated the law of the struggle for existence and showed its dominant role in the life of species. Yet Lyell failed to realize that with the help of this law one could explain the mystery of evolution of life on the earth.

Here arise two questions of extreme theoretical importance. How it happened that Sir Charles Lyell, convincingly demonstrating the huge impact of the universal struggle for existence on the living world, did not yet use it to build a radically new theory of evolution? Second, why did not Charles Darwin use the important idea of Lyell, which he learned on the board of the Beagle in 1832, for his goal of building the theory of evolution and, instead, prolonged his great discovery until the publication of the *Origin of Species* in 1859?

Loren Eiseley tries to explain the failure of Lyell supposing that the famous scientist was handicapped by his non-progressionist general conception of the living world.[37] But this argument does not work satisfactorily. If the non-progressionism were the real reason, it would not prevent Charles Darwin to build his theory of evolution much earlier since he was completely free from such a prejudgment.

Everything neatly matches its place when we notice that Lyell never intended to build a new theory of evolution of species. In the absence of such an intention, no observation or idea could lead Lyell to the formulation of a new evolutionary theory. Even if he were successful to discover all the laws of organic evolution, he would not compose from them a new theory since he did not consider such a task.

The same is true in regard of young Charles Darwin, before he undertook the task of developing a new theory of evolution. In 1832, when Darwin studied Lyell's volume, he was an inexperienced naturalist very far from a dream to elaborate a theory of his

[37] Loren Eiseley, *Darwin's Century*, p.106-108.

own. So no idea of Lyell's work could lead young Darwin to the formulation of the new conception of the origin of species.

In general, hints are useful only for a mind preoccupied by the search of solutions. Even an idea decisive for the complete solution of a problem will be of no use for a scientist if he is not involved in its investigation.

Albert Einstein was a living legend of twentieth century physics. The traditional image of Einstein is that of a very sympathetic, shy and lonely young man who had never been appreciated by his teachers and professors, but instead, at the age of 26, produced from nowhere three papers containing the greatest discoveries of the century. Such a legendary phenomenon of a one-month long mental explosion that revolutionized physical science for many decades is really unexplainable. Thanks to god, the reality was essentially different.

Though markedly shy and a bit lazy, Albert Einstein was very ambitious from the first years at the Zurich Polytechnic Institute. Already in 1895, just before starting his studies at the Institute, he outlined a program for the investigation of the difficulties of the conception of the ether – the basic instrument of classical field theory.[38] The general impression of Albert Einstein as of a student was that of a young man "*who thought he knew more than his elders and betters*".[39] "*Elders*" were his professors, "*betters*" – his friends who were more successful in their learning and academic efforts. In fact, Einstein's high self-appraisal was not a mere exaggeration common to many youngsters. It was based on his ability to see, sometimes just to feel the weaknesses of the widely accepted conceptions and theories.

Most of all he was disturbed by the strange statue of ether in the classical electromagnetic theory. Related to it, he became dissatisfied with the conception of the absolute motion in the Newtonian mechanics. Already in September, 1899 he mentioned in his letter to his sweetheart Mileva Marič that he had written to Professor Wien about "*the relative motion of the luminiferous ether against ponderable matter*", which topic, according to Einstein, was treated by classical theory in a very "*stepmotherly fashion*".[40] In an earlier letter of August, 1899 he told Mileva the reason of his dissatisfaction with classical theory in a more detailed way: "*I am more and more convinced that the electrodynamics of moving bodies, as presented today, is not correct... The introduction of the term "*ether*" into the theories of electricity led to the notion of a medium of whose motion one can speak without being able, I believe, to associate a physical meaning with this statement*".

Einstein was not satisfied either with Planck's new conception. Usually the situation is presented in a very simplified form according to which Einstein immediately approved Planck's theory and developed it further suggesting the idea of light quanta. In actuality, Einstein had serious doubts in regard of quantum conception of radiation. "*About Max Planck's studies on radiation*", wrote Einstein in a letter to Mileva Marič in April 1901, "*misgivings of a fundamental nature have arisen in my mind, so that I am reading his article with mixed feelings*".[41]

Ambitions are necessary, but not sufficient for great deeds. An acquaintance of mine

[38] Albert Einstein, *On the Investigation of the State of the Ether in Magnetic Field.* Albert Einstein – Caesar Koch, summer 1895. *The Collected Papers of Albert Einstein*, vol.1, p.4.

[39] Ronald W. Clark, *Einstein. The Life and Times.* New York, The World Publishing Company, 1971, p.74. On another occasion, Ronald Clark directly mentions that young Einstein was really ambitious even in the ordinary meaning of the term: "There was also his personal ambition. It is fashionable to think of Einstein as a man insulated from the problems of real life, never worrying about money, scornful of honors and careless of the position which the world accorded him. Later on, as the most famous scientist in the world, he could afford to be causal. But earlier ... he had perfectly valid reasons for wishing to press on for recognition." (*Ibidem*, p.131.)

[40] *The Collected Papers of Albert Einstein*, vol.1, p.135.

[41] *Ibidem*, p.162.

was completely sure he could become one of the best chess players in the world if he went for it seriously; but he did no real effort in that direction, and he was never the best even in our friendly circle. Great ambition must be supported by hard work.

Ambition is a very positive factor if it functions as a driving force for great efforts. Just as in the case of Albert Einstein. Popular stories tell us of a genius who in a short period of several weeks realized the most important problems of physics, concentrated on them and revealed the absolute truth concerning the deepest secrets of nature.

The reality was far different from this exciting but simplistic picture. Biographers prove that the above-mentioned program formulated by young Einstein for the investigation of the problem of ether should be dated summer 1895. So it took Einstein over 10 years to solve the problem of the electrodynamics of moving bodies. Einstein's letters to Mileva Marič clearly show that he was deeply involved in the investigation of relativity and electromagnetic radiation at least during the period of six years preceding his famous publications.

Moreover, letters to Mileva Marič prove that already in 1901 Einstein formulated to himself the concrete problems of his 1905 fascinating papers. In March 1899, Einstein wrote that his "*broodings*" about radiation were "*starting to get on somewhat firmer ground*". In August of the same year, he mentioned his intention to present the electrodynamics of moving bodies "*in a simpler way*". A month later Einstein wrote to Marič, "*A good idea occurred to me in Aarau about a way of investigating how the bodies' relative motion with respect to the luminiferous ether affects the velocity of propagation of light in transparent bodies*". In April 1901, he mentioned his considerations in regard of Max Planck's quantum conception. The same month he wrote of his lengthy talks with Michele Besso on luminiferous ether, absolute rest, molecular forces, surface phenomena and dissociation. It is remarkable, that just the days when he studied the electron theory of metals he was preoccupied with Planck's quantum hypothesis. This lucky coincidence could spark Einstein's first insight into his future photon conception of light. A sentence of the December 1901 letter proves that already from this days Einstein was brooding over the concrete problem of his most famous 1905 paper: "*I am now working eagerly on an electrodynamics of moving bodies, which promises to become a capital paper*".[42]

Einstein's letters prove that there was neither a direct insight into the secrets of nature nor a declaration of the final truth. Einstein was curious himself whether something will come out of his broodings. Several times he mentioned that his thoughts had "*again sunk back into the sea of haziness*". Not all of his expectations came out to be true. In December, 1901 he wrote, "*I got again a very self-evident and important scientific idea about molecular forces... If this were true, then this would be end of the molecular-kinetic theory of liquids*". As we know, the molecular-kinetic theory succeeded to survive.

Now I would like to discuss another aspect of my thesis of great ambitions. In their social relations and claims, all my real geniuses were very shy and unpretending individuals. Yet, in regard of their destination in science their ambition was enormous, though often well hidden.

Socrates was widely known for his modest way of life and the ability to talk even to child as an equal to him. Yet, he was enormously ambitious and believed that his single occupation – life long talks with anyone ready to listen to him – was predestined by the Heavens. In Plato's *Apology*, Socrates expressed his belief straightforwardly, "*Now, this duty of cross-examining other men has been imposed upon me by God; and has been*

[42] *The Collected Papers of Albert Einstein*, vol.1, pp.126, 131, 133, 135, 162-163, 187. Some of these ideas are mentioned also in two letters to Marcel Grossmann. In April 1901 Albert wrote to his friend, "As to science, I have a few splendid ideas, which now only need proper incubation. I am convinced that my theory of atomic attraction forces can also be extended to gases". Some months later Albert wrote of his new idea of a simple method "of investigating the relative motion of matter with respect to luminiferous ether that is based on ordinary interference experiments". (*Ibidem*, pp.165, 181.)

signified to me by oracles, visions, and every way in which the will of divine power was ever intimated to any one". So he held it natural that the world had decided that he was in some way superior to other men.

In the case of Charles Darwin, the task of proving his ambitiousness is significantly easier since I found direct evidence in his *Autobiography*. Recalling days of his voyage on the *Beagle*, Charles Darwin mentioned the following. "*As far as I can judge of myself, I worked to the utmost during the voyage from the mere pleasure of investigation, and from my strong desire to add a few facts to the great mass of facts in Natural Science*". It sounds like a quite modest attitude of a freshman. But immediately Darwin added the crucial sentence: "*But I was also ambitious to take a fair place among scientific men.*"

Of course, we must not take for granted the recollection of the sixty-seven years old maestro of the odd thoughts that crossed his mind at his early twenties. It is quite usual that events proceed in autobiographies the way they should or could happen in the light of later great achievements of their authors.

