LOGIC, LANGUAGE, METHODOLOGY

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CONTENTS

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POSSIBLE WORLDS IN THE LANGUAGE OF NON-FREGEAN LOGIC

I. Introduction

The term "possible world" is used usually in the metalanguage of modal logic, and it is applied to the interpretation of modal connectives. Surprisingly, as it has been shown in Suszko [68a] certain versions of that notion can be defined in the language of non-Fregean logic exclusively, by means of sentential variables and logical constants. This is so, because some of the non-Fregean theories contain theories of modality, as shown in Suszko [71a]. Intuitively, possible worlds are maximal (with respect to an order of situations) and consistent situations, while the real world may be understand as a situation, which is a possible world and the fact.

Non-Fregean theories are theories based on the non-Fregean logic. Non-Fregean logic is the logical calculus created by Polish logician Roman Suszko in the sixties. The idea of that calculus was conceived under the influence of Wittgenstein's Tractatus. According to Wittgenstein, declarative sentences of any language describe situations. Different explanations of what is a situation may be found in Wittgenstein [94], Wolniewicz [99], Barwise and Perry [83], Wójcicki [86] and others.

II. W-languages

To speak in a formal way about the structure of the universe of situations, Suszko introduced languages which he called W-languages (in honor of L. Wittgenstein). In the alphabet of these languages, there are two kinds variables: sentential variables: $p, q, r, \ldots$, and nominal variables: $x, y, z, \ldots$, identity connective and identity predicate, both symbolized by the sign "$\equiv$",

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and quantifiers binding the two kinds variables. The intended interpretation of W-languages is such that nominal variables range over the universe of objects while the sentential variables run over the universe of situations. All other symbols in these languages, except the sentential and nominal variables, are interpreted as symbols of some functions both defined over the universe of situations and the universe of objects. The identity connective corresponds to the identity relation between situations, and the identity predicate corresponds to the identity relation between objects. It is obvious that the language of the ordinary predicate calculus with identity is a part of the W-language excluding sentential variables, but the most frequently used sentential languages are the part of the W-language without nominal variables and the identity predicate.

If a language does not contain sentential variables then according to Suszko it is not fit for a full formalization of a theory of situations, but at most for that of a theory of events considered as reified equivalents of situations (see Suszko [94]).

In contemporary science the majority of studied theories are those which are expressed in languages without sentential variables. The appearance of the Fregean sentential semantics, Leśniewski's prothotetics, Wittgenstein's Tractatus and the Non-Fregean Logic has been an important step in the development of logico-philosophical reflection, because these theories require a language with sentential variables. According to Suszko, *situations* are primitive with respect to *events*, for the latter are objects abstracted from the former. In Suszko [94] it is proved that:

(i) certain theories of situations are mutually translatable into theories of events,

(ii) certain algebras of situations are isomorphic with algebras of events,

Suszko posed the question:

> *".... What, therefore, is the cause of the fact that our thought and the natural language to a certain degree discriminate sentence variables, and particularly, general and existential sentences about situations?..., Why, therefore, should we prefer the theory of events to that of situations?"*

And in the same paper Suszko answers:

> *"It is probably the symptom of some deep, historically determined attribute our thought and of natural language, the examination and explication of which will certainly be long and arduous".*

These features of our thinking induce an account of the world rather as the universe of objects possessing certain properties and connected by certain relations, not – as the totality of facts obtaining a logical space as in Wittgenstein's *Tractatus*. According to Suszko, one of the aspects of

this bias of our thinking is the tendency (originating from logical empiricism) of shifting philosophical problems from the object language to the metalanguage. E.g., such terms as: *the real world*, *a possible world*, *a fact*, *a situation* usually do not occur in the object language, but are used mostly in the metalanguage of modal logic applied to the interpretation of modal connectives.

III. SCI with quantifiers

In this paper, for the sake of simplicity, I have restricted myself to languages without nominal variables, i.e. to languages whose alphabet contains only the sentential variables, the logical connectives, quantifiers, and some auxiliary symbols defined by them, that is, to the SCI languages with quantifiers.

In that language, a non-Fregean logic is generated by the Modus Ponens rule and by some logical axioms divided into three groups:

A1 – The axioms for the truth-functional connectives:

(1) $\forall p \forall q\ [p \to (q \to p)]$

(2) $\forall p \forall q \forall r\ [(p \to (q \to r)) \to ((p \to q) \to (p \to r))]$

(3) $\forall p \forall q\ [\neg p \to (p \to q)]$

(4) $\forall p\ [(\neg p \to p) \to p]$

A1 is the set of axioms characteristing the connectives: $\neg, \wedge, \vee, \to, \leftrightarrow$ in the classical way.

A2 – Axioms for quantifiers binding sentential variables, which are all the formulas represented by the following schemas:

(5) $\forall p\ \alpha \to \alpha[p/\beta]$, where $\alpha[p/\beta]$ is the result of correctly substituting in the formula α the formula β for the variable p;

(6) $\alpha \to \forall p\ \alpha$, if p is not free in α;

(7) $\forall p\ (\alpha \to \beta) \to (\forall p\ \alpha \to \forall p\ \beta)$

(8) $\exists p\ \alpha \leftrightarrow \neg \forall p\ \neg \alpha$

A3 – axioms for the identity connective:

(9) $\forall p \forall q\ [(p \equiv q) \to (p \to q)]$;

(10) $\forall p \forall q\ [(p \equiv q) \to (\neg p \equiv \neg q)]$;

(11) $\forall p \forall q \forall r \forall s\ [(p \equiv q) \wedge (r \equiv s) \to (p\ \%\ r) \equiv (q\ \%\ s)]$, where $\%$ stands for $\wedge, \vee, \to, \leftrightarrow$;

(12) $\alpha_1 \equiv \alpha_2$, where α_1, α_2 differ at most by bound variables;

(13) $\forall p\ (\alpha \equiv \beta) \rightarrow (Qp\ \alpha \equiv Qp\ \beta)$, where Q stands for $\forall, \exists$.

This calculus is a part of the non-Fregean logic and is called the non-Fregean sentential logic or 'SCI with quantifiers'. Although every logical theorem is at the some time an ontological one, the non-Fregean logic doesn't stipulate any structural and quantitative conditions on the universe of sentential variables, except that it must contain at least two-elements. This is expressed by the logical theorem: $\exists p \exists q\ \neg(p \equiv q)$. For example: '$\forall p\ (p)$' present a different situation than the sentence '$\exists p\ (p)$'.

To express in the language of logic certain extra-logical presuppositions of the ontology pertaining to the structure of situations, let us adopt the following notations. If A is a set of formulas, then $Gn(A)$ is the set of all generalizations of formulas in A, and $Eqv(A)$ is the set of all equations $\alpha \equiv \beta$, such that $(\alpha \leftrightarrow \beta) \in A$.

IV. Ontology of situations

According to the principles of non-Fregean semantics as presented in Omyła [94] each sentence α in any model M has a semantic correlate, which denote by $|\alpha|_M$. The models for the language of non-Fregean sentential logic are structures:

$$M = (\boldsymbol{U}, F),$$

where: $\boldsymbol{U}$ is a generalization of the SCI-algebra on a given set U, and F is a suitable subset of U. In any model M the logical constants have the intended interpretation, therefore any model for the language of sentential logic will be treated as a formal representation of a certain universe of situations with a distinguished set of facts in it. In order to simplify the formulations a generalized algebra of any model $\boldsymbol{M}$ for the non-Fregean sentential logic will be called the algebra of situations, and the set F will be called the set of all facts occuring in this model. The algebra situations is the same what Suszko understood by semi-models. Let $\boldsymbol{M}$ be

$$\boldsymbol{M} = (\boldsymbol{U}, F),$$

any model for the language of non-Fregean sentential logic, and

$$\boldsymbol{K} = \{(\boldsymbol{U}, F_i) : i \in I\}$$

be the family of all models for the language of non-Fregean sentential logic L determined by the algebra of situations $\boldsymbol{U}$. The fact that the models from the

class $\boldsymbol{K}$ have the same generalized algebra $\boldsymbol{U}$ means that these models are determined by the same set of situations and in the same way are articulated in the language L. The models from the class differ at most from the set of facts realized in them.

We denote: $TR(\boldsymbol{M})$ – the set of all formulas true in $\boldsymbol{M}$ of the language of non-Fregean sentential logic,

$$Val(\boldsymbol{U}) = \cap\{TR\{(\boldsymbol{M}) : \boldsymbol{M} \in K\}$$

$$\alpha \in Val(\boldsymbol{U}) \leftrightarrow \forall \boldsymbol{M}\ (\boldsymbol{M} \in \boldsymbol{K} \rightarrow \alpha \in TR(\boldsymbol{M}))$$

Definition 1.

T is an ontology of situations in the language of non-Fregean sentential logic L iff T is the theory in L and there exists an algebra of situations $\boldsymbol{U}$ such that

$$T \subset Val(\boldsymbol{U}).$$

Symbolically:

$$T \text{ is } OS_L \leftrightarrow T \in TH(L) \text{ and } T \subset Val(\boldsymbol{U}).$$

where: OS_L – denotes the set of all ontology of situations in the language of non-Fregean sentential logic L, $TH(L)$ – the set of all theories in the language L.

The idea of ontology of situations defined in this way reflects those intuitions which state that ontology contains necessary statements, dependent only on the structure of the universe of situations and not on the occuring facts.

Three direct corollaries of the definition:

1. $Cn(\emptyset)$ is the smallest ontology of situations, i.e. $Cn(\emptyset)$ is an ontology of situations and moreover every ontology of situations includes $Cn(\emptyset)$.
2. If X is a set of equalities i.e. $X = \{\alpha \equiv \beta : \alpha, \beta \in L\}$ such that $Gn(X)$ is consistent, then $Cn\ (Gen(X)$ is a certain ontology of situations (where $Gen(X)$ is the set of all generalizations of all formulas from the set X).
3. In the language of classical sentential logic there is only one ontology of situations, i.e. the set of all formulas true in two-element Boolean algebra, i.e. the set of all tautologies of the classical sentential logic.
4. The set $TR(M) - Val(M)$ is the set of sentences describing the facts holding contingently in the model M, but which may not hold in other models defined on $\boldsymbol{U}$.

Remarks:

1. The term "ontology of situations" has been taken from the title of Wolniewicz [85], where it is used in a little different meaning.

2. What has been called "algebra of situations" and "ontology of situations" it was in Suszko [71b] called respectively "semi-model" and "truth in algebra", symbolically $Val(\boldsymbol{U})$.

Let the set D be constitued by the definitions

(d1) $0 \equiv \forall p\ (p)$

(d2) $1 \equiv \exists p\ (p)$

(d3) $\forall p \forall q\ [(p \leq q) \equiv ((q \to p) \equiv 1)]$

(d4) $SFp \equiv \{\forall q(q \to (q \leq p) \wedge \forall r(\forall q(q \to (q \leq r)) \to (p \leq r)\}$

(d5) $InfFp \equiv \forall q(q \to (p \leq q) \wedge \forall r(\forall q(q \to (r \leq q)) \to (r \leq p)\}$

(d6) $PWp \equiv \{\neg(p \equiv 0) \wedge (\forall q\ [(q \leq p) \vee (\neg q \leq p)]\}$

(d7) $RWp \equiv (p \wedge \forall q(q \to (q \leq p))$

The terms defined by (d1), (d2) have the following intuitive import: 0, 1 are sentential constants. They are the abbreviations of some sentences i.e. sentential formulas with no free variables. 0 is the designated impossible situation to the effect that all situations are facts. The sentence $\exists p\ (p)$ is a theorem of the non-Fregean sentential logic, thus it represents an improper fact. Consequently, 1 is an improper fact to the effect that in any model the set of facts is not empty.

Using these notations we are in a position to determine the following theories of situation known in the literature:

$$WBQ =_{\text{def}} Cn(Eqv(Cn_0(\emptyset)) \cup D);$$
$$WTQ =_{\text{def}} Cn(Eqv(Cn(\emptyset) \cup D)),$$
$$WHQ =_{\text{def}} Cn(WBQ \cup H)$$

where:

- Cn_0 is a subconsequence of Cn generated by the sets of axioms (A1), (A2) and the rules (MP),
- H is the set consisting of the two formulae:

$$\forall p \forall q[(p \equiv q) \equiv ((p \equiv q) \equiv 1)]$$
$$\forall p \forall q[\neg(p \equiv q) \equiv ((p \equiv q) \equiv 0)]$$

The theory WBQ contains all generalizations of the valid Boolean equations written out by means of sentential variables, connectives and quantifiers only. Particularly, theorems WBQ are all generalization of formulas of the following form:

$$\alpha(p) \leq \forall p\ \alpha(p), \qquad \exists p\ \alpha(p) \leq \alpha(p),$$
$$1 \leq p, \qquad p \leq 0$$

The formula '$(p \leq q)$' under any theory containing the set WBQ, is read: "*the situation p is contained in the situation q*" or "*the situation p obtains in the situation q*", or "*the situation p occurs in the situation q*". This is justified by the circumstance that in any WBQ-model the counterpart of the connective "$\leq$" is an ordering relation on the universe of situations, called *ordering of situations*. The formula: "SFp" is to say that *the situation p* is – under the ordering of situations – the least upper bound of the set of all facts, i.e. it is the sum of all facts. Similarly, $InfFp$ says that p is its greatest lower bound. Formula 'RWp' is to say that p is a fact containing all other facts.

Any theory T expressed in the language of the non-Fregean sentential logic L such that $WBQ \subset T$ is called a WBQ-theory, and its model a WBQ-model. (With W – for Wittgenstein, B – for Boolean algebra, and Q – for quantifiers).

To be able to read the formula 'PWp' as 'the situation p is a possible world', we assume that 0 is the only impossible situation. This holds for these models M of considered language L in which $WHQ \subset TR(M)$, where $TR(M)$ is the set of all formulas true in the model M.

Furthermore, any theory T such that $WHQ \subset T$ is called a WHQ--theory, and its model a WHQ-model.

We get the following:

Metatheorem 1.

In any WBQ-theory these formulae are theorems:

(i) $\exists p\ SFp$

(ii) $\exists p\ InfFp$

By the completeness theorem for the non-Fregean logic metatheorem 1 says that in every WBQ-model there exists the sum of all facts, and also their infimum which is the Boolean unit 1.

Metatheorem 2.

For any WHQ-model $M = (\boldsymbol{U}, F)$ we have:

(i) with regard to the ordering of situations, the least upper bound of a set of possible worlds is $|\forall p\ (PWp \to p)|$;

(ii) the greatest lower bound of such a set is $|\exists p\ (p \wedge PWp)|$.

Simple proofs of the metatheorems may be found in Omyla [86]. From metatheorem 2, and in view of the connection between truth in algebra of situations and truth in the model defined on that algebra, we get the following:

(i) No situation is a possible world in the algebra of situation $\boldsymbol{U}$ iff

$$`\exists p\ (p \wedge PWp) \equiv 0' \in Val(\boldsymbol{U})$$

(ii) In the algebra of situations $\boldsymbol{U}$ there are situations which are possible worlds iff

$$`\neg[\exists p\ (p \wedge PWp) \equiv 0]' \in Val(\boldsymbol{U}).$$

(iii) In M there is a situation which is the real world iff '$\exists p\ (p \wedge PWp)$' is true in M.

(iv) In $\boldsymbol{U}$ each possible situation is contained in some possible world iff

$$`\exists p\ (p \wedge PWp) \equiv 1' \in Val(\boldsymbol{U}).$$

Finally, let me add that in this paper I have considered certain particular kinds of situations, such that as facts and possible worlds, and I have analysed them from the point of view of ordering of situations determined by the definition (d3). The definitions (d1)–(d7) are little modifications of definitions considered by Suszko in the papers Suszko [68a], [68b]. This paper is a reconstruction and systematization Suszko's consideration about possible worlds contained in those papers.

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TENSE LOGICS AND ARISTOTELIAN ARGUMENT ABOUT DETERMINISM

Logical determinism[1] is a point of view which proves the thesis that only logical principles are sufficient while discussing determinism. Logical deterministsay that the principles of bivalency and excluded middle low are sufficient to construct an argument about determinism. The problem was clearly formulated by Aristotle in Chapter IX of *On Interpretation.* Aristotle assumes that sentences about the past and present are either true or false. He claims, however, that the assumption that sentences about the future are either true or false is sufficient while constructing an argument about determinism. As he puts it:

> When the subject, however, is individual, and that which is predicated of it relates to the future, the case is altered. For if all propositions whether positive or negative are either true or false, then any given predicate must either belong to the subject or not, so that if one man affirms that an event of a given character will take place and another denies it, it is plain that the statement of the one will correspond with reality and that of the other will not. For the predicate cannot both belong and not belong to the subject at one and the same time with regard to the future. Thus, if it is true to say that a thing is white, it must necessarily be white; if the reverse proposition is true, it will of necessity not be white. Again, if it is white, the proposition stating that it is white was true; if it is not white, the proposition to the opposite effect was true. And if it is not white, the man who states that it is making a false statement; and if the man who states that it is white is making a false statement, it follows that it is not white. It may therefore be argued that it is necessary that affirmations or denials must be either true or false. Now if this be so, nothing is or takes place fortuitously, either in the present or in the

[1] Apart from logical determinism **physical determinism** is considered. Physical determinism is a point of view which states that every fact has immemorial causes in other earlier facts. Physical determinism is connected with the principle of causality.

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future, and there are no real alternatives; everything takes place of necessity and is fixed[2].

If all sentences about the future are true or false, then the events described by these sentences are determined. If all future events are determined, there are not accidental events and everything is necessary. Therefore, the thesis that sentences about future events are either true or false implies that – apart from the past and present – the future is also logically determined.

Therefore, if we accept the principle of necessity and the principle of the excluded middle, the argument on determinism can be reconstructed as follows:

Let $T(p)$ means "*p is true*", and $\Box(p)$ means "*p is necessary*".

1) $T(p) \to \Box(p)$ – the principle of necessity,
2) $T(\neg p) \to \Box(\neg p)$ – the principle of necessity,
3) $T(p) \vee T(\neg p)$ – the principle of excluded middle,
4) $\Box(p) \vee \Box(\neg p)$ – 1, 2, 3 and $\dfrac{\alpha \to \gamma, \beta \to \delta, \alpha \vee \beta}{\gamma \vee \delta}$.

To get a very similar proof, we can construct an argument using the principle of bivalency.

Determination should be considered in a temporal context. Therefore, we will get a better approximation of the notion of determining if we introduce temporal expressions into the language. It is realized in the varied tense logics.

Standard tense operators are as follows:

$F\alpha$ – at least once in the future α,
$P\alpha$ – at least once in the past α,
$G\alpha$ – it is always going to be the α,
$H\alpha$ – it has always been the case α.

The expression which we should recognize as a notation of the thesis of determinism in the language of tense logic is:

$$F\alpha \vee F\neg\alpha.$$

With regard to understanding of F tense operator, we will read $F\alpha \vee F\neg\alpha$ as follows:

At least once in the future α or at least once in the future $\neg\alpha$.

[2] Aristotle, *On Interpretation*, Chapter IX.

In our consideration we assume that sentences are semantic correlates of events, therefore, a possible interpretation of $F\alpha \vee F\neg\alpha$ is:

*For event **A** (which is a semantic correlate of the sentence α) is either determined with a moment of time in the future such when the event **A** holds at that moment, or is determined with a moment of time in the future when the event **A** does not hold at it.*

Because in the expression $F\alpha \vee F\neg\alpha$ α is any, therefore, for any event it is either determined that this event holds at some moment of time in the future, or it is determined that it does not hold at any moment of time in the future. In other words, all future events are determined and there are no future accidental events.

If $F\alpha \vee F\neg\alpha$ is a thesis of some system of the tense logic then the language of such a system has limited possibilities to describe the world because if we use the language of this formal system, we can describe only the properties of such worlds which belong to the class of determined worlds. However, in this case, logic is ontological involved in the matter of determinism.

A following question arises:

What conditions should be fulfilled for the expression $F\alpha \vee F\neg\alpha$ to be a tautology of the system of tense logics?

We are going to consider two kinds of tense logic:

- tense logic based on classical logic and
- tense logic based on intuitionistic logic

First, let us consider tense logic based on classical logic. The most known deductive system of tense logic based on classical logic is K_t system. K_t is a minimal system with no conditions imposed upon R (earlier-later) relation, therefore, the structure of semantic time can be any. The expression $F\alpha \vee F\neg\alpha$ cannot be a tautology of K_t because for a semantic time we can accept the time which includes the last moment. If a moment t is the last moment of the time structure, then $F\alpha$ is not satisfied at the moment t whereas moment t does not satisfy $F\neg\alpha$. A necessary condition for the truth of the expressions $F\alpha$ and $F\neg\alpha$ at the moment t is the existence of the moment of time later than the moment t.

A following question arises:

Is $F\alpha \vee F\neg\alpha$ a tautology of classical tense logic of non-ending time?

The answer is YES. In the language of tense logic a class of non-ending time is characterized by the following expression: $G\alpha \Rightarrow F\alpha$. We will prove the following theorem:

THEOREM 1.

$$K_t \cup \{G\alpha \Rightarrow F\alpha\} \vdash (F\alpha \vee F\neg\alpha).$$

PROOF

1) $\alpha \vee \neg\alpha$ – excluded middle law,
2) $G(\alpha \vee \neg\alpha)$ – 1, R2[3],
3) $G(\alpha \vee \neg\alpha) \Rightarrow F(\alpha \vee \neg\alpha)$ – expression added to axioms of K_t,
4) $F(\alpha \vee \neg\alpha)$ – 2, 3, MP,
5) $F(\alpha \vee \neg\alpha) \Rightarrow (F\alpha \vee F\neg\alpha)$ – K_t tautology[4],
6) $(F\alpha \vee F\neg\alpha)$ – 4, 5, MP.

The thesis of determinism formulated as above is a tautology of classical tense logic of non-ending time.

Now let us consider the connections between the thesis of determinism formulated as $F\alpha \vee F\neg\alpha$ and the intuitionistic equivalent of K_t system. This system is called IT_m[5].

In the case of the assumption that the real world is not determined the question: *Is the thesis of determinism a tautology of the minimal intuitionistic tense logic?* is not important. It is the following question that is fundamental: *Is the thesis of determinism a tautology of the intuitionist tense logic where as a semantic time we accept time which posses the properties usually attributed to real time?* Therefore, it is the following question that appears to be essential: Is the thesis of determinism a tautology of the intuitionist tense logic of linear, dense and non-ending time?

We can prove that the thesis of determinism formulated as $F\alpha \vee F\neg\alpha$ is not a tautology of the intuitionistic tense logic of non-ending, dense and linear time.

THEOREM 2

$Fp \vee F\neg p$ is not a tautology of the intuitionistic tense logic of non-ending, dense and linear time.

PROOF

To prove the theorem we will show that the formula $Fp \vee F\neg p$ has a counter model.

Let model $\mathfrak{M}_{(T,\wp)}(= \{m_i : i \in I\})$ satisfies the conditions below when in any world $m_i(= \langle T_i, R_i, V_i\rangle)$ the relation R_i is as follows:

1) $\forall_{t\in T_i}\forall_{t_1\in T_i}\forall_{t_2\in T_i}$ [if $(t_1R_it$ and $t_2R_it)$, then $(t_1 = t_2$ or $t_1R_it_2$ or $t_2R_it_1)$] (left linearity),

[3] Axioms and rules of inference of K_t are presented in the appendix.

[4] R. P. McArthur, *Tense Logics*, p. 22.

[5] Axioms and rules of inference of IT_m are presented in the appendix.

