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Organization and Management Theory in the Aspect of Signs and Symbols of Modern Humanities

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Abstract:

Purpose: *The text concerns the foundations of the methodology of science (primarily in its pragmatic application to organization and management theory) with reference to the two fundamental dimensions (approaches) through which processes and objects are analysed in science—form and contents. Why are only these two dimensions considered in our analysis? On the one hand, it is the legacy of Plato, and above all, of Aristotle, who conducted this discourse in great detail. This approach and perception of form and contents are embedded in the dilemmas of contemporary management. However, our approach to this issue is expressed through the structures of the humanities—soft structures.*
Design/Methodology/Approach: *The two approaches to understanding matter influence how objects are examined and studied using the resulting methodologies. One category of methodology includes formal models and methods, while the other involves content-based approaches. This article discusses the application of these methodologies to the study of real and mental processes from a humanities perspective. Here, the focus is on perceiving the form and contents of processes for management practice, rather than viewing them solely through the lens of formal theories.*
Findings: *The analysis of the relationships occurring in the sciences that form the foundation of science (through the classification of signs, forms, and contents of the humanities) demonstrates the vast potential of science to create its language for practical purposes, including broadly understood management, applicable in every area of human activity.*

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Practical Implications: *The theory of form and contents offers invaluable practical benefits for management practice and organization theory. They facilitate the interpretation of research results obtained through formal management methods. For management purposes, it is practically obligatory to interpret the contents of results provided by formal sciences in a rational way (transforming quantity into words).*
Originality/Value: *The authors' originality lies in emphasising the integration of three humanities disciplines in the analysis of content related to management, among other things, and the methods of the formal sciences. The authors have added biology and psychology to the fields of mathematics and physics. These disciplines collectively comprise three areas: the physical, the biological and the semantic (mental, content-related, psychological and abstractly mathematical).*

Keywords: *Cognitive structures, category of signs and symbols, epistemology of science, contents, scientific language, language of ontology, language of science and its unity.*

JEL codes: *B40, D83, Z13.*

Paper type*: Theoretical and conceptual paper.*

1. Introduction

In the first part of our discourse on form and contents—in relation to their role in the concept of Matter as understood by Plato (Plato, 1958) and Aristotle (Aristotle, 1983; 2013), our focus was on the language of science in general. We considered the aspect of concepts, theories, and paradigms.

But what do these major and significant categories of science rely on—what are they built from, what are their foundational building blocks? Perhaps these elements are even more crucial than many scientific theories themselves. When we look at this issue holistically, we can see an analogy to the essential structures (objects) in physics, chemistry, and biology. All of them are constructed from the elements of the periodic table.

These elements are their foundation. Likewise, here we aim to identify what our magnificent language of science is built from. This language, embedded in all human activity, expresses external reality through the information systems of scientific disciplines. It represents both the objects and processes as a whole (analogous to H2O, water composed of hydrogen and oxygen in specific proportions). A similar analogy applies to the objects in all disciplines of the humanities[6].

[6]*In the periodic table of Mendeleev, everything is unambiguous; however, in the table of the Humanities, its properties are still being discovered with the help of mathematics and the humanities themselves. In a sense, this is the core content of the article.*

2. Nature and Categories of Dynamic Processes

One might ask why we should classify scientific (and even poetic or colloquial) concepts. The classification of concepts and their systems, created and continuously developed by science and life, enables the discovery and formulation of invariants, schemes, patterns, and similar entities based on their properties.

These constitute the structures of our world (those invisible connections between processes and concrete objects). Complex and sometimes presently undecidable properties emerge between concepts within the current state of scientific knowledge. Thus, all human knowledge heavily depends on how concepts are classified and defined—on how they are understood both in science and in everyday life.

In practice, this directly translates into how people make decisions (Ajdukiewicz, 1935; 1960; Russell, 1958; Kolmogorov, 1988; Kotarbiński, 1965; 1982). Classification can only be carried out according to the forms available to science. As previously mentioned, these forms are formal (quantitative and topological, for example) and qualitative (e.g., semiotic—as will be discussed below).

In principle, almost everything (except for thinking) is based on signs and symbols, which we shall elaborate on shortly. One may logically hypothesize that our internal, pure thinking does not require signs and symbols. Why? Because they are external to our self—our "Id." Signs and symbols are carriers for communicating our thoughts externally (conveying information about them) (Thalassinos *et al.,* 2023).

What structure, then, does our human thinking possess? René Thom postulated that it has a topological structure. But that was just his philosophical reflection[7]—an informal commentary on the creed of the language of science composed of signs, symbols, theories, paradigms, and the idea of creating a unified language of science (also useful for Organization and Management Theory) (Velinov *et al.,* 2023).

2.1 Categories of Concepts Expressing the Nature of Processes

Humans seek to understand reality not only out of intellectual curiosity but also out of a need for pragmatic thinking and understanding of the world around them—to live in relative harmony with it, scientifically speaking, in equilibrium. One must know how to manage and organize one's actions in alignment with the nature of the surrounding reality.

For this reason, the diversity of reality should be analysed in terms of understanding the structure of its objects and processes. Only then decisions made by the management become genuinely useful. This means that the decisions we make should be logical (rational and understandable to us), should serve a purpose, and

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[7] *The debate on this subject has been, and still remains, open within science.*

most importantly, they should be teleological in nature—that is, directed in terms of content toward a specific object or process.