There is strong reason to believe that months of solitude on board of the *Beagle* and the exciting experience of wondrous observations on the oceanic shores and in pampas and mountains of South America radically changed young Darwin's whole approach to life. Darwin was sure that not the years at the Edinburg and Cambridge universities, but rather the voyage on the Beagle provided "*the first real training and education*" of his mind. The evidence of the *Autobiography* is entirely convincing here. "*Looking backwards, I can now perceive how my love for science gradually preponderated over every other taste... I discovered, though unconsciously and insensibly*" recalled Darwin, "*that the pleasure of observing and reasoning was a much higher one than that of skill and sport.*"

When science becomes the highest value of life, one unavoidably begins to dream of great discoveries. The exciting dream naturally brings with it a desire to realize it and become a famous discoverer. Desires lead to intentions, and strong intentions can eventually convince the dreamer that he has the abilities to achieve his fascinating task. At least, long after the voyage, Charles Darwin could be sure he not only dreamed of making his own modest contribution to natural science, but that he was full of ambition to become a prominent naturalist.

Indeed, already eighteen months after his return from the voyage on the *Beagle*, Darwin opened the first of his note-books in which he collected all kind of information concerning the problem of species. That was the first step of the very ambitious task of creating the theory of evolution of species. Moreover, in one of his note books Darwin directly declared his ambitious goal: "*My theory would give zest to recent and fossil comparative anatomy; it would lead to the study of instincts, heredity, and mind heredity, whole of metaphysics.*"[43]

It is important to realize that geniuses of science explored the secrets of nature in full accordance with hypothetical-deductive conception of the logic of scientific investigation we have outlined above. For instance, Einstein paid full attention to correct formulation of basic problems of theoretical physics. He devoted over six years to the detailed analysis and research of electrodynamics. Einstein tried and verified many ideas and hypotheses until he came to his revolutionary discoveries.

But if Albert Einstein made his epochal discoveries with the help of the universal method of hypotheses which directs the research of each one scientist, why it happened the way that just Einstein succeeded to solve the most fundamental problems of physics? What was his advantage compared to many other scientists?

The answer is the same – the great ambition. Einstein's ambition drove him to the investigation of the most fundamental secrets of nature. He never lost energy and time

[43] *The Life and Letters of Charles Darwin*, p.370.

to consider ordinary problems of physics. His task was exceptional. All his attention was dedicated to the exploration of basic laws, principles and fundamental conceptions of physics.

It was a sort of gamble. There was no guarantee that his efforts would succeed. But he was victorious. Einstein's great ideas determined the progress of physics for a whole epoch. Loren Eiseley wrote about Charles Darwin's theory of evolution that "*the thought of the world would never be the same afterwards*". These words are even more true applied to Albert Einstein's revolutionary discoveries.

Step 16. THE PASSION TO REACH FOUNDATIONS

" I have no particular talent, I am merely extremely inquisitive."

Albert Einstein

Ambition leads to formation of irrepressible passion when converted into purposeful activity. Passion in action is like real obsession. Passion transformed into obsession belongs to most damaging things. But the obsessive passion for knowledge provides the power of creative cognition. Just passionate people obsessed with the desire to understand the foundations of nature make greatest scientific discoveries. Grand passion takes the whole intellect of the discoverer into its service. "*Nothing succeeds in which high spirits play no part*" said old sage.

The leading role of science and scientific discoveries in the life and progress of modern society is well recognized. Making science is an important field of social activity. In this sense, science has become the passion of many intellectuals. Today it is quite easy to understand the passion for knowledge so characteristic to many prominent scientists. Yet there is one important difference. Lord Byron, the great admirer of beauty and young ladies, wrote the following wonderful lines: "*Man's love is of man's life a thing apart. 'Tis women's whole existence*".

Science holds the most dominant position. Yet scientific research never absorbs talent's entire interests. Love of knowledge is geniuses' whole existence. Many biographers have mentioned Einstein's passionate personality. His all-absorbing passion was science. Antonina Vallentin rightly noticed that the passionate love of science always remained with him. In a letter to his sister Maja, Einstein commented on his everlasting passion, "*As in my youth, I sit here endlessly and think and calculate, hoping to unearth deep secrets*". From the years at the Zurich Polytechnic, Einstein made himself a rule to concentrate upon significant problems of physical science. "*In this field, however*", recalled later the great scientist, "*I soon learned to scent out that which was able to lead to fundamentals and to turn aside from everything else*".[44]

Aristotle believed that science and knowledge come from human curiosity. Einstein insisted that there could be no scientific progress without passionate devotion to the great goal of revealing the secrets of nature. "*The scientific method itself*", explained Albert Einstein, "*would not have led anywhere, it would not even have been born without a passionate striving for clear understanding.*"[45]

Einstein devoted all his life to the research of foundations of the physical world. A passion for understanding the universe seemed to him as natural as the passion for

[44]Albert Einstein, *Autobiographical notes.* in: *Albert Einstein: Philosopher-Scientist*, p.17.

[45]Albert Einstein, *The Common Language of Science.* In: Albert Einstein, *Ideas and Opinions.* New York, Crown Publishers, 1954, p.337.

music.[46] "*Joy in looking and comprehending is nature's most beautiful gift,*" believed the great physicist. In his later years, Einstein revealed the only and principal motif of his entire life. "*My scientific work is motivated by an irresistible longing to understand the secrets of nature*", wrote the aging sage.

Ronald Clark proves that Einstein's obsession to explore and understand nature caught him early and set fast for the rest of his life.[47] Einstein's passion to explore the physical world was so strong that he was ready to devote everything and sacrifice anything to this great goal. This steely and persistent determination, concluded Ronald Clark, separated Einstein from other men.

The passion to understand the secrets of nature, the continual super-concentration on the fundamental problems of science eventually resulted in many strange personal features, which today are perceived as canonic characteristics of a genius of science. Einstein's dress and habits were causal and shocking sometimes while his absentmindedness gave rise to many humorous stories.

Friederich Adler, who was very close to Albert Einstein at the beginning of his academic career, noticed in a letter that Einstein "*in all practical things is absolutely impractical*". Mileva Marič wrote to her friend how many troubles have been caused to Einstein by his way of speaking. Ronald Clark mentioned Einstein's facility for being "*his own worst enemy*". By the by, as Einstein became unanimously accepted as the greatest mind of the century, the awkwardness and strangeness of his behavior and habits were perceived in a more tolerant manner. Eventually all the oddness and eccentricity in Einstein have been understood as the stigmata of an extraordinary genius.

Boris Kuznetsov begins Einstein's biography with an epigraph from Shakespeare: "*He was a man, take him for all in all*". With all the feelings and interests of an earthly human being. Nevertheless, Einstein the patriarch of the twentieth century scientific community was markedly different from the Einstein at the beginning of his academic career. Einstein-the patriarch was a personification of the ideal of a scientific genius deeply absorbed into the secrets of nature and completely ignoring all other aspects of personal and social life. "*Einstein's fundamental indifference to titles, positions, and money is so complete that it seems exaggerated*", mentioned Antonina Vallentin who was close to Einstein's family in the years of his unprecedented popularity.[48]

Einstein-the beginner, judging outwardly, was much different. He eagerly struggled for his professorship, moved from Zurich to Prague University and back again, gaining higher salary and better position. Einstein made friends, met famous scientists of Europe, looked after his children, lectured, traveled, played violin with members of royal families, and enjoyed life as it could a young man in his early thirtieth. But I have no doubt, if he had to choose between the comfortable life of a university professor with an ordinary contribution to science and that of the hard life of a Patent Office expert who somehow managed to make an epochal discovery, Einstein would definitely prefer the latter. Anyone who has a little bit knowledge of Einstein's life and work, I am sure, will agree with me. It proves that, not only at his patriarchal age, but also through all the years of his youth and maturity, the highest value and the dominant motive of Einstein's personality was the love for science.

This sacred love endowed Einstein with enormous strength and determination to go

[46] "There exists a passion for comprehension," wrote Einstein, "just as there exits a passion for music. That passion is rather common in children, but gets lost in most people later on. Without this passion, there would be neither mathematics nor natural science. Time and again the passion for understanding has led to the illusion that man is able to comprehend the objective world rationally. By pure thought, without any empirical foundation – in short, by metaphysics." (Albert Einstein, *On the Generalized Theory of Gravity.* In: Albert Einstein, *Ideas and Opinions.* New York, Crown Publishers, 1954, p.342.)

[47] Ronald W. Clark, *Einstein. The Life and Times.* New York, 1971, p.32.

[48] Antonina Vallentin, —em The Drama of Albert Einstein. New York, 1954, p.119.

forward with his explorations even in the disastrous years of total neglect. Due to the same sacred love, Einstein did not swerve from his great task of the explorer of nature also in the later years of total admiration and unprecedented worldwide popularity.

Thus we come closer to *Albert Einstein's main secret – the enormous ambition in regard of his potential abilities of an explorer*. And this in strong cohesion with factors that put into action the huge potential energy of his ambition, namely *the sacred love for science and obsession with the fundamental problems of physics*.

These factors are quite sufficient to understand what kept Einstein in unceasing research of the most difficult problems of physical science. A tradition coming from ancient thinkers acknowledges that genius is only a great aptitude for patience. Our analysis helps to understand the source of this enormous patience. Only an obsessive passion can keep an explorer inseparably tied to an absolutely stubborn and unyielding problem, which often becomes the object of a life-long research. What else can force a scientist for long years, day after day to return to the same stubborn problem that never promised any sign of possible solution? Over twenty years, Einstein started each morning by a new attempt of creating the theory of the unified physical filed. Only an unlimited passion to understand the foundations of nature could lead Einstein on this hard and painful path; for there were few results that this investigation was able to present to scientific community. The undertaken research seemed so unproductive that it seemed justified to publish even the negative results to save other scientists from wasting their time and effort.