2) $\forall_{t\in T_i}\forall_{t_1\in T_i}\forall_{t_2\in T_i}$ [if $(tR_it_1$ and $tR_it_2)$, then $(t_1 = t_2$ or $t_1R_it_2$ or $t_2R_it_1)$] (right linearity)

3) $\forall_{t\in T_i}\forall_{t_1\in T_i}\exists_{t_2\in T_i}$ $(tR_it_2$ and $t_2R_it_1)$ (density)

4) $\forall_{t\in T_i}\exists_{t_1\in T_i}$ tR_it_1 (there is not a last moment of time).

Let $m_1(= \langle T_1, R_1, V_1\rangle)$, $m_2(= \langle T_2, R_2, V_2\rangle) \in \mathfrak{M}_{(T,\wp)}$ are such that $t_0 \in T_1$ and following conditions are satisfied:

5) $\forall_{t\in T_1}$ if t_0R_1t, then $p \notin V_1(t)$,

6) $\forall_{t\in T_2}$ if t_0R_2t, then $p \in V_2(t)$,

7) $m_1 \leq m_2$.

In the world m_1 there is no moment t later than t_0 (t_0R_1t) where a sentence p is satisfied in t.

From the definition 5.f we arrive at

8) $\mathfrak{M}_{(T,\wp)} \not\models Fp[t_0, m_1]$.

However, in the world m_1 there is no moment of time t later than t_0 when sentence $\neg p$ is satisfied in t. To satisfy sentence $\neg p$ at some moment of time t in the world m_1, it is necessary for sentence p not to be satisfied at the moment t in every world determined not less than world m_1 (definition 5.b[6]). The condition cannot be fulfilled because in the world m_2 (determined not less than the world m_1) at any moment t later than t_0 (t_0R_1t) sentence p is satisfied.

As a result, in the world m_1 there is no moment t, later than t_0 (t_0R_1t) such that, in t is satisfied the sentence $\neg p$. From the definition 5.f we have

9) $\mathfrak{M}_{(T,\wp)} \not\models F\neg p[t_0, m_1]$.

8), 9) and definition 5.c present the following:

$$\mathfrak{M}_{(T,F)} \not\models (Fp \vee F\neg p)[t_0, m_1].$$

From the above theorem we arrive at the following corollaries:

COROLLARY 1

$F\alpha \vee F\neg\alpha$ is not a tautology of non-ending, dense and linear time.

COROLLARY 2

$F\alpha \vee F\neg\alpha$ is not a tautology of minimal intuitionistic tense logic IT_m.

Because $F\alpha \vee F\neg\alpha$ is not even a tautology of intuitionistic tense logic, we assume that a semantic time is linear, dense and non-ending. Therefore, we can say that in the language of IT_m it is possible to describe that some

[6] See appendix.

events are not determined, though in the real world there are no such events. However, intuitionistic tense logic is not determined by it.

$F\alpha \vee F\neg\alpha$ is a tautology of tense logic if a possible semantic world fulfills some conditions. A class of these semantics is determined by the following theorem:

THEOREM 3

For any p, $\vDash(Fp \vee F\neg p)$ if and only if

a) for any model $\mathfrak{M}$, for any world $m_i \in \mathfrak{M}$ a time in the world m_i is non-ending,

b) for any model $\mathfrak{M}$, for any $m_i, m_j \in \mathfrak{M}$ holds $m_i = m_j$.

PROOF

To prove this theorem, we have to prove two theses:

A) If $Fp \vee F\neg p$, then it fulfills conditions a) and b),

B) If conditions a) and b) are fulfilled, then $\vDash(Fp \vee F\neg p)$.

PROOF A)

We will construct our proof using the *ad absurdum* method.

Let us assume that $\vDash(Fp \vee F\neg p)$. Imagine that a) condition is not fulfilled. Let us consider model $\mathfrak{M}_{(T,\wp)}$ and world $m_i(\in \mathfrak{M}_{(T,\wp)})$ with $m_i = \langle T_i, R_i, V_i\rangle$ and time in the world m_i possessing the last moment. If $t\ (\in T_i)$ is the last moment of time, then it is not true that $\exists_{t_1 \in T_i} tR_it_1$. In the world m_i there is no moment of time later than t. Then

$$\mathfrak{M}_{(T,\wp)} \nvDash (Fp \vee F\neg p)[t, m_i].$$

It is in contradiction with the assumption that $\vDash(Fp \vee F\neg p)$.

Now let us assume that condition b) is not satisfied.

Let us consider $\mathfrak{M}_{(T,\wp)}$ model which we used in the proof of the theorem 2. For $m_1, m_2(\in \mathfrak{M}_{(T,\wp)})$ $m_1 \neq m_2$. To prove the theorem 2 we showed that

$$\mathfrak{M}_{(T,\wp)} \nvDash (Fp \vee F\neg p)[t_1, m_1].$$

It contradicts the assumption that $\vDash(Fp \vee F\neg p)$.

PROOF B)

In this case, we will also construct our proof using the *ad absurdum* method.

Let $\mathfrak{M}_{(T,\wp)}$, $m_1(\in \mathfrak{M}_{(T,\wp)})$ be any, but conditions a) and b) are given and satisfied.

Let $m_1 = \langle T_1, R_1, V_1\rangle$. From the principle of bivalency for any moment $t\ (\in T_1)$ **1)** $\mathfrak{M}_{(T,\wp)} \vDash p[t, m_1]$ or **2)** $\mathfrak{M}_{(T,\wp)} \nvDash p[t, m_1]$. From b) condition for any $m_i, m_j \in \mathfrak{M}_{(T,\wp)}$ $m_i = m_j$. If $\mathfrak{M}_{(T,\wp)} \nvDash p[t, m_1]$, then for any m_j $\mathfrak{M}_{(T,\wp)} \nvDash p[t, m_j]$. So, from the definition 5.b we get **3)** $\mathfrak{M}_{(T,\wp)} \vDash \neg p[t, m_1]$. From 1) and 3) we get **4)** $\mathfrak{M}_{(T,\wp)} \vDash p[t, m_1]$ or $\mathfrak{M}_{(T,\wp)} \vDash \neg p[t, m_1]$. A moment t is any, then 4) is true at every moment of time of the world m_1. From a) condition it follows that for any moment $t\ (\in T_1)$ there is a moment $t'\ (\in T_1)$, when tR_1t'. So, in the moment t' **5)** $\mathfrak{M}_{(T,\wp)} \vDash p[t', m_1]$ or $\mathfrak{M}_{(T,\wp)} \vDash \neg p[t', m_1]$. Because of tRt', then from 5) and the definition 5.f we will get **6)** $\mathfrak{M}_{(T,\wp)} \vDash Fp[t, m_1]$ or $\mathfrak{M}_{(T,\wp)} \vDash F\neg p[t, m_1]$. From 6) and the definition 5.c we have **7)** $\mathfrak{M}_{(T,\wp)} \vDash (Fp \vee F\neg p)[t, m_1]$. Because of the model $\mathfrak{M}_{(T,\wp)}$, world m_1 $(\in \mathfrak{M}_{(T,\wp)})$ and moment t $(\in T_1)$ were the satisfied conditions are a) and b), we will arrive at the conclusion that in the class of such models $\vDash(Fp \vee F\neg p)$.

Let us highlight that if the class of models satisfies condition b) of the above theorem, there will not be proper models for tense logic based on intuitionistic logic. Because for any i, j $m_i = m_j$, the multiplicity of worlds given in the possible world's semantics for intuitionistic tense logic is reduced to one world. The one-world semantics suits tense logic based on classical logic.

Aristorelian "sea fight"

Now let us consider connections between the thesis of determinism formulated as $F\alpha \vee F\neg\alpha$, and Aristotelian example "*There will be a sea battle tomorrow or there will not be a sea battle tomorrow*".

The Aristotelian example has no an equivalent in the language of tense logic with standard tense operators. We can suggest writing "*in the future there will be* α", but we cannot suggest "*tomorrow will be* α".

However, we can imagine a language where, except for F operator, there is F^T operator (this is an example of a metric tense operator) and the expression F^Tp is understood as "*there will be p tomorrow*".

If we assume that p means "*sea fight*", then in the language with a F^T operator the Aristotelian sentence:

"*There will be a sea battle tomorrow or there will not be a sea battle tomorrow.*"

can be written as:

$$F^Tp \vee F^T\neg p.$$

Because of $F^Tp \vee F^T\neg p$ is not an expression of the language of tense logic with standard tense operators, we cannot study syntactical connections between the following expressions: $Fp \vee F\neg p$ and $F^Tp \vee F^T\neg p$. However, intuitive $Fp \vee F\neg p$ is a semantic result of $F^Tp \vee F^T\neg p$.

$$F^Tp \vee F^T\neg p \rightsquigarrow Fp \vee F\neg p$$

If the sentence "*There will be a p tomorrow or there will not be a p tomorrow.*" is true, then we can say that there is a moment of time in the future when p or *not* p is true at this moment. However, $F^Tp \vee F^T\neg p$ is not a semantic result of $Fp \vee F\neg p$. If $Fp \vee F\neg p$ is true, then we can say that there is a moment of time in the future when p is true at this moment, or we can say that there is a moment of time in the future when $\neg p$ is true. However, it is not enough to say that p, or $\neg p$ will be true exactly tomorrow. Therefore, we can say that the truth of the sentence $F^Tp \vee F^T\neg p$ is a necessary condition for the truth of the sentence $Fp \vee F\neg p$.

On the other hand, the falsity of the statement $Fp \vee F\neg p$ implies the falsity of the statement $F^Tp \vee F^T\neg p$. Therefore, we arrive at the conclusion that the truth of the sentence $Fp \vee F\neg p$ is a necessary condition for the truth of the sentence $F^Tp \vee F^T\neg p$.

The following conclusions can be drawn from the above considerations:

CONCLUSION 1

In tense logic of non-ending time based on classical logic necessary conditions are fulfilled to reconstruct the Aristotelian argument about determinism. If we add a specific tense operator F^T, to the language of such logic, it will be possible to arrive at a formal reconstruction of this argument.

CONCLUSION 2

In intuitionistic tense logic of non-ending time necessary conditions are not fulfilled to reconstruct the Aristotelian argument about determinism (even if we assume that the semantic time is linear and dense). If we add a specific tense operator F^T, to the language of the intuitionistic tense logic of non-ending time, we still cannot perform a formal reconstruction of the Aristotelian argument about determinism.

Therefore, intuitionistic tense logic seems to be a better formalism to describe the properties of non-determined worlds. Intuitionistic tense logic is constructed at the cost of the refutation of excluded middle law. However, it was already in the past that this law was questioned. Aristotle wrote:

> In the first place, though facts should prove the one proposition false, the opposite would still be untrue[7].

[7] Aristotle, *On Interpretation*, Chapter IX.

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APPENDIX

THE SYSTEM K_t

SYNTACS

Alphabet:

- set of propositional letters Ψ,
- connectives: $\neg, \Rightarrow$,
- temporal operators: G, H[8],
- parentheses:), (.

Set of sentences of language K_t of is defined as follows:

DEFINITION 1

Set of sentences is the smallest set $\boldsymbol{Z}$ where:

- $\Psi \subseteq \boldsymbol{Z}$,
- if $\alpha, \beta \in \boldsymbol{Z}$, then $\neg\alpha, (\alpha \Rightarrow \beta), G\alpha, H\alpha \in \boldsymbol{Z}$.

In K_t we have the following definitions:

DEFINITION 2

$$
\begin{aligned}
(\alpha \vee \beta) &\equiv (\neg\alpha \Rightarrow \beta),\\
(\alpha \wedge \beta) &\equiv \neg(\alpha \Rightarrow \neg\beta),\\
(\alpha \Leftrightarrow \beta) &\equiv \neg[(\alpha \Rightarrow \beta) \Rightarrow \neg(\beta \Rightarrow \alpha)],\\
F\alpha &\equiv \neg G\neg\alpha,\\
P\alpha &\equiv \neg H\neg\alpha.
\end{aligned}
$$

[8] Some formulations of systems of tense logic accept operators F i P as the basic ones.

SEMANTICS

In semantic considerations in K_t we assume that time has a point structure.

Let T be any non-empty set (elements of this set are called "moment of time"). A time $\mathcal{T}$ is an ordered couple $\langle T, R\rangle$, where R is a binary relation (earlier-later) on T. Let V be a function mapping points $t \in T$ to subsets $V(t)$ of the set of propositional letters ($V : \Psi \to 2^T$). Model "$\mathfrak{M}$" is an ordered triple $\langle T, R, V\rangle$.

The so-called "truth definition" explains what it means for α to be true model $\mathfrak{M}$ in a moment of time ($\mathfrak{M}, t \vDash \alpha$):

DEFINITION 3

a) $\mathfrak{M}, t \vDash \alpha \equiv t \in V(\alpha)$, if $\alpha \in \Psi$,

b) $\mathfrak{M}, t \vDash \neg\alpha \equiv$ not $\mathfrak{M}, t \vDash \alpha$,

c) $\mathfrak{M}, t \vDash (\alpha \Rightarrow \beta) \equiv$ if $\mathfrak{M}, t \vDash \alpha$, then $\mathfrak{M}, t \vDash \beta$,

d) $\mathfrak{M}, t \vDash G\alpha \equiv$ for any t_1 such that tRt_1 holds $\mathfrak{M}, t_1 \vDash \alpha$,

e) $\mathfrak{M}, t \vDash H\alpha \equiv$ for any t_1 such that t_1Rt holds $\mathfrak{M}, t_1 \vDash \alpha$.

AXIOMS

1. $\alpha \Rightarrow (\beta \Rightarrow \alpha)$,
2. $[\alpha \Rightarrow (\beta \Rightarrow \gamma)] \Rightarrow [(\alpha \Rightarrow \beta) \Rightarrow (\alpha \Rightarrow \gamma)]$,
3. $(\neg\alpha \Rightarrow \neg\beta) \Rightarrow (\beta \Rightarrow \alpha)$,
4. $G(\alpha \Rightarrow \beta) \Rightarrow (G\alpha \Rightarrow G\beta)$,
5. $H(\alpha \Rightarrow \beta) \Rightarrow (H\alpha \Rightarrow H\beta)$,
6. $\alpha \Rightarrow GP\alpha$,
7. $\alpha \Rightarrow HF\alpha$.

RULES OF INFERENCES

R1: Modus Ponens.

Rules of temporal generalization

R2: $\dfrac{\alpha}{G\alpha}$ R3: $\dfrac{\alpha}{H\alpha}$

Axioms 1,2 and 3 are substitutions of tautologies of classical propositional calculus. Axioms 4, 5, 6, 7 are specific axioms of K_t system.

IT_m – MINIMAL INTUITIONISTIC TENSE LOGIC

SYNTAX

Alphabet:

- set of propositional letters: Ψ,
- intuitionistic unary connective: $\neg$,
- intuitionistic binary connectives: $\wedge, \vee, \Rightarrow, \Leftrightarrow$,
- temporal operators: G, H, F, P,
- parentheses:), (.

Set $\boldsymbol{Z}$ of sentences of language of IT_m system is defined according to the standards.

NOTATION

I – nonempty set of indexes of worlds,

T_i ($i \in I$) – nonempty set of moments of time in world indexed by i,

R_t ($\subseteq T_i \times T_i$) (Binary relation on T_i),

$\mathcal{T}_i$ ($= \langle T_i, R_i\rangle$) (A time in a world indexed by i),

$\mathcal{T} = \bigcup\limits_{i\in I} \mathcal{T}_i$ (Set of all moments of time),

R ($= \bigcup\limits_{i\in I} R_i$) (Binary relation on the set of all moments of time),

V_i ($\subseteq T_i \times 2^{\Psi}$), where $i \in I$ (V_i is a function mapping to elements t ($\in T_i$) subsets $V_i(t)$ of the set of propositional letters),

$\wp = \{V_i : i \in I\}$,

m_i ($= \langle T_i, R_i, V_i\rangle$), where $i \in I$ (m_i is a world indexed by i),

$\mathfrak{M}_{(T,\wp)} = \{\langle T_i, R_i, V_i\rangle : V_i \in \wp, i \in I\}$, then $\mathfrak{M}_{(T,\wp)} = \{m_i : i \in I\}$

($\mathfrak{M}_{(T,\wp)}$ is a model based on time $\mathcal{T}$ and class of functions $\wp$).

Between elements of a model $\mathfrak{M}_{(T,\wp)}$ we introduce a relation $\leq$ ($\subseteq \mathfrak{M}_{(T,\wp)} \times \mathfrak{M}_{(T,\wp)}$) defined as follows:

DEFINITION 4

For any $i, j \in I$:

$$m_i \leq m_j \equiv (T_i \subseteq T_j \text{ and } R_i \subseteq R_j \text{ and } \forall_{t\in T_i} V_i(t) \subseteq V_j(t)).$$

$m_i \leq m_j$ means that the world m_j is no less determined than the world m_i.

REMARK

m_i^* (where $i \in I$) means any m_j ($\in \mathfrak{M}_{(T,\wp)}$) such that $m_i \leq m_j$.

DEFINITION 5

For a model $\mathfrak{M}_{(T,\wp)}$, world m_i $(= \langle T_i, R_i, V_i\rangle)$, element t $(\in T_i)$, a tense-logical formula α $\mathfrak{M}_{(T,\wp)} \vDash \alpha[t, m_i]$ is defined by the following conditions:

a) $\mathfrak{M}_{(T,\wp)} \vDash \alpha[t, m_i] \equiv \alpha \in V_i(t)$, if $\alpha \in \Psi$,

b) $\mathfrak{M}_{(T,\wp)} \vDash \neg\alpha[t, m_i] \equiv \forall_{m_i^* \in \mathfrak{M}_{(T,\wp)}} \mathfrak{M}_{(T,\wp)} \nvDash \alpha[t, m_i^*]$,

c) $\mathfrak{M}_{(T,\wp)} \vDash (\alpha \vee \beta)[t, m_i] \equiv \mathfrak{M}_{(T,\wp)} \vDash \alpha[t, m_i]$ or $\mathfrak{M}_{(T,\wp)} \vDash \beta[t, m_i]$,

d) $\mathfrak{M}_{(T,\wp)} \vDash (\alpha \wedge \beta)[t, m_i] \equiv \mathfrak{M}_{(T,\wp)} \vDash \alpha[t, m_i]$ and $\mathfrak{M}_{(T,\wp)} \vDash \beta[t, m_i]$,

e) $\mathfrak{M}_{(T,\wp)} \vDash (\alpha \Rightarrow \beta)[t, m_i] \equiv \forall_{m_i^* \in \mathfrak{M}_{(T,\wp)}} (\mathfrak{M}_{(T,\wp)} \nvDash \alpha[t, m_i^*]$ or $\mathfrak{M}_{(T,\wp)} \vDash \beta[t, m_i^*])$,

f) $\mathfrak{M}_{(T,\wp)} \vDash F\alpha[t, m_i] \equiv \exists_{t_1 \in T_i} (tR_i t_1$ and $\mathfrak{M}_{(T,\wp)} \vDash \alpha[t_1, m_i])$,

g) $\mathfrak{M}_{(T,\wp)} \vDash G\alpha[t, m_i] \equiv \forall_{m_i^* \in \mathfrak{M}_{(T,\wp)}} \forall_{t_1 \in T_i^*}$ (if $tR_i^* t_1$, then $\mathfrak{M}_{(T,\wp)} \vDash \alpha[t_1, m_i^*])$,

h) $\mathfrak{M}_{(T,\wp)} \vDash P\alpha[t, m_i] \equiv \exists_{t_1 \in T_i} (t_1 R_i t$ and $\mathfrak{M}_{(T,\wp)} \vDash \alpha[t_1, m_i])$,

i) $\mathfrak{M}_{(T,\wp)} \vDash H\alpha[t, m_i] \equiv \forall_{m_i^* \in \mathfrak{M}_{(T,\wp)}} \forall_{t_1 \in T_i^*}$ (if $t_1 R_i^* t$, then $\mathfrak{M}_{(T,\wp)} \vDash \alpha[t_1, m_i^*])$.

AXIOMS

For any $\alpha, \beta, \gamma \in \boldsymbol{Z}$:

A1) $\alpha \Rightarrow (\beta \Rightarrow \alpha)$,

A2) $(\alpha \Rightarrow \beta) \Rightarrow \{[\alpha \Rightarrow (\beta \Rightarrow \gamma)] \Rightarrow (\alpha \Rightarrow \gamma)\}$,

A3) $[(\alpha \Rightarrow \gamma) \wedge (\beta \Rightarrow \gamma)] \Rightarrow [(\alpha \vee \beta) \Rightarrow \gamma]$,

A4) $(\alpha \wedge \beta) \Rightarrow \alpha$,

A5) $(\alpha \wedge \beta) \Rightarrow \beta$,

A6) $\alpha \Rightarrow [\beta \Rightarrow (\alpha \wedge \beta)]$,

A7) $\alpha \Rightarrow (\alpha \vee \beta)$,

A8) $\beta \Rightarrow (\alpha \vee \beta)$,

A9) $(\alpha \wedge \neg\alpha) \Rightarrow \beta$,

A10) $(\alpha \Rightarrow \neg\alpha) \Rightarrow \neg\alpha$.

H1) $H(\alpha \Rightarrow \beta) \Rightarrow (H\alpha \Rightarrow H\beta)$,

H2) $H(\alpha \Rightarrow \beta) \Rightarrow (P\alpha \Rightarrow P\beta)$,

H3) $\alpha \Rightarrow HF\alpha$,

H4) $PG\alpha \Rightarrow \alpha$,

H5) $P(\alpha \vee \beta) \Rightarrow (P\alpha \vee P\beta)$,

H6) $(P\alpha \Rightarrow H\beta) \Rightarrow H(\alpha \Rightarrow \beta)$,

H7) $P\alpha \Rightarrow \neg H\neg\alpha$.

G1) $G(\alpha \Rightarrow \beta) \Rightarrow (G\alpha \Rightarrow G\beta)$,

G2) $G(\alpha \Rightarrow \beta) \Rightarrow (F\alpha \Rightarrow F\beta)$,

G3) $\alpha \Rightarrow GP\alpha$,

G4) $FH\alpha \Rightarrow \alpha$,

G5) $F(\alpha \vee \beta) \Rightarrow (F\alpha \vee F\beta)$,

G6) $(F\alpha \Rightarrow G\beta) \Rightarrow G(\alpha \Rightarrow \beta)$,

G7) $F\alpha \Rightarrow \neg G\neg\alpha$,

RULES

Modus Ponens

$$MP: \frac{\alpha \Rightarrow \beta, \alpha}{\beta}$$

Temporal generalization rules:

$$RH: \frac{\vdash_{IT_m} \alpha}{\vdash_{IT_m} H\alpha}$$

$$RG: \frac{\vdash_{IT_m} \alpha}{\vdash_{IT_m} G\alpha}$$

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JOHANNES GLOGOVIENSIS' CONCEPT OF CONSTRUCTION*

The extensive writings of Johannes Glogoviensis (1445–1507)[1], a well-known lecturer of Cracow University at the end of the 15th century and the early 16th century, include among others two grammar textbooks: *Declaratio Donati minoris de octo partibus orationis*[2] and *Exercitium secundae partis Alexandri*[3]. Both works were commentaries in the form of *questiones*: *Declaratio* referred to *Ars minor* by the Roman grammarian Aelius Donatus (4th/5th c. AD), whereas *Exercitium* discussed the second part of *Doctrinale*, a versified grammar treatise, by Alexander de Villa Dei (12th/13th c.). These commentaries were written in the spirit of speculative grammar, philosophical grammar, also called the modist grammar, since its basic term was *modus significandi* – the mode of signifying. Speculative grammars flourished in West European universities at the end of the 13th century and the beginning of the 14th century. The tradition of these grammars survived in the teaching programs of many universities, particularly German ones[4]; although in a secondary, non-creative form. The interest in this approach

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[1] For biographical data and references on Glogoviensis, cf. *700 lat myśli polskiej. Filozofia i myśl społeczna XIII–XV wieku*, J. Domański (ed.), Warszawa 1978, pp. 382–383.