In the 1920s, the young linguist Ferdinand de Saussure (de Saussure, 1961) introduced the issue of the arbitrariness of the sign into scientific analysis. He was also a co-creator of a still-relevant scientific school known as structuralism (Piaget, 1977b).

The development of this approach also involved J. Baudouin de Courtenay and M. Kruszewski, creators of the Kazan School (Milewski, 1965). Many years later, another French scholar—this time the mathematician René Thom (René Thom, 1972, 1973a, 1973b), asserted that every sign has a motivation for its use, a reason for its occurrence or emergence.

A similar thesis, stating that there is no purely arbitrary use of signs, was presented by Polish semiotician Jerzy Pelc (1981). Why is this so? Signs can be both natural and artificial—created and continuously generated by humans. Each category of sign serves a function; from a human perspective, each has a motivation for its manifestation.

A similar position was held by logicians and mathematicians regarding the meaning of terms in their fields, namely, that a term acquires meaning only in terms of its use or application (a view also held by intuitionists). This is a manifestation of the arbitrariness of the sign.

The notions of "definition" and "language sign" form the fundamental basis of scientific terminology. It is precisely at this point that the precision of definitions intersects with the arbitrariness of the sign—where convention (form) meets nature (contents) of the sign.

The problem of defining and classifying concepts from the perspective of the sign is outlined briefly here, as it remains largely an unexplored dimension of methodology, logic, the humanities and the philosophy of science more broadly.

Science concerns higher goals. Therefore, in virtually every domain of science, both matters of primary importance and those of secondary relevance are considered. Reasoning finds application in the conceptual frameworks existing within a given field of knowledge.

From the perspective of methodology and logic (or more broadly, philosophy), the issue of concepts can be fundamentally approached in two dimensions. The first consists of concepts necessary for calculations (including complex ones). The second category involves significant relational links formed between various important concepts—and even between entire fields of knowledge[8]. Philosophically speaking, for the pragmatics of knowledge, this implies that humans essentially operate with numbers (quantities) and words (their contents); in broader terms, the quantitative and qualitative dimensions—measure and contents.

Furthermore, one might ask what contributions the notions of metric and dimension (including the fractal one) have made to scientific advancement. The formal definitions of these categories have provided new insights and a better understanding of many processes in our surroundings[9].

Returning to the relationship between numbers and words, words are immeasurable in quantitative terms. Disciplines such as linguistics, psychology, sociology and axiology — especially the theory of qualitative values—are concerned with the word (Kołwzan *et al.,* 1921).

However, the question arises as to which of the two categories (word or number) is more important in acquiring knowledge, whether in terms of concepts, problems, theories, paradigms or fields of science. Moreover, is it even appropriate to ask such a question? After all, both dimensions are components of knowledge and the human mind, and only together do they constitute the unity of cognition[10].

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[8]*An example can be found in the relationships between domains of mathematics within the dimension of metalogic (metamathematics) (Grzegorczyk, 1969, pp.490-492). In reference to two-valued logic (as seen in axiom systems), each proposition of logic (except the set of axioms) is directly and consequently indirectly connected with a certain number of other propositions. In other words, propositions can be derived from one another through logical inference—deduction—since they are linked by logical relations. These propositions form a highly complex network of logical interrelations. Such connections confirm both the complexity and diversity of our reality (Grzegorczyk, 1969, pp. 92-107).*

[9]*New measures and metrics occasionally make it possible to resolve classical statistical problems concerning the existence of certain parameters within the studied population. Thanks to them, fractal statistics is emerging (Peters, 1997, pp. 105-119). Within its conceptual framework, one can measure the variability of processes that lack variance—variance being dependent on the existence of the mathematical expectation. One such distribution, whose expected value is infinite, is the Cauchy distribution with the following probability density function:*

$$f(x)=\frac{1}{\pi}\cdot\frac{1}{1+x^2} \qquad for \qquad -\infty < x < +\infty.$$

Among such concepts (supporting statistics) is the Hurst exponent (which classifies dynamic processes—time series—into distinct classes). The fractal dimension of a process, introduced into science by B. Mandelbrot, defines the extent to which the process fills the spatial capacity in which it occurs (Peters 1997, pp. 57-62).

[10]*The anatomical structure of the human brain is asymmetrical: one hemisphere is more responsible for discrete—measurable (algebraic) processes, while the other governs content-based—semantic, and thus continuous (topological) processes. Yet the human being possesses only one brain. How our brain translates measurability into non-measurability,*

For this reason, the conceptual system of science presented in this article has two approaches, one measurable dimension and one whose measurability may require different metrics—because ultimately, everything must be understood in some way.

There have been attempts to assign quantitative measures to concepts that do not belong to the measurable class. In such cases, it might be necessary to consider creating qualitative measures in both measurable and content-related aspects—measures corresponding to the nature of conceptual categories that cannot be represented by numerical (quantitative) values (Martynov 1974; 1977)[11].

At present, only natural language best represents and measures the content-related dimension of concepts, terms, and problems—including those that may still be unmeasurable in the sense understood by philosophical intuitionists.

On the other hand, natural language is also subjected to mathematical measurement (formal grammars, topological models of language, or its analysis in statistical dimensions)—though this often pertains more to the disciplines describing it, such as linguistics[12]. These are the questions addressed in this part of our discourse.

3. The Participation of Knowledge in the Creation of a Comprehensive Language of Science (Through the Form and Content of Matter and Abstraction)

The problem of classifying concepts constitutes one of the fundamental dimensions of the form and contents of science and its pragmatism (alongside pure scientific knowledge). Thus, it is a universal issue to be addressed by science, particularly from the perspective of the humanities. It concerns understanding ourselves and the surrounding reality.