But no hardships were able to divert Einstein from his passionate work. "*I am an old man mainly known as a crank who doesn't wear socks. But I am working at a more fantastic rate than ever, and still hope to solve my pet problem of the unified physical field*", wrote Einstein to his old friend during these years of persistent and pathetic research.[49]

The later years of Einstein's research should be a real torment to him since he had to deal with an extremely complex mathematical apparatus. When the last formulation of the generalized theory of gravitation was published many theoreticians admitted that they would need at least a year to understand it. The author himself did not see initially how he could derive any particular conclusions of his basic equations to verify them experimentally. To apprehend fully the huge dimensions of Einstein's efforts, I would like to remind that he met unsurpassable mathematical difficulties already elaborating his first theory of gravitation until he got the helping hand of his close friend Marcel Grossmann.

No doubt, Einstein would continue his titanic work if even he did not see any real perspective for its successful completion. So it was a great justice that to his seventieth birthday Einstein at last succeeded to reach a significant generalization of his theory of gravitation. Nevertheless, he continued his research to the last days of his conscious life.

Socrates, another prominent "*real*" genius, was ready to continue his "*search into true and false knowledge*" even after the inevitable transition into the better world. If it were true that death is a journey to another world, what good could be greater than this? What would not a man give if he might converse with Orpheus and Musaeus, and Hesiod and Homer?

Socrates continuously demonstrated a passionate striving for the truth and inquiry. "*I have no particular liking for anything but the truth*", declared the great thinker. His entire life and even his death seem specially designed to prove that he was just unable to alter his sacred passion, even if he had "*to die many times*".[50] Passion and the "*inspired*

[49] *Helle Zeit; Dunkle Zeit*. Ed. Carl Seelig. Zurich, 1956, p.50.

[50] Addressing the people of Athens and his judges, Socrates announced: "if you say to me, Socrates, this time you shall be let off, but upon one condition, that you are not to inquire and speculate in this

madness" should be highly appreciated if one's longing after wisdom had caused them.

A further illustration provides Niels Bohr. For many years Bohr persistently tried to convince Albert Einstein, as well as any other skeptically minded physicist, that his probabilistic interpretation of quantum mechanics was correct. Sometimes this unlimited persistence created comical situations. Shortly after Erwin Schrödinger published his famous papers on wave mechanics, he was invited to lecture at the Copenhagen Institute. Schrödinger should be unhappy that he accepted the invitation. From the very first day, he was involved in exhausting discussions that continued for long ours. Bohr proved him uninterruptedly, with almost fanatic conviction, how wrong was the classical interpretation of wave mechanics. Eventually, Schrödinger broke down under the pressure. He got ill. But it did not help him. Bohr was always at side of his bed, persistently repeating, "*Come on, Schrödinger, you must accept that...*".[51]

One should bear in mind that Einstein's obsessive love for science had quite a definite object. Foundations of nature and fundamental principles of physics were the main preoccupation of his thoughts. "*For me,*" explained Einstein his attitude to science, "*interest in science is restricted to the study of principles, and this offers the best explanation of my work. That I have published so few papers derives from the same circumstance: a consequence of my ardent desire to understand the principles is that much of my time has been spent on fruitless efforts*".[52]

Einstein's obsessive determination to build a unified field theory followed from his passion to understand and reveal the very foundations of the physical world. He was deeply convinced that beneath the surface of the apparently different gravitational and electromagnetic phenomena there should be a deeply hidden physical entity.

The insight of a cardinal truth occurs by a lucky blending of experience and motivation. If it were allowed to draw a general principle from a single observation, Einstein's attitude to science and knowledge would be the best ground for the above statement. Yearning for the most fundamental laws of nature was young Einstein's sole motif of life. By 1905, he had an extremely rich experience in deliberating upon the most basic problems of physics. This gave him an overwhelming advantage compared to the most prominent physicists of the century.

Step 17. THE LAW OF INDEPENDENCE OF THOUGHT

"At the frontiers of science explorers must be brave."

Anonymous

Revolutionary ideas never appear in a mind full of deep and uncritical respect to the great names of science. To be a revolutionary, one has to have a skeptical mind. "*The seeker after the truth*", insisted René Descartes, "*must, once in the course of his life, doubt everything, as far as possible*".[53]

way any more, and if you caught doing so again you shall die; - if it was the condition on which you let me go, I shall reply: Men of Athens, I honor and love you; but I shall obey God rather than you, and while I have life and strength I shall never cease from the practice and teaching of philosophy..."

[51] Werner Heisenberg, *Erinnerungen an Niels Bohr aus den Jahren 1922-1927.* In: Werner Heisenberg, Schritte über Grenzen. Munchen, 1973, S.62.

[52] Albert Einstein, *Lettres a Maurice Solovine.* Paris, 1956, p.49.

[53] René Descartes, *Principles of Philosophy.* In: *The Philosophical Writings of Descartes*, vol.1. New York, Cambridge University Press, 1985, p.193.

Radical skeptics often went to the extremes. For instance, Metrodorus of Chios declared, "None of us knows anything, not even whether we know or do not know, nor do we know whether not knowing and knowing exist, nor in general whether there is anything or not." (Quoted in David Park, The How and Why. Princeton, Princeton University Press, 1988, p.24.)

Actually, no student can escape the feeling of admiration with fundamental theoretical science, especially when one starts learning mathematical theories with their clear and transparent concepts and absolutely strict proofs. Albert Einstein and Charles Darwin, my specimens of geniality, admired Euclid's geometry from their early youth.

Fundamental theories are the basis upon which science is built. Due respect to foundations of science is quite natural. But if you regard a fundamental theory with an unlimited respect, you will never be able to reconstruct it radically. If one admires a theory, he cannot question its truth. But in absence of a question, no one will search for a more adequate answer. Let us consider some illustrations of these general statements. Immanuel Kant was denied a minute chance for revolutionary discoveries in mechanics, geometry, and formal logic since he was completely convinced that Newton's mechanics, Euclid's geometry, and Aristotle's logic were examples of the absolute truth. By contrast, Kant doubted and rejected all philosophical teachings of his day. No surprise that his *Critique of Pure Reason* suggested a radical reconstruction of the entire philosophical theory of human cognition.

Skepticism is the best ground to grow freethinking. Possibly John Milton meant this important point of human cognition in his beautiful phrase, "*Suspicion sleeps at wisdom's gate.*"

There is no absolute truth for a skeptical mind. If one is skeptical enough, he can question the most fundamental laws of science and cast doubt on the most apparent and evident truths. A skeptic may deliberate whether do parallel lines ever cross each other? Skeptical mind is able to question the necessity for the product of A and B to be equal to the product of B and A. Skeptics can doubt even that $c + c$ is equal $2c$.

Extreme skepticism is often annoying.[54] But the history of science proves that just skeptics had made the most fundamental scientific revolutions. "*If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties,*" pointed out Francis Bacon.

For educated men it was quite evident that given a straight line L and a point P on the same plane one can draw only one straight line passing through the point P and parallel to L. But a skeptic appeared there and asked, "*How do you know that?*" Trying to prove him this obvious truth, mathematicians discovered the non-Euclidean geometry where one of the most evident mathematical truths – Euclid's fifth postulate – did not hold.

When Heisenberg was told that according to his most promising paper one must conclude that the product of the matrix A and matrix B was not equal to the product of B and A, he thought that all his conception was ruined. But the reaction of Paul Dirac, one of the greatest skeptics of his generation, was completely different. Developing his theories he thought it was quite legitimate to make "*any assumptions if they did not immediately bring to contradictions*". As a physicist, he never had a slightest doubt that A and B variables should be commutative. But the non-commutative matrixes in Heisenberg's paper did not seem to him enough ground to reject flatly the new conception. Dirac concentrated all his attention upon Heisenberg's surprising result. Soon he proved that postulating the difference of the matrix products AB and BA to be equal to $h/2\pi$, one arrives at the most fundamental principle of quantum mechanics. When the paper with Dirac's interpretation was published he got a letter from Hiesenberg. "*I have read your wonderful work with great interest. All your results are completely correct if we believe, of course, in the new theory*", wrote with relief the author of the paradoxical

[54] "Skepticism," noticed Bertran Russell, "while logically impeccable, is psychologically impossible, and there is an element of frivolous insincerity in any philosophy which pretends to accept it." (Bertrand Russell, *Human Knowledge. Its Scope and Limits.* London, Allen and Unwinn, 1948, p.9.)

discovery.[55]

Possibly, just the skeptical approach helped Hendrick Lorentz to deny the Galilean transformations of classical mechanics which, in a sense, included the most evident assertion $u + u = 2u$. Lorentz suggested instead that in the case of electromagnetic radiation some special form of transformations must be used, the conclusion from which should be the extravagant $c + c = c$ for the speed of light. Consider a mental experiment when a space ship is passing near the Earth with a speed equal to the speed of light c and a light beam is sent from the space ship in the direction of its motion. Then, according to Lorentzian transformations, the speed of that beam in regard of the Earth would be not $c + c = 2c$, but it will just remain the same c.