[2] Its publications while the author still lived included those in 1500 in Lepizig, 1503 in Cracow and 1505 and 1506 in Leipzig. Information on those and later editions was provided in the article: K. Krauze-Błachowicz, *'Declaratio Donati minoris' by Jan of Głogów – 'Prologus' and 'Quaestio prima'*, "Acta Mediaevalia" 2002, p. 427–433.

[3] Published in 1500 in Leipzig; in 1504, 1510, 1516 and 1517 in Cracow; and in 1518 in Vienna.

[4] T. Heath, *Logical Grammar, Grammatical Logic, and Humanism in Three German Universities*, "Studies in the Renaissance" 18/1971/, p. 11.

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at Cracow University very distinctly increased in the third quarter of the 15th century, and persisted even up to the 1530s[5].

Both "Donatus" and "Alexander" had for centuries been the basic items of the initial university curriculum. The tradition of commentaries on these two authors' works was just as many centuries old. One of the most popular 15th-century commentaries on *Doctrinale* in Germany was *Glosa notabilis* by Gerhard of Züpthen who lectured at Cologne University. It was repeatedly reprinted after its first Cologne edition in 1488[6] and it was well known in Cracow, where it was republished in 1525[7]. In many places, Johannes Glogoviensis' *Exercitium secundae partis Alexandri* resembles *Glosa notabilis*; still, its distinctly different nature can be seen in its terminology and choice of arguments. In both these works, the basic modist authority was Thomas of Erfurt, called the *auctor modorum significandi*.

Syntax is the subject of the second part of *Doctrinale*. The Middle Ages adopted the concept of construction – the basic concept of syntax – from *Institutiones grammaticae* by Priscianus (6th c. AD). However, the Roman grammarian had not developed it in a systematic manner. Starting as early as the 12th century, the medieval scholars undertook this task. The modists also dealt with the issues of construction. Entire works and their chapters were entitled *De constructione*. It is in the second part of *Doctrinale* that a fragment on construction can be separated. In Glogovienis' work, it can be found exactly under the heading *De constructione*. It is to this part of Johannes Glogoviensis' commentary that we will address several comments.

Johannes Glogoviensis gives three concepts of construction which emerge from his reading of earlier grammarians' writings. Its first meaning, the origin of which the grammarians traced back to Aristotle's *Hermeneutics*, is as follows: "construction is a combination (*combinatio*) of words the purpose of which is to cause the listener to understand"[8]. As regards the second definition of construction - the definition which he himself calls the proper one – Glogoviensis refers us to the definition by Thomas of Erfurt, which was as follows: "the construction is a combination of constructibles

[5] C. Mielczarski, *Między gramatyką scholastyczną a humanistyczną. Komentarz Jana Sommerfelda Starszego do traktatu gramatycznego Eberharda Hiszpańskiego*, Ph. D. dissertation at the Institute of Philosophy and Sociology, Polish Academy of Science, 1989, p. 77.

[6] T. Heath, op. cit., p. 13.

[7] M. Cytowska, *Od Aleksandra do Alwara*, Wrocław 1968, p. 102.

[8] Johannes Glogoviensis, Exercitium in secundum partem Alexandri, Kraków 1517, f.71r: "combinatio dictionum ad invicem ad constituendum aliquem sensum audienti".

made up of the modes of signifying, caused by the intellect and devised for the purpose of expressing a compound concept of the mind"[9].

Johannes Glogoviensis does not quote Thomas' definition; still, he claims that it can be inferred from it that "the construction dictates the congruous (*congrua*) order of words and their mutual proportion (*proportio*)"[10]. We will return to this conclusion shortly, to discuss it at greater length. The third definition of construction – the one which is the most proper one from the point of view of the author of the work commented upon, i.e. Alexander de Villa Dei – is the classical definition of sentence, which dates back as far as Priscianus' definition: "the construction is a congruous order of words designed to transmit a complete thought"[11]. Glogoviensis, who supports the modist concept of Thomas of Erfurt, does not regard the third approach as a proper one, since the construction does not need to be the cause of a complete sentence. As the Cracow scholar says, there are, indeed, perfect and imperfect constructions (*perfecta et imperfecta*), i.e. complete and incomplete ones (*totalis et partialis*). While criticizing Alexander from the modist point of view, Glogoviensis is not aware that he does not fully observe the rules imposed by the modists. His concept that the construction indicates the "congruous order" (*congrua ordinatio*), both in the manner of expression and the content, reflects the influence of traditional, pre-modist school grammar. According to the modists' view, it was characteristic of the construction to be a combination of two elements of a construction, called constructibles (*constructibilia*), whereas the function of the combination *per se* did not determine its congruity. Constructibles could combine to produce a congruous or incongruous construction: "Just as the construction requires the union of constructibles in absolute terms, so too congruity requires the union of constructibles, not just any but the proper one"[12]. The postulate for the congruity of the construction survived in traditional grammar, where since its very beginning the construction had been identified with the con-

[9] Thomas of Erfurt, *Grammatica speculativa*, ed. & transl. G. L. Bursill-Hall, London 1972, p. 279.

[10] Johannes Glogoviensis, op. cit., f. 71r: "constructio dicit congruum ordinem dictionum adinvicem et proportionem dictionum".

[11] Ibidem: "ordinatio dictionum congrua sententiam perfectam demonstrans; cf. *Priscianus, Institutionam grammaticarum libri XVIII*, (ed.) M. Hertz, vol. 1, Leipzig 1855 (= *Grammatici Latini*, ed. H. Keil, vol. 2), II, 15, p. 53: "oratio est ordinum dictionum congrua sententiam prefectam demonstrans".

[12] Thomas of Erfurt, Grammatica Speculativa, (ed.) G. L. Bursill-Hall, London 1972, p. 308: "sicut constructio requirit constructibilium unionem absolute, sic congruitas requirit constructibilium unionem, non quamcumque sed debitam.".

struction of a sentence[13]. The modists replaced the old concept of *ordinatio* by that of *unio*. This was a change not only in the mode of signifying. For many early grammarians, "construction" was a concept equivalent to the concept of "constructed utterance". In contrast, for the modists, "construction" was a "property of an utterance" (*passio sermonis*)[14], a form which combined two elements into a whole.

When describing the theoretical assumptions of grammar, Glogoviensis adopts, in principle, the postulate that it should consist of two elements[15]. Just as many other grammarians, he does not manage to avoid the expression "oratio" in the meaning of "utterance" or that of "sentence" with reference to the construction. Still, his manner of expression indicates his efforts to distinguish between the construction and the utterance; indeed, he uses the definition: "the construction is the cause of an utterance".

In accordance with the order of the lecture of Thomas of Erfurt, which Glogoviensis follows, the construction is transitive, intransitive, reciprocal and retransitive. Johannes Glogoviensis describes these constructions by means of the model introduced into grammar by Johannes Balbi de Janua (c. 1280)[16]. The transitive, reciprocal and retransitive constructions resemble, respectively, rectilinear, circular and compound motion. The intransitive construction corresponds to rest. What may seem to us to be slightly naive visualization is in fact one of the attempts to describe the problem of construction in terms of Aristotle's physics[17], the influence of which became visible in the modists' theory, albeit formulated in different ways than that of Johannes Balbi de Janua. Indeed, in their doctrine the modists combined the Aristotelian motif with a grammatical idea which originated from the early medieval concept of *regimen*, which had been unknown to the ancient grammarians, i.e. with the idea of dependency (*dependentia*)[18]. Glogoviensis drew on modist theory when describing the transitive construction: The first constructible depends on the adjunct, as in the example: "I deliver a lecture", where "I deliver" is the first constructible and "a lecture" is the second constructible which terminates the dependency of the verb[19]. Using such an understanding of the transitive construction, he conducts a demonstration to show that the reciprocal construction is the transitive construction. The entire demonstration, drawing on the notional scheme of Thomas of Erfurt[20], is based on the syntactic dependency of the constructibles on each other; it does not refer to the concept of "the thing determined" through the particular components of the utterance. In this way, Glogoviensis supported the modist solution to the problem which troubled the medieval grammarians, most of whom would traditionally adopt the "semantic" definition of the reciprocal construction, indicating that both elements referred to the same "thing determined". Based on such a definition, it could be regarded as the intransitive construction, where, in accordance with the "traditionalist" definition, both constructibles refer to the same thing[21]. For example, in the sentence "Socrates runs", both elements refer to the same thing – Socrates.

Johannes Glogoviensis also represents the modist approach regarding the issues of congruity (*congruitas*) and completeness (*perfectio*) of the construction. The congruity[22] of the construction is the mutual match of the "accidental respective modes of signifying" of parts of speech. The respective modes of signifying are the properties of the parts of speech which are responsible for their performance of syntactic functions. Indeed, each part of speech is equipped with essential and accidental modes of signifying. The essential modes of signifying can be general[23] – common to several parts of speech – or they can be special[24], too. The latter serve to distinguish parts of speech from one another. The accidental modes of signifying are such properties of them as number, gender and tense. The respective ones are those that affect the syntactic correctness of an utterance, i.e. its congruity or, rather, its consistency. E.g. the tense is not a respective mode,

[13] Defined by means of the words "ordinatio ... congrua...".

[14] Cf. Thomas of Erfurt, op. cit., p. 272.

[15] Cf. Johannes Glogoviensis, *Declaratio Donati minoris*, Lepizig 1506, f.B2v.

[16] In his work entitled *Catholicon*, cf. M. A. Covington, *Syntactic Theory in the High Middle Ages*, Cambridge 1984, p. 79. C. H. Kneepkens, *On Medieval Syntactic Thought with Special Reference to the Notion of Construction*, "Histoire, Épistémologie, Langage" 12/2 (1990), p. 155.

[17] Thus, in the transitive construction, the action or sensation is shifted from the thing determined by the subject to the thing determined by the adjunct. In the reciprocal construction, starting from the subject, the action is re-directed to the same subject from which it started. The retransitive construction constitutes a combination of the previous two descriptions. In the intransitive construction, the action and sensation do not go beyond the acting subject. Cf. Johannes Glogoviensis, *Exercitium...*, f. 71r.

[18] The lecture on the construction based on the concept of dependency can be found in: Thomas of Erfurt, Diasynthetica, Idea 2000, translated by K. Krauze-Błachowicz.

[19] Johannes Glogoviensis, ibidem, f.71v.: Est autem constructible primum in constructione quod dependet ad obliquam ut lego lectionem est constructibile primum quod dependet ad lectionem et lectionem constructibile secundum quod terminat dependentiam verbi".

[20] Cf. Thomas of Erfurt, op. cit., p. 180.

[21] Cf. Footnote 17.

[22] Which, with some caution, may be represented by the contemporary term "grammaticality".

[23] *Generales*, which can also be translated as "generic".

[24] *Speciales*, or "specific", cf. the preceding Footnote,

since the utterances "Socrates runs" and "Socrates ran" are not different in terms of congruity. When "Socrates runs" is replaced by "Socrates run", the latter utterance is inconsistent (incongruous). It can be seen that the number is an accidental respective mode of signifying, due to which parts of speech produce congruous or incongruous syntactic constructions[25]. To use the language of the modists (i.e. also that of Johannes Glogoviensis, who followed them in this respect), the mutual consistency of respective modes of signifying determines whether a construction is congruous or incongruous[26].

According to Glogoviensis, the complete construction is such a construction as, due to the correct combination of the constructibles, leads to the expression of a complete thought, i.e. it leads of the formation of a complete sentence in the mind of the listener[27].

Both congruity and completeness may be such according to sense or according to understanding. The former case occurs when both of the indispensable components of a construction are expressed by words, e.g. "I am reading"; the latter, when the entire construction is expressed by one component of it only and then it is said "Reading". The listener has to complement this expression by adding "I am" in his or her mind[28].

In introducing the issues relating to the constructions "ad sensum" and "ad intelectum" in his commentary, Glogoviensis demonstrates his interest in this problem. In contrast, other commentators, such as Gerhard of Züpthen, neglect this subject as of no significance at this point of a commentary on *Doctrinale*. Thus, either the author had a natural predilection to deal with it or it was a permanent subject which was not omitted in the teaching in Cracow. After all, this was an essential issue which had by then troubled philosophical grammarians for several centuries. It was the problem of how to cope theoretically with expressions which were not grammatical, but still fully understandable for the users of the language[29].

It can be seen that, as regards the concept of construction, Johannes Glogoviensis' views took shape under the influence of the thought of Thomas of Erfurt. Still, in interpreting a text by a classical modist author, who

[25] Johannes Glogoviensis, *Exercitium*, f. 4v.

[26] Ibidem, f. 72r: "Congruitas est proprietas vel passio sermonis ex modorum significandi respectivorum conformitate ad aliquam speciem constructionis requisitorum derelicta".

[27] Ibidem. Thomas of Erfurt's lecture on the complete construction is much more complex and subtler. Cf. *Thomas of Erfurt*, op. cit., pp. 191–194.

[28] Johannes Glogoviensis, ibidem; *Thomas of Erfurt*, ibidem.

[29] The book by I. Rosier, *La parole comme act*, Paris 1994, is for the most part concerned with these issues.

Thomas of Efrurt undoubtedly was, Johannes Glogoviensis could not resist other influences characteristic of a certain permanent medieval didactic tradition of grammar. However, they did not veil the entire image of his understanding of syntax, the ambition of which was to gain the status of a theoretical science – one which would deal with the theoretical concept of construction and its components connected by appropriate modes of signifying and whose correctness might be evaluated without having to refer to the semantic contents of utterances.

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THE ROLE OF LANGUAGE IN THE PHILOSOPHICAL SYSTEM OF THOMAS HOBBES

Linguistic consideration understood by Thomas Hobbes as an arranged system of signs making the basis of thinking creatures[1] called speech appeared in his works relatively early. In the workbook of logic entitled *Computatio sive logica* which he had been preparing since 1655 (it was not until 1655 that it was published as the first section of philosophy entitled *De Corpore*)[2] Hobbes tackled issues of language, the topic which he would continue exploiting in his later works presenting his views on social philosophy.

The consequence characteristic for Hobbes's commitment to the issue of language and its meaning in his most important works allows us to state that "language" alone has a significant role in his system. It is necessary to notice that what Hobbes had in mind was basically a language of science, that is to say, a humble, dry language consciously deprived of any glare of eloquence[3]. Hobbes's ideas about other uses of language appeared accidentally in his works.

Hobbes's views on the genesis of language – *the most noble and profitable of all inventions*[4] – are not precise and explicit. In *Leviathan* published in 1651 Hobbes stated that speech was created by God and was given as a gift to Adam who eagerly grasped at the chance of enlarging his supply of words. In *De Homine* published in 1658 Hobbes was trying to prove that speech

[1] See R. Tokarczyk, *Hobbes*, Warszawa 1985, p. 67.

[2] The source of the information is S. Kamiński, *Hobbesa pojęcie definicji*, in *Metoda I język. Studia z semiotyki i metodologii nauk*, Lublin 1994, p. 31.

[3] T. Hobbes, *Elementy filozofii*, Vol. I, translated by C. Znamierowski, Warszawa 1954, p. 12.

[4] T. Hobbes, *Leviathan*, Oxford 1909, p. 24.

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was established directly by people. Disputes between God and Adam before that establishment were conducted in a *supernatural way*[5], apparently with the help of the language of mind spoken without words since words did not exist then.

Independently of accepting either of the two concepts of language's genesis, it is undoubtedly a man who has the most important role when it comes to the origins, development and propagation of the language. The vocabulary of the first language primary and common for all people and gathered by Adam and his descendants was lost together with the fall of the Biblical Babel. National languages contemporary for Hobbes were a human product which was the result of the fact that people had been gradually enlarging the dictionaries of their languages.

Every language is based on words. According to Hobbes's theory, the assumption that a single name can include several words allows for almost every word (with the exception of copula)[6] to be a name or its part. The appearance of particular elements of the language or, in other words, names was possible due to a special feature of man which is the ability to create **signs** or *memorizing things*. According to Hobbes, signs are objects governed by senses which have been accepted as signs voluntarily in order to adopt in our minds thoughts similar to the ones which have been the inspiration for the thoughts accepted as signs[7].

In the above-mentioned definition Hobbes expresses his assumption that the decision to adopt a given sign is entirely a result of man's will. This assumption reveals Hobbes's devotion to **conventionalism**[8]. In contrast to naturalists searching for connections between a name of the object and its essence, Hobbes highlights the role of man's freedom while naming objects. Such declarations highlighting the rationality of his stand reinforced by the example of the variety of national languages seem to be common for Hobbes[9].

[5] T. Hobbes, *Elementy filozofii*, Vol. II, translated by C. Znamierowski, Warszawa 1954, p. 117.

[6] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., pp. 41–43. See also J. W. N. Watkins, *Hobbes's system of ideas*, New York 1965, p. 143.

[7] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 24.

[8] See P. Hoffman, *The quest of power. Hobbes, Descartes and the emergence of modernity*, New York 1996, p. 4.

[9] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 26. and T. Hobbes, *Elementy filozofii*, Vol. II, op. cit., p. 118., see also B. Suchodolski, *Antropologia Hobbesa*, "Studia Filozoficzne" 1967, p. 195.

Undoubtedly, signs have a significant role allowing us to register a course of thinking of the one who has accepted the sign. Moreover, signs make it possible to go back to the previous thoughts as well as to perform reasoning. Nevertheless, they do not reveal a feature of universality. A sign is made for an individual use: what is a sign for one person may not be the same sign for another person which means that signs themselves are not enough to make even significant discoveries of an individual be common knowledge for the rest of the people.

To make achievements of an individual be shared with other people, it is necessary to use **universal signs**, in other words, signs common for all people. For Hobbes, an example of such a conventional (or accepted by man's will) universal sign is a sprig of ivy hung over the house to inform that it is possible to buy wine there. Another example of such a universal sign is a stone left in a certain place to mark a boundary of the field[10].

The way in which signs created by an individual for mnemonic aims could become universal requires a separate discussion. Apparently, before a sign becomes universal, it has to be accepted by the society. However, such a statement implies the existence of the society in the period preceding a creation of language which contradicts Hobbes's thesis (discussed later in this paper) that language (speech) constitutes a necessary condition for the creation of the state and abandonment of the state of nature[11]. It may have been a social agreement that cleared up the uncertainty as to the signs created for an individual use which finally got the status of being universal and therefore entered a dictionary of the people accepting that social agreement[12]. When it comes to the state of nature, it must have been during a period when many private languages coexisted and an effective exchange of thought was limited.

It is necessary to state that only universal signs allow for communication of the acquired knowledge to the contemporary as well as to the following generations. It is easy to notice that in relation to universal signs individual signs are elementary: all universal signs have the quality of signs whereas not all signs may become universal. If we consider the role of functions which complement each other to a great extent, the role of signs is undoubtedly primary (basic), nevertheless, the function of universal signs seem

[10] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 25.

[11] See J. W. N. Watkins, *Hobbes's system of ideas*, op. cit., p. 140.

[12] See R. Tokarczyk, *Hobbes*, op. cit., p. 68.

to be equally significant for they allow to practise real science – philosophy. Names seem to have the roles of both individual and universal signs for they relate to terms; therefore, names seem to relate to terms (not to objects) as well[13].

Interesting is the fact that for the cohesion of his theory Hobbes was ready to accept as objects[14] something which S. Kamiński calls a characteristic reism[15]. The statement that every name remains in certain relation with the object named[16] led him to accept something which has been named as an object. He postulates the existence of names of the names, the category which was especially useful in science. What is more, by introducing a division into primary and secondary intentions[17], he was ready to note (but he did not go further than that) a difference between the language and metalanguage[18].

Among numerous divisions of names conducted by Hobbes significant is the division into the names common for many objects and the names common for individual objects[19]. It is only in case of individual objects' names that it is possible to point out a designation since Hobbes is convicted that common objects do not exist; what exists is a name of common objects: *in respect of all which together, it is called Universal; there being nothing in the world Universal but Names; for the things named, are every one of them Individual and Singular*[20]. The equivalents of names of common objects in the mind are the images of singular individual objects. It is words that are general but not objects. In his rejection to acknowledge the existence of the names of common objects, Hobbes joins a group of nominalists with their strong tradition regarding the question of universality. Nevertheless, he does not negate the role of general names in science: general names are essential since they enable us to think and understand without having to perceive an object primary and common for all people each time we think about it[21].

[13] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 27.
[14] Ibid., pp. 27–28.
[15] S. Kamiński, *Hobbesa pojęcie definicji*, op. cit., p. 35.
[16] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 28.
[17] Ibid., pp. 31–32.
[18] See S. Kamiński, *Hobbesa pojęcie definicji*, op. cit., pp. 35–36.
[19] T. Hobbes, *Leviathan*, Oxford 1909, pp. 25–26.
[20] T. Hobbes, *Leviathan*, op. cit., p. 26.
[21] R. Tokarczyk, *Hobbes*, op. cit., p. 69.

One of indirect consequences of Hobbes's nominalism is the statement that we can talk about truth or falsity only in relation to words and replies; one has no rights to relate these categories to the world of objects[22]. Only a sentence which consists of names can be either true or false. The notions of truth and falsity appeared together with speech for they had no reason to exist before speech. Therefore, the words "truth" and "falsity" function in relation to the human linguistic reality. As false it is possible to treat only a kind of mistake which appears not because of sensual grasping and is not a part of the thing itself but it is rather a result of the reply being inconsiderate[23]. Just as well-understood speech causes proper reasoning, badly-understood speech causes mistakes and falsity[24].

In accordance with the above-mentioned thesis and his conventionalism remains another thesis of the philosopher which states that the very first truths appeared as a result of the will of those who were either the first to name objects primary and common for all people or accept the names given by others[25]. He claims that these first truths are characterized by some kind of arbitrarity (eg. a statement "a man is an animal" is true only due to our ancestor having a freak to give one object two names). These "first truths" have a function of the "first sentences" or, in other words, initial premises of reasoning which, because of their arbitrarity, do not require any proofs[26].

This particular point of Hobbes's theory of language was heavily criticized by his contemporaries and followers. Gottfried Wilhelm Leibniz blamed it for the fact that if the premises of a given sentence were optionally defined, every sentence could easily be proved[27]. Using the language of contemporary logic, S. Kamiński tries to defend Hobbes from Leibniz's critique (assuming that in the Hobbesian system optionality means only the ability to replace one name with another) but at the same time he blames him for other inconsistencies. In his theory Hobbes accepts both the optionality of choice giving a name and the optionality of choice while giving the name a defined meaning (sense) which consequently leads us towards a paradox allowing to prove every thesis[28].

[22] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., pp. 47, 50, 70. See also M. Dascal, *Leibniz. Language, Signs and Thought*, Philadelphia 1987, pp. 8, 18.
[23] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit, p. 69.
[24] Ibid., p. 48.
[25] Ibid., p. 48.
[26] Ibid., p. 49.
[27] See S. Kamiński, *Hobbesa pojęcie definicji*, op. cit., p. 37.
[28] Ibid., p. 37.