Once again, psychology comes into play here, as it deals with thinking and, in this sense, becomes a central science. But in what way does it deal with thinking—from the perspective of its origin as well? Could it be that thinking created mathematics (its form) and then the tools for external expression through speech and its linguistic form? One hypothesis posits that these two components (categories) of today's human mind have followed different paths (ways) toward mutual connection.

A thought is clothed in a word, and the word contains the content of the thought. Sounds of nature convey information—but do they, as sounds, contain a thought?

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discreteness into continuity, or number into word—remains an open question for science (Ivanov, 1978; Sloman, et al., 2021).

[11] *V.V. Martynov developed a distinctive grammar for semantic code theory (Martynov, 1977, p. 17).*

[12] *Sometimes these formal models reflect the discipline of linguistics as a science more than they do the actual structure of the language of speech.*

They certainly possess an organization, a structure. One might wonder: at what level of organization do sounds give rise to thought? Or perhaps it is the reverse: thought generates sounds to express itself, using them as its carriers.

But if there exists pure thought, what enables its transmission—what provides the vehicle for its externalization in the form of sound, writing, or image? Perhaps thought itself creates and generates these modes of expression.

These questions are fundamental to research in the area of contemporary artificial intelligence. Why? Because artificial intelligence operates through syntax, operationalization, and, more specifically, algorithms. The contents (semantics) are transmitted via these forms.

And thus, the structure of speech and thinking is interconnected—both components forming a whole. The question then arises: how can content be embedded within form—within syntax—in artificial intelligence systems[13].

3.1 Classification of Signs and Symbols of Speech, Thinking, and Semiotics

The preceding paragraph's reflections necessitate the pursuit of answers to the therein-posed questions. While we do not seek to provide definitive answers, our objective is to present the intricacies of signs and symbols in our thinking and communication.

This is a domain that merits consideration not only by experts in management and organisation theory but, most crucially, by developers of artificial intelligence. It is evident that contemporary artificial intelligence continues to function within the confines delineated by mathematical principles. In the contemporary context, algorithms assume a pivotal role within this emergent domain of informatics, while signs prevail in the domain of linguistic communication[14].

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[13]*This is a question that informatics must answer if the systems it creates are to think and not merely calculate and compute. Therefore, it is appropriate to cite here a single, yet highly representative classification of spoken language signs created by T. Milewski (1965, pp. 5-26):*

[14]*Linguistics divides the signs of spoken language into six categories: symptoms, appeals, acoustic images, one-class signals, non-phonemic two-class signals phonemic two-class signals (language).*

The order of the above classification of signs also reflects their chronological order. It constitutes the sequence and ontology in which these types of signs came into use throughout the evolution of thinking and language. Moreover, when analysing speech, one can observe that all of these categories of signs function daily within it. However, in the course of mental development (of a child), these categories do not appear simultaneously, but in the same sequence in which they emerged over the course of organic evolution on Earth. Hence, one may conclude that ontogenesis—that is, the individual development of a person—recapitulates, in brief, phylogenesis, meaning the evolutionary process of life forms on our

Any analysis of the process of cognition—understood as a process of communication—should take into account the richness and complexity of the signs of speech. This richness is most fundamentally reflected in the syntax of language, that is, phonemic binary-class signs whose highest form is the utterance—a unit capable of informing the recipient about any spatiotemporal phenomena. Yet this information, conveyed through form, carries the contents of the utterance.

The combination of signs (their possible relations) enables the formation of concepts, which constitute a category superior to signs, as they are derived from the relationships among them. The previously discussed structure of language signs represented a linguistic classification.

However, signs and symbols can also be categorized based on the processes of thinking occurring in the human mind. This constitutes another mode of encoding information, which we mentioned earlier when discussing the classification of language signs. From this perspective, C. R. Morris (Morris, 1946) divided signs into four classes, each differing in how they designate certain (though fundamental) mental processes[15].

One of the classic and still recognized sign classifications from the point of view of psychology, presented above, and the linguistic classification given earlier, show how complicated and rich in terms of interpretation the sign structure of human signs is[16].

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planet. From the perspective of both species development (phylogenesis) and individual development (ontogenesis), language—as a two-class semantic and conventional code—is the most recent construct. It is layered upon a series of older codes such as symptoms, appeals, and others that emerged during the evolution of living organisms and preceded language. These older systems of language signs have not ceased to exist but rather coexist with language within the speech of an adult human being, which functions as an orchestra of all types of signs (Milewski, 1965, p. 26).

[15]*These are:*

1. *The designator – signifies the properties (stimulus-based) of objects.*
2. *The appraiser – denotes the degree of an organism's preference for a given property.*
3. *The predictor – indicates the extent to which certain sequences of reactions are desirable.*
4. *The formator – modifies the way the organism responds to other signs or symbols it accompanies.*

See also: D.E. Berlyne et al., 1969, 158.

[16]*This gives rise to an important methodological problem: how to transform one classification into another, as we are dealing here with two types of diversity. In accordance with Ashby's philosophy, a given diversity can be explained only through another diversity—thus, there always exists a possibility of expressing one form through another. However, this necessitates the creation of appropriate operationalization within the scientific dimension, although the mind may possibly perform this spontaneously.*

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But is this complexity due to ignorance of the true structure of signs, or to the diversity of the languages of the various sciences. But, after all, in everyday communication, the statistical man is not guided by these scientific classifications, because he knows nothing about them in principle, and yet the process of communication proceeds spontaneously, but only at the level of so-called adaptation (at the level of so-called adaptation), that is, the simplest exchange of information.

