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Special Topic: ***In the Beginning was the Word - The Word as a Technical Artefact***

Calculating with Words: Perspectives from Philosophy of Media, Philosophy of Science, Linguistics and Cultural History

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Abstract

This essay pursues the title of the special issue *In the Beginning was the Word - The Word as a Technical Artefact* and asks if words can be (technical) artefacts. The following thesis will be defended: as long as words are spoken they are part of parole, of spoken language and cannot be an object. Words as some kind of res are signs, but signs as a class of objects cannot be subsumed under the class of artefacts at large. Words can only be treated as artefacts if they are elements of a formal system; to think of them as being somehow technical means requires to understand them without reference to language. Prima facie, this leads to a paradoxical conclusion: if they are words, uttered words, they are part of language; if words are technically produced material entities, artefacts, they are devoid of meaning and are, therefore, not words.

Keywords: Word; Logical symbols; Formal systems; Notations; Written language; Algorithms; Goodman; Wittgenstein.

Аннотация

Данное эссе, следуя названию специального выпуска "В начале было Слово - Слово как технологический артефакт" спрашивает, могут ли слова быть (технологическими) артефактами. Будет защищен следующий тезис: пока слова произносятся, они являются частью разговорной речи и не могут быть объектами. Слова как своего рода реальность являются знаками, но знаки как класс объектов не могут быть отнесены к классу артефактов в целом. Слова можно рассматривать как артефакты, только если они являются элементами формальной системы; чтобы думать о них как о технических средствах, необходимо понимать их без привязки к языку. На первый взгляд это приводит к парадоксальному выводу: произнесенные слова являются частью языка; но если слова являются технически произведенными материальными объектами, артефактами, они лишены смысла и, следовательно, не являются словами.

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Is it possible to regard words as artefacts as the title of this special issue suggests and if, yes, in which way can we understand them as technical means? Usually, we consider linguistic expressions to be signs; they are conventions, but not artificial or technical objects. Further, we think of artefacts as objects which result from technical work, of *poêsis*, we think of them as being fabricated. From this perspective the question arises whether calling artefacts *technical* artefacts is a tautology since all artists, craftswomen as well as engineers are specialists in some kind of *technê. Technê* involves skills, capacities, knowledge and its putting into practice from which all artefacts, technical objects and works of art are ultimately brought into being. Artefacts are always the product of some sort of technique.

Is it possible to consider words in the same way as artefacts? Who is producing them? In this article I will defend the theses that in a strong philosophical and linguistic sense words cannot be artefacts; from the perspective of Ordinary Language Philosophy it is not even possible to see them as signs, and that means, as entities. A position like this can be considered as old fashioned – didn't Jacques Derrida show that the tradition of occidental philosophy always prioritizes spoken language, *phoné* and *parole*, while neglecting the status of written signs? This is what he calls Logocentrism. Or am I defending a narrow-minded conviction from (good old) philosophy of language, a position that denies any relation to kinds of technique on the basis of principle? Or is my view subject to a very general repugnance against any kind of philosophy of technology?

Against all these suspicions I will present arguments not primarily committed to philosophy of language but based on the history of graphic signs and theories of writing. My thesis is the following: as long as the word is spoken it is part of *parole*, of spoken language and in this sense, it cannot be an object. Words as some kind of *res* are signs and it is important to understand that they can only be considered in this way if there exists some sort of alphabet that allows to reify the elements of a spoken language and to transform them into stable entities. But as I wrote before, signs as a class of objects cannot be subsumed under the class of artefacts at large. Therefore, I will argue in a further step that words can only be treated as artefacts if they are elements of a formal system or binary code; to think of them as being technical means in some sense requires to understand them without reference to language. Prima facie, this seems paradoxical: if they are words, uttered words, they are part of language; if words are technically produced entities, artefacts, do they not stand in any relation to language?

The following considerations introduce a specific type of written signs: logical and mathematical symbols. These are genuinely graphic insofar as they are non-phonetic, i.e. they have not been developed in order to codify spoken language. Literal symbols in general can be understood as language-neutral forms of writing. This argument has been established with respect to a theory of notation as it has been presented by the American

philosopher Nelson Goodman in *Languages of Art.* Systematically developed by the British linguist Roy Harris[1], it shows how we have to understand the relationship between an alphabet, considered as notation, and an expression system, i.e. the writing system for any given natural language. Harris identifies both notation and expression systems as sign systems. From this vantage point, I will treat algorithms and calculus as forms of media, as I introduce in detail in part three of this paper. My understanding of the distinction between the two rests on work by Paul Lorenzen and Bruno Lorenz, founders and representatives of the so-called constructivism of the Erlangen and Konstanz school, a distinct line of thought within philosophy of science. It runs as this: whereas algorithms can be understood as symbolic machines that run automatically, a calculus is a more flexible set of sentences that allows to interpret its components with regard to a discrete field of research. In consequence, we can speak of words as artefacts in the sense of being the results of algorithmical, quasi-automatical operations. In contrast to algorithm, calculi carry meaning.