Correct reasoning which requires the existence of language is guaranteed by the correctness of the definition of names (for the philosopher, a correct definition is the definition which **clearly** represents the idea of the thing discussed). Hobbes presents a detailed concept of reasoning many times reducing it to calculating, addition (or subtraction) replies and names[29]. Therefore, reasoning occurs when human mind performs mathematical operations (in practice, two of them – for multiplication and division can be reduced to division and subtraction). A starting point for reasoning are the first definitions and the meaning of names agreed upon. It aims at finding their close and far consequences[30]. Hobbes's concept was perfectly complemented with a notion of syllogism as a composition of the sum which is the result of the two sentences linked[31] (therefore, sentences or statements are in turn the result of the addition of two names). Reasoning (or proof) is governed according to the strictly defined laws of syllogism and it is proper to prove premises of the next syllogism with the help of the first definitions[32].

When reasoning is based on words of general meaning and leads us towards a general conclusion, it is called absurdity. Hobbes uses the formulation of privilege of absurdity to highlight that it is exclusively man who is capable of committing it; only man can make generalizations with the use of words (also those burdened with a mistake)[33]. A lot of absurdity which the English philosopher found in the works of his preceders (only few works of geometricians were free from mistakes) were rooted in the wrong method chosen by them for they did not start the process of reasoning from the definition or, in other words, explanation of the terms accepted in the beginning[34].

Although Hobbes certainly put too much emphasis on the role of syllogism in the process of reasoning, his role was undoubtedly significant when it comes to the development of science of definition. Hobbes's theory of definition was to a great extent polemics with Aristotle who treated defining as an operation from the field of ontology: for him, a definition was an answer to the question about the essence of object; according to him, the process

[29] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit, p. 50. and T. Hobbes, *Leviatahan*, op. cit, pp. 32-33.

[30] T. Hobbes, *Leviathan*, op. cit, pp. 34–35.

[31] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 60.

[32] See A. Child, *Making and knowing in Hobbes, Vico, and Dewey*, California 1954, p. 273.

[33] T. Hobbes, *Leviathan*, op. cit., pp. 35–36.

[34] Ibid.

of defining aimed at highlighting essential features of the object defined. (Aristotle differentiated between oral definitions which informed about the sense of the word especially characteristic for geometry; nevertheless, he claimed they were unimportant for science)[35]. The Aristotelian stand survived almost unchanged till the times of Hobbes[36]. (surprisingly enough, it was accepted even by the authors of *Logic from Port-Royal* who were quite innovative in their views[37]) therefore, one has to notice the courage of the Hobbesian concept which contributed to the depart from the hitherto tradition[38].

Hobbes, fascinated by the theory of Euclides, arrived at the conclusion that his theory of defining mathematical terms based on the explanation of names was the only correct and universal method which had to be accepted in all fields of science. Breaking up with the Aristotelian concept of definition understood as exploration of the essence of the object defined, he accepted a definition (defining) as an operation on language dealing with names (words)[39]. Therefore, the term "definition" means defining sense of the words.

To understand fully a status of definition in the theory of Hobbes, it is necessary to employ certain differentiations of terms. Bearing in mind the aim of definition, Kazimierz Ajdukiewicz divides it into the definition of things which aims at recognition of things (it seems that such a character is revealed by the Aristotelian definitions) and the definition of word which aims at the enrichment of the language with the word defined. The latter includes also the definitions which while defining a given term relate to the thing (real, inner linguistic definitions) as well as the ones which while defining a word relate to the words (nominal definitions or metalinguistic)[40].

Ajdukiewicz points out that the British scientist does not provide any division of the definitions into real and nominal definitions. Since a name of the designation was always an object, every definition was a real definition being at the same time a definition of the word (his definitions are the

[35] T. Kotarbiński, *Wykłady z dziejów logiki*, Warszawa 1985, pp. 28–29.

[36] S. Kamiński, *Hobbesa pojęcie definicji*, op. cit., pp. 27–32.

[37] Ibid. See also A. Arnauld, P. Nicole, *Logika*, translated by S. Romahnowa, Warszawa 1958, pp. 114–125 and pp. 234–239.

[38] S. Kamiński, *Hobbesa pojęcie definicji*, op. cit., pp. 49–50.

[39] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 97.

[40] K. Ajdukiewicz, *Logiczne podstawy nauczania*, in „Encyklopedia wychowania", vol. II, (ed.) S. Kempicki, Warszawa 1934, pp. 35–36.

definitions which, while defining an object, speak about the object itself)[41]. Attributing the status of nominal definitions to the definitions presented by Hobbes would contradict his entire system[42].

For Hobbes, the essence of knowledge or, in other words, the real philosophy, is an intellectual recognition of reasons or ways in which different phenomena take place[43]. Since the condition for correct thinking (argumentation) is a primary acceptance of the definition of words (as the first premises) with a key role, it would be useful if the definitions showed the reasons of the given thing. While talking about primary principles, Hobbes differentiates between the definitions of words which mean objects whose reason can be thought of and the definitions of words which mean objects but cannot be understood without recognition of their reason. The rank of the latter is wide in science; it is because of them that science develops since definitions – primary principles do not speak about the reasons of objects, the results of thinking cannot mention them (after all, it is the discovery of reasons that is the aim of science)[44].

A basic role of definitions in science is a removal of ambiguities and obscurities and precise settlement of the meaning of the object defined[45]. A name purified from all other meanings so that it reveals its real meaning becomes clear and comprehensible – it clearly presents the idea of the object considered and may have a role of *principium* in argumentation. The definitions of names are also the means which enable us to reveal the falsity of the reply[46]. Thus, in the Hobbesian philosophy argumentation and science become a logical consequence of the definition[47]. However, the acceptance of a given name in one of the fields of philosophy in its concrete meaning does not exclude the possibility of its different defining in other field of science (Hobbes notices that a parabola in geometry undoubtedly differs from a parabola in rhetoric).

The considerations presented above lead as to believe that language in some sense constitutes intellect and is an initial condition for the development of science, its cultivation and passing its results to the next generations. Apart from its undoubtedly significant role which is a func-

[41] Ibid., pp. 28–29, 42.
[42] Ibid., p. 34.
[43] T. Hobbes, *Elementy filozofii*, op. cit., pp. 12, 79, 82.
[44] Ibid., p. 96. See also S. Kamiński, *Hobbesa pojęcie definicji*, op. cit., pp. 40–41.
[45] T. Hobbes, *Elementy filozofii*, Vol. I, op. cit., p. 98.
[46] Ibid., p. 75.
[47] S. Kamiński, *Hobbesa pojęcie definicji*, op. cit., p. 47.

tion of language, we can highlight another important role of language: for Hobbes, language is a primary condition for the establishment of the government. People, who have already acquired a language, are following a voice of the intellect aiming at the abandonment of the state of nature (a strenuous experience), which has been their destiny so far. The alternative they want to leave it for is the state which, although artificial, still guarantees peace.

According to Hobbes, one of the basic conditions for people to abandon the state of nature is an assignment of the **social agreement**, characteristically understood. The philosopher did not write much about the nature of the agreement. It is known that every person agrees to give the right to rule himself to the sovereign person on condition that every member of the given community does the same[48]. Hobbes did not explain the mechanism of giving the rights to that person neither did he explain which of the subjective rights were to be given to the sovereign person. In many places he mentioned that a citizen did give something to the sovereign person, something secret and elusive, which symbolized the act of imposing the reigns upon the Sovereign. Hobbes claimed in *Leviathan* that a citizen whose decision was taken by the Sovereign was still the author of his actions[49].

J. W. N. Watkins, a famous researcher of Hobbes's works, puts forward an interesting concept trying to explain Hobbes's theory of social agreement in the light of his nominalism. According to this concept, every citizen gives the Sovereign a sign (symbol) of his persona – his name[50]. From that point on the monarch represents the citizen becoming so to say his procurator and acting for him with the right of the law. Since the agreement has been assigned by every citizen, the Sovereign is the procurator of all the citizens. A citizen, who in the act of the social agreement has directly given the rights to the Sovereign to act efficiently in his name, is still (at least nominally) the author (aspirator) of these actions.

The aim of the social agreement is the constitution of the government whereas the aim of the state is the assurance of safety for the citizens. The basic guarantee of safety is the establishment of equal moral principles compulsory for everybody. Finally, it is the Sovereign accepted by the social agreement who can introduce a differentiation between moral and immoral acts; it is him who distinguishes between good and evil. In the state of nature preceding the state of state there was no objective criterion as

[48] T. Hobbes, *Leviathan*, op. cit., pp. 131–134.
[49] Ibid.
[50] J. W. N. Watkins, *Hobbes's system of ideas*, op. cit., pp. 160–161.

for good and evil: what was good for one person could be evil for another. Thus, everybody wanted to be "the source" of moral judgment and everybody wanted to give the words **good** or **evil different** meanings: *For these words of Good, Evil, are ever used with relation to the person that useth them: There being nothing simply and absolutely so: nor any common Rule for Good and Evil, to be taken from the nature of the objects themselves*[51]. At that time there was a great number of particular laws each of which was deprived of even a relative attribute of permanence. Undoubtedly, the way in which the Sovereign establishes the common standards defining moral matters is worth mentioning. It seems that even here the Hobbesian philosophy of language remains in close connection with his political and social philosophy.

Chosen by the will of the citizens and acting in their names, the Sovereign does more than just pure expression in the moral matters. With the reference to Austin's theory of speech acts, his declaration can be called a performative declaration[52]. Naming certain moral acts by the Sovereign constitutes a legislative act; a staring point for the evaluation of the future conduct for the citizens. Surprisingly enough, this operation has the features of the process of defining objects and it indeed is. Since, as it was mentioned before, the process of defining is characterized by the arbitrarity, it also characterizes the legislation ·ts of the Sovereign. Since a correctly (although arbitrarily) formulated definition is not the subject for controversy or discussion, the legislated acts of the Sovereign should not (cannot) become the subject of public debate[53]. Just like correct definitions begin reasoning and the construction of the system of scientific knowledge, legislation acts (laws where the Sovereign decides what is right and what is wrong) constitute the foundation of a safe state. Questioning these acts by the citizens is unsteady and highly dangerous for the state order. Therefore, in Hobbes's system any critique of the law established by the Sovereign is eliminated. Another reason for its absence is the lack of the possibility for the law to be unjust or faulty[54].

In conclusion, it is necessary to highlight that for Hobbes a language is a necessary element in the development of the institution of state, law and morality. The discovery of language (speech) enabled man to leave the state

[51] T. Hobbes, *Leviathan*, op. cit., p. 41.

[52] See J. W. N. Watkins, *Hobbes's system of ideas*, op. cit., p. 153.

[53] T. Hobbes, *Leviathan*, op. cit., p. 136.

[54] Ibid., p. 163., see also J. W. N. Watkins, *Hobbes's system of ideas*, op. cit., pp. 153–157.

of nature and resulted in the next discovery – the discovery of state[55]. It is the discovery of language that has definitely separated man from the world of animals resulting in the development of science and recognition. Speech, just as state, is an artificial product of men which contributed to the fact that a man became an intelligent and moral creature[56]. Therefore, it may seem that in the philosophy of Hobbes political and social implications of language are wider than they have known to be and may reveal a source for further studies.

Translated by *Renata Jermołowicz*

[55] See B. Suchodlski, *Antropologia Hobbesa*, "Studia Filozoficzne" 1967, p. 202.

[56] Ibid.

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ON THE PROJECT OF A UNIVERSAL LANGUAGE IN THE FRAMEWORK OF THE XVII CENTURY PHILOSOPHY

Language is only the instrument of science, and words are but the signs of ideas: I wish, however, that the instrument might be less apt to decay, and that signs might be permanent, like the things they denote.
S. Johnson

By the end of the seventeenth century Europe was fully influenced by the philosophy of Renaissance which had affected nearly every field of life and aimed at the critical revision of the heritage left by the Middle Ages. The goal was to provide solid foundations for the new science based on reason and experiment. It was in that light that the issue of language had become the subject of discussion for almost every thinker of the period. According to Heinz, there were three main issues in the field of linguistics that had captured the interest of the seventeenth-century philosophy: universal language, universal grammar, and the origins of language[1]. The attempt to find a universal pattern remained in accordance with the general direction of the new science that aimed at simplification and logical organization of things. It was no longer that dead languages such as Latin, Hebrew and Greek could provide sufficient material for linguistic research. Natural languages, which had remained in the shadow of the dead ones, appeared on the scene challenging philosophers to establish universal features of languages, the discovery of which would lead to the discovery of a universal language, also known as a philosophical language.

The issue of language was not new to philosophy – Socrates and the Sophists were known to have raised questions as to the correctness of names, the function of speech, and the meaning of words as the concepts of definitions. Aristotle, in turn, laid the foundations of a philosophy of grammar, which was further elaborated by the Stoics. Plato stated that gods

[1] A. Heinz, *Dzieje Językoznawstwa w Zarysie*, PWN, Warszawa, 1978, p. 99.

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would have made people perfectly happy if they had given them one common language shared by every nation. St. Augustine in his *City of God* commented on different tongues that divided man and man. The desire for one language shared by all people was as old as the Biblical Adam who witnessed "...the whole earth was of one language and of one speech"[2]. That linguistic idyll lasted till the moment when the language spoken by Adam's grandchildren was taken away forever in the act of punishment when God decided to condemn people's conceit. A language understood by everybody appeared once again on the day of Pentecost when Christ's disciples and casual observers "were all filled with the Holy Ghost, and began to speak with other tongues, as the Spirit gave them utterance [...] the multitude came together, and were confounded, because that every man heard them speak in his own language"[3]. Grasped by so large a group, mutual linguistic understanding once again left a shadow of hope to be found and established forever.

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* *

One of the first designers of a universal language was Claudius Galenus, a doctor, who lived at the times of the ancient Rome (200 BC). Unfortunately, his project did not survive in the course of history and all we know is that he suggested an international system of signs which was meant to enable his contemporaries to communicate easily. Another attempt to design a universal language dates back to the thirteenth century. The project was elaborated by Raymundus Lullus, a Catholic philosopher and writer, who suggested a logical classification of terms, the idea which echoed in the seventeenth century. The sixteenth century brought other projects of universal languages. One of them was proposed by Teofilo Folengo, an Italian poet, who based his language on the simplified version of Latin enriched by a number of dialect elements of Italian. Folengo put his ideas in practice and used his language to write an epos "Baldus". The idea to base universal languages on natural languages was widely used later (eg. Esperanto). In 1516 Sir Thomas Morus published a book entitled "Utopia" where he described a language used by the Utopians. Just like everything in Utopia, it was based on logic, truth and universality. Certainly, the above-mentioned projects were not of minor interest in search for the hidden key to the universal language but it was not until the seventeenth

[2] Genesis, 11:1

[3] Acts, 2:4 – 6

century that the issue of a universal language came into scope with serious attention[4].

The need for a universal language advanced together with the development of trade routes, missionary works and colonization. Further economic progress depended on communication with people who not only spoke different languages but also had little to do with Latin or Greek. The possibility of having one international language was further provoked by the discovery of written Chinese used in the Far East as a means of communication by people whose natural languages differed greatly[5]. For the seventeenth-century philosophers it was clear that spoken languages with their developed system of phonograms remained out of question to fit a universal pattern, whereas the ideal was "a written language constituted by a new system of ideograms which could also be spoken."[6] Thus the seventeenth-century philosophers saw a universal language not only in terms of the Utopian dream but also as a necessity on which both the economic progress and the development of science depended.

Among the thinkers of the seventeenth century Francis Bacon (1561–1626) was the first to introduce a programme for the construction of a universal language. In his *Essay on the Dignity and the Advancement of Learning* (1605) Bacon proclaimed his beliefs that all languages, oral and visual, were means of conveying thoughts between men. Troubled by the fact that the existing system of communication had become inadequate, Bacon intended to invent one language where each word would carry a clear meaning. In *De Augmentics Scientarium* (1623) Bacon distinguished between two types of grammar: grammatica litteraria and grammatica philosophica. According to him, logic was *traditiva*, whereas language was seen as a transfer of thoughts: *vehiculum cogitationum*. Therefore, a universal language as seen by Bacon depended on the inductive comparison between grammars of different languages in search for the most perfect elements. Those perfect elements were to be summed up and further organized into one system. Bacon saw words as "the tokens current and accepted for conceits, as moneys are for values." The system of his language would be analogous to that of the Chinese language where "real characters [...] express neither letters nor words, but things or notions."[7] Bacon's optimism for the project found

[4] For more information about the projects see Marian Jurkowski, *Od Wieży Babel do Języka Kosmitów*, Krajowa Agencja Wydawnicza, Białystok 1986.

[5] J. Cohen, *On the Project of a Universal Character*, in *Mind, a Quarterly Review of Psychology and Philosophy*, Vol. LXIII – 1954, p. 51.

[6] Ibid., p. 51.

[7] See J. Cohen, *On the Project of a Universal Character*, p. 51.

expression in his statement that "any book written in characters of this kind can be read off by each nation in their own language." [8]

Francis Bacon was soon followed by his secretary, Thomas Hobbes (1588–1679), who also tried to elaborate on the project of a universal language. Being under strong influence of Galileo, Hobbes tried to apply the principles of calculative methods to the process of acquisition of knowledge. Instead of Galileo's mathematical symbols in his universal language Hobbes suggested the application of natural words used as artificial symbols, the idea which was later developed by Leibniz. Hobbes was also interested in the origins of language. It is necessary to mention here that the majority of the seventeenth-century thinkers accepted the monogenetic hypothesis according to which all the languages were based on the original language which, due to the natural division of peoples and land, developed itself into dialects which later developed into independent languages[9]. For him, the ideal was to find the lost *lingua adamica* which, according to him, was the original language and would be the key to the perfect understanding between people.

The ideas of John Locke (1632–1704), another Enlighted thinker of the century, were of great importance when it comes to the development of language. Locke was interested in the language as in the means of communicating human thoughts. He tried to show how language was used to represent ideas as communicated to others. In his *Essay Concerning Human Understanding* (1690) he put forward the idea that man was created by God to live in society and was therefore equipped with the language which was to be "the great instrument and common tie of society" [10]. According to Locke, man was not given a complete language: man was only created capable of articulating sounds. To "activate" a language, it was not enough to combine sounds into words. What was an essential condition for words to become a language was the need for words to represent "internal conceptions" of ideas. To put it differently, man cannot understand a word for which he has no idea. By using words for which we have clear ideas attached we will prevent our language from being abused. For him, words became sensible marks of ideas that stood behind the words being their signification. Thus Locke was the first among his contemporaries to connect understanding with the analysis of human mind.

[8] Ibid., p. 51.

[9] M. Jurkowski, *Od Wieży Babel do Języka Kosmitów*, p. 10.

[10] J. Locke, *An Essay Concerning Human Understanding*, in *The Philosophical Works of John Locke*, ed. J. A. St. John (London 1996), Vol. II, p. 1.

René Descartes (1596–1650), although not primarily interested in the issue of language, also commented on the project of a universal language. In 1629 a leaflet written by Hardy appeared. The author of the leaflet presented a project of a universal language. Unfortunately, the leaflet did not survive and the information preserved is based on the few comments Descartes made in his letter to Mersenne. Hardy claimed that his language would be simple enough to enable an average student to produce short sentences with the help of a dictionary within few days. Such a language would possess no irregularities and could be used by an average person. Descartes was sceptical as for the language presented by the author though he thought it was possible. According to him, the first step towards such a language was the discovery of the true philosophy which thoroughly described reality. Thus, a universal language would be a natural consequence of the true philosophy. Such a language would reflect thinking processes and its construction would depend on the following steps: discovery of elementary ideas in mind, natural order of the ideas and assembling each elementary idea a word[11]. Like Bacon, Descartes highlighted the role of the method applied. In his *Discours de la méthode* (1637) he commented on the role of method as being the most decisive aspect when discussing true knowledge. The method seen by Descartes as the only possible was to be analytical, aiming at the primitive concepts, and mathematical.

Triggered by Descartes' comments on the issue of a universal language, Gottfried Wilhelm Leibniz (1646–1716) took a stand claiming that "although this language depends on the true philosophy, it does not depend on its perfection" [12]. He made a further point that such a language could be established regardless of philosophy's imperfection and develop itself further into real knowledge. Leibniz highlighted a close relationship between languages and thought seeing the language as a mirror of the intellect[13]. Therefore, language is subordinate to reason and to create a universal language it is necessary to follow the rules of reason. For Leibniz, a universal language (*characteristica universalis*) is a kind of human thoughts' alphabet by analysing which one could discover practically everything whereas a pattern of such a language was revealed in the language of mathematics[14]. Leibniz's lingua universalia was based on "universal mathematics". He claimed

[11] J. Kopania, *Funkcje poznawcze Descartesa teorii idei*, Białystok, p. 191.

[12] G. W. Leibniz, *Opuscules et Fragments Inedits de Leibniz*, C, p. 28.

[13] H. Święczkowska, *Harmonia linguarum. Język i jego funkcje w filozofii Leibniza*, Wydawnictwo Uniwersytetu w Białymstoku, 1998, pp. 31–38.

[14] Ibid., pp. 137–139.

that thinking could be perceived as counting, correct thinking meant correct counting provided the signs used were as clear as those used in mathematics. Leibiniz went further in his praise for mathematics suggesting devising a calculus operating on the formulae of the language. To achieve that goal, it was necessary to elaborate an adequate system of symbolism, something which Leibniz never did though constantly urged others to do so. As for Leibniz's concern with the origins of language, it was to some extent provoked by John Locke whose *Essay concerning Human Understanding* was followed by Leibniz's counter essay entitled *Nouveaux Essais sur l'Entendement Humain par l'Auteur du Systéme de l'Harmonie preétablie* written in 1704. He disagreed with Locke on several points. Unlike Locke, Leibniz supported the monogenetic hypothesis and stated that all existing languages were descendants of a single mother tongue – *lingua adamica*, which, due to the migration, developed into numerous daughter languages. A thorough analysis of the natural languages would enable researchers to come closer to the lost *lingua adamica* and perhaps reconstruct it[15].

While discussing the projects of universal languages in the seventeenth century it is worth mentioning that all of them are thought to be influenced (at least to some extent) by the ideas of Bacon and Descartes. J. Cohen divides all the projects that the seventeenth century was rich in into two types: the Baconian one and Cartesian one. According to him, all projects were granted on either of the two types. While mentioning the projects of the Baconian type, it is necessary to highlight the characteristic features of his project. J. Cohen compares the language of this type to "the modern international code of nautical signals" and describes it as "not a mere cipher of limited applications"[16]. Many researchers point out that there was little about mathematics in Bacon's project which Ward, Bacon's contemporary, explained by the fact that Bacon was not simply skilled at it[17]. Nevertheless. his project served as a guideline to many of his contemporaries, just to mention William Bedell, Bishop of Kilmore, Vos & Herman Hugo, Philip Labbé and Edward Somerset, the second Marquis of Worcester. Unfortunately little is preserved as far as their projects are concerned with the exception of Philip Labbe and Cave Beck whose project appeared in 1657 entitled *The Universal Character, By which all the Nations in the world may understand one another's conceptions, reading out of one Common writing their own Mother Tongues.* In his project Beck proposed a universal system of writing putting the Ten Commandments in his alphabet. Thus, the written commandments become the combination of letters and numbers. As far as Labbe's project is concerned, it was based on the simplified form of the Latin grammar deprived of all irregularities. The project was entitled *Grammatica linguae universalis* and published in 1650. Interesting is the fact that Leibniz was under impression of Labbé's project claiming that Labbe's universal language was easier than Latin and more regular than Lingua Franca[18].