Other forms of communication require other sign and thought structures, structures with deeper forms of representation of the information needed on a given topic (need). These elements, in essence, represent the scientific dimension of concepts and information more generally.

As evidenced by the views of the classical scholars in the field of psychology—presented above—on the origin and understanding of meaning through signs and symbols, in comparison with the linguistic approach to the same issue, it must be noted that both disciplines articulate this problem using fundamentally different languages[17]. What does this imply?

One may venture to assert that the nature of the sign escapes the grasp of science in terms of precise formulation—that is, the understanding of its essence and even of its formal structure, or more precisely, its ontology. Perhaps what is at stake here is the ontology of information**.**

We shall now introduce a classification of signs expressed in the language of semiotics[18]. This classification, in turn, divides signs and symbols from the standpoint of a discipline more general than the previous ones. Semiotics is the science that deals with all signs—signs as such[19]. Figure 1 below synthesizes the structure of signs and symbols in the humanities.

always exists a possibility of expressing one form through another. However, this necessitates the creation of appropriate operationalization within the scientific dimension, although the mind may possibly perform this spontaneously.

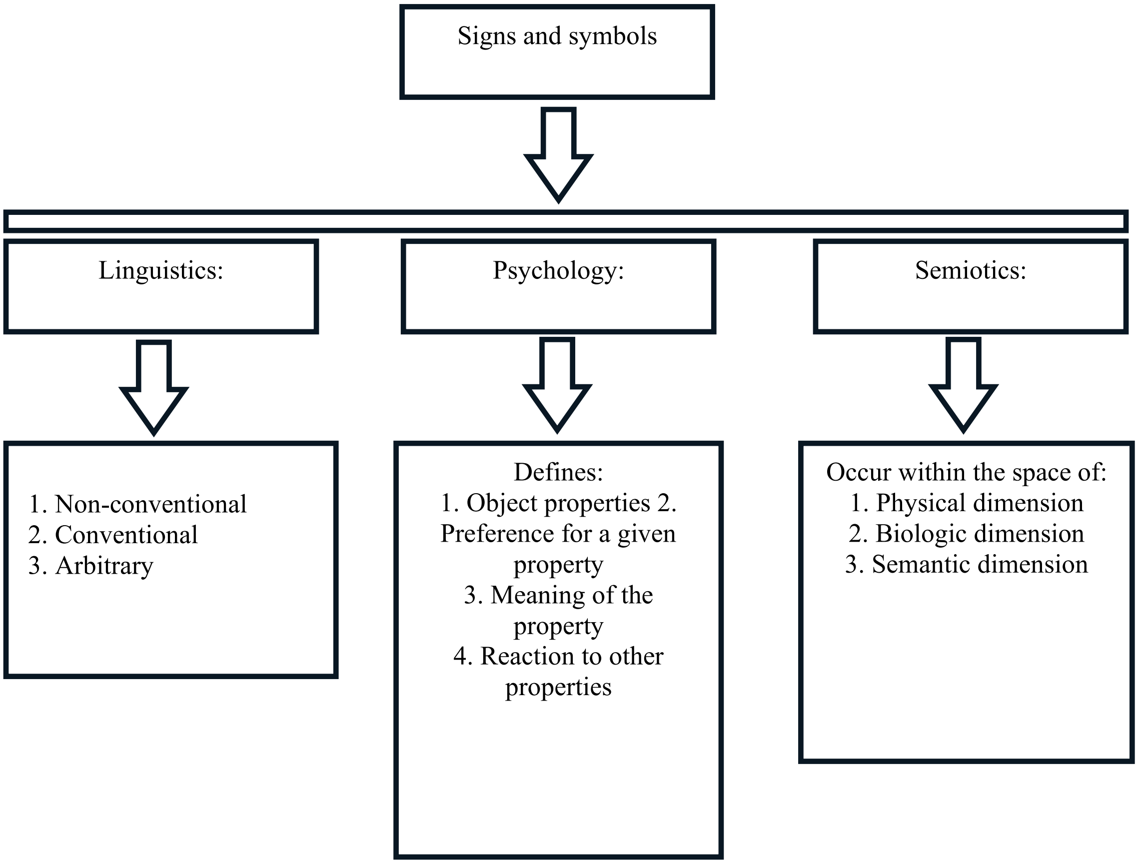
[17]*At this point, the question arises as to whether these languages can be expressed through one another, i.e. whether they are mutually translatable.*

[18]*The science of ancient Greece already demonstrated a methodologically grounded interest in semiotics. See, for example: (I. Dąbska, 1984).*

[19]*A classical representative in this area of science is Charles Sanders Peirce, who divided the category of the sign into three classes forming a natural hierarchy of our mental space (Peirce 1960a, 1960b):*

1. ***Icons (images)*** *– faithful (within the limits of tolerance) graphic representations of real-world objects (physical signs).*
2. ***Indexes*** *– objects or living beings that are linked to the signified object by virtue of its existence (biologic signs).*
3. ***Symbols*** *– arbitrary forms whose relation to the designated object results from social convention (semantic signs, but also conventional ones).*

Figure 1. *Signs and symbols of linguistics, psychology, and semiotics representing their content and dimension*



Source: *Own work.*

4. Foundations of the Structures of Speech Language

The various types of signs and symbols used in the humanities were outlined above. Science, after all, has at its disposal a powerful array of theories, methods, tools, and many other formal instruments for studying the Nature of the surrounding Reality and ourselves—what may be regarded as its arsenal of formal tools. These instruments were created from mental and perceptual material.