There is no doubt that Einstein's new approach to the electrodynamics of moving bodies was supported and directed by his skepticism. Only a good portion of skepticism could allow him to plunge into the critical review of basic concepts of classical physics. There were many manifestations of Einstein's positive scientific skepticism prior to the moment of his great discovery. The skeptical approach was first invoked in Einstein at the age of twelve when being influenced by popular scientific books he gave up believing in the stories of the Holy Scriptures. "*Through the reading of popular scientific books*", recalled Einstein, "*I soon reached the conviction that much of the stories in the Bible could not be true*".

It is very probable that Einstein's critical perception of the most fundamental scientific conceptions was significantly supported by his inborn skepticism that developed further and strengthened itself by the circumstances of his childhood and youth. Ronald Clark, discussing in detail young Einstein's personal features, proved that his skeptical attitude in regard of widely accepted beliefs was developed as early as at the Gymnasium.[56]

In the following years, Einstein's skeptical approach extended to the very foundations of physical science. Only a well-developed skeptical mind would permit him to think of putting an "*end*" to the molecular-kinetic theory of liquids. Earlier he boldly assumed that "*the electrodynamics of moving bodies, as presented today, is not correct*". Young Einstein expressed serious doubts concerning the newly born quantum conception of radiation. Such a skeptical perception of the foundations of physical science convinced Einstein that he understood the principle problems of physics more deeply than "*his elders and betters*" who appeared fully satisfied with classical theories.[57]

Very close to the skeptical approach stands the *independence of thought*. Actually, skepticism and independent thinking are two sides of a coin.

Skepticism has mainly a negative function. But to make a discovery, one has to

[55]Dirac mentioned also that his position was definitely more advantageous than that of Heisenberg. He had not be worried too much that the non-commutative matrixes will ruin the new theory. Secondly, he had some hope that Hamiltonian equations, which he knew well, could help him to understand the real cause of the difficulty. (Paul Dirac, *Recollections of an Exciting Era*. In: *History of Twentieth Century Physics*: Proceedings of the International School of Physics "Enrico Fermi". Course LVII. – New York, Academic Press, 1977, p.121.)

[56]"Not giving a damn about accepted beliefs was an attitude which certainly developed at the Gymnasium," concluded Clark. (Ronald W. Clark, *Einstein. The life and Times*. New York, The World Publishing Company, 1971, p.13.)

[57]I would like to note here the parallel between Einstein's skeptical attitude and that of Socrates. The famous ancient thinker was well aware that Athenians were especially delighted when he gave them chance to hear the "cross-examination" of a pretender to wisdom. Even the greatest thinkers could not avoid Socratic irony. Socrates questioned and denied even the views of Protagoras though the latter was the only philosopher whom Socrates accepted as "the wisest of all living men".

Nietzsche believed that skepticism provides the freedom of a mind "through strength and superior strength". But one cannot exclude that skepticism is rather an attitude to life and knowledge than an intellectual capacity following from the strength of mind. One can meet a strong intellect with a conventional mode of thinking as well as a highly skeptical thinker with ordinary intellectual capacities.

be also positive. The central point of any discovery is the new, original, sometimes strange or even crazy idea. A scientist deeply influenced by existing theories would hardly have the courage to suggest a really unordinary conception. The independence of mind combined with skepticism composes the essence of freethinking. Albert Einstein most of all encouraged just the independence and skepticism in the thinking of a scientist. He praised Mach in his *Autobiographical Notes* for these important intellectual qualities. "*I see Mach's greatness in his incorruptible skepticism and independence*", pointed out Einstein.

There is no need to prove the independence of Einstein's thinking. Friedrich Adler wrote that Einstein had "*the most of independent brains*".

Einstein was not merely an independent thinker. Not less important is the fact that he was the most courageous theoretician. One should really be brave to suggest a conception that sounded strange to all contemporary scientists. But one had to be enormously brave to suggest a conception that was in apparent contradiction to well-established facts and observations. That was the case with Copernicus. And that was also the situation with Albert Einstein. Using poet's words, one may characterize Einstein as presenting a union of "*the mildest manners with the bravest mind*".

Einstein was the first physicist to deny radically the "*ghostly existence*" of the ether in a time when the entire physics community was deeply convinced that ether was the necessary media for the very existence of the electromagnetic field.

When in1905 Einstein suggested his conception of light quanta, he had serious reasons to qualify it cautiously as a "*heuristic viewpoint*". By that time, it had been clear to any physicist that the phenomena of diffraction and interference of light could be explained only assuming that light was propagated as a wave. So one had to be extremely courageous to consider light composed of particles. That bald scientist was Einstein. Later, in 1909, he forecast that the apparent contradiction of photon conception and classical wave theory could be solved only through a new synthesis of the wave and corpuscular conceptions. Einstein was sure that the next phase of the development of theoretical physics will bring us a theory of light that can be interpreted as a kind of "*fusion of the wave and emission theories*".[58]

Making this bold assumption, Einstein actually foresaw not only de Broglie principle of wave-particle duality, but also heralded the coming of the quantum mechanics itself. "*The great achievement of Einstein*", noticed Hans Reichenbach, "*consists in that his thinking is free from conventional ideas, that he did not hesitate to disregard the oldest laws of natural science, the laws of geometry, and to set new ones in their place*".[59]

Einstein's independence of thought was unlimited. Even his own great discoveries could not restrain his bold intentions. In 1910, just five years after his historic discovery of light quanta, he wrote to his close friend and colleague Jacob Laub: "*I now have the greatest hopes of solving the radiation problem, actually without light quanta... We must renounce the energy principle in its present form*".[60]

The task to penetrate into the thoughts of the author of an important discovery is always enormously difficult. This task becomes almost unsurpassable when one has to deal with a genius of such unique gifts as Albert Einstein. Cornelius Lanczos clearly re-

[58]Einstein's argument, which he presented in his invited paper at the 1909 Salzburg conference, is of such importance that I would like to present it here in detail. "It is undeniable," explained his position Einstein, "that there is an extensive group of data concerning radiation which show that light has certain fundamental properties that can be understood much more readily from the standpoint of the Newtonian emission theory than from the standpoint of the wave theory. It is my opinion, therefore, that the next phase of the development of the theoretical physics will bring us a theory of light that can be interpreted as a kind of fusion of the wave and emission theories." (Quoted in Ronald W. Clark, *Einstein. The Life and Times.* New York, 1971, p.125.)

[59]Hans Reichenbach, *From Copernicus to Einstein.* New York, Philosophical Library, 1952, p.121.

[60]Carl Seelig, *Albert Einstein: A Documentary Biography.* London, 1956, p.116.

alized the difficulty of his task when he attempted to explain how Einstein could suggest his striking hypothesis of quanta of light. Yet Lanczos undertook this challenging task and convincingly showed that the main factor that helped Einstein to make his great discoveries was his unlimited scientific courage. "*In the case of the light quantum hypothesis*", wrote Lanczos, "*the conclusion was so startling that only an unprejudiced mind of highest unconventionality could accept the result without cringing. The probability expression for the statistical action of light had exactly the same form as if the action of n equal particles were involved. From this Einstein fearlessly drew the conclusion that light actually behaves, as if it were a particle, endowed with the energy* $h\nu$*. To an ordinary mind this would appear absurd, since the wave nature of light had been so convincingly demonstrated on innumerable occasions. Einstein did not deny the wave nature of light; but he had an uncanny physical intuition which was not afraid of conclusions which were contrary to accepted notions, if undeniable physical observations forced him to accept these conclusions*".[61]

Some historians of science argue that it required Einstein not much intellectual courage to propose strange ideas since he was completely unknown and did not risk his reputation. In general, a prominent scientist, indeed, is definitely handicapped by his high statue in scientific community, while one can readily forgive a young and unknown scientist even his craziest suggestions.[62] But Einstein demonstrated not less courage also in the years of full blossom of his fame. He firmly stood almost alone against all the "*combined forces*" of the twentieth century physicists for over three decades. I mean Einstein's opposition to the so-called Copenhagen interpretation of quantum mechanics. Mainly due to Niels Bohr's active and unceasing argumentation, it was almost unanimously accepted from the early 1930s that atomic phenomena did not follow the principle of strict determinism and were rather statistical in their essence. Einstein opposed this conception during all his active life in science. His aphoristic argument "*God never plays at dice*" became a popular saying even by general public.

Explaining his position Einstein insisted that only those can have a deep insight into foundations of modern physics who have successfully "*wrestled*" with the problematic situations of their age. In this respect, he had sufficient ground to hold to his own viewpoint. "*I am, in fact, firmly convinced that the essentially statistical character of contemporary quantum theory is solely to be ascribed to the fact that this [theory] operates with an incomplete description of physical systems*", declared Albert Einstein his position.[63]

Einstein held his ground firmly to the very last years of his active life in science. "*He spent those years*", recalled Robert Oppenheimer, "*first in trying to prove that the quantum theory had inconsistencies in it... When that did not work, after repeated efforts, Einstein had simply to say that he did not like the theory. He did not like the abandonment of continuity or of causality... He fought with the theory which he had fathered but which he hated*".[64]

By the irony of history, Einstein's main opponent Niels Bohr also came from the ranks

[61] Cornelius Lanczos, *The Einstein Decade*. London, Elek Science, 1974, p.107.

[62] Friedrich Gauss claimed that he had deliberated for a long time over the idea of non-Euclidean geometry. But the famous mathematician never discussed in public his idea. Gauss might believe that the publication of such a strange idea could damage his well-deserved authority.