As for the Cartesian type of a universal language, which fully relied on the basics of "true philosophy" and simple notions, we can distinguish the following names: F. Lodwick, a London merchant, J. A. Comenius, the Czech educationalist, Sir Thomas Urguhart. F. Lodwick wrote two books on the subject: *A Common Writing. whereby two. although not understanding one the other's language yet by the help thereof may communicate their minds one to another* (1647) and *The Groundwork. or foundation laid (or so intended) for the framing of a new perfect Language and a universal or common writing* (1652). Unfortunately little is known as for the details of his project. John Amos Comenius (1592–1670) was concerned with the invention of a universal language of science which would enable educationalists to pass their knowledge to the people of different nations. He claimed that "the framers of the new language shall rather follow the guidance of the things themselves. since everything in our new language must be adapted to the exact and perfect representation of things"[19]. As a result, such a language with its harmony would be comparable to Nature enabling to teach new things in a totally new way. What Comenius proposed was a strictly defined system of meanings which would match different combinations of phonemes[20]. Letters represented symbolism and were combined according to the symbol they denoted. Worth mentioning is the fact that the universal project proposed by Comenius revealed some features of the Czech language.

As J. Cohen mentions[21] Urguhart (1611–1660) was the only seventeenth century thinker who based the project of a universal language on phonograms. His system was presented in the book entitled *Logopandecteision or an Introduction to the Universal Language.* According to Urquhart, every letter of every word in his project of a universal language was to express

[15] Ibid., pp. 129–154.

[16] J. Cohen, *On the Project of a Universal Character*, pp. 52–53.

[17] Ibid., p. 56.

[18] M. Jurkowski, *Od Wieży Babel do Języka Kosmitów*, p. 23.

[19] See R.Frazer, *The Language of Adam ,Columbia University Press*, New York, 1977, p. 45.

[20] M. Jurkowski, op. cit., p. 27.

[21] Ibid., p. 55.

a defined idea. Thus the meaning of the concrete word would already be present in its written form[22].

While discussing the projects of a universal language based on the Cartesian philosophy, it is necessary to mention the name of Seth Ward (1617–1689), a professor of astronomy at Oxford and later Bishop of Salisbury, who elaborated on Descartes' idea of simple notions. Although Ward never produced a universal language by his own, in the 1650s it was "felt that Ward was very close to completing the design of a universal character" [23]. All he published on the subject was a brief section in *Vindiciae Academiarum* which appeared in 1654 and presented the readers with the "programmatic statement of principles concerning a philosophical language" [24]. George Dalgarno and John Wilkins soon followed him and took the pain of developing Ward's ideas into details. Dalgarno published *Ars Signorum, vulgo Character Universalis et Lingua Philosophica* in 1661 where he claimed that he had discovered a logical analysis which represented the normal articulation of human thought. What is interesting about Dalgarno's project is the claim that his universal language could be used for conveying knowledge by the dumb and deaf[25].

John Wilkins (1614–1572) in his vision of a universal language was concerned with the role of an artificial symbol system in the investigation of reality. His *Essay Towards a Real Character and a Philosophical Language* was published in 1668 though it is thought to have been finished by 1665. Most of the manuscript was destroyed in the Great Fire and what was printed two years later was the reconstruction of the parts saved. In the essay Wilkins proposed the division of terms into six categories which were later divided into sub-categories so that it was possible to attach a logical sequence of letters to match each category. Looking at the written form of the word, one could easily reconstruct the meaning of it and vice versa. It is worth mentioning that Wilkins put his project into practice - he used his language to communicate with Robert Boyle who was his friend from Royal Society[26].

Another important thing Wilkins was credited for was his distinguishing between grammars of two kinds: natural and general, and instituted

[22] Unfortunately, most of his manuscript was lost at the battle of Worcester in 1651.

[23] D. Cram, *Universal Language, Specious Arithmetic and the Alphabet of Simple Notions* in *Beiträge zur Geschichte der Sprachwissenschaft*, 4.2 (1994), p. 214.

[24] Ibid., p. 226.

[25] His work *Didascalophus, or the Deaf and Dumb Man's tutor* was published in 1680.

[26] M. Jurkowski, op. cit., Białystok 1986, p. 29.

and particular. Wilkins stated that Natural grammar or, in other words, philosophical and universal, had been neglected when compared to that of the instituted and particular kind whereas "it should contain all such Grounds and Rules, as do naturally and necessarily belong to the Philosophy of letters and speech in the *General*" [27]. Therefore, his project of a universal language was a step towards the development of the grounds of a philosophical grammar.

The popularity of Cartesian philosophy triggered the research of a philosophical grammar. By the end of the seventeenth century studies of grammar had already become a popular activity among the philosophers. As it was mentioned before researchers were driven by the need to find universal features of natural languages. Claude Lancelot and Antoine Arnauld collected their thoughts about a universal grammar in the book entitled *Grammaire générale et raisonnée de Port-Royal*, the book which marked "the apex of (philosophy of language) evolution in the general grammars of the seventeenth and the eighteenth centuries" [28]. In their book they showed that there was a need to create a universal grammar which would follow the thinking processes of the mind[29]. Such a grammar would be universal and rational, in other words, applicable to all languages. To discover the truth about language, the grammarians of Port-Royal arrived at the conclusion that grammar is completely subordinated to logic. Since there is one logic for all mankind, it is natural to assume that there is one general grammar for all languages. They define grammar as an art of speaking. Speaking, in turn, is an art of translating our thoughts with the use of signs. Since thinking structures are stable and unchangeable, all languages are governed by the same universal rules. The discovery of those rules would lead to the discovery of a universal language. Arnauld and his followers adopted a completely rational approach to the formation of language trying to show that language can be explained rather than observed. The *Grammarie de Port-Royal* enjoyed great popularity till the beginning of the nineteenth century. It was not until 1957 that it was brought again on a linguistic scene by N. Chomsky whose thesis concerning generative grammar echoed some of its fundamental features[30].

[27] See *History of Linguistic Thought and Contemporary Linguistics*, (ed.) H. Parret, WdeG, 1976, p. 90.

[28] T. Sharadzenidze, *On the Two Trends in Modern Linguistics*, in *History of Linguistic Thought and Contemporary Linguistics*, (ed.) H. Parret, WdeG, 1976, p. 71.

[29] H. Święczkowska, *Idee ogólne i jednostkowe w "Gramatyce" i "Logice" z Port-Royal*, in *Idea - Studia nad strukturą i rozwojem pojęć filozoficznych*, Białystok 1986, p. 43.

[30] N. Chomsky, *Cartesian Linguistics*, Harper & Row, New York & London 1966, p. 76.

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As we have seen, the seventeenth century was a turning point in the field of science. Intensive research in the fields of science and philosophy was an immediate answer to the outgoing changes in the economic and social life in Europe. It was in that light that the issue of a universal language captured the minds of the seventeenth-century philosophers provoking them to find the key to mutual understanding once lost at Babel. Numerous projects appeared proposing philosophically supported systems of a universal character. Only few of them were based on clear concepts and systems which could meet the requirements of the notion of universality. None of them was accepted as the truly universal language. Although the seventeenth century failed to find the key to the linguistic paradise with its mutual understanding, the above-mentioned projects belong to the first and undoubtedly the most important wave of the ideas which have never stopped to serve as a guideline in search for a universal language. Pieter V. Verbung[31] claims that Leibniz's century was the beginning of the philosophical thought of Wolf, Kant, Humbolt and Bopp whereas the Cartesian universal principles of language structure found their way in the transformational grammar as presented by Chomsky.

Today the search for universal languages is conducted in the framework of interlinguistics which deals with artificial languages and aims at their development, classification and evolutional and futuristic research. The geography of intelinguistics covers such countries as the USA, France, Italy, Japan, Russia and many others. Among the interlinguists who are among the promoters of the idea of a universal language are Otto Jespersen, Roman Jakobson, Baudouin de Courtenay and Andre Martinet. Now there are about seven hundred projects of artificial languages among which we can distinguish such projects as Volapük, Esperanto, interlingua IALA, computer languages and many others[32]. As for now, it has proved impossible to find one universal language which could be based on the categories discussed in this paper and meet the expectations of an average person. The answer to this failure may be hidden in the false assumption made by the seventeenth-century thinkers that one language may serve as a language of science and literature simultaneously. Although the scientific progress we witness day

[31] P. A. Verbung, *The Idea of Linguistic System in Leibniz*, in *History of Linguistic Thought and Contemporary Linguistics*, (ed.) H. Parret, WdeG, 1976, p. 614.

[32] M. Jurkowski, op. cit., p. 7.

by day has undoubtedly driven us far away from the day of Pentecost, we still share the same Utopian dream of finding one common language which would enable mutual linguistic understanding. The key to the reconstruction of Babel still remains to be found.

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ON "AUTHORIAL" VERSION OF THE HISTORY OF LINGUISTICS

Remarks on the margins of interpretation of Jean Jacques Rousseau's theory of language

In the introduction to the collective work entitled "Studies in the History of Linguistics – Traditions and Paradigms" and published in Bloomington in 1974 Dell Hymes[1] raised a topic for discussion regarding the techniques and methods of conducting historical research in the field commonly known as history of linguistics. The inspiration for the discussion was a famous book by Thomas S. Kuhn entitled "The Structure of Scientific Revolutions"[2], which in the 1960s resulted in a significant increase in interest in the various aspects of scientific studies whose turning points, characterized by rapid changes of the notional device, problems and methods of research, appeared to be the most attractive for reflection.

The basic questions formulated by Kuhn are: What is science? How is the development of science conducted? How are some theories replaced by others? These are the problems traditionally associated with philosophy or methodology of science. Kuhn is convicted that the answers to the above-mentioned questions cannot be found in the field of the traditionally conducted philosophy of science for its abstracts from history. Therefore, Kuhn objects to any attempt made to evaluate scientific views of the past from the point of view of canons and patterns which have come to be taken for granted. This ahistoric evaluation makes it impossible to understand

[1] Dell Hymes, *Introduction: Traditions and Paradigms*, in Dell Hymes (ed.), *Studies in the History of Linguistics – Traditions and Paradigms*, Indiana University Press, Bloomington. London 1974, pp. 1–40.

[2] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, The Chicago University Press, Chicago 1962.

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a process which governs shaping scientific knowledge. He falsely suggests that in the past scientists were engaged in the very same problems which they either solved or left to the contemporarily known theories to do so. He creates an illusion that the whole process of the development of knowledge is of an utterly cumulative character masking revolutions in science which are based on changing of "paradigmatical points of views". Therefore, it is false to treat later theories as a purely logical development of the previous ones because, among other things, theories which are historically older were submitted to absolutely different patterns and assumptions – paradigms of science conducted in the historically and culturally defined place and time.

Kuhn assumes that the development of science is to the same extent a development of the defined paradigmatical points of view as well as a revolutional abandonment of the previous "views on the world" fed by other assumptions and scientific canons. According to him, the theory of knowledge which does not take into account a historic and sociological conditioning of scientific contents by accepting only "the context of justification" and eliminating "the context of discovery" has to be one-sided.

Kuhn's work, which was published in 1962, coincided with a radical change in the research movement in the American linguistics, the beginning of which was marked by Noam Chomsky's book entitled "Syntactic Structures" and published in 1957. The concept of linguistics as presented by Chomsky challenged classical structural linguistics in the subject of research and, above all, in the field of the method applied. Kuhn's idea could hardly need a more spectacular confirmation than the outgoing "linguistic revolution".

Dell Hymes accepts the basic assumptions of Kuhn's doctrine. Nevertheless, he claims that a presentation of the history of linguistics as a one-sided consequence of the paradigms which result in the fundamental change of the research perspective is as inadequate as a chronological history of the linguistic thought written in accordance with the Hegelian vision of history's progress for none of the paradigms has ever captured the whole field of linguistics[3].

A fundamental problem arises when it comes to the definition of the scope of the term "history of linguistics" contrasted with the multitude of the outgoing linguistic research, conducted not only by linguists, but also by psychologists, psychiatrists, physiologists or physicists. Contemporary linguistics is slowly becoming an integral part of the new field of research known as cognitive science. Hymes suggests comprising a wide range of source material, in other words, any pretheoretical reflection on the language

[3] Dell Hymes, *Introduction...*, op. cit. pp. 13–14.

supported by anthropological or ethnographic research, under the name of folk linguistics, national philologies and general linguistics, assuming that material research has been giving necessary data for a universal generalization on the scale of the latter discipline[4].

It is clear that in the so widely-defined research perspective one can hardly separate all the paradigms in the linguistic perspective present in the course of history. It is even harder to separate one dominating pattern. Nevertheless, it does not discredit the essence and importance of Kuhn's theory. Apart from its controversy, it does explain the essential features of the scientific cognitive process. Kuhn assumes that a new paradigm or a new insight is not simply better. It differs from the previous paradigm in terms of its ability to explain new things which the former one failed to do, and continues to have explanatory qualities of the previous paradigm. It is rather impossible to fully transfer Kuhn's model of historic research to the research field of linguistics since, according to Hymes, the change of paradigms in linguistics did not meet both requirements because of the character and features of the method accepted in numerous fields of linguistics.

According to Hymes, in case of linguistics the term of linguistic community creating a research group or school which is gaining a dominating position in the given period is far more significant than the term of paradigm. Hymes's suggestion is an elaboration on Kuhn's thesis which assumes a need for the consideration of a wide cultural context accompanying institutional science before and in the course of revolutional change. In other words, it treats a wide sociological aspect of paradigm's change. While analyzing a spectacular success of Chomsky's theory, Hymes highlights social and psychological inner-linguistic reasons of numerous attempts recalling the term of a paradigmatical community. Such a community, concentrated around a certain leader and accepting a certain theory, is conscious of its participating in a revolutionary change whose rank depends mostly on personal qualities of the author's theory and his power to influence the community. Although not directly, Hymes claims that in case of Chomsky and his believers the "revolution" is not the result of the fact that their paradigm is more effective, but it is rather the result of that revolution's proclaiming. Hymes notices that self-awareness of the so-called paradigmatical community is one but not the last aspect of the process of change which has its roots both in science as well as beyond it. The recognition of every element in this process would allow for its objective evaluation[5].

[4] Ibid., p.13.

[5] Ibid., pp. 15–16.

It can be easily noticed that the American structuralism was reinforced as a result of the establishment of linguistics as an academic branch independent of philology or anthropology. Chomsky's theory appeared at the moment when the prestige of its representatives was increasing. A previous group needed independence. Chomsky and his group inherited that independence as a natural consequence which resulted in the fact that students began studying linguistics just like they started together.

Hymes highlights that such a situation brings a temptation to write a history of the branch once again since Chomsky postulates connecting it with psychology and defining its area and methods once again. This is an approach caused by the belief, still present in linguistic literature, that in the past linguistics was in the right position only when its frames were in accordance with the currently accepted definition. Instead of an overall history of the branch we are exposed to its certain stages organized according to one of the chosen paradigms in the pale of science. This kind of history can be called a history of anticipation.

While developing his theory of linguistics, Chomsky broke with the widely accepted tradition of behaviorism accepted in the American structuralism. He acknowledged that notional apparatus of behaviorism did not describe the essence of language - its creative character expressed in the ability to produce and interpret an unlimited number of replies. Grammar in this framework is understood as a limited number of rules generating an unlimited number of sentences. Thus a grammar theory should be a deductive theory of language general enough to cover all possible languages.

It has to be made clear that Chomsky created his theory independently of any existing philosophical system. He notes that the direction of research in creating an adequate theory of natural language has been inspired by the research and results achieved in mathematics in the twentieth century. The need to appeal to the philosophical tradition was felt considerably later, namely in the half of 1960s. For Chomsky, rationalism became an alternative to behaviorism which was rooted in empiricism.

Although Chomsky appeals to the rational tradition in many works, it is Cartesianism that he chooses as a historic basis for his theory of language. While searching for philosophical ancestors, Chomsky wanted to find thinkers with whom he could share both a vision of language as well as a vision of the world. Universal grammar theories of the Middle Ages were of rational character, but that was rationalism rooted in epistemology of the Aristotelian empiricism – rationalism rooted in the belief that being was primary in its relation to thinking. Two basic theories of Chomsky's research concern a thesis about a creative character of the language and a thesis

about the existence of a universal mechanism responsible for the acquisition and use of the language characteristic for human beings. They demand an acceptance of the fact that being is primary in relation to existence. This assumption makes the foundations of Cartesian philosophy[6].

Chomsky acknowledges that the Cartesian theory of mind is identical to the one which makes the foundations of generative grammars. He also highlights the identity and concurrence of his views to the views presented in the works of the Cartesians, especially as presented in the Grammar from Port-Royal[7].

The choice of the historical and philosophical perspective of generativism may be interpreted in many ways, one of which is searching for the arguments confirming the principles of the Cartesian version of rationalism. We may attack the choice accusing it (as Hans Aarsleff does) of overinterpreting the texts included in the so-called Cartesian tradition as well as of the unconscientiousness of Chomsky's historic study (Aarsleff calls Chomsky's history of linguistics a partisan history)[8]. We may as well decide that the choice for a philosophical perspective does not throw any important light as far as the theory of generativism is concerned; it is rather an element of decoration, an expression of Chomsky's philosophical taste. Finally, this choice may be utterly questioned bearing in mind the anti-linguistic character of the Cartesian philosophy. Apart from its controversy, it cannot be doubted that Chomsky is credited for including a certain philosophical tradition in the history of the linguistic field, a collection of numerous questions and problems which have appeared in the long run of the history. The opening of the "Cartesian" perspective has resulted in the number of studies and monographs which verify historic material of "The Cartesian Linguistics". However, one should keep in mind the fact that Chomsky did not create his theory based on any philosophical system. It was not until the moment when the theory was put forward than the need for a philosophical background appeared. Therefore, all we can appreciate is the rightness of his choice of historic material.

A linguistic reflection of the seventeenth and eighteenth centuries undoubtedly revealed some seeds which would germinate in the modern theories of linguistics but the mechanism of anticipation is extremely deceptive,

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[6] Compare Jerzy Kopania, *Wstęp*, in *Antoine Arnauld, Claude Lancelot, Powszechna Gramatyka Racjonalna (Gramatyka z Port-Royal)*, Warszawa 1991, xiv–xvi.

[7] See Noam Chomsky, *Cartesian Linguistics*, Harper & Row, Publishers, New York, London 1996.

[8] See Hans Aarsleff, *The Tradition of Condillac*, in Dell Hymes (ed.), *Studies in the History of Linguistics*, op. cit., p. 111.

therefore, there have to be some strong proofs to state the identity of reasons presented in the completely different systems of knowledge. An interpretation of historic data always reveals some amount of subjectivism which is to some extent connected with the persona of the author – selector of facts, theories and directions within the boundaries of the given field. According to Hymes, this subjectivism makes an integral part of history itself like a motivation to write history whose consecutive version is the result of the increase in knowledge as well as the change in the research perspective and numerous outer and inner scientific reasons. We could even accept "rewriting" history every time we face a turning point in science. But we should demand that inevitable subjectivism of authorial histories should both agree with the data and stay in harmony at least to a certain degree. Unfortunately, Hymes notices that this demand is not what many researhers of the contemporary linguistics respect[9].

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As we know, one of the turning points in the twentieth history of linguistics was the theory of language as presented by Ferdinand de Saussure. The historians of idea have been trying to define the source of his inspiration and the framework of the tradition it grew in. Kazimierz Polański[10] presents a review of these points in the introduction to the last Polish edition of "The course of general linguistics". Although none of the researchers has ever questioned the originality of de Saussure's achievements and there is a common agreement as to it, there are differences when considering the degree of the influence the author of the "The course of general linguistics" experienced while studying numerous texts and theories written by those researchers. One thing is certain – the theory of de Saussure makes the climax of the wide European linguistic tradition whose general framework is highlighted by the conventional character of language.

Therefore, Jacques Derridda's statement that at least at the level of theoretical intentions, outlines and basic terms there are no principal disproportions between de Saussure's grasp of linguistic field and its opening by Jean Jacques Rousseau[11] sounds surprisingly enough in the context of

[9] Dell Hymes, *Introduction*, op. cit., p. 20.

[10] Kazimierz Polański, *Wstęp*, in Ferdinand de Saussure, *Kurs językoznaznawstwa ogólnego*, translated by Krystyna Kasprzyk, PWN Warszawa 2002, pp. 10–20.

[11] Compare Jacques Derrida, *Le cercle linguistique de Genève* in *Marges de la philosophie*, Minuit, Paris 1972. I present the views of Derrida on the basis of Bogdan Banasiak's text entitled "Szkic o szkicu Rousseau" preceding a Polish edition of Jean Jacques Rousseau's "Szkic o pochodzeniu języków", translated by Bogdan Banasiak, Aureus, Kraków 2001.

the research conducted by E. Coseriu, Jacobson or Aarslef. In the book published in 1968 and entitled "About grammatology", Derrida devoted big parts of his book to the analysis of Rousseau' texts. Several years later he completed his considerations adding a view that a principal vision of language as presented by Rousseau did not differ from the vision of de Saussure who has come to be recognized as the creator of the modern linguistics as well as the model of scholarship in the field of humanism in general.

In Derrida's opinion, Rousseau takes a fundamental part both in the discovery of modern linguistics' territory and the process of its boundaries' constitution. This process is accompanied by an inevitable turning away from the reflection on the language traditional for the seventeenth and eighteenth centuries whereas its basic aim is to define a system of basic notions, requirements and standards governing contemporary linguistics.

In his turning away from the traditional research on the language's sources, Rousseau conducts a research on the conditions of the possibility of its construction rejecting Condillac's theological hypothesis and initiating exiting a "bewitched circle" which presupposes speech before an idea or an idea before speech. According to Derrida, a starting point for Rousseau is the assumption that "society and language came into life simultaneously". This assumption allows for the establishment of a certain independent sphere of research in whose framework "society, language, agreement, history, etc. together with all the possibilities accompanying them constitute a certain system, certain organized whole, whose primarity may become a subject for some theory (...) A break from a genetic and factual derivation becomes a necessary condition for this sphere's research. An ideal genealogy or a structural description, as Derrida states, make the crux of Rousseau's project. In Derrida's opinion, under the pretext of consideration of genetic and fictional issues concerning the source Rousseau managed to formulate the whole theory of language: functional, systematic and structural[12].

Let us try to confront this view with Rousseau's linguistic doctrine as presented in the published posthumously *Essai sur l'origine des langues* as well as in *Discours sur l'origine et les fondements de l'inégalité*. It seems probable that the philosopher started his *Essai* while he was writing *Discours sur l'origine et les fondaments de l'inégalité*. Primarily *Essai* was meant to be a sort of comment[13] on Discours. Therefore, although *Essai sur l'origine des langues* is an independent part, it seems that its posthumous

[12] See Bogdan Banasiak, *Szkic o szkicu*, in J. J. Rousseau, *Szkic o pochodzeniu języków*, op. cit., p. 18.

[13] See B. Banasiak, *Szkic o szkicu Rousseau*, in Jean Jacques Rousseau, op. cit., p. 18.

edition deprived of the final authorial editing together with its thematic connection with fragments of *Discours* should be studied as a confrontation with the author's other works concerning his remarks on language.