Thus, one may ask: why does science need other research tools—those that are imprecise, ambiguous, and cultivated within non-formal sciences that operate with soft structures, as opposed to the strict and unequivocal tools that are the hallmark of scientific research?

What is the structure (foundation) of understanding the messages conveyed through speech and language—especially messages in fields such as logic and mathematics? According to intuitionists, natural language is not essentially needed by mathematics. It serves only for communication—but what kind of communication?

The propositions of mathematics must be understood—one must think and comprehend the mathematical language, including both its semantic content and what is described through mathematical form. This reflects how mathematics is perceived by Brouwer and his Intuitionist School[20].

In this section, the question must be posed: for what reason are we presenting certain linguistic features that are realised within the speech system in the context of our central topic, namely the category of diversity in representing processes and their contents through form? These representations may vary and sometimes misrepresent the nature of the contents due to the arbitrariness of the form – that is to say, the language used.

However, as previously stated, appearances can be deceptive. It is well established, both from the preceding discussion and from the science in general, that linguistic communication plays a fundamental role in understanding reality.

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[20]*For an utterance to be comprehensible and capable of referring to reality, it must not only be bounded (finite), but its relation to the represented reality must also be defined. The designated aspect of individual words and word groups within a given text consists of representations (images, concepts, processes, and other mental constructs) held in our psyche. Thus, a mental act must occur—one that relates these representations to their position within reality. This is the resonance between speech and language with reality, as previously mentioned in reference to René Thom's theory on the subject. This act, associated with a particular linguistic form, is referred to in linguistics as modality (Milewski, 1965, pp. 95-96). The form of this modality is always syntactic intonation, and it is often its only form. A word in the semantic (content-related) system merely corresponds to a class of expressions and representations. To make it into a concrete language sign—that is, an utterance—it must be spoken with a specific intonation, which bounds it and introduces modality; that is, it informs the recipient about the type of mental act by which the word is related to reality. Thus, declarative intonation indicates that the speaker (the sender of information) places the representational content of the utterance in place of reality. Simply put, this utterance represents (or replaces) reality—e.g.,* You came back home. *Interrogative intonation, on the other hand, expresses doubt. The speaker, through such intonation, conveys the possibility of multiple states, from which they wish to select one, possibly the most suitable—e.g.,* Did you come back home?Why did you come back home? *Finally, imperative intonation signals that the sender considers the content of the utterance to be unreal (as it has not yet been realized) but wishes for it to become reality—e.g.,* Come back home! *This last intonation is one form of exclamatory intonation and, like others in this group, serves an expressive function (expressing the sender's emotions) and an impressive function (influencing the recipient's will and behaviour). In the military, it signifies the issuance of a command, and the command itself assigns that intonation particular meaning, defining the communicative roles of sender and receiver.*

To what extent can one rely on and trust the formal symbol—its convention—as being independent of the essence of natural language and the arbitrariness inherent in the interpretation of its signs? We have the locus of our mind (Bobryk, 1987; Chwistek, 1963). We ask whether we can speak of a locus of mathematics within it—as something distinct from the base of thinking that existed before mathematics emerged.

4.1 Language Structures in Information Transfer Processes

There is logic, psychology, linguistics, and many other scientific disciplines—each differing in how they represent themselves through their concepts and, more broadly, through language. Yet, when lightning strikes, all these fields comprehend it in the same way. Curious, isn't it?

For in the realm of the humanities, their conceptual systems cannot be reduced to a single pattern. However, underlying the language of each of these disciplines is, in a sense, natural language—an anchor or mirror for the concepts they formulate.

Thus, the path toward a universal language of science leads either through logic and mathematics or through the logical analysis of our linguistic communication embedded in the relationship between speech and thought. But to formulate such or another approach, a certain conceptual system must be established—defined—so that its terms can be understood unequivocally[21].

So, what does the scientific discourse in linguistics say regarding the concept of the syntactic schema of language within human speech? What components constitute it from the perspective of linguistic concepts? And what potential relationships exist between the schemata of these two disciplines of science—relationships mediated by human thought, which serves as the only philosophical foundation—one that is unified and underlies all domains of knowledge?

Some mathematicians argue that natural language is of no use in constructing mathematics. Yet, through speech—as one of its elements—it remains linked to our thinking. Does this imply that thinking is unnecessary in building mathematical theories? For within mathematics, there are internal means for conveying information about its objects.

This is the borderline—the bridge—between mathematical thinking expressed through symbolic means and thinking expressed in natural language.

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[21]*In classical logic—including Aristotle's syllogistic, propositional calculus, and the calculus of quantifiers (first-order predicate logic)—numerous inference schemata have been developed (or discovered). Many of them have their own names, as they represent a wide array of common processes from everyday life (Grzegorczyk, 1969; Borkowski, 1977). Furthermore, these schemata constitute the laws of logic and, from the general.*

The phenomenon of connotation, the existence of a single element within a system (in logic, this concept corresponds to a propositional variable), arises from the incompleteness—the lack of semantic clarity—of connoting words. That is, basically, from the indeterminacy of every single word in a given syntactic structure. By themselves, they are semantically incomplete and fail to convey full, unambiguous information.