Mendel presented an opposite case. He was absolutely unknown to scientific circles. So he was not under any kind of pressure elaborating his own viewpoint. "Perhaps he was fortunate," mentioned Loren Eiseley, "so far as his experiment went, in not being a famous man already laboring under a point of view." (Loren Eisley, *Darwin's Century*, p.213.)

[63] Albert Einstein, *Remarks Concerning the Essays Brought Together in This Co-operative Volume*. in: *Albert Einstein: Philosopher Scientist*, volume 2. Ed P. A. Schlipp. La Salle, Illinois, Open Court, 1970 (first edition 1949), p.666.

[64] Quoted in Ronald W. Clark, *Einstein. The Life and Times*, p.534.

of "*real*" geniuses. He began his discussions with Einstein in 1927 at the Fifth Physical Conference of the Solvey Institute and never ceased to prove his point all the following years. And that notwithstanding his deepest admiration regarding Albert Einstein's scientific achievements. Bohr acknowledged the "*indebtedness of our whole generation for the guidance his genius has given us*" and highly evaluated Einstein's scientific heritage as of "*epoch making contributions to the development of natural philosophy*".[65]

Ronald Clark pointed out once that many contemporaries of Einstein "*had sent up sparks of genius during their early years yet failed to set the world ablaze*". Most probably, Einstein set the whole twentieth century science ablaze just due to his unlimited intellectual courage.

I could include into the set of the derivative factors of great discoveries the originality of ideas and strong imagination, too. "*A good deal of his genius lay in the imagination which gave him courage to challenge accepted beliefs*", suggested Ronald Clark in regard of young Albert Einstein.[66], p.32. But in fact, the intellectual courage covers up both these factors since it assumes an extreme originality of thinking as well as unlimited imagination.

The independence of thought was so characteristic and essential for the greatest physicist of our epoch that Abraham Pais believed it could serve as an overall characteristic of his genius. "*If I were asked for a one-sentence biography of Einstein's life*" , wrote Pais, "*I would say, He was the freest man I have ever known*".[67]

[65]Niels Bohr, *Discussions with Einstein on Epistemological Problems in Atomic Physics.* In: Niels Bohr, *Atomic Physics and Human Knowledge.* New York, John Wiley & Sons, 1958, p.32.

Interestingly enough, the positions of the both great physicists can be traced back to Greek philosophers. The founder of atomistic philosophy Leucippus declared, "Nothing happens at random; everything happens out of reason and by necessity". While Tisias and Gorgias insisted the contrary, namely, that probability is "superior to truth".

[66]Ronald Clark, *Einstein. The Life and Times*

[67]Abraham Pais, *"Subtle is the Lord. . . " The Science and the Life of Albert Einstein.* New York, Clarendon Press, 1982, p. VII.

Step 18. SOME ADDITIONAL AGENTS OF GENIALITY

"What mattered was the talk."

Ronald Clark

All the above revealed secrets of Albert Einstein's genius, beginning from his great ambition and ending with the extreme intellectual courage, tell us the psychological features that determined his intellectual potential for great discoveries. Here a question can arise whether did not Einstein have also some secret methods of thinking with the help of which he was able to solve the most difficult problems of theoretical physics? Since I have proved earlier that the hypothetical-deductive method is the universal method of scientific discoveries, my answer to the question can be only negative. Einstein's letters prove that he explored the foundations of physics in full accordance with the method of hypotheses.

Nevertheless I would like to call your attention to three important points in Einstein's method of research. First, Einstein got great advantage in regard of all other physicists at the very start of research. Any scientific research begins with problem formulation. Einstein followed the principle to explore only those problems that were of great significance for the further advancement of physical science. Just the investigation of this type of problems had the potential to bring eventually to great discoveries. For instance, Einstein explained in a letter to Jakob Laub, "*This quantum question is so incredibly important and difficult that everyone should busy themselves with it*".

In his quest for the fundamental laws of nature, Albert Einstein was substantially supported by his approach to scientific knowledge. Einstein learned only basic knowledge. He denied "*cramming*" into one's mind non-essential, superficial information. It enabled Einstein to reach a deep understanding of fundamental theoretical conceptions and reveal the essence of the most difficult problems of theoretical physics.

Probably, this kind of selective learning was intuitive, since Einstein regretted sometimes that he was lacking some important knowledge. Recalling the years at the Zurich Polytechnic Institute, Einstein admitted that he "*neglected mathematics to a certain extent*". His professor of mathematics Hermann Minkowski was of the opinion that Einstein "*never bothered about mathematics*". Consequently, Einstein had certain difficulties elaborating his revolutionary theories, especially when he worked out the conception of general relativity. Another case when Einstein felt he was handicapped by the lack of some important information concerns his research in statistical physics. Developing his original statistical conception, Einstein was unaware that J. Willard Gibbs had already solved the problem. During the discussion of his work he admitted, "*Had I been familiar with Gibbs' book at that time, I would not have published those papers at all, but would have limited myself to the discussion of just a few points*".[68]

Einstein disliked learning. He did not read much. Apparently, he was not fond of his work of a lecturing professor as well. Einstein's real destiny was scientific research. Nothing could stop him from exploring the secrets of nature – neither the bitterness of the total neglect, nor the enthusiastic admiration of the educated world. In his inaugural address before the Prussian Academy of Sciences, of which he became a member in 1913, Albert Einstein expressed his gratitude just for the possibility to devote himself to scientific studies.[69]

[68] *The Collected Papers of Albert Einstein*, vol.3, p.251.

[69] "First of all", said Einstein to German academicians, "I have to thank you most heartily for conferring the greatest benefit on me that anybody can confer on a man like myself. By electing me to your academy you have freed me from the distractions and cares of professional life and so made it possible for me

The only thing that could for a moment shift aside his study of science was again the science. I mean Einstein's enormous passion to talk about science, to discuss various topics of science with anyone ready for the task, were it a student having difficulties in his physics course or a world wide famous scientist.

Young Einstein's first opponent was his Uncle Kaiser Koch. Just to him addressed young Einstein his first cogitation on the nature of luminiferous ether. At the Zurich Polytechnic he discussed physical theories with his friends Conrad Habicht and Marcel Grossmann. Given a slightest chance, Einstein would involve people he met into tense discussions of complex problems of physical science. When he took his dissertation to Professor Kleiner, it resulted, quite naturally, in a lengthy discussion of many topics of modern physics.

Einstein's salary at Patent Office was not sufficient to afford decent life conditions to his young family. He decided to get some additional income by private lessons. Maurice Solovine, a student from Romania who had to improve his poor knowledge of physics, became Einstein's first pupil. From the very first meeting, Einstein's lessons turned into exciting discussions of scientific topics. Both the teacher and the pupil were so fond of these talks that they became close friends and continued their meetings till 1903 when Solovine left Bern.

A short while later, Conrad Habicht joined the meetings of this peculiar pair. The three romantic friends got such a profound satisfaction from their regular meetings that they called their small fraternity "*Academy Olympia*". To his last days, Einstein had the warmest memories of their "*academic*" activities. In 1953, the patriarch of the twentieth century science recalled in a letter to Solovine the "*immortal*" Academy, its "*childish joy in clarity and reason*", and wished its members his fidelity and devotion "*to the last enlightened breath*".

Topics of these "*academic*" discussions were of general nature. It was Michelangelo Besso who got the privilege to discuss Einstein's original papers during the process of their elaboration. In a letter to Mileva Marič Einstein characterized Besso as an "*extraordinary fine mind*". Then he mentioned that they talked almost four hours on ether and matter, the definition of absolute rest, the nature of molecular forces etc. – problems that preoccupied Einstein constantly.

Their talks became regular in1904 when Besso, with the help of Einstein, got a position at the Bern Patent Office. Every day the two friends returned home together from the office deeply involved in discussions of Einstein's conceptions. These regular discussions continued up to the beginning of 1905. Einstein once mentioned in a letter to Habicht that after Solovine's departure even talks with Besso had ceased. Most probably, by that time Einstein was bringing to completion his famous papers of 1905 all of them published during the year 1905 in the vol.17 of "*Annalen der Physik*".

Impressed by Einstein's papers, Professor Wilhelm Wien sent Jacob Laub who was taking degree at Leipzig to see who that unknown Einstein was. Coming to Bern and meeting the young scientist Laub was drawn, as everyone else who met Einstein on a professional basis, into an "*obsessional discussion that soon rose and swamped every thing else*".[70] Naturally Laub and Einstein became close friends, continued their discussions for about two years, and even published three joint papers.

When in 1911 Einstein moved to the German University of Prague, a strong friendship struck up between him and George Pick. These days Einstein was busy with his theory of general relativity. He often discussed with Pick his new conception, especially the difficulties he met in building its mathematical apparatus.

to devote myself entirely to scientific studies." (Albert Einstein, *Principles of Theoretical Physics.* in: Albert Einstein, *Ideas and Opinions.* New York, Crown Publishers, 1954, p.220.)

[70] R. Clark, *op. cit.*, p.110.

Did not these endless talks mean merely wasting precious time? What could Einstein get, for instance, from the talks with Solovine whose knowledge of theoretical physics was next to nothing? It is not excluded that talking and discussing science was just a passion for Einstein (as it was certainly for Niels Bohr), and passion does not require reason or rational goal. But this passion appeared to be very useful to Einstein. Factually, Einstein implied in his talks one of the most effective methods of problem solving, which I would like to call "*brainstorming discussion*". Talking to Solovine and explaining to him the perplexing points of physical theories, Einstein could consider problems of theoretical physics from many different standpoints, a circumstance extremely important in fundamental research. On the other hand, talking with Besso and his physicist colleagues, Einstein could check his own ideas and consider possible objections. These two types of discussions could induce also some valuable hints for new approaches and solutions.