Making an attempt to answer the question concerning the origins of language, Rousseau in his *Essai sur l'origine des langues* joined a group of thinkers who promoted a reflection on language as independent from any material research building their theories based on critique or acceptation of views and assumptions existing in literature and reinforced by an accidental knowledge about facts. Therefore, *Essai sur l'origine des langues* has to be treated as a theoretical work deprived of objective empirical background just as Condillac's *Essai sur l'origine des connaissances humaines* with which it remains in conflict. However, it is necessary to highlight the fact that the whole of Rousseau's literary output is characterized by an additional anti-methodological background which was the result of his philosophical beliefs. It was reflected in questioning the primary role of mind in the process of knowledge acquisition which resulted in his abandonment of science based on rational or empirical foundations and hostility towards any kinds of intellectualism responsible for the development of civilization, which, according to the philosopher, would result in the degradation of mankind. Rousseau condemns civilization with all its products, depriving them of any value. He replaces the category of reason with the category of emotion whereas civilization as a source of all evil is opposed to nature. Rousseau saw nature in a different light than his contemporaries did. For him, nature is the most perfect primary state and people deprived of the civilization's influence constitute an essential part of it[14]. In his *Essai* Rousseau presents the fundamental assumptions of his doctrine in the linguistic context and his views on the genesis and functions of language are obvious consequences of these assumptions.

Chapter I, entitled *Des divers moyens de communiquer nos pensées*, starts with the statement: "La parole distinque l'homme entre les animaux: le langage distingue les nations entre elles; on ne connaît d'où est un homme qu'après qu'il a parlé. L'usage et le besoin font apprendere á chacun de la langue de son pays: mais qu'est-ce qui fait que cette langue est celle de son pais et non pas d'un autre? Il faut bien remonter, pour le dire, à quelque raison qui tienne au local, et qui soit antérieure aux mœurs mêmes: la

[14] Compare Władysław Tatarkiewicz, *Historia filozofii*, PWN, Warszawa 1993, vol. II, pp. 151–153. However, it is necessary to add that the theoretical trend of the linguistics of the seventeenth and eighteenth centuries reveals remarkable works which are the result of creative reflection on extensive material research. They include the works of G. W. Leibniz as well as *Grammaire générale et raisonnée* by Antoine Arnauld and Claude Lancelot.

parole étant la première institucion sociale ne doit sa forme qu'á des causes naturelles"[15]. In the first paragraph Rousseau highlights a few problems which he intends to tackle. The first problem deals with the fundamental difference between the worlds of people and animals. The second problem tackles the linguistic differences in the people's world. The third one is about their foundations whereas the fourth one deals with the conventional character of language whose source is in nature.

Rousseau notices that although the construction of the vocal mechanism of animals is good enough to communicate in the right way for a person, it is not decisive when producing a language: "...l'invention de'art, de communiquer nos idées dépend moins des organes qui nous servent à cette communication que d'une faculte propre à l'homme qui lui fait employer ses organes à cet usage, et qui, si ceux-lá lui manquaient, lui en ferait employer ses organes à cet usage, et qui, si ceux-là lui manquaient, lui en ferait employer d'autres à la même fin."[16] Similarly to Descartes and Leibniz, Rousseau considers the rights of physiological nature but he does not allow for animals' ability to create a language on other grounds. Let us remind that according to Descartes, the lack of language in case of animals is a consequence of the absence of thinking process whereas Leibniz does not make a direct statement that animals do not speak because they do not think but because they do not have a necessary tendency to create a language. It may seem that Rousseau, in accordance with his predecessors, is apt to raise a question of the dependence of language on thinking process in the context of essential differences between man and the world of animals. The conclusion Rousseau arrives at is surprising enough. In his opinion, animals do not need to create any new language because they communicate by the means of their natural language. This is an inborn language/languages – "les animaux qui les parlent les ont en naissant; ils les ont tous, et partout la même; ils n'en changent point, ils n'y font pas le moindre progrès"[17]. Rousseau highlights that he has no doubts as for this matter. Nevertheless, a question arises whether animals do not create a language because they have it from nature. A positive answer to a considerable extent weakens the argument concerning the lack of proper abilities. What would that ability be for if not for creating another new language? There appears a new dilemma whether to create a new language when there is a better one backed up by

[15] Jean Jacques Rousseau, *Essai sur l'origine des langues*, introduction, notes, bibliographie et chronologie par Catherine Kintzler, GF Flammarion, Paris 1993, p. 55.

[16] J. J. Rousseau, *Essai sur l'origine des langues*, p. 59.

[17] J. J. Rousseau, *Essai...*, p. 60.

nature. One is tempted to name this ability "thinking" or "the Leibnizian apperception" but Rousseau does not agree with that. Commenting on the issue of relations between language and thinking process and their mutual conditioning in *Discours de l'inègalitè*, Rousseau claims that it is impossible to prove such relations suggesting silence or continual work in the course of centuries in this difficult subject.

Rousseau presents his own, original to his mind, conception. He assumes that language is the means to transmit our ideas:

"Sitôt qu'un homme fut reconnu par un autre pour un être sentant, pensant et semblable à lui, le désir ou le besoin de lui communiquer ses sentiments et ses pensées lui en fit chercher les moyens. Ces moyens ne peuvent se tirer que des sens, les seuls instruments par lesquels un homme puisse agir sur un autre. Voilà donc l'institution des signes sensibles pour exprimer la pensée. Les inventeurs du langage ne firent pas ce raisonnement, mais l'instinct leur en suggéra la conséquence" [18].

Nevertheless, he highlights that the oldest known languages of the world contradict the conviction as to the their rational background – "Ces langues n'ont rien de méthodique et de raisonné; elles sont vives figurées" [19].

According to Rousseau, the background for creating a language is not thinking but rather a spiritual need or, as he calls it, a passion. It is a quality which makes the difference between human beings and the world of animals. Furthermore, it is an ability which, leading to a language, uses its foundations to build both culture and civilization. Therefore, it is not intellect but rather passion that marks an essential difference between man and animals. Should it be understood that animals possess intellect but they lack that creative ability responsible for an animal type of language which is different from a natural type? Rousseau does not seem to notice this aspect. Although he notices that thanks to the language agreed upon "l'homme fait des progrès, soit en bien, soit en mal, et pourquoi les animaux n'en font point" [20], but the assumption as to the primary role of passion in the process of creating a language allows for a sort of thinking in case of animals. It is necessary to add that the philosopher is not fully convinced as to the linguistic creativity of the function of passion since in one chapter he points out feelings or emotions whereas later, while discussing a developmental process of languages of the soul, he talks about 'the vitality of pleasant passions which made people speak'. A few sentences later, while

[18] J. J. Rousseau, *Essai*, p. 55.

[19] Ibid., p. 61.

[20] Ibid., p. 60.

formulating the hypothesis as for the development of northern languages, it is no longer pleasure which is complementing passion but needs which are the results of certain emotions that make the crux of the languages, "tristes filles de la nécessité" [21].

Surprisingly enough, Rousseau is not consequent. In Chapter II he ignores Condillac's hypothesis claiming that although "on prétend que les hommes inventéront la parole pour exprimer leurs besoins", this view cannot be accepted. As we can see, it is no longer one but at least two causes that decide whether a language can be created. None of them (and here Rousseau is consequent) relates to the intellectual categories which are systematically questioned by him.

If we accept Rousseau's statement that the most perfect state for man is the state of nature, we may ask a question whether in this perfect primary state deprived of the civilization's influence its member possesses an equally perfect (because natural) system of communication or is rather deprived of any language. It seems that the author of *Essai* is closer to the second solution. In *Discours sur de inégalité* he notices that it is difficult to imagine the causes for which languages could become useful. Since people did not have any connections for they did not need any, the necessity of this discovery as well as its possibility become unclear if it has to be essential [22]. In the state of nature a language of the child trying to communicate all his needs to the mother was the only means of communication [23]. The language was private, singular, and transitory, doomed to die at the moment of the disconnection with the mother. Rousseau explains "ces temps de barbarie étaient le siècle d'or, non parce que les hommes étaient unis, mais parce qu'ils étaient séparés" [24]. The philosopher denies the existence of any social institutions understood in the contemporarily term but he advocates the belief that although there were no peoples, there were families and home languages. The author of *Essai* is surprisingly inconsequent. There was a language and at the same time there were no languages; there were families but at the same time people lived separately. It may seem that Rousseau wants to connect the creation of language with the process of the society's formation presenting mutually excluding ideas. He notices in *Discours de l'inégalité*: "Le premier langage de l'homme, le langage le plus universel, le

[21] See J. J. Rousseau, *Essai*, p. 98.

[22] See Jean Jacques Rousseau, *Discours sur l'origine et les fondements de l'inégalité parmi les hommes*, ed. J.-L. Lecercle, Éditions Sociales, Paris 1971, p. 86.

[23] Ibid., p. 86.

[24] J. J. Rousseau, *Essai...*, p. 85.

plus énergique, et le seul dont il eût besoin avant qu'il fallût persuader des hommes assemblés, est le cri de la nature. Comme ce cri n'était arraché que par une sorte d'instinct dans les occasions pressantes" [25]. The cry does not differ much from the animal speech – "Des cris inarticulés, beaucoup de gestes, et quelques bruits imitatifs, durent composer pendant longtemps la langue universelle" [26].

While reading *Discours de l'inégalité* one may have a feeling that Rousseau is finally ready to present the idea of the simultaneous development of man, society and language pointing out their mutual conditioning. A primary system built on the instincts exits beyond the sphere of private consideration. Singular family languages in the conditions of social interference remove from natural motivation creating a conventional system of signs which is the first social agreement. However, it does not look like this for one cannot reconcile the idea of gradual development of language with the view that contradicts the idea of primary language presented in the text. According to Rousseau's view advocated in *Essai*, this primary language was a poetic language, the language of tropes and metaphors characterized by an extraordinary richness of expressive means [27]. The author has no doubts as to the fact that all the expressions of that language were to be found in pictures, feelings and metaphors. In many respects it reminds Chinese, Greek and Arabic. It may seem that this vision of the language reinforced by a creative passion excludes the need to develop for it is no longer a cry of nature similar to the language of animals but an artistically sophisticated system. Why should one fix something which is almost immaculate? In that light the idea of social interference becomes useless for it is difficult to place such a linguistic conception in the first social institutions, for instance, a family.

Rousseau was not the first philosopher who wanted to connect the beginnings of language with the beginnings of society. All French writers dealing with the issue of language in the eighteenth century made attempts to answer the question "which was before: language or society?"; the question which replaced a former dilemma regarding the mutual conditioning of the language and intellect. Most writers agreed with the assumption that society forwarded a need to create a common means of communication. Condorcet and Rousseau were an exception to the general agreement. According

[25] J.J. Rousseau, *Discours...*, p. 88.

[26] Ibid., p. 112.

[27] J. J. Rousseau, *Essai...*, pp. 66–67.

to Condorcet [28], even at the most primitive stage of his development man possessed a language to communicate his needs whereas the development of the communities contributed to the perfection and development of language. Disagreeing with the views accepted in literature, Rousseau gives a number of his own solutions. Nevertheless, he does not manage to give convincing arguments as regarding the parallelism of the development of social institutions and language. He gives up in his *Discours sur l'inégalité* [29]. While facing multiplying difficulties, he sees the impossibility of appearance of languages and their acceptance by only human means as almost proved.

The Enlightenment aimed at the systematical elimination of irrational aspects in scientific research. Inasmuch as intellect had become the final stage in the field of mathematics and natural science, the pre-scientific research in many fields which dealt with man and his history still remained in close connection with the Biblical vision of the world. Rousseau was not the only promoter of the divine intervention but in his case a reference to the natural order was an escape which enabled him to abandon a creative role of intellect in the process of the language formation. It seems that the author, overburdened by the excess of ideas, includes supernatural power into the process of language creation which reveals the assumption that the author of this process is a person equipped with mind.

Therefore, Rousseau comes to the starting point. With one sentence he destroys all his efforts put into proving the dependence between the development of language and other social institutions for he is not able to decide "what was more useful: the already formed society which influenced the creation of languages or already formed languages which influenced the raise of the society?" [30].

Rousseau's theory of language is written in the research context of XVII and XVIII centuries which is characterized by a rapid increase in the literature dealing with the beginnings of human race and different social institutions. To illustrate this, we can mention Condillac's *On the origin of human knowledge*, Fontanelle's *L'origine des fables* and Poisent de Sevry's *L'origine des premiéres sociétés*. In the seventeenth century the issue of the origin of language appeared not only in connection with outgoing material

[28] Antoine Nicolas Caritat Condorcet, *Esquisse d'un tableau historique des progrés de l'esprit humain*, Euvres, ed. A. C. O'Connor and H. F. Arago, Paris 1847, Vol. VI, p. 11. After Pierre Julliard "Philosophies of Language in the Eighteeth-Century France, Mouton, Hague-Paris 1970, p. 25.

[29] See J. J. Rousseau, *Discours sur l'inégalité*, p. 92.

[30] Ibidem.

research but it was also situated in the context of questions regarding the history of human race which was gaining a new meaning in the framework of the discovery of communities of the New World. At the same time scientists came to realize that in the field of the ancient history they neither had true insights nor possessed necessary means to exploit it. They came to the conclusion that before they could start talking about the reality of the ancient life, it was necessary to exploit how people had spoken, counted and measured time. It appeared that the discovered civilizations had their past which exceeded the timeframes established by the Bible. For scientists, the past was still an anthropomorphic area. The history of human race, societies and peoples was at the same time the history of the Earth whereas a natural history was rather a history of great catastrophes than a history of slow evolution. There was a theory of the immutability of classes accepted; the idea that the world of nature is subjected to evolution and has a time dimension was still to face its great future[31]. Therefore, one can hardly expect Rousseau to present a theory of language which would be ahead of his predecessors as well as his contemporary researchers. What is more, one can hardy expect a singular convincing theory on language origins for there is no such theory even today. Nevertheless, one can expect cohesion of reasoning from anybody who tackles the issue. What makes Rousseau different from the rest is his consequent inconsequence which puts a serious thesis that Rousseau has not simply created the theory. His *Essai sur l'origine des langues* together with the extracts on language from *Discours sur l'inégalité* may be regarded as the evidence of his trials with mutually contradicting assumptions.

Pierre Juliard in *Philosophies of Language in the Eighteenth-Century France*[32] presents a critical analysis of linguistic trends present in the works of the French writers. A comparative analysis rooted in the philosophical and cognitive context reveals that in his thesis dealing with the origins of language Rousseau was not very original for the majority of researches were involved into similar considerations referring the first hypothetical language which could not be reconstructed. In their linguistic research they were rather philosophers than linguists. The main aim of their research was to situate and coordinate the views on language with their own system rather than to construct a pure theory of linguistic system. Juliard points out that

[31] See Halina Święczkowska, *Harmonia linguarum. Język i jego funkcje w filozofii Leibniza*, Wydawnictwo Uniwersytetu w Białymstoku, Białystok 1998, p. 41.

[32] Pierre Julliard, *Philosophies of Language in the Eighteenth-Century France*, Mouton, Hague-Paris, 1970, p. 25.

the contemporary state of knowledge did not create necessary circumstances for the theory of linguistic system to be created.

While Julliard explains what Rousseau has written, Derrida points out the things which, according to Julliard, could not have been in the philosopher's text but, according to Derrida, are nevertheless present. For Derrida, *Essai sur l'origine des langues* anticipates ethnology as presented by Claude Lévi-Strauss as well as the ideas of general semiology with its theory of natural language[33]. In the framework of the historic and comparative strenuous analysis, Derrida's interpretation is undoubtedly attractive. Therefore, there arises a question as to the accuracy of the interpretation. An inquisitive reader is advised to study *Cours de linguistique géneralé* on his own.

Clumsily indicated anticipations became the source of impetuous attacks on Noam Chomsky, the father of tranformative and generative grammar, who, as many historians of idea[34] claim, presented his own history of linguistics in *Cartesian Linguistic* which became the basis for his theory of language. Inasmuch as historic context served as an ornamentation for the theory of Chomsky (not fortunately chosen: the theory defends itself well enough), the incrustation of the *Course of general linguistics* with the ideas of Rousseau without the possibility of getting de Saussure's permition to do that should become the subject of the detailed analysis. In his hypothesis dealing with the origins of language which constitute only a part of his linguistic ideas, Rousseau stayed in the framework of paradigms accepted by his epoch.

Translated by *Renata Jermołowicz*

[33] Jacques Derrida, *O gramatologii*, translated by Bogdan Banasiak, Wydawnictwo KR, Warszawa 1999, pp. 223–304.

[34] Compare Hans Aarsleff, *The History of Linguistics and Professor Chomsky*, in H. Aarsleff "From Locke to Saussure", Althone, London 1982, pp. 101–119.

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ON MECHANIZATION OF REASONING, DECIDABILITY OF LOGIC, AND UNCOMPUTABLE NUMBERS

1. Introduction

The concept of mechanization (in Turing's sense) is equivalent as to its scope with that of formalization (in Hilbert's sense), though they may differ in their pragmatic functions[1]. What has Turing done, it was the devising of a mathematical model, stylized as a machine, of the behaviour of a mathematician who acts strictly according to Hilbert's formalistic programme. Thus Turing made it precise what had been aimed at not only by Hilbert, but also Russell, Wittgenstein, and the whole Vienna Circle (and even some catholic writers who dreamed of mechanizing the proofs of God's existence). There are two curious facts about the idea of mechanizability of reasoning.

First, there is the psychological phenomenon that the formalists, now better recognizable under the denomination of computationalists, are so much enthusiastic about the claim that there does not exist any creativity in the world, be it mathematical, technological, philosophical, social, artistic or any other creativity. Thus they are bound to believe that the creation of algorihms, that is, mechanical procedures, or programs, does not require any invention as all. This does not appear to be a special title to pride for reasonable beings, as programmers etc. Moreover, this does not seem to agree with personal experiences of programmers and other mathematicians who happen to be extremely creative minds. The only solution might be as follows: all the insights, though felt to be creative, are in fact due to

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some hidden algorithms in human brains, somehow produced by Nature or Evolution, while the said experience of creativity is a mere illusion.

The second riddle to be considered is as follows. The formalist, or computationalist, claim is maintained in spite of all the limitative results, concerning the limitations of algorithms, that have been demonstrated by Gödel, Tarski, Post, Church, Turing and others. The literature on AI, in which computationalism is defended, is enormous, but the problem can be conveniently restricted to that of decidability of logic which has been solved in the negative by Turing, Church and Post. It is also a consequence of Gödel's result concerning the incompletability of mathematics (this point being lucidly explained by Kneale 1962). Now the isssue is to the effect: how the statement that (A) the first-order logic is not (mechanically) decidable may be compatible with (B) the claim that all correct reasonings can be formalized (mechanized) with the means of that logic? In fact, this is the claim of strong AI.

The only way out which appears is to make explicit that supposedly implicit assumption in B that we are interested only in those correct reasonings which are really *useful* for our either theoretical or practical purposes. Such a restriction ought to be duly substantiated, and the argument could be based on the following Ontological Assumption (of Computationalism).

OAC: **In the empirical world do not appear uncomputable functions, that is, functions taking uncomputable numbers as their values.**

This assumption does not remove the air of strangeness as hinted in the first comment above, but would properly address the second comment, that about sufficiency of algoritmic procedures in dealing with the empirical world. Are they sufficient, then people can be replaced by machines both in cognitive and in practical dealing with the empirical world. In what follows, I am to discuss some points relevant to the OAC principle.

2. The undecidability of logic

2.1. The possibility to mechanize reasoning depends on whether the first-order logic, being the standard instrument of proving, is a decidable theory. And it is decidable if and only if there exists an algorithmic (or effective) method, allowing us to decide about any formula whether it is a law of logic or not. First-order logic is not decidable, and thus there exist formulae about which one cannot recognize (using algorithmic methods) if they are

laws of logic. If a reasoning occurs, whose schema follows an undecidable formula, then the computer carrying out the operation will never stop, as stoppong means the solving of the problem in question.

That for every statement of logic there exists a decision procedure, still by Wittgenstein himself (so a great authority in philosophy of logic) was regarded as an unquestionable principle. Here are the solemn expressions in the "Tractatus".

> Our fundamental principle is that every question which can be decided at all by logic can be decided off-hand.... It is possible... to give at the outset a description of all "true" propositions. Hence there can *never* be surprises in logic.... Proof in logic is only a mechanical expedient to facilitate the recognition of tautology, where it is complicated. (*Tractatus Logico-Philosophicus*, 5.551, 6.125, 6.1251, 6.1262).

The same idea of mechanizability of demonstration was shared by Leibniz; as he did not even dream about electric current, he foresaw machines with gears and punched pieces of metal (to conduct or withhold mechanical impulses). The idea of formalization was also close to late scholastics from the circle of nominalism, whom Leibniz referred to in his polemic with anti-formalism of the Cartesian school, as when he tried to free young Christian Wolff from under their influence (in which he succeeded). It is more difficult to say to what extent this medieval formalism drew from Aristotle himself, and to what extent it was an original current; if the former is true then the prehistory of the mechanization idea would go back to the beginnings of logic.

This story shows that it was the overcoming of the program of the mechanization of reasoning in the 1930s, and not the program itself, that bore the signs of a scientific revolution.

Overcoming it in the most visible way, that is with the use of the notion of a machine as an essential means of argumentation, was Turing's achievement. It is true that his work would have been impossible without the preceding works by Cantor (the idea of the diagonal demonstration), Skolem (elimination of quantifiers), Hilbert and Gödel and that an equivalent result was reached by Church at the same time, and that Gentzen's deductive methods proved invaluable for further development. However, regarding the role of the idea of the machine, confirmed by the developments in computer science, Turing's name fits best as a symbol of a breakthrough in the history of logic, a breakthrough which took place in 1936. Post, who published a similar analysis in 1936, could also claim this title, but his analysis was rather sketchy, and did not have such a wide continuation

as Turing's work. Anyway, even if we do not persist in choosing Turing to become the symbol of that scientific revolution, the appearance in the same year of the three independent proofs of the impossibility of mechanizing reasoning makes that date crucial for the issue of mechanization.

2.2. The issue of the decidability of the classical first-order logic, which I shall shortly call logic, was stated in Hilbert and Ackermann's seminal textbook *Grundzûge der theoretischen Logik* (1928) which belongs to the classics of logic; it is referred to in this text as HA-1928. The issue came to be known under the German name of *Entscheidungsproblem*, in short EP. Paragraph 11 in HA-1928, devoted to that question, ends with the following sentence: "EP must be said to be the main problem of mathematical logic" (Das Entscheidungsproblem muss als das Hauptproblem der mathematischen Logik bezeichnet werden).

The next paragraph starts with the following words: "While in propositional calculus EP was not difficult to solve, finding a general procedure of determination for predicate calculus is a difficult issue, which has not been solved yet" (note how this cautiousness differs from Wittgenstein's naive confidence in algorithmic nature of logic).

That was how it was written in 1928. The solution came a few years later (Gödel 1931, Turing 1936, Church 1936). Against Hilbert's expectations an Wittgenstein's illusory certainty (see quotes above), however, it was negative. An important step towards that solution was the discovery by Gödel (1931) of the incompletability of formal arithmetic, here called in short (when referring to the system studied by Gödel) arithmetic.

In order to realize the link between the undecidability of logic and the incompletability of arithmetic, one must carry out the operation of eliminating functional symbols characteristic of the language of arithmetic, such as the symbol of the consequent, of addition and multiplication, replacing them in a certain way with predicates. Those predicates can be interpreted arithmetically. Owing to such a move, individual variables run through the set of individuals from a given field, while predicative symbols, introduced instead of functional symbols, can be interpreted in any domain whatever. That is how we obtain formulae of predicate logic.