I

In a short passage of *De la grammatologie* Jacques Derrida (1967) refers to the *characteristica universalis* developed by Leibniz (p. 39). Derrida takes these as an example for a non-phonetic writing system, i.e. an autonomous system of symbols that does not denote spoken words. Leibniz` project was part of the Enlightenment movement insofar as it was aiming to be above and beyond any given specific language. Derrida, however, is not interested in integrating the *characteristica* into the discussions of Western philosophy. Instead, he follows Hegel who claimed that these types of written signs "cheat life". The meaning of a word comes naturally, words are alive. The meaning of a symbol needs to be assigned to it, symbols are dead.

A more promising and detailed discussion can be initiated with the work of the German philosopher Sybille Krämer. She introduces the notion of typographical or operational graphic systems (Krämer, 1991). The elements of a *typographical* system can be treated as objects, like letterpress characters, for example. The *operational* aspect emphasizes the rule-following character. In this line of thought, *signum* and *signatum* are one and the same. Krämer justifies her stance on the basis of historical and systematical arguments.

Krämers's historical narrative begins with (i) the ancient Greek *psêphoi* used in arithmetics by the early Pythagoreans; this development continues with the introduction of (ii) Arabic graphic figures in Europe, an important step by which the technique of calculating by abacus had been detached from computing with written signs in the long form. A further step marks the introduction of (iii) variables into algebra by François Viète, introducing the representation of indefinite entities, this being a vital requisite for the formulation of the (iv) indefinite calculus by Leibniz. The evolution from *psêphoi* to

[1] Comp. part II of this paper.

the symbols of indefinite calculus are taken by Krämer as a continuous process of formalization and abstraction.

Krämer`s position confirms what we know about the history of written sign systems: As Denise Schmand-Besserath (1979, 1981) convincingly shows, the origins of graphic systems are not to be found in ideographic depictions but in early practices of calculating and registration, based on the use of so-called calculi (Nissen et al., 1991) . In addition, Peter Koch (1997) emphasizes three different lines of development of what he calls *graphé*: the first is based on the just mentioned calculi or *psēphoi* of ancient practices; the second includes writing systems in the narrow sense, *i.e.* graphic systems used to codify natural languages; and, third, the symbols of mathematical and logical systems. As we have seen, the last can be integrated into the first line, understanding them as written continuations.

Following Krämer's perspective, Pythagorean arithmetics can be understood as (some kind of) proto-theory along the lines of the Erlangen School of Constructive Philosophy of Science. It is a precursor of arithmetics as a scientific established theory of natural numbers. It is important to understand this kind of proto-scientific practice by considering its main features: calculi serve as objects in order to visualize numbers resp. quantities; they are moved schematically and, what is of central importance, there exists no fundamental difference between the calculi themselves and what they are representing. In a different light, Pythagorean arithmetics can be understood as a kind of magical symbolism, as Ernst Cassirer pointed out: The configurations of calculi do not symbolize quantities but are constructed by the process of rule-based operations.

Krämer identifies these characteristics to happen at each evolutionary step: schematic operations rule the handling of the numerals of Arabic notation. By introducing the figure '0' into the scheme of numerals we are confronted with the first abstract entity. In addition, the syntactic moment can be identified at this level, too: the 'meaning' of the numerals >0, 1, 2, 3, 4, 5, 6, 7, 8, 9< is deduced from their position within the sequence of signs. Moving from here to the variables in Viètian algebra enforces the syntactic aspect: the elements cannot be treated with respect to their possible reference but only syntactically. The indefinite calculus represents the culminating point of this development. Indefinites cannot be represented but only constructed by operations (according to Krämer). The calculus is both location and medium in which abstract entities are constituted.

It is important that from this perspective, mathematical and logical symbols denote sign systems which are essentially non-verbal; they do not codify everyday language and they need not be pronounced in order to be worked with.