It is impossible to assess to any reasonable extent what contribution had these talks made to Einstein's scientific achievements. But one thing is absolutely clear. These talks should be very helpful in developing Einstein's magnificent creation of the Special and General Relativity. Discussions with Besso had been so important to Einstein that he mentioned Besso's contribution to his theory in the final paragraph of his famous paper on relativity. "*I should like to note in conclusion*", wrote Einstein, "*that my friend and colleague M. Besso was my devoted assistant in the elaboration of the questions herein and I am indebted to him for a number of valuable suggestions*".

Another partner of Einstein's discussions – George Pick – helped him to find out the mathematical apparatus for the General Relativity, the so-called tensor calculus. In this particular case, the mathematical apparatus had an essential role since Einstein's revolutionary ideas on gravity, and space and time would lack the power to convince physicists if they were not presented in the form of a strict quantitative theory. In fact, the final recognition of the theory of relativity and the worldwide fame to its author came after the confirmation of the quantitative conclusions of Einstein's theory by the observations of 1918 solar eclipse.

Einstein's conception of relativity has an exceptional standing even compared to his own other important contributions to the development of theoretical physics. As we have seen above, the conceptions of Special and General Relativity had been brought to completion with the help of Einstein's method (or rather passion) to talk out his ideas and problems to his friends and colleagues. In the light of this fact, one has to consider a possibility that the most fundamental problems of science are likely to be solved in the atmosphere of collective discussions and friendly talks rather than in the solitude of the research of individual scientists.[71]

Of course, at the basis of scientific progress lie the individual efforts of scientists. Not only great discoveries but also ordinary scientific achievements presume that investigators should completely concentrate on their research problems. Einstein had been no exception. Maurice Solovine recalled Einstein "*wrapped himself completely in his thoughts to the point of oblivion of everything around him*". Another classical picture is that of Einstein in his Bern apartment rocking the cradle of his child and reading a book, but ready to expose the black notebook from his pocket the first quiet moment. Ronald Clark emphasized Einstein's "*ferocious concentration*" on his research and his determination that "*nothing should be allowed to divert him from it*".[72]

But one should not exaggerate the image of Einstein as of "*scientific loner*". This

[71] I have found a supporting remark by G. J. Whitrow. In his book on Albert Einstein he noted, that the form in which he chose to communicate his theories to the scientific world was considerably influenced by the endless discussions he had with Besso. "This shows that, even in the case of the most original scientific geniuses, discussion with others is invaluable," concluded Whitrow. (G. J. Whitrow, *Einstein. The Man and His Achievement.* New York, Dover Publications, 1967, p.18.)

[72] R. Clark, *op. cit.*, p.106.

picture was true for the last decades of his life when all his great discoveries had already been made. Einstein the revolutionary of science was very fond of communicating people and talking out to his colleagues his ideas and problems.

Perhaps, the passion for talking was common to all real geniuses. Socrates admitted having a benevolent habit "*of pouring out himself*" and being ready "*to pay for a listener*". It was not much important to him who was his listener. "*Any one, he be rich or poor, may ask and answer me and listen to my words*", declared the great thinker.

Niels Bohr was very fond of friendly talks too, especially on the central issues of atomic physics. He could talk out his mind to any group of listeners, be it his assistant or a student auditorium. Heisenberg recalled that when he was invited to work in Copenhagen Institute, almost from the first day began regular talks and discussions with Niels Bohr. These everyday meetings were not something exceptional. Bohr actively discussed the research work of all his young colleagues to the extent that there remained little time for his personal research and administrative work.[73]

In his recollections Paul Dirac mentioned Bohr's notorious habit to think aloud. He even believed that Bohr carried on all the gigantic work of his mind by talking aloud.[74] There could be no better proof of Plato's thesis "*Thinking is talking to oneself*". A sage, talking himself out to his listeners, seems to be rather a common experience. By Gene Derwood I met the following lines, "*There must be something wrong with being wise – talking we go, wondering and wandering with woes*".

A really striking case of scientific success by mere talking is that of James Watson and Francis Crick winning Nobel Prize for the discovery of DNA structure. By March 1953, when their paper on the discovery of the double helix structure of DNA was sent to publication, James Watson was only twenty-four years old and Francis Crick thirty-five. And what is really astonishing, by that time Watson had not done yet any worthwhile research, while Crick had just started serious work for his Ph.D. at the famous Cavendish laboratory.

Crick's serious trouble was his inability to concentrate on some central issue of theoretical research. Since he was always involved in talking and discussing completely different issues of science and social life, Watson called him "*talking machine*". Crick talked not only excessively but also louder and faster than anyone else did. And as if this non-interruptible loud talking was not enough, he also used to exercise a Homeric laugh. "*When he laughed*", recalled Watson, "*his location within the Cavendish was obvious*".

By that time an intensive investigation of DNA structure went on mainly in Linus Pauling's laboratory in California and Maurice Wilkins' laboratory in London. The basis of all investigations was Pauling's discovery of the helix structure if DNA. Wilkins' advantage was that he had come to the edge of experimental discovery of the main building blocks of DNA through long and systematic X-ray diffraction studies.

So how could Francis Crick, not speaking of James Watson, jump ahead of these two powerful laboratories? In fact, Crick benefited from his obsessive talking.

Crick talked and discussed problems almost with all Cavendish research teams since anything important immediately attracted his attention. He frequently visited other labs to see which experiments had been done. This general attitude and constant talking sometimes brought very useful results. For instance, the central idea of modern genetic theory – the scheme of gene replication – emerged during a casual talk with an astronomer on the "*perfect cosmological principle*".[75]

[73]Werner Heisenberg, *Erinnerungen an Niels Bohr aus den Jahren 1922-1927.* In: Werner Heisenberg, *Schritte uber Grenzen.* Munchen, 1973, S. 56-57.

[74]Paul Dirac, *Recollections of an Exciting Era.* In: *History of Twentieth Century Physics*: Proceedings of the International School of Physics "Enrico Fermi". Course LVII. New York, Academic Press, 1977, p.133.

[75]James D. Watson. *The Double Helix*, p.84.

Through talking and jumping into each one's business Crick eventually appeared in a very advantageous position. His quick mind immediately appreciated the bright perspectives of molecular model building approach used by Linus Pauling. But Pauling, as a very strong rival, was denied the newest diffraction data of Maurice Wilkins' laboratory. Wilkins had to keep his data away from anyone else and especially from Crick, knowing his obsession to talk to everyone and about everything. But Crick and Watson found finally an unordinary way to the newest results of Wilkins' research group.[76]

This way Crick got a decisive advantage over the two main research groups. He used Pauling's method of molecular modeling and could guide his research with the help of the newest experimental results of Wilkins' group. No wonder that his solution of the mystery of DNA structure was brilliant and rapid. Yet one should bear in mind that the passion for talking served the fertile soil out of which grew this grand achievement.[77]

Step 19. BECOMING A QUASI-GENIUS

"Blessed is he who has found his work."

Thomas Carlyle

Revealing the secret of geniality, I am ready to teach educated men to get a chance for a great discovery.

First, I am going to prove that the above revealed intellectual capacities, which helped Albert Einstein to become the greatest scientist of our epoch, are *necessary* to make a great discovery and *sufficient* for getting a chance to make a great discovery.

I start by proving the necessity. To reach this goal, I have to prove that great ambition, passionate love of science and freethinking are necessary factors of a great scientific discovery. Without great ambition no one would have the courage to undertake the research of a fundamental problem of science. That is the first precondition for any significant discovery. Great discoveries are produced by intensive and persistent exploration of fundamental super-difficult scientific problems. Such an exploration can accomplish only a scientist driven by a passion for fundamental theoretical research, an investigator in a state of holy obsession in regard of fundamental problems of science, a thinker in deep and passionate love with science. A radically new, revolutionary idea can visit only a mind brave and courageous, free of traditional taboos and independent of any opinion – even of those sanctified by the history of science.

The above revealed "*secret*" qualities of geniuses are determined by their task to make a revolutionary discovery. Any epochal discovery presupposes solving a fundamental problem. In the case of greatest discoveries, one has to solve a super-difficult fundamental scientific problem. And to explore such a problem, it is absolutely necessary to have great ambition. On the other hand, super-difficult problems require complete mobilization of explorer's intellectual powers and the ability to perform hard and unceasing

[76]Max Perutz, a department chief at the Cavendish, was appointed member of a committee that coordinated biophysics research. So he regularly got reports with comprehensive summaries of accomplishments of Maurice Wilkins' laboratory. "The report was not confidential and so Max saw no reason not to give it to Francis and me," tells James Watson in his book. (James D. Watson, *The Double Helix*, p.115.)

[77]But what could be James Watson's contribution to this discovery? Watson confessed in his book that he had neither abilities nor capacities of carrying any serious research work. Actually, he was not engaged in a direct DNA research either. So how he could appear so helpful in the discovery of DNA structure that he eventually was rewarded the Nobel Prize? There was a remarkable point that the Nobel committee could never overlook in any circumstances. Watson managed to be the first to send a letter to a California research group about his and Crick's idea of the double helix structure of DNA.

research. In its turn, this may be accomplished only with the help of passion supported by all-absorbing love for science. And lastly, greatest discoveries grow from the seeds of revolutionary ideas. To be revolutionary, one has to be brave and courageous, absolutely independent and completely free in his thinking.