2.3. There is the following relationship between the decidability of logic and the completability of arithmetic. *Had logic been decidable, then for any logical formula the question of its being a law of logic would have been answered through the use of an effective procedure.* Then any true arithmetic proposition, let us say P, could be proved on the basis of the conjunction K of

axioms and of the implication $K \Rightarrow P$ being an appropriate law of logic. And that would suffice to demonstrate any given arithmetic truth. However, it is not so (Gödel's result that any arithmetic truth can be demonstrated on the basis of its axioms (the incompletability of the axiomatic system of arithmetic). Thus, logic is not decidable.

The above reasoning assumes that proposition K (the conjunction of axioms) is true, and thus is not inconsistent, for only then does the derivation of P (from K) prove its truth (the assumption of consistency of arithmetic). The clause given in italics in the preceding paragraph also requires a further comment. One should distinguish between the syntactic notion of provability and the semantic notion of logical consequence (a confusion is due to the fact that the ordinary langauge meaning of the word "proof" is not identical with the technical notion which is limited to syntax). What is meant in the said clause is obviously the purely syntactic notion. The lack of proof in this technical sense does not hinder an intuitive grasping of the entailment from K* to P*, which could be called a demonstration in the larger sense, also admitting non-syntactic methods of arriving at truth.

One would reach the same negative result, if there existed evidence for the incompleteness of another theory which uses first-order logic in the course of demonstration and which also deserves the assumption of consistency, as arithmetic does. Thus arithmetic is de iure not distinguished in any way in the discussion regarding the problem of the decidability of logic; however, it de facto serves the role particularly well.

2.5. And that is how we find one of the reasons why not all reasoning can be mechanized. It is a key reason, in the sense that it is sanctioned by a strict metamathematical result (while other reasons, to be mentioned later, are just intuitive ones). Namely, the program for a digital machine, that is a computer, is a translation of a certain algorithm into the language of the machine; first, it is a translation into one of the programming languages, and then this translation is rendered (automatically through a special program) in the internal machine language of the computer in question.

In the case that we are dealing with, the role of the algorithm should be performed by the procedure deciding about the conformity of reasoning with the laws of logic. We enjoy possessing such a procedure only when we can decide about every logical formula used in that reasoning, whether it is a law of logic. That this necessary condition is not fulfilled is the essence of the theorem about the undecidability of logic. And since that condition is not satisfied, the necessary condition of the mechanization of reasoning is not satisfied either.

The term "decidability" has until now been used in a sense which was possible to capture intuitively, but which lacked a closer analysis, to explain the term "procedure" which appears in the intuitive idea of decidability. A precise explanation can be found in several different, but equivalent, theories such as the theory of algorithms, the theory of recursive functions, the lambda calculus and the conception of the Turing machine. The last one is particularly useful for the discussion of our problem. For it not only gives a precise definition of decidability, as the other teories do as well, but it also provides a certain model of mind which helps to state the issue of scope and limits of mechanizability of reasoning.

3. When a machine works without halting

3.1. The notion of undecidability was elaborated by Turing in 1936 with the help of a construction which he called a machine. Church called it Turing machine. This became a technical term, a key concept in both logic and informatics.

Such a machine is like a computer program, that is a set of instructions to ensure the solving of a problem in a finite number of precisely enumerated steps, the solution being achieved through operations on well-definied physical objects, especially symbols made out of a material stuff. However, that is a significant difference for which we rather speak of a machine than of a program or an algorithm.

The difference consists in equipping such an entity with memory, and (as one puts it in cybernetics) with receptors, effectors and internal states. The receptor reads symbols on a moving tape, while the effector writes or effaces the symbols, according to the instructions included in the program. Such instructions take into account both the current state of the machine and the symbol being perceived by the receptor, so that each next move is strictly determined as a function of these two variables.

Such description of the machine allows for a more precise definition of the notion of effective (algorithmic) procedure, which was formerly used in a rather intuitive way. For it is now possible to behaviorally define the process controlled by the program, dividing it into steps visible from the outside (the movement of the tape, the writing of symbols etc.), being elementary components, as if atoms of the proceeding, such that no simpler or more tangible elements might be found.

This method of describing provides us with the following definition of decidability. The problem is solved when the machine stops, that is, when

it writes the answer on the tape, and afterwards has nothing else to do. It would seem that the introduction of the term "stop" does not add anything new, for instead of the stopping of the machine, we can speak about its solving the problem. However, it turns out that this way of speaking about the procedure carries a fertile theoretical idea. Namely it guides us in looking for the reason why in some situations the machine does not halt.

One of such situations is the case when the machine is to test the satisfying of a certain condition by an infinite number of objects, particularly natural numbers. The lack of a stop signifies that the machine never reaches a counter-example. Such a statement about the lack of stop would be e.g. Goldbach's hypothesis that every even number is the sum of two prime numbers; if it is true, then the machine checking particular even numbers will never find a counter-example, and thus it will never stop working.

3.2. To exemplify what is said above, let us examine Fermat's big theorem:

$$x^n + y^n = z^n$$

The theorem is to the efect that the above equation has no solutions in the domain of natural numbers, when n is greater than 2, and x, y, z are greater than 0. This is a general statement, in which after the universal quantifiers binding x, y, z, n (with the restriction $n > 2$) there follows the negation symbol, and then the formula mentioned. Is the statement true, then if we substitute consecutive natural numbers, our machine will never find a counter-example (that is, three numbers which with a given n will be the solution of the equation). Thus it will never stop. Let us refer to that machine used for calculating particular substitutes of Fermat's formula as M_k, that is the machine number k in an infinite sequence of numbered machines, starting with the smallest one (e.g. in the sense of having the smallest number of symbols).

However, we cannot know that M_k will never stop if Fermat's statement is true (as it encounters no counter-example), since the machine has an infinite number of elements to examine. The problem could only be solved if there existed a machine that could decide about any machine whatever whether it will ever stop or not. Hilbert hoped that the proof procedure using the laws of logic would become such a machine (he did not use the word "machine" itself, but his idea can perfectly be rendered in this way). Indeed, in some cases the demonstration of a mathematician (a living being or an electronic one) performs such a task. Let us mark such a machine with the symbol H, in honour of Hilbert.

Suppose for a moment that the demonstration of Fermat's big theorem,

which was published by Andrew Wiles in 1995, has been performed as if a formalized proof (which is not the case, for in highly complicated proofs the attempt to make them formalized would make them unreadable). Then it is really an application of machine H to a specific case, that is, to proving that M_k will never stop due to the lack of counter-examples, and hence that the great theorem of Fermat is true.

The existence of such a machine H, capable of deciding about every machine whether it will stop or not, is equivalent to the positive solution of the problem of decidability, as expected by Hilbert. However, the solution is in the negative, which in the arithmetical case results from Gödel's theorem of the incompletability of arithmetic, and whichTuring proved in a general way in 1936.

The main idea of Turing's argument, despite all its complexity, can be expressed in the following simple way. One gives the machine H the text of any program as input. The machine has to work out whether the program it was given as input will eventually stop, or go on for ever. If the former, it prints 'Halts', otherwise – 'Doesn't halt'.

Turing proved that program H is impossible to devise. It's a logical impossibility, not that imposed by technology. To prove it, Turing showed that if such a machine existed, it would, when given itself as input, both halt and run forever. Since this is impossible, program H must be impossible too (cp. Paine 2000).

This also concerns the universal procedure postulated by Hilbert which was supposed to prove the lack of stop for any general theorem (as Goldbach's or Fermat's formula), when it is true. For this procedure, involving an infinite set of procedures which it diagnoses, must contain an infinite number of steps. Thus, it cannot ascribe the lack of stop to itself, so it cannot answer the question whether it is generally applicable. Hence there exist undecidable problems.

3.3. This should not be understood in the sense that there are problems doomed never to be solved. Maybe for each problem it is possible to find a program (algorithm) to solve the problem in question. Anyway, there is no such single algorithm applicable to all the problems, while this was the task which Hilbert wished to ascribe to formalized reasoning in first-order logic. Hence there may occur a process of reasoning about which Turing machine could not decide whether it is correct. In this sense such a reasoning cannot be mechanized.

As if at the margin of this discussion, there may arise a psychological problem. If the limitative argument (that limiting the scope of the applica-

bility of formalized, or algorithmic, proof procedures) appears in its essence so simple (though technically complex), then why it has not been intuited by Wittgenstein (compare Section 1) and to others, especially to such a master of logic like Hilbert himself?

An analogy with another master of science, namely Einstein, comes to mind. He shared with all the preceding mankind the belief in the immutability of the universe so firmly that in the face of disagreement between that belief and some points of his own relativity theory, he rejected those points, not daring to depart from the sanctified conviction; only after the discovery of the galaxies' escape by Hubble he has restored the theory to its original content.

A similarly strong belief, this time concerning the solvability of every correctly formulated scientific problem, is frequently visible e.g. in the writings of the 17th and 18th century rationalists, as well as in the statements of 19th century physicists. As far as the question of solvability of mathematical problems, which absorbed Hilbert so much, is concerned, there also existed a specific mental blockage consisting in the identification of truth with derivability. It had its origins in a certain mathematical tradition, and was in Hilbert's times a philosophical dogma in influential circles, such as the Vienna Circle. (The role of Hubble, as mentioned above in Einstein's case, here was played by Gödel and Tarski who have successfully attacked that philosophical dogma.)

This conclusion about insolvability is interpreted by some authors (including Gödel and Post) as an argument for the superiority of the human mind over machines. Turing however, although his contribution to this limitative conclusion was so enormous, did not think the limitations of machines to be considerably larger than those of humans. Man, Turing wrote in an essay in 1950, when he accepts the truth of an arithmetical statement, which cannot be demonstrated by a machine, has the feeling of dominating it. But how to gain the certainty that one is not wrong when one accepts the statement as true? And if there is no ground for such certainty, then with regard to the reasoning ability there is no major difference between the machine and the human mind.

Turing's argumentation could be discussed and questioned on the basis of philosophical assumptions, which would possibly turn out to be more convincing than Turing's philosophy (hidden somewhere behind his arguments). However, it will be more fruitful to think what scientific results could undermine Turing's position. The last part of the essay, referring to Turing's proof of the existence of uncomputable numbers and to its consequences for mechanization of reasoning, is concerned with this issue.

4. Reasonings beyond Turing's barrier

4.1. The discovery of uncomputable numbers is a breakthrough whose import can be compared to the discovery of irrational numbers. It also leads to important consequences for the concept of the mind and of the science; in this respect, it may even surpass the Pythagorean discovery in its weightiness.

But how to discover something, and thus become certain that this something exists when it belongs to a class of objects which are ex definitione incognoscible? It was made possible by George Cantor's method of going beyond what is already known, called diagonal argument.

Here is the application of this argument by Turing (1936). He numbered all the possible machines in a way which was analogous to Gödel's numbering of formulae and proofs. The important difference is that machines are not linguistic objects, but devices used for the calculation of functions. This significant generalization (much appreciated by Gödel when commenting Turing's contribution) was possible as Turing did not employ the notion of proof, which requires a relativisation to axioms and rules, and thus to language; instead, he made use of the notion of calculation procedure, which he defined through the description of the machine's behaviour.

The number of a machine is like its definition, encoding the features of the machine in question. The list of such numbers forms an ordered infinite set of natural numbers. Because it is a denumerable set, no machine is left out the enumeration; this completeness of the list is an important feature in the diagonal argument.

We place that sequence in the first column of the table. In the first row we write the numerical data, which will be transmitted for calculation to every machine; this gives us the same sequence of successive natural numbers as in the first column (when the data form a pair, a tripple etc. of numbers, then the appropriate method of encoding reduces them to one). At the intersection there are the results of the processing (that is, of the calculation) of the given data by the given machine.

Let us now consider all the results located on the diagonal (whence the name of the argument) of our table. Written in one row, they form a certain infinite countable sequence. We then change all the elements of the sequence in a systematic way e.g. by adding one to each of them. A new sequence is formed which differs from all those written in the successive rows of the table. It differs from the sequence in the first row, because there the first position (that is, the first one in the first column) is occupied by a certain number, let's say n, while here it will be $n + 1$. The second position differs

from the second number of the second row, the third from the third one etc. We thus have a sequence of numbers, different from all those in the table. Yet we have included in the table all possible calculating machines! Therefore, the new sequence from the diagonal cannot come from any of the machines registered in the table, that is the machines producing countable numbers. So the number represented in the sequence cannot belong to the countable numbers.

In order to use this discovery in the discussion about the possibility to mechanize reasoning, one must introduce the notion of the universal machine. It corresponds to the notion of the computer and is also comparable to the notion of the mind. The machines enumerated on the above-mentioned list are specialized in particular arithmetic operations. They correspond to the formulae recording particular mathematical functions; the simplest one, for instance, can only add one to successive natural numbers, another one can extract roots etc. Of course, machines from this set are also suitable for operations which in their original form do not belong to arithmetic (e.g. syntactic analysis, reasoning), but which are programmed to be represented by arithmetic formulae.

Let us create a machine equipped with a program which is able to imitate any machine from our list. Such an ambitious program is not a phantasy; we have it in every computer through the linking of the operational system and the other elements of the software (translators, applications etc.), which enable us to perform quite a number of tasks on one computer. Such a machine is commonly known as the universal Turing machine.

4.2. After these conceptual preparations we are capable of a more precise statement of the problem put in the title, Now it runs as follows: Is all reasoning which is feasible for the human mind/brain feasible as well for the universal Turing machine?

Before we reached that formulation, we had obtained a negative answer, resulting from the undecidability of logic. But the answer in the context of Turing machine and the computability defined by Turing's method opens new perspectives to the problem, which do not appear in other conceptualizations. However, they are present in the theory of Turing machines, which is suitable as a model of the mind or the brain.

It might not be expected that we shall find the answer at once, whether in informatics, in neurobiology or in physics. However, the very statement of the question is a step forward, as it allows us to make a blueprint of research, in which we would determine which questions must be answered first, before the main issue could be addressed.

A vital question to be included in such research project is the following: do uncomputable numbers appear in nature? More precisely: do certain physical quantities, if they are characterized with absolute accuracy, require uncomputable numbers for their characteristic?

How is this issue related to the question of the mechanization of reasoning? In fact, there is a connection, provided the brain is a physical system. Therefore, if systems characterized by uncomputable numbers are possible in nature, the brain can be claimed to belong to that part of nature (as the mystery of the consciousness phenomenon encourages us to turn to formerly unexplored regions of physics).

The next step in posing questions is the followig. Suppose the brain is a system characterized by some uncomputable numbers, May this result in the possibility of carrying out operations on uncomputable numbers? There is, obviously, a difference between a system which is characterized by certain numbers and a system which performs operations on such numbers. However, it is possible to see a connection, if we consider analog systems. These are devices which map features of some physical phenomena through entering some states which are structurally analogous with those being mapped (that is how the telephone, the phonograph, the photocell, the eye, the ear, etc. work).

Among those operations dealing with uncomputable numbers there may be some reasonings; this is just a conjecture but a serious one, once considered by Turing (1939) himself. There is a relatively little known fact in Turing intellectual quests, commented by Hodges 1997 in a way which he shortly repeated in the following passage (www.turing.org.uk/bio/part3.html).

> The work on 'ordinal logics', probably his most difficult and deepest mathematical work, was an attempt to bring some kind of order to the realm of the uncomputable. This also was connected to the question of the nature of mind, as Turing's interpretation of his ideas suggested that human 'intuition' could correspond to uncomputable steps in an argument.

Obviously, human intuition as mentioned above is that exemplified by asserting an undecidable arithmetical proposition as the result of an informal (i.e. non-algorithmic) reasoning. Hence it is a resoning that cannot be performed by Turing machine.

4.3. However, the very fact that a conclusion cannot be reached by Turing machine does not necessarily entail that this conclusion when obtained by a human being is undoubtedly true. Some authors believe that only algorithms ensure infallibility. According to that view, the subjective

feeling that one has certainly reached the truth does not guarantee truthfulness.

Anyway, if the united forces of logicians, computer scientists, physicists and biologists, in a gigantic research project, one day discover structures in the brain which are able to operate on uncomputable numbers, then such processes will prove no more mysterious nor less credible than those which are dealt with by the universal Turing machine, and at the same time they will transgress the limitation of that machine. Among those structures there will probably be a logical reasoning which could not be put in symbols and algorithms, as being crucial in the mechanization process.

Finally, an apology from the author may be necessary for why he is discussing a topic in which still very little is certain, and which requires making one's way among a tangle of hypotheses. The solution, if it is reached, will not depend on philosophical speculation, but rather on the results of particular sciences, whether mathematical or empirical. Wouldn't it be reasonable to refrain from speculation and to wait for those results?

The answer lies in a certain conception of philosophy, which is strongly supported by the success of the ancient atomism. Being once a purely speculative conception, when it was revived in the Renaissance as a philosophical doctrine, it found favourable conditions to inspire and to be tested by physics. It should be observed that stoical philosophy, competitive to atomism, never achieved such mature cooperation with sciences. However, its time seems to be approaching. While the atomists concentrated on what we call hardware, the genius of the stoics anticipated the role of the software. The next wave of philosophy orientated to software came with Leibniz, but it was still too early to use it in the scientific context. Modern times seem to be getting ready for entering that path, although the aim may still be far away.

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THE PRISONER'S DILEMMA AND THE GAME OF LIFE

This paper aims at simulating social processes with the use of cellular automata[1]. At first glance, the theories of games and cellular automata seem to be unrelated despite the fact that they were created by the same person (John von Neumann) at the same time. It was not until recently that the two disciplines have been brought together. Here I intend to simulate social processes with the use of automata widely known as the Game of Life.

Let us start with a game between two players each having two strategies: to cooperate (C) and to defect (D). The player using C receives a payoff R (the reward) if the co-player uses C, and S (the sucker's payoff) if the co-player uses D. The player using D obtains the payoff T (the temptation) against the C-player, and P (the punishment) against the D-player (Tab. 1).

	cooperate	defect
cooperate	R, R	S, T
defect	T, S	P, P

Table 1. The game matrix

We assume that the payoff R for the two C-players is larger than the payoff P for two D-players. The game's satisfying conditions: $T > R > P \geq S$ and $2R > S + T$ are called the Prisoner's Dilemma.

Imagine that both players are prisoners who have been accused of a crime and are being interrogated in separate rooms. They can choose

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either of two options: to admit themselves guilty or not. If both maintain their innocence, they will be released for the lack of evidence or will go to jail for a short time. If A claims innocence but B says A is guilty, then A goes to jail and B gets a reward. A symmetric result follows if B claims innocence and A says B is guilty. If each says the other is guilty, both go to jail. The outcome for each player is called the player's payoff. Maintaining the innocence of both is called cooperating, saying that the other person is guilty is called defecting.

Why must the Prisoners Dilemma satisfy the conditions recalled before? – Because the sucker's punishment must be suitably high and the sum of acquittal must be greater then the sum of the full punishment and betrayal.

Let us analyze the payoff matrix (Tab. 2).

	cooperate	defect
cooperate	4,4	0,5
defect	5,0	2,2

Table 2. The payoff matrix

The amount of payoffs is for instance a number of years at liberty during the next 5 years.

In Nowak and May's version, when two cooperators play, both receive a payoff 1; when two defectors play, both receive 0; when a defector and a cooperator play, the cooperator receives 0 and the defector receives b. The dynamics of the interactions depends on the value of b (Tab. 3).

	cooperate	defect
cooperate	1,1	0,b
defect	b,0	0,0

Table 3. The payoff matrix

For a single game there is no reasonable solution for the Prisoner's Dilemma. From psychological regards, all players choose to testify against her or his companion (because every player is afraid of betrayal) and, as a result, all players loose. D is the dominant strategy and the C-players are doomed to extinction.

However, it is not the case when we consider players meeting for another round. This time each player plays according to a certain strategy and has some knowledge about the strategy of his enemy. We call such a game the Iterated Prisoner's Dilemma (IPD).

There are a lot of possible strategies in the IPD:

- Random (RAND) – makes random moves – defect or cooperates with 1/2 probability,
- Always Defect (AD) - always plays defection,
- Always Cooperate (AC) – always plays cooperation,
- Grim Trigger (GRIM) – starts with cooperation, but after one defection plays 'always defect',
- Tit-for-Tat (TFT) – starts with cooperation, then repeats opponent's moves,
- Tit-for-Two-Tats (TFTT) – like TFT, but forgives one defection.

Let us consider now the Prisoner's Dilemma game played on a square grid (Spatialized Prisoner's Dilemma). Each cell is occupied by one player. Each player plays one round of the Prisoner's Dilemma game against his/her eight nearest neighbours. The sum of payoffs from these eight games is the payoff of each player. After each iteration, each player looks at his/her neighbours and switches his/her strategy to the strategy that has obtained the highest score. As a result of the repeated games only the best strategies survive – the ones which give the greatest payoffs. There are some characteristic states of the configuration. Usually strategies group in clusters.

Notice that in the Spatialized Prisoner's Dilemma a further dimension (a spacial dimension) is added. It forms a bridge between the theory of games and the theory of cellular automata. The fields of strategies in the Spatialized Prisoner's Dilemma evolve in the manner of cellular automata.

A cellular automaton (CA) has the following features:

- It consists of a number of identical cells (often several thousand or even millions) arranged in a regular grid. The cells can be placed in a long line (a one-dimensional CA), in a rectangular array or even occasionally in a three-dimensional cube. In social simulations, cells may represent individual or collective actors such as countries.
- Each cell can be in one of a few states, for example, 'on' or 'off', 'alive' or 'dead'. We shall encounter examples in which the states represent attitudes (e.g. supporting one of several political parties), individual characteristics (e.g. racial origin), or actions (e.g. co-operating or not co-operating with others).
- Time advances through the simulation in discrete steps. After each time step, the state of each cell may change.

- The state of a cell at any time step is determined by a set of rules which specifies how that state depends on the previous state of that cell and the states of the cell's immediate neighbours. The same rules are used to update the state of every cell in the grid. The model is therefore homogeneous with respect to the rules.
- Because the rules only make reference to the states of other cells in a cell's neighbourhood, cellular automata are best used to model situations where the interactions are local. For example, if gossip spreads orally and individuals only talk to their immediate neighbours, the interaction is local and can be modelled with a cellular automaton.

To summarize, cellular automata model a world in which space is represented as a uniform grid, time advances by steps, and the 'laws' of the world are represented by a uniform set of rules which compute each cell's state from its own previous state and those of its close neighbours.

Cellular automata have been used as models in many areas of physical science, biology and mathematics, as well as social science. As we shall see, they are good at investigating the outcomes at the macro scale of millions of simple micro-scale events. One of the simplest, and certainly the best known example of cellular automata is Conway's Game of Life.

This is a two-dimensional cellular automaton. Each cell has one of two possible states: 'live' or 'dead'. Each cell has eight neigbours. The states of cells are changing according to certain rules:

- a dead cell with exactly three live neighbors becomes a live cell,
- a live cell with two or three live neighbors stays alive,
- a live cell with one or no neighbours dies (the case of loneliness),
- a live cell with four or more neighbours dies (the case of over population).

These specific rules were selected in 1970 by the mathematician J. H. Conway to guarantee that the cellular automaton is on the boundary between unbounded growth and decay into dullness. It was proved that its chaotic behaviour is unpredictable and it could be used to build a universal Turing-machine and even a universal constructor. The contrast between the simplicity of this rule and the complexity of the behaviour it produces is a constant source of wonder.

Note that each cell acts independently based on the old arrangement to produce a new one. The number of neighbours is counted from the old arrangement only. Therefore, if a dead cell has 3 neighbours, the cell will be alive in the next generation, even if those neighbors die.