Thus, they require supplementation, just as one-word utterances do. However, while one-word utterances depend on their surroundings—the communicative situation—connoting words, in turn, require supplementation determined by context. This supplementation must be precisely defined, tailored to the semantic content of the entire utterance (sentence).

This entire set, comprising the connoting word (category) and the adjacent open slots in the text to be filled by specific categories of connoted words, is referred to as a syntactic schema (syntactic structure; Gołąb *et al.,* 1968).

Since these are schemata, they must have a fixed structure (an invariant complexity), and this is one of the features of language that, through the structure of speech (language), relates to social communication. The syntactic schema used—filled with content, with semantic substance—should be understandable to all recipients within that language.

However, it is important to note that the speaker's role is limited to selecting only one word from the class of connoted elements and placing it in the utterance (or more broadly, in the text) next to the connoting word. Parts of speech—as categories within the system—serve to classify (organize) their elements (within the system):

Since connotation stems from word meanings, their division into various groups (categories) according to their function in the connotation system is also, to some extent, based on their content-related (semantic) features. One might again say that there is a resonance between these two systems: contents (semantics—representing reality) and syntax (representing speech through language).

What does all of this mean for understanding the functioning of language in speech? Well, those particular words that fulfil the same function in the connotation system and exhibit corresponding semantic features are classified into the same word class, known as a part of speech. Systems of parts of speech differ greatly across language families[22].

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[22]*A significant commentary on the concept of syntactic schema concerns the place and role of verbs within the system of language. What exactly are verbs? The point here is not so much the function they fulfil in spoken language, but their ontology.* ***.*** *Linguists debate the primacy of the relation: noun–verb. Which of these two fundamental categories of speech is primary in the entire system of human language, forming and cementing the abstract (syntactic)*

In this section – or more accurately, above – the general structure of how language is constructed has been indicated. The following categories of elements are to be considered in the following enumeration in order to establish the semantic, syntactic and stylistic systems (the form of expressing the contents of utterances, of speech communication).

As previously mentioned, this system is crucial for individual, interpersonal, and social communication. These categories broadly correspond to what is referred to in linguistics as parts of speech[23].

5. Relationships of Fundamental Fields of Science (and their Categories)

The previous section touched to some extent on the relationships between convention and contents. Convention, by its very nature, is arbitrary, whereas contents do not possess this property. Although contents may be understood differently—or even erroneously—by different individuals, they in fact have only one true meaning (for example, the law of gravity is independent of our individual interpretation of it).

On the other hand, human communication—especially with reality—follows a certain language. In order to understand the behaviour of natural processes, one must be able to express them somehow. Supposedly, only humans possess free will and reason, which are linked to language. The meaning of real and abstract objects

structure of language—not merely that of a specific nation's language. The verb represents dynamics, the behaviour of an object or an entire process. The noun, in turn, is the object itself or a component of the process. The feature of dynamics, the capacity for action, is inherently assigned to the verb by nature—a priori. From this viewpoint, the two categories constitute a whole. It is rather our mind that divided them, for reasons related to the static and dynamic form of linguistic communication. This issue can also be approached from the perspective of physics: time appears to be a fourth dimension of matter, and nouns represent this matter. Abstract nouns exist precisely to describe the material world.

[23]*Since words do not occur in all language systems of the world (Milewski, 1965, p. 124), a general classification cannot take words into account, but only morphemes, as these linguistic units exist in all languages. Thus, they have a universal character and play a fundamental role in forming the syntax of utterances expressed through thought. If morphemes are indeed present in all languages, and thereby form a common basis for human cognition—then why are there wars? What patterns of thought provoke them? Which syntactic structures and linguistic contents underlie war-oriented thinking accepted by certain groups? Hypothesis: perhaps it is the differences in language systems (words, syntax, and contents) that generate contradictions in thinking, lack of resonance, and other divergences within the general human system of supposedly shared values. The discussion on linguistic universals remains ongoing. One of the best-known and most classical works on this subject is the book edited by Joseph H. Greenberg, entitled Universals of Language (Greenberg, 1968).*

created by humans is framed within many dimensions of science, particularly: linguistics, psychology, sociology, physics, biology, logic, and mathematics.

In contemporary science, one can encounter numerous and often divergent conceptions of how meaning is defined or understood. One of these perspectives interprets this category of meaning through a major field of mathematics, topology.

5.1 Fields that Form the Foundation of the Language of Science

As emphasized above, the classification of concepts can be considered not only in terms of the internal relationships within the signs (symbols) of a single field of knowledge but also between the fundamental scientific disciplines—which include mathematics, physics, biology, and psychology. This approach allows us to view science as a human-constructed, unified system. Why? Because despite the diversity of the surrounding reality, it is fundamentally one.

Mathematics is an abstract science. Physics deals with inanimate matter. Biology investigates the structure of living systems. Psychology explores the nature of the human mind.

From a logical standpoint, this scientific system ought to be analysed in a cyclical rather than linear manner. Drawing upon the continually expanding corpus of epistemological, psychosociological, mathematical, and technical knowledge, it appears that the two extremes of this continuum – mathematics and psychology – are converging to form a kind of circle.

Why is psychology one extreme and mathematics the other? Mathematics arises from thinking and from arbitrary signs used to record and represent thought. Psychology, in turn, is the foundation of formal thinking. Without thinking, mathematics exists only in the structure of matter.