This set of mental qualities – great ambition, passionate love of science and obsession with its basic problems, intellectual courage and complete independence of thought – contains the real secret of geniality. If one lacks any of these necessary qualities, hardly he would have any chance to make a revolutionary discovery. So, one must admit that the intellectual capacities revealed above in regard of Albert Einstein's great scientific achievements are the necessary preconditions of great theoretical discoveries.

Now let us turn to the second part of my thesis. Consider an investigator in possession of the above-discussed intellectual capacities that we presented as the intellectual basis of geniality. Since these intellectual capacities are proved to be the set of the necessary preconditions of great discoveries, there will be no factor barring for this investigator the way to a great scientific achievement. In other words, an educated man with the above mentioned intellectual qualities will have a chance to make a great scientific discovery.

In general, when all necessary conditions of a phenomenon are met, there remains no factor that may prevent its birth. This means that the appearance of a phenomenon should be considered as a possibility if its necessary conditions are presently given. Likewise, when an explorer acquires all the intellectual qualities composing the secret of geniality he gets a chance to make a revolutionary discovery since there remains no factor barring him from a great idea. Of course, the question how significant will be the chance for a great discovery remains open.

Now, to the main point of this discussion. It is not difficult to see that none of the above revealed components of geniality requires any special type of intellectual capacities. Any educated man, if properly instructed, can easily pretend that he has great ambitions and passion for fundamental theoretical research and is continuously obsessed with basic problems of science. It will not be also difficult to him to hold a position of a skeptical thinker, doubting each one theoretical principle and scientific law and feeling himself independent of modern conceptions as well as of opinions of great names of science.

So my discovery is that any educated man can get a chance for a great scientific discovery if he learns the above revealed secret of geniality and behaves himself according to the above listed characteristics of real geniuses. Of course, behaving like a genius, one will get only some chance to make a great discovery. The probability of making a discovery will depend upon the intensity and persistency of his efforts to exercise the undertaken obligation of behaving like a genius.

Consider now a scientist or any other educated person who advances in his research applying in full extent all the above mentioned factors of geniality. Such a person, apparently, will behave himself just *like* a real genius of science. Though the above revealed characteristic features of a real genius are not inborn to that person, yet he will acquire all the necessary characteristics of behavior of a real genius. These two points – the close similarity of the behavior and the fact that geniality is not inborn to that person – provide sufficient ground to call such a person a "*quasi-genius*".

In a sense, quasi-geniuses are "*artificial products*". They are not born with the set of characteristic features of real geniuses, but with the help of my discovery of the secret of geniality they are able to proceed in their research as if they were real geniuses.

Here I have to introduce an essential correction. Quasi-geniuses should hold to my following advice. They must exercise their function of a real genius only on part-time terms. I have mentioned above that there is no guarantee that a given super-difficult problem will be solved by an explorer if he were even a real genius. So if one decides to become a "*full-time*" genius and investigates only fundamental, super-difficult problems,

he, of course, will get a chance to make a great discovery. Yet the probability will be much greater that he would not succeed to solve any of the fundamental problems he intended to explore. Young students must remember George Polya's warning: "*Waiting for ideas is gambling*".

A "*full-time*" genius risks losing all his life in a hard research of super-difficult problems not getting any positive result. I understand well the feelings of Wolfgang Bolyai when he learned that his son Janos decided to study one of the most difficult problems in the field of geometry – the problem of Euclid's fifth postulate. "*You must not attempt this approach to parallels*", Wolfgang Bolyai heartily asked his son. "*I know this way to its very end. I have traversed this bottomless night, which extinguished all light and joy of my life. I entreat you, leave this science of parallels alone. You should detest it just as much as lewd intercourse; it can deprive you of all your leisure, your health, your rest, and the whole happiness of your life. This abysmal darkness might perhaps devour a thousand towering Newtons*".

To avoid such a disaster, a "*quasi-genius*" must devote part of his efforts to the investigation of the ordinary problems of science or to any other ordinary activity. That will enable him to achieve normal goals of life, get scientific degrees and make a respectful career not losing the chance for a great discovery. So, a quasi-genius should act as "*part-time genius*".

Facing a super-difficult problem, all scientists are equal. A super-difficult problem, by its definition, can be solved only with the help of an extremely remote analogy, a crazy idea. But there is no logical way leading to such a solution. Exploring a super-difficult problem, scientists have no idea what kind of analogy can be helpful to solve it. They cannot even be sure in which direction one has to search for plausible ideas. Success comes only due to unceasing search of new ideas supported, necessarily, by a good piece of luck. Even in theoretical research, solutions of difficult problems come to light with the help of a lucky chance. Nevertheless, a lucky chance is not an independent factor. Good luck is realized probability. Luck and success depend upon the intensity of efforts in the search of solutions.

Great discoveries grow up in the land of difficult problems, while *greatest* discoveries are brought about from the land of *super-difficult* problems. Talents rule the land of difficult problems and gather the harvest of great discoveries. But in the land of super-difficult problems all scientists are equal. Moreover, I will now prove that talented scientists are definitely handicapped in regard of super-difficult problems.

First, a talent is highly successful in solving difficult problems of contemporary science. He makes many "*ordinary discoveries*" just in the framework of normal science feeling no need for the revolutionary reconstruction of existing classical theories. Second, a talented scientist is well aware of the enormous danger of being involved in the research of super-difficult problems that can absorb his life's efforts without any tangible result. Third, possessing highest scientific intuition, a talented scientist is well prepared to distinguish super-difficult problems from the solvable ones. It permits him to avoid the adventurous research of questions for which there is negligible chance to reach a satisfactory answer in a foreseeable future. Fourth, a talent is an early fruit. He gains position and reputation very early, often during his first years in science. So a talent would never permit himself to risk his high reputation suggesting revolutionary ideas which would always sound suspicious to his solid colleagues.

Actually, talents are not ambitious. They never require an inner conviction of possessing a potential for great discoveries. Talented scientists just make discoveries. Talents can manage without any special passion for science and scientific research. They get everything so easily that scientific research appears to them an amusing playground, a kind of continuous fiesta. For instance, neither Clerk Maxwell nor Richard Feynman had

been ambitious since it was quite clear to their friends and teachers that they had the most brilliant brains for theoretical research. Talents are never involved in talks and discussions since they understand everything to the extreme clarity and have no desire to prove to anybody the correctness of their interpretations.

Thus, talented scientists lack the most important characteristic features of potential geniuses. That means that a talent is seriously handicapped in regard of the greatest discoveries.

One more point which keeps a talented scientist at a distance from revolutionary ideas. Talented scientists have the best understanding of the problems under research. But the higher is the level of understanding of a scientist, the more strict and definite is for him the boundary that separates the land of possible solutions from that of absolutely wrong ideas. But in the case of super-difficult problems, revolutionary ideas are often found among those ones, which seem apparently absurd. So the advantage of the best understanding often closes the gate of the kingdom of greatest discoveries. *Talent is ability, genius – intention.* The extreme intellectual power of a talent is a result of an unceasing exercise based on exceptional inborn capacities. The extreme ambition and obsession of a genius, most probably, are inborn, too. But the ambition to be a genius can be formed also by intention. In this sense, it is never late to make a decision to become a "*quasi-genius*".

Actually, a real genius puts on risk his whole life devoting it to obsessional investigation of super-difficult problems for the sake of a minute chance of making an epochal discovery. And though their life full of unreserved love to science always fascinated me, I would not like seeing any of my young readers involved in such a gamble. My final advice is as follows: be more reasonable and behave yourself as a "*quasi-genius*", undertaking the task of revolutionary discoveries only on a "*part-time*" basis.

Step 20. MAKING THE CHANCE FOR GENIALITY GREATER

"What is all knowledge too but recorded experience."

Thomas Carlyle

A quasi-genius as well as any other explorer undertaking the investigation of a super-difficult problem should be ready finding himself eventually into an impasse. The feeling of a deadlock overwhelms a scientist when he gets convinced that all his usual methods of solution appeared unproductive in the case of the given problem. And, as we know, a super-difficult problem cannot be resolved with the help of usual methods and ordinary ideas.

If human beings were logical creatures and their brains operated like computers, then no investigator would have a feeling that he is in a deadlock. Analysis-synthesis-verification cycles would repeat one another, again and again generating new hypotheses and their modifications and testing them. Thus the process of scientific investigation should keep going on until a satisfactory hypothesis would be produced. Anyway, in the logic of research, there had to be no place for an impasse.

But we, human beings, are chiefly psychological creatures. Each one of us has his own boundaries that separate the field of reasonable ideas from the unreasonable ones. A scientist has also his personal set of methods that proved to be useful in his particular professional activities. Apart from paradigms of science which shape the world vision of the epoch, each scientist has his personal set of concepts and methods that proved their efficiency during numerous investigations. The more experienced and successful is a scientist, the more rigid are the boundaries built by the efficient ways of gaining

knowledge. This set of general paradigms and personal methods are the mighty weapon, the real *organon* that insures scientist's productive research and his success in normal science.

These paradigms and methods are formed in the field of normal science and prove their efficiency in regard of ordinary problems. But when scientists meet an unordinary problem, when the phenomenon under research belongs to an entirely new level of reality, paradigms and methods of normal science do not work. Moreover, the authority of paradigms and stereotypes becomes a serious obstacle in the research and understanding of extraordinary phenomena.

Stereotypes restrict scientist's field of vision. They keep scientists within the strict framework of old theories and forbid thinking of unreasonable (but potentially revolutionary) ideas and hypotheses.