Let us compare the Prisoner's Dilemma and the Game of Life:

the Prisoner's Dilemma	**the Game of Life**
the future of any player depends on the strategy of his/her neighbours	the future of any cell is determined by the state of its neighbours
the players are changing their own strategies in the way determined by the strategies of their enemies	the cells are changing colours in the way determined by the colours of their neighbours
the player can choose one of the two options: to cooperate or to defect	the cell has one of two states: live or dead
strategies	rules

Because of these similarities I should think that it is possible to define the strategies in the Prisoner's Dilemma in such a way that fields of strategies in the Spatialized Prisoner's Dilemma evolve in the manner of the Game of Life.

I claim that strategies in the Prisoner's Dilemma correspond with the rules in the Game of Life. There are four rules, so we have to group all strategies into four groups:

- strategies which are cooperators and were cooperators in the previous generation (blue)
- strategies which are defectors and were defectors in the previous round (red)
- strategies which are cooperators but were defectors in the previous round (green)
- strategies which are defectors but were cooperators in the previous round (yellow)

If we compare the colours of strategies with the colours of cells, it is possible to reach our target:

- the cells which are now dead and were dead in the previous generation are red
- the cells which are now live and were live in the previous generation are blue
- the cells which are now dead and were live in the previous generation are yellow
- the cells which are now live and were dead in the previous generation are green

Let us analyze some more examples. When we choose a low value for p (p is fraction of defectors in the first round) and b value about 1.85 (b is advantage for defection when opponent cooperates), we can see the gradual defector invasion pattern. Starting from a field of all cooperators with a single defector (with b = 1.85) we can observe a dynamical fractal or a kaleidoscope.

We can observe such configurations playing the Game of Life. If we start with a relatively simple initial condition, the emerging configuration can lead to wonderful kaleidoscopic patterns, periodic blinkers and gliders moving through a sea of dead cells or their gradual death.

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STUDIES IN LOGIC, GRAMMAR AND RHETORIC 6 (19) 2003

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METHODOLOGICAL DESCRIPTION OF BRAIN DEATH DEFINITION

The traditional definition of death of the whole organism as the state of irreversible termination of blood circulation turned out to be useless in situations, increasingly more common in intensive therapy units, when circulation and other bodily functions are sustained artificially. Thus this definition has been replaced with a new one, namely the definition of the death of the human organism as a whole. The basis for this definition is a mechanical understanding of the organism – the whole organism may be dead even though some parts are still alive; similarly we consider a mechanism to be out of order even though some parts still function properly. We believe that a mechanism as a whole is broken down when its most important part cannot function. The main part of the human body is the brain, and an irreversible damage of brain stem indicates death. The new definition is described as the definition of brain death. It can be explained in the following terms: "The death of the human organism is constituted by an irreversible termination of the functioning of the brain stem". According to this definition the fact that the brain has irreversibly lost its ability to direct body functions allows physicians to turn off the systems sustaining the functioning of particular parts of the body (artificial respiration, artificial circulation etc.) It is believed that the human organism as a whole is a system consisting of many inter-connected subsystems. Thus if the brain stem loses its ability to conduct integrative functions, particular sub-systems (live or artificially sustained) do not any longer constitute a live human organism as a whole.

As it can be seen, the definition of death has a certain diagnostic purpose, that is, it should facilitate in practice the recognition of the defined status, i.e. the death of the whole human body. This type of aim is attributed to the so called real definitions, that is, such which offer an unambiguous

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description of the object defined; a real definition of an object is a statement which states about that object something which may truly be stated about one and only one object[1]. It does not seem, however, that the definition of brain death of a human could be considered a real definition. Even though it is a real definition, the problem lies in the fact that it could fulfil its diagnostic purpose only under such circumstances when the termination of the functioning of brain were a well-defined condition, that is not requiring empirical procedures leading to its recognition. The medical problem is, however, determining through proper examining procedures, whether, in a given case, the brain stem cannot function – if the condition of irreversible damage is found empirically, it is believed that the human body is dead. However, this decision does not recognise the objective, realistic condition, but it is arbitrary made agreement that the recognition of certain state is the recognition of the death of the human being. Thus methodologically it is arbitrary, i.e. made to meet the aim which is to be achieved; in the medical sense it is essentially justified, i.e. made on the basis of the knowledge used.

From the methodological point of view, we deal here with two types of definitions, distinct and different in kind – the definition of death of the brain stem and the definition of death of the human organism. It seems, however, that the definition of death of the brain stem complies with the scheme of so called operational definitions. An operational definition describes the defined notion by giving the operations leading to the creation of the notion. The scheme of the operational definition is the following sentential formula: $\forall x[Px \rightarrow (Qx \equiv Rx)]$, where Q represents the defined notion, Px stands for the description of the conducted operation, while Rx stands for the description of the behaviour of the object which undergoes this operation[2]. Let us thus try to define death of the brain stem using the scheme provided. We will do it according to the instructions of the Polish Ministry of Health and Social Care from 29 October 1996 concerning the criteria of brain death.

According to the ministerial instructions, the recognition of death of the brain stem has to be based upon the recognition of irreversible loss of its function. This condition is to be recognised by a two-stage-qualifying proce-

[1] See K. Ajdukiewicz, *Pragmatic Logic*, translated by O. Wojtasiewicz, Warsaw 1974, p. 81.

[2] The given formula should be read as follows: "for each x, if Px then Qx only and only if Rx". The symbol corresponding to the phrase "for each x", i.e. so called universal quantifier. The sentential function occurring behind the quantifier is said to be within the range of this quantifier.

dure. At the first stage only the suspicion of brain stem death is undertaken. In order to make this suspicion likely, a series of findings and exclusions in the patient needs to be done. It has to be stated that the patient is in a state of a coma; is under artificial breathing; the cause of the coma has been recognised; the structural damage to the brain has been proved; and it has been found out that the damage is irreversible due to the exhaustion of the possibilities of the further therapy and the passage of time[3]. At the same time this potential group should exclude patients who are poisoned, under the influence of some drugs, in the state of hypothermia caused by external factors, with metabolic or endocrynological disturbances, with convulsions and decerebrate spasms, as well as mature new-born babies younger than seven days. From the logical point of view these considerations should be treated as a definition of a set of values of an individual variable x, that is from the range of the name "patient in whom the termination of the function of brain stem, that is brain death, is suspected".

The second stage involves carrying out of certain tests, which confirm the absence of stem reflexes and the recognition of apnea. A whole sequence of such tests should be conducted, as only their appearance together allows us to state brain death. It is evident that from the logical point of view we deal here with the presence of not only the one sentential function $Px \rightarrow (Qx \equiv Rx)$ within the range of a universal quantifier, but also the conjunction of many sentential functions of this kind. As a consequence, the operational definition of brain stem death qualifies within the following scheme:

$$\forall x\{[P_1x \rightarrow (Qx \equiv R_1x)] \wedge [P_2x \rightarrow (Qx \equiv R_2x)] \wedge \ldots \ldots \wedge [P_nx \rightarrow (Qx \equiv R_nx)]\}.$$

This scheme can also be similarly written down in the following way:

$$\forall x[P_1x \rightarrow (Qx \equiv R_1x)] \wedge \forall x[P_2x \rightarrow (Qx \equiv R_2x)] \wedge \ldots \ldots \wedge \forall x[P_nx \rightarrow (Qx \equiv R_nx)].$$

According to the instructions of the Ministry of Health and Social Care on the criteria of brain death, six tests should be conducted to confirm the absence of stem reflexes and one confirming the recognition of apnea; thus the definition of brain stem death can be given as a conjunction of seven sentences:

[3] The recognition of the cause of coma is of utmost importance as there are known cases of deep coma caused by factors other than permanent damage to brain stem, e.g. due to overdose of drugs, inborn enzymatic defects, temporary damage to brain due to anoxia.

$$\forall x[P_1x \to (Qx \equiv R_1x)] \wedge \forall x[P_2x \to (Qx \equiv R_2x)] \wedge \ldots$$
$$\ldots \wedge \forall x[P_6x \to (Qx \equiv R_6x)] \wedge \forall x[P_7x \to (Qx \equiv R_7x)].$$

In the first six sentences within the range of the quantifier there are sentential functions describing the lack of stem reflexes (determined by symbols $R_1, R_2, \ldots R_6$) while the sentential function R_7 from sentence seven is a description of apnea. Symbol Q stands for the expression "brain stem is dead". Since the description of the required tests (description of operations indicated in the scheme by symbols $P_1, P_2, \ldots, P_7$) is unimportant for this discussion, in the sentential functions below only the names of the tests are given[4].

Operational definition of brain stem death given in Polish instructions can thus be described as a conjunction of the following seven sentences:

1. "for each x, if x has been submitted to the test of reaction to light, brain stem is dead only and only if x's pupils do not react to light";
2. "for each x, if x has been submitted to the test of cornea reflex, brain stem is dead only and only if x lacks cornea reflex";
3. "for each x, if x has been submitted to caloric test, brain stem is dead if and only if x lacks eyeball movements";
4. "for each x, if x is submitted to tests of reaction against pain, brain stem of x is dead if and only if x lacks any reaction against pain within the area of skull nerves";
5. "for each x, if x is submitted to tests of vomit and cough reflex, brain stem of x is dead if and only if x lacks vomit and cough reflexes";
6. "for each x, if x is submitted to a test of eye-brain reflex, brain stem of x is dead if and only if x lacks eye-brain reflex";
7. "for each x, if x is submitted to a test of apnea, brain stem of x is dead if and only if x lacks breath reaction";

Of course the definition of brain stem death characterised above is not a definition of death of human organism[5]. It is only a defined notion, which

[4] This can be illustrated by the example of the description of caloric test: in order to check whether the patient has full patency of external auricular canals we should direct a stream of 20 ml of cold water (temp. 3–10 degrees C) upon the tympanum and observe the nystagm of eyeballs.

[5] New York Institute of Society, Ethics, and Life Sciences created a special team – Task Force on Death and Dying – in order to prepare a report on methodological and deontological property of criteria of brain death. The report found that all these criteria should be sufficiently clear and simple so that they could be used by physicians as a routine, while being at the same time clear for lawyers; additionally, it was underlined that traditional criteria should not be eliminated (such as those which determine the termination of spontaneous breathing and circulation, in those cases in which artificial support of these functions was not in use. See *Refinements in Criteria for the Determination of Death: An Appraisal*, A Report by the Task Force on Death and Dying of the Institute

can now serve as a defining notion in the definition of the death of the organism: "The death of the human organism as a whole is a state in which death of brain stem occurred". For stylistic reasons the phrase "state in which death of brain stem occurred" shall be replaced with a phrase "condition of irreversible termination of function of brain stem". This definition will then take the form of "Death of human organism is a state of irreversible termination of functioning of brain stem". Since it is not a question of the whole organism, but organism as a whole, an exact expression will be: "Death of human organism as a whole is a state of irreversible termination of functioning of brain stem".

The above definition is undoubtedly a real one as it gives explicit (unambiguous) characteristics of the object defined. Since the defining notion (i.e. "irreversible termination of functioning of brain stem") was already previously defined operationally, the given definition fulfils also a diagnostic purpose, that is, it allows a recognition of the defined object, namely the condition of death of organism. Furthermore, the definition formed in this way can be given one more task which has been indicated by philosophers since Aristotle's time – the requirement that real definitions give not only unambiguous, but also essential descriptions of objects they define[6]; in this case it would be essential features of the condition of death of organism.

The requirement that the definition should give essential features must be related to a given field, that is, a real definition should provide those features which are significant, that is, particularly important in a given field. This creates a difficult problem of deciding which features of a defined object may and should be found as relevant from the point of view of a given field; more precisely – due to research purposes of a given field. Of course, aims in theoretical sciences (both humanities and natural sciences) are different from applied sciences. The main aim of theoretical sciences is to discover natural regularities, their explanation and predicting, on this basis, events so far unobserved. Applied sciences aim to indicate means necessary to reach certain goals. Thus it should be discussed whether the definition: "Death of a human organism as a whole is a state of irreversible termination

of Society, Ethics, and the Life Sciences, "Journal of the American Medical Association" 221, 1, 1972, 48–53 In the editorial comment of JAMA to the report it was found to be justified to stress: "Criteria, any criteria, do not *define* death. Rather, they can allow us to say only that death has occurred. It is detection rather than definition. Thus, they are merely tools and their proper use depends on proper judgement"; *Harvard Criteria: An Appraisal*, Editorial Comment, "Journal of the American Medical Association" 221, 1, 1972, p. 65.

[6] See K. Ajdukiewicz, *op. cit.*, p. 83.

of functioning of brain stem" belongs to theoretical science, namely biology, or practical science, namely medicine.

The problem of death belongs, of course, to the discipline of biology, as biology is a science concerning live organisms – death remains within the realm of biology only as it is the end of the living organism. Is biology, however, able to answer the question of what life is, and, as a consequence, what death is, if the question involves indicating relevant features of these notions? There is no doubt that the question posed in this way goes not only beyond the realm of biology, but natural sciences in general, as it is also a psychological problem, as well as – even more importantly – a philosophical one. Thus the definition of the death of the organism as a whole is not a theoretical definition, but a practical one – it belongs not to theoretical biology, but to medicine as a practical science.

It should be stressed that the definition of death of human organism is not a definition of death of a human being. If we assume that a human being is a live organism, which has real or potential consciousness, as a consequence we will agree that human organism ceases to be a human being at the moment of irreversible termination of functions of consciousness of the brain. Thus the definition of death of a human being could have the following form: "The death of a human being is a state of irreversible termination of functioning of higher parts of the brain". In order for this definition to fulfil practical aims – particularly to describe the moment when the resuscitation of a person whose higher brain functions are irreversibly damaged (whose cortex area is irreversibly destroyed), although brain stem is still alive – an operational definition of death of higher parts of brain should be given, in analogy to the definition of death of brain stem. It seems that the present level of medical science does not make it possible to formulate such a definition.

STUDIES IN LOGIC, GRAMMAR AND RHETORIC 6 (19) 2003

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A COMMENT ON HAYEK'S IDEAS OF FREE MARKET AND CIVILIZATION

as discussed in his lecture

The Defense of Our Civilization Against Intellectual Error

This paper is to contribute to the discussion concerning complexity of social systems and its methodological implications[1]. It should direct attention to some vital points which were forcefully defended by the eminent social philosopher and economist Friedrich A. Hayek (1899–1992), a pupil and collaborator of Ludwig von Mises in Vienna; both have become the most prominent representatives of what is known under the name of the Austrian Economic School, the one so firmly fighting for liberal ideas in economics and social philosophy. Hayek was awarded the Nobel Memorial Prize for Economics in 1974.

After a successful career in the London School of Economics, since 1931, he took up an appointment at the University of Chicago, 1951, and then since 1962 at University of Freiburg (Germany). His many books include *The Road to Serfdom*, *Individualism and Economic Order*, *The Pure Theory of Capital*, *The Constitution of Liberty*, *The Fatal Conceit, and Law, Legislation*, and *Liberty*. An impressive summary of Hayek's ideas and attitudes has been done in a talk of him, entitled as quoted above (in the title of this comment)[2].

My endorsement of Hayek's ideas is related to the following personal experience. Once upon a time I wrote the essay entitled *Economics and the*

[1] This contribution was supported with financial means of the State [Polish] Committee for Scientific Research in 2003–2006 as research project no. 2 H01A 030 25: *Nierozstrzygalność i algorytmiczna niedostępność w naukach społecznych* (Undecidability and Algorithmic Intractability in Social Sciences).

[2] The lecture is made available at the following page, providing also necessary bibliographical data: www.libertyhaven.com/thinkers/friedrichvonhayek/defensecivil.html.

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Idea of Information. Why socialism must have collapsed?[3]. When arguing on its main point in talks with some collegaues, mainly philosophers, I did not succeed in gaining a sympathetic attitude. The issue was perceived as rather boring and irrelevant. The ideas of Friedrich Hayek, much in that old essay of mine appreciated, seemed to be rather alien to quite a number of philosophers in this country (I mean Poland, but the same might be true of other places).

However, anybody who keeps up times, is likely to observe that Hayek's key notions, those of information, complexity, self-organization, etc. become ever more in vogue in the current science and philosophy. Moreover, the notion of computational (i.e., dealing with information processing) complexity proves to be crucial in computer science. How closely are these concepts related to physics and cosmology, one can learn from *The Anthropic Cosmological Principle* by John D. Barrow and Frank J. Tipler (Oxford University Press, 1996).

The same principles of information, complexity and self-organization which rule cosmic evolution also rule – according to Hayek – social and economic processes. This is why in the cosmological study by the physicists Barrow and Tippler, as mentioned above (p. 140), we find the following quotation from Hayek's "The pretence of knowledge" (1974 Nobel Lecture). Here is the passage involved.

> [1] – "Organized complexity here means that the character of the structures showing it depends not only on the properties of the individual elements of which they are composed, but also on the manner in which the individual elements are connected with each other. [...] This is particularily true of our theories accounting for the determination of the system of relative prices and wages that will form themselves on a well-functioning market. Into the determination of these prices and wages there will enter the effects of particular information possessed by every one of the participants in the market process – a sum of facts which in their totality cannot be known to the scientific observer, or to any other single brain. It is indeed the source of the superiority of the market order, and the reason why [...] it regularly displaces other types of order."

Hayek's idea of free market has found an inspiring expression in the following passage where a market is seen as an information-processing unit (functioning in a real time – it can be added tu use a metaphor taken from computer science). This point was a subject of controversy between Hayek

[3] The essay was published in the collection *Social System, Rationality and Revolution* edited by Leszek Nowak and Marcin Paprzycki, Editions Rodopi, Amsterdam 1993.

and those socialistic authors (as e.g. Oskar Lange) who believed that free market should have been replaced by a central planning unit sufficiently equipped with computational power.

> [2] – "The whole acts as one market, not because any of its members survey the whole field, but because their limited individual fields of vision sufficiently overlap so that through many intermediaries the relevant information is communicated to all." (F. A. Hayek, "The Use of Knowledge in Society", *The American Economic Review.* 35, September 1945, pp. 519–530, cit. p. 526).

It is inspiring to see how the idea of spontaneous order, as characteristic of free market, is by Hayek generalized towards the all-embracing system of civilization. Here are extensive quotations on this subject taken from Hayek's address entitled "The Defense of Our Civilization Against Intellectual Error" (in the collection of tributes published in honor of Leonard E. Read's seventieth birthday, 1968).

> [3] – "In the first instance I wanted to emphasize that what is threatened by our present political trends is not just economic prosperity, not just our comfort, or the rate of economic growth. It is very much more. It is what I meant to be understood by the phrase "our civilization." Modern man prides himself that he has built that civilization as if in doing so he had carried out a plan which he had before formed in his mind. The fact is, of course, that if at any point of the past man had mapped out his future on the basis of the then-existing knowledge and then followed this plan, we would not be where we are. We would not only be much poorer, we would not only be less wise, but we would also be less gentle, less moral; in fact we would still have brutally to fight each other for our very lives. We owe the fact that not only our knowledge has grown, but also our morals have improved – and I think they have improved, and especially that the concern for our neighbor has increased-not to anybody planning for such a development, but to the fact that in an essentially free society certain trends have prevailed because they made for a peaceful, orderly, and progressive society."

In the next passage, there appears the consequential notion of emergence. Even if Hayek employed it in the everyday meaning, this meaning accords with a more technical one as used nowadays in the theory of dynamic complex systems. One speaks there of emergence when a process of system's becoming ever more complex surpasses a treshhold, and a new significant quality of the system unexpectedly appears. Thus the idea of emergence nicely agrees with Hayek's claim concerning unpredictability of social processes.

> [4] – "This process of growth to which we owe the emergence of what we now most value, including the growth of the very values we now hold, is today often presented as if it were something not worthy of a reasonable being, because it was not guided by a clear design of what men were aiming at. But our civilization is indeed largely an unforeseen and unintended outcome of our submitting to moral and legal rules which were never "invented" with such a result in mind, but which grew because those societies which developed them piecemeal prevailed at every step over other groups which followed different rules, less conducive to the growth of civilization. It is against this fact to which we owe most of our achievements that the rationalist constructivism so characteristic of our times revolts. Since the so-called Age of Reason it seemed to an ever-increasing number of people not worthy of a rational being that he should be guided in his actions by moral and legal rules which he did not fully understand; and it was demanded that we should not regard any rules obligatory on us except such as clearly and recognizably served the achievement of particular, foreseeable aims."

In the next passages, Hayek deplores the great intellectual error as mentioned in the title of his address. However, it seems that recently we can see the history of views on civilization in a more optimistic way. It was not so that once people had had right views, and then some of them committed the error of disregarding the spontaneous order. Contrary to that most people (if not all) first believed in abilities of a single leader to order things according to his wisdom and with good results. The less advanced is a society in civilitation, the less people can see the incredible complexity of social affairs, and the more they believe in the existence of simple solutions as promised by their leaders, successful in seducing. Only recent insights of modern science, those connected with complexity, chaos, self-organization, emergence, the anthropic principle, etc. increase our capability of perceiving the spontaneous order. Here are Hayek's claims.

> [5] – "It is, of course, true that we only slowly and gradually begin to understand the manner in which the rules which we traditionally obey constitute the condition for the social order in which civilization has arisen. But in the meantime, uncomprehending criticism of what seemed not "rational" has done so much harm that it sometimes seems to me as if what I am tempted to call The Destruction of Values by Scientific Error were the great tragedy of our time. They are errors which are almost inevitable if one starts out from the conception that man either has, or at least ought to have, deliberately made his civilization. But they are nevertheless intellectual errors which bid fair to deprive us of values which, though we have not yet learned to comprehend their role, are nevertheless indispensable foundations of our civilization.

This has already brought me to the second part of my definition of our task. When I stressed that it is genuine intellectual error that we have to fight, what I meant to bring out is that we ought to remain aware that our opponents are often high-minded idealists whose harmful teachings are inspired by very noble ideals. It seems to me that the worst mistake a fighter for our ideals can make is to ascribe to our opponents dishonest or immoral aims. I know it is sometimes difficult not to be irritated into a feeling that most of them are a bunch of irresponsible demagogues who ought to know better. But though many of the followers of what we regard as the wrong prophets are either just plain silly, or merely mischievous trouble-makers, we ought to realize that their conceptions derive from serious thinkers whose ultimate ideals are not so very different from our own and with whom we differ not so much on ultimate values, but on the effective means of achieving them.

I am indeed profoundly convinced that there is much less difference between us and our opponents on the ultimate values to be achieved than is commonly believed, and that the differences between us are chiefly intellectual differences. We at least believe that we have attained an understanding of the forces which have shaped civilization which our opponents lack. Yet if we have not yet convinced them, the reason must be that our arguments are not yet quite good enough, that we have not yet made explicit some of the foundations on which our conclusions rest. Our chief task therefore must still be to improve the argument on which our case for a free society rests."

To sum up the answers as given by Hayek, let me put the main economic problem to be answered. For this purpose, let me use the following statement by the competent Hayekian Brent M. Johnstone from his paper "Information and the Economic Problem" [4].

> "Information, it will be seen, is the key to solving the economic problem. That problem is this: How do you get people to cooperate in the production of goods and services necessary to society? No one person or family can, beyond a bare subsistence level, produce everything it needs. People must rely on outsiders to help them get what they want: individuals who may very well live in different lands, worship different gods, speak different languages, and who may have very different goals, values, needs, and desires. These different people may very well even hate each other. How, then, can we get them to cooperate?"

[4] The text can be found at the followig page: www.libertyhaven.com/theoreticalorphilosophicalissues/austrianeconomics/inforeconomic.shtml.

The answer, as we have seen in Hayek's statements, is found in acknowledging the immense complexity of economic and social life, and respecting those rules which govern so complex universe.