This circle, therefore, becomes understandable through the lens of psychology. Its representatives seek to explain why the development of human intelligence leads to the emergence of systems of reversible operations that can be combined into relational structures—an essential form of physical and biological equilibrium.

However, the reversibility of relations must be understood in two dimensions. One is the physical dimension—in which no reversible relations exist. Humans cannot reverse time. The other is the mathematical dimension. Mathematics, in a sense, is indifferent to time. It operates with functions that have inverse functions—mutually one-to-one.

Psychology is also capable of this, for humans possess memory and can mentally reverse time, albeit only virtually. From the mathematical perspective, the detailed analysis of this issue reveals two fundamentally divergent views regarding the origins of mathematical operations. Supporters of the first, including the mathematician Poincaré, argue that mathematical operations have a natural, intuitive basis—thus forming a direct bridge between psychology (its intuitive basis) and the subject of mathematics.

Advocates of the second view—including mathematicians and scholars of various schools of mathematical logic such as Russell, Hilbert, and Ajdukiewicz—reject the psychological approach. They rely on adopted axioms, relations, and various other mathematical and logical constructs without attempting to explain their contents (i.e., psychologically). These are based on abstract, conventional relations. Hence the term conventionalism for this school of thought[24].

Thus far, we have presented scientific views on the origins of formal operations concerning the relationship between mathematics and psychology. Now we must similarly analyse the connection between mathematics and biology, followed by the remaining binary relationships.

Mathematics and biology are also mutually complementary. The former is a thoroughly deductive science and, as it evolves, increasingly distances itself from experience. As such, it maximally exploits the activity of the subject (the capacity for deduction). Biology, on the other hand, minimizes the activity of the subject because it is fundamentally an empirical science and uses deductive methods—

[24]*In science, there also exists an intermediate approach, which assumes that certain operations, such as thinking and human behaviour, have a genetic, that is, innate origin. In contrast, there are operations that originate from intelligence—or more precisely, from human thinking—that is genetically assigned to humans, or rather ontologically inherent. Such thinking lacks a specific character; it must be shaped through human experience in relation to reality. None of the three main epistemological approaches provide unequivocal scientific evidence to support their philosophical stance, which is why none of them prevails. Regardless of the origins of relations, the question remains: what are abstract relations? Are they reflections of eternal ideas, expressions of linguistic convention, or axiomatizations of the intellectual operations of the thinking subject? Whether basic mathematical concepts are directly related to the cognitive activity of the mind, or whether this connection is formed indirectly—through axiomatization—the result in both cases is a link between the domain of thought (as studied by psychology and sociology of language) and the domain of abstract objects in mathematics and logic. As previously noted, both ends of this epistemological chain converge. The problem resolves itself in the system of subject–object relations present in every act of cognition, as demonstrated many years ago by Hoeffding. The object is knowable only through the thinking subject, while the subject becomes aware of itself only through adaptation to the object. Thus, the world is knowable to humans only through logic and mathematics, which are products of the human mind. Conversely, how logic and mathematics came into being can only be understood by a human through self-examination in the psychological dimension—that is, in one's relationship with the universe. This statement contains the true meaning of the circle of sciences, that is, the unity of science, which reveals the mutual interdependencies among various disciplines of knowledge and demonstrates the necessity of such unity (Piaget, 1977a, pp. 121-126).*

available in mathematics—only to a very limited extent (only insofar as mathematics permits). Whereas mathematics seeks to reduce the object to the subject, biology aims to reduce the subject to the object.

Now let us consider the binary relation in this cycle between physics and psychology. Physics applies mathematics to describe reality, thereby facilitating the adaptation of reality to the schemata of the human mind. Furthermore, physics can never fully detach the object from the abstract or concrete operations that influence it during the process of cognition.

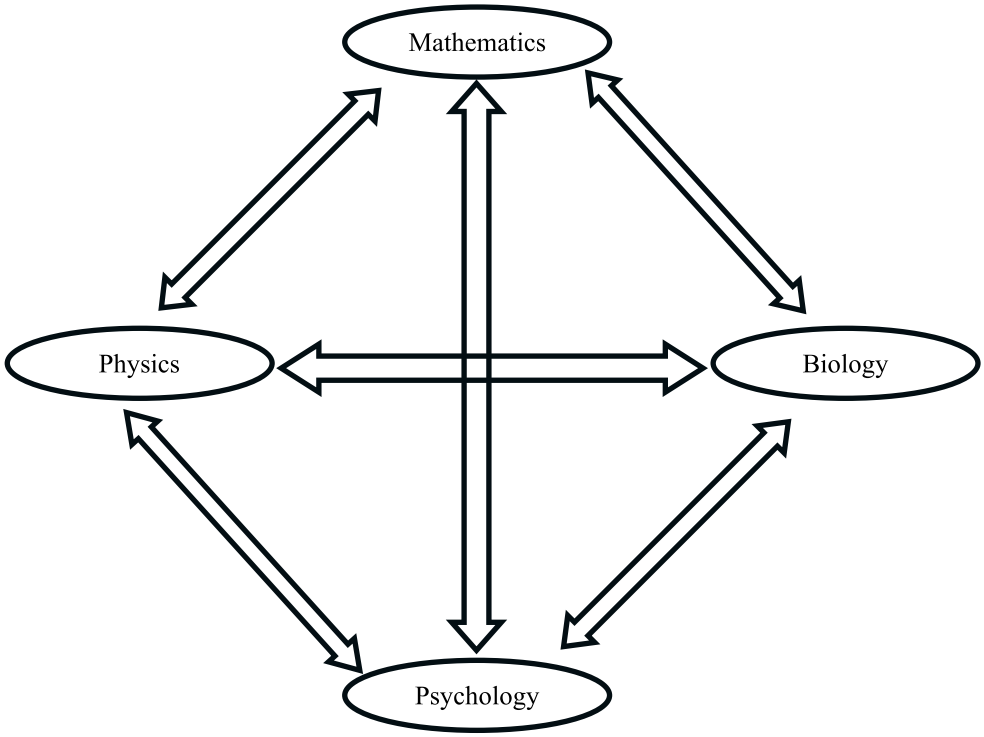
Psychology, by contrast, inherits realism from biology and attempts to explain behaviours of organisms that influence mental life by reducing the subject to the material object. This represents an attempt to capture the organic aspect of life, which affects mental functioning[25].