So meeting a super-difficult problem and exhausting for its solution the domain of ideas permitted by the scope of general knowledge and personal methods, a scientist comes to the conclusion that the problem is unsolvable, for his epoch or at least for him personally. This is the way that brings scientists to the dreadful feeling of a deadlock and impasse.

To make his chance for success greater, a quasi-genius should apply all the methods designed to overcome an impasse. Some of them I have already mentioned above discussing specific features of Albert Einstein's way of thinking discussed.[78]

As it was mentioned above, an impasse is formed by the walls that separate reasonable ideas from the unreasonable ones. So the first thing in fighting an impasse is to weaken these walls, to make breaches in them, to shift them aside or move further away. Here most helpful appears the skeptical attitude to the basic scientific knowledge on which the walls of an impasse are built.

The other important factor is the quality and amount of available knowledge. The more systematic, extended and elaborated is one's knowledge of a theoretical conception, the stronger are the walls of the impasse he has to overcome. Conversely, the less extended and detailed is one's knowledge of a basic theory, the bigger is the probability to find ideas to overcome the impasse in this field.

An impasse, by its nature, is a psychological phenomenon. As we have just mentioned above, an explorer feels himself driven into impasse when he becomes convinced that he had already tried *all* the possible approaches to the problem. But how can one be sure that he had examined all possible approaches? In fact, any explorer considers only reasonable ideas and approaches. The sat of reasonable ideas is determined by explorer's knowledge of the subject of research. It is the critical judgment of the explorer that forbids him to consider apparently unreasonable and absurd ideas. Basic theoretical conceptions and paradigms are the glasses through which the critical mind looks at the relevant ideas.

In view of this specific pattern of problem solving, one should admit that the most extreme way for overcoming an impasse is to forbid any critical judgment of ideas during the attempts to generate new solutions. This is just the essence of Alex Osborn's method of "*brainstorming*". Albert Einstein can be considered as one of Osborn's forerunners in practical use of collective idea generation. He liked to discuss his ideas and problems with his friend M. Besso. He was eager to discuss general problems of theoretical physics with any one interested in the subject. There is much evidence how gentle and considerate was Einstein in regard of his opponents during scientific discussions. This attitude should pay back. Explaining a fundamental problem to different listeners, Einstein had to use various, often unusual approaches and analogies. And this is one of the most effective

[78]See also the scope of these methods in Robert Djidjian, *Twenty Rules for Talented Thinking*, Tel-Aviv, Raemim, 1998, chapters 13 and 14.

means of overcoming an impasse.

As it was mentioned above, the basis of critical judgment of ideas is formed by means of fundamental concepts and conceptions. So, one can critically analyze the fundamental concepts themselves thus opening ways for new understanding of the problematic situation, shifting and pushing aside some boundaries of the kingdom of reasonable ideas. I would like to call this critical revision of fundamental concepts – *basic analysis*.

To carry on the analysis of a basic concept is a very difficult task since one has to judge critically a fundamental idea with the help of which the theory of the given field of science is built. Aristotle was famous for his thorough analysis of fundamental concepts. Many chapters of *Metaphysics* explicate the meanings of such basic concepts as essence, being, time, space, change, motion, matter, cause, etc. Basic analysis was characteristic for Einstein's way of thinking, too. In fact, his conception of the Special Relativity was elaborated through the detailed analysis of the concept of simultaneity.

The result was so much impressive that after the publication of his famous paper many physicists became convinced that no one did understand relativity as deep as did it Einstein. Recalling the years of formation of the Special Relativity, Max Born emphasized that though European physicists read and discussed works of Lorentz, Poincaré and Fitzgerald, it was Einstein who "*disclosed the epistemological root of the problem*" and thus fully deserved that the principle of relativity became connected to his name.[79]

It is quite easy advising to be skeptical and critical in regard of basic scientific knowledge. But it is very hard to exercise such an advice. How can one be critical in regard of concepts that he learned from his school years, when any statement written in a handbook and presented by a teacher was conceived as the absolute truth. How can one be critical in regard of a basic scientific conception that he admired from his youth? Is anyone able to doubt that forces of interaction appear of same intensity in identical conditions and that charges create fields of force in the surrounding space, etc, etc.?

Even if one agrees to be critical considering the basic concepts of science, it will be of little use in his practice of research. Factually, one can hardly be critical in regard of a theory that he has conceived from his youth as a specimen of true knowledge.

By contrast, experienced scientists are usually very critical to any new theory. Scientists' strong judgment notices the smallest discrepancies in the newly developed conceptions. A mature explorer conceives any new hypothesis or theory utmost critically.

But it is hardly a good policy to seat and wait for new theories to criticize them. It will be much more effective if one goes to learn an entirely new field of science. Being already an experienced and successful researcher, he will be critical to any fundamental principle of this new field. And it is very probable that he will perceive skeptically even the most fundamental conceptions of this field.

Summing up, we can state that one will significantly increase his chance for great discoveries if he changes his specialty, or more correctly, if he begins learning an entirely new science. It is quite evident that if one starts to study a new field of natural phenomena, being already an experienced explorer in some field of science, the critical approach to all theories in this new field of research is granted to him.

Here are some historic confirmations. Andre-Mary Ampere was already chosen to the French Academy of Sciences for his work in mathematics and chemistry when he started to explore electromagnetic phenomena. Michael Faraday was chosen to the Royal Society of London for his works in chemistry, too. Only later he turned to the study of electromagnetism.

No doubt, both Ampere and Faraday, being already experienced scientist, could have only critical attitude to all theoretical conceptions of electricity and magnetism of their day. That circumstance should have been very helpful in the elaboration of their original

[79]Max Born, *Physics in my generation*. New York, Pergamon Press, 1956, p.109.

conceptions. To stress the significance of such a transfer of the activity of a scientist into entirely new field of research, I would like to label the advantage one gains by radically changing the field of his research as "*the critical vision of an unprejudiced eye*".[80]

Greatest discoveries, by definition, emerge from solutions of super-difficult problems. Nevertheless, *one has negligible chance to make a great discovery if he tries to solve a super-difficult problem.* I devised this paradox to emphasize that one should avoid exploring super-difficult problems as such. Instead, it is much more effective to investigate some particular cases of a given super-difficult problem. Apparently, the best way is to start by investigating the simplest cases. Reaching a particular solution, one can proceed to its generalizations and ascend to a fundamental revolutionary principle.

Let us label this way of increasing the chance for a great discovery as the "*method of particular problems*". There are many striking examples of such an approach in the history of science. Gregor Mendel explored not the general problem of inheritance, but rather the laws of plant hybridization. Werner Heisenberg solved first a particular problem of radiation dispersion. Only his colleagues found out that Heisenberg's method can lead to the fundamental principle of new quantum mechanics. Max Planck introduced the idea of quanta of energy just as a possible way to build a correct formula of the density of energy distribution in radiation spectra. Albert Einstein suggested the idea of photons only as a heuristic means to account for the strange features of photoelectric phenomena. To use the method of particular problems one should realize that for the substitution of the initial problem by its much simpler particular instance one has to reformulate the original problem.

Studying the history of science is the best school to learn the ways of great discoveries. As Richard Feynman put it, guessing nature's laws is an art, which can be learned looking at the history of science in order "*to see how the other guys did it*".

For human mind the best teachers are examples, and the history of science provides many excellent examples of great discoveries. Learning the history of science, one realizes what a variety of approaches and principles were there considered for the explanation of the phenomena under investigation. This circumstance, on the one hand, demonstrates to students that by a persistent search one gets a possibility to reveal even the most deeply hidden secrets of nature. On the other hand, it shows what a variety of remote analogies and crazy ideas can be used in quest of fundamental principles and laws of science. Last but not least, learning the history of science, students become used to the idea that any successful scientific theory can be revised and substituted by a more adequate one. This experience is very helpful in developing a skeptical perception of theoretical conceptions and principles, a vital factor in the quest of revolutionary ideas.

Unfortunately, the history of science provides little information regarding the particular steps that led explorers to their great discoveries. Great scientists seldom wrote autobiographies. And when they did so, their autobiographies afford few facts concerning the ways by which they succeeded to uncover the secrets of nature.

Moreover, when you meet in a great scientist's autobiography an occasional remark that tells important particularities concerning the ways of his great discovery, you cannot completely rely on that evidence. As a rule, famous scientists write their memoirs at a venerable age when one is practically unable to reconstruct the details of the chain of thoughts that had brought to his great discovery. And what is even more limiting, it is a very difficult task for a scientist to reconstruct this chain of thoughts even immediately

[80]The critical perception by an experienced scientist of a new field of knowledge, undoubtedly, is a very positive factor in the research of basic problems. But, of course, this advantage does not guarantee that a scientist turning to the new field of research will make great discoveries. For instance, Richard Feynman turned to the study of biology at the age of forty, but did not succeed to make any major contribution to the field. Possibly, the motivation of the Nobel Prize winner for fundamental research in biology was not strong enough.

after the moment of the great discovery. That is why the typical answer of famous scientists to the question about the ways of their great discoveries is that the great idea had visited him suddenly, unexpectedly, in an amazing instant of illumination.

Learning all the knowledge presented in the previous chapters on the ways of scientific revolutions and "*secrets*" of geniuses of science is indispensable if one intends to increase his chance for a great discovery. Yet one of the most important preconditions is to get used to revolutionary ideas and ways they can be dealt with. This you can learn reading and rereading the appendix of this book.

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