To summarize the above analysis, one may say that the scientific circle described here indicates a strict interdependence between the subject and the object. This is not a novel scientific discovery, but it suggests that the language used by any given scientific discipline is more abstract or more realistic (in the colloquial sense) depending on its location within this scientific circle and the position occupied at a given moment by the Observer (broadly defined; see Figure 2)[26].

[25]*As a result, psychology—while tracing the stages of mental development—seeks to explain the basic operations of mathematics, physics, and biology (including biological behaviours of the subject). It undergoes, to some extent, an idealist reduction of the object to the subject, a concept dominant in pure mathematics. This implies that the human psyche is capable of mentally switching the roles of subject and object, thereby shifting the observer's position in relation to the processes observed—an ability that has led to numerous scientific discoveries (Kozan, 1992; Nosal, 1992).*

[26]*Even Piaget himself asks: which of these languages is the true one? His answer is as follows: "… if biology is ever fully mathematized, it will become clear whether the equations of protoplasm—and thus protoplasm itself—are the result of our mental activity, or whether our mind and the equations it produces are derived from protoplasm.* ***At that point, psychology may already be sufficiently developed to demonstrate to mathematicians who support the first thesis and biologists who favour the second that, in essence, they are saying the same thing. Yet it is psychologists who will understand (first) why this is the case" (Piaget, 1977a; 125-126). Ultimately, every scientific discipline—not only among the four selected—employs concepts that are either precise or fuzzy, in the literal sense of fuzziness as defined by fuzzy logic. Hence, the fundamental question resurfaces: What determines the recognition of reality—the language and thought structure of the knowing subject, or the nature of the object of knowledge? This question is familiar to science, having already been posed in terms of the extent to which reality is knowable and the degree to which language and thought can comprehend the surrounding reality. One might go even further and ask: To what extent do language and thought construct reality—and what kind of reality? Thus, the scientific circle described above implies the need to create a new dimension of scientific language and a conceptual system aligned with its structure. Both systems should aim to strengthen the link between form and contents—in other words, between syntax and*

Figure 2. *Geometric representation of relations connected with fundamental disciplines of sciences*



Source: *Own work based on: J. Piaget 1977a, pp. 121-126.*

6. Conclusions

Two dimensions of the relationship between form and content have been analysed: the formal, which includes mathematics, logic and metamathematics, and the humanistic, which includes psychology, linguistics and sociology. The foundation of the language of science has also been expanded to include physics and biology.

semantics. This presents a serious challenge for the future of science and knowledge. While Aristotle divided the notion of the object into form and contents, it was Descartes who first recognized the need to connect contents with mathematical form. Today, it seems that Aristotle's and Descartes' ideas regarding scientific representation—especially in relation to Piaget's scientific circle—have been most pragmatically realized by Ashby. In a single work, one finds representations (conceptual and linguistic) of problems common to mathematics, physics, psychology, biology, and technology. This constitutes a robust scientific conceptualization of the fundamental circle of sciences (Ashby, 1963).

This analysis allows us to derive several conclusions that form the cognitive categories of both dimensions, particularly in relation to organisation and management theory. These conclusions concern the relationships between form and content in our world and within ourselves (human beings). These can be summarised as follows:

Formal sciences face significant issues related primarily to the decidability of certain (yet cognitively and substantively important) theories and concepts developed within their frameworks. This creates cognitive and interpretative challenges in practice, particularly within the pragmatics of logic, mathematics, and metamathematics.

Difficulties in unequivocally understanding some of the processes or objects described by mathematics become apparent in practical management, especially when formal modelling is involved.

In a similar manner, the humanities encounter significant cognitive challenges within their own theoretical frameworks. These challenges are largely dependent on formal sciences and the arbitrariness of signs. Issues such as synonymy, homonymy, and the mutual translatability of terms from one scientific field to another (arising from the arbitrariness of signs) must also be given full consideration.

The translatability of scientific language into colloquial language and vice versa is also worthy of note. The popular understanding of concepts and systems within scientific language becomes relevant in this context. Science is created for human beings, not merely for scholars.

Finally, the question arises whether it is possible to develop a unified language of science—one that integrates formal sciences and the humanities (through technology, informatics, and other disciplines). At its core, such a language would be based on mathematics, psychology, biology, and physics. This is, at least, how Jean Piaget envisioned the issue.

The present text has outlined new directions for building a comprehensive language of science—ideally grounded in topological thinking (geometry of space). This perspective opens further avenues for exploring the ontology of reality and of ourselves—our minds—within the dimension of topological space, as well as for creating new semantic measures (ones better than those developed so far).

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