The thesis of language independence can be extended to writing systems in general, to a language-neutral conception of written signs. The main function of the Greek alphabet, for example, is codifying and notating spoken language. However, this common-sense view can be challenged if the difference between spoken and written language in their specific material realisation is neglected: It is a commonplace in media theory as well as in the early research on *Orality and Literacy* that spoken words have a fluid, transient character whereas graphic symbols are solid (Ong, 1982). Yet, with

Nelson Goodman's theory of notation, the difference between oral and graphic realisations could also be located in their structural aspects. In *Languages of Art*, Goodman points towards a fundamental difference between analogue and digital kinds of art. This difference is based on a nominalistic conviction that signs are not abstract entities, but material realisations called marks or inscriptions. A set of inscriptions is called 'character':

"Characters are certain classes[2] of utterances of inscriptions or marks … Now the essential feature of a character in a notation is that its members may be freely exchanged for one another without any syntactical effect; or more literally, since actual marks are seldom moved about and exchanged, that all inscriptions of a given character be syntactically equivalent. In other words, being instances of one character in a notation must constitute a sufficient condition for marks being 'true copies' or replicas of each other." (Goodman, 1976, p. 131)

Therefore, characters have to be considered as "an abstraction-class of character-indifference among inscriptions." (Goodman, 1976, pp. 132-133) In consequence, an inscription cannot be assigned to more than one character. This formal demand is expressed in the demands of disjointness and finite differentiation. Disjointness means that no two characters have common elements; finite differentiation says that it must be possible, at least in principle, to assign an inscription to one and only one character. In other words, there must be no transition area between two characters. A scheme that fulfills the syntactical demands of disjointness and finite differentiation is called a notational scheme. Such a scheme is digital; schemes that do not fulfil the second demand of finite differentiation are called syntactically dense.

Obviously, the Latin alphabet satisfies Goodman's syntactical demands for notations:[3] its elements, letters, are distinguishable from one another; conversely, it is in principle possible to assign any mark to one and only one character.[4] It is just the second claim, finite differentiation, to which spoken language cannot conform because of the permanent transitions between phonemes.

II

Until now I have shown, first, that graphic systems such as calculi or logical symbols have to be understood as being independent from spoken language. Second, I pointed out that it is possible to regard writing systems to be self-sustaining in relation to language. These results relate to central positions within Analytic Philosophy of Language: Ordinary Language Philosophy focuses on the value of everyday language. Ludwig Wittgenstein (1953), for example, states in his *Philosophical Investigations* that it is impossible to understand everyday communication by means of formal logics. He argues against an objectifying theory of reference and the demand for strictly limiting

[2] Being a nominalist, Goodman doesn't accept the notion of classes, he is using this term only in a non-formal way.
[3] For these arguments see in detail: Krämer (1996); with respect to notations of informatics: Fischer (1996).
[4] For discussions of non-distinct cases comp. (Goodman, 1976, p. 133).

concepts as formulated by Frege, establishing thereby the notion of a 'language game'. Wittgenstein (1922) here reverses his own previous logicist approach presented in his *Tractatus locigo-philosophicus.*

Similarly, John L. Austin (1962) emphasized the performative dimensions of everyday language, giving credit to the original notion of *logos* as action. And Walter Ong (1982), a cultural historian and researcher in the field of Orality and Literacy, pointed towards the basic phenomenological differences between spoken and written language: uttered words and sentences are realized in the medium of sound, they are fluid and ephemeral; in contrast, graphic marks are robust visual signs.

These positions have in common that they are arguing against some sort of reifying perspective on language, against the linguistic stance that takes language to be a system of signs. In the history of writing and the theory of writing systems, it is a truism that we can only understand language as sign systems if there exists a graphic coding system. But we are also confronted with some myths about the features of alphabetic notations. Eric A. Havelock (1963) expressed with great conviction the supremacy of the Greek alphabet as the only alphabet that transforms the sound of words into graphic signs. In a way, he is right. The letters of the Greek alphabet immediately depict the sound of a spoken word. The Greek alphabet is similarily important for Ferdinand de Saussure, who wants to develop a universal linguistic system on its basis. He overlooks, though, that other realisations of sign systems such as the Arabic scripture which is based on syllables would generate a different perspective on spoken language.[5] This debate exposes a central conflict of two basic principles, the principle or arbitrariness and the phonematic principle. The principle of arbitrariness points towards the conventional character of signs. The phonematic principle asserts that the orthographic order of letters in a written word reproduces the sequence of sounds in utterances. The latter can only be endorsed if the Greek alphabet is taken to be the only and unique example of an alphabet that codifies a complete idiom. One of the central arguments against this view is presented by the English linguist Roy Harris: when endorsing the phonematic principle, how then can we explain that one and only one alphabet is used to codify different idioms? In other words, how is it possible to explain interlingual homography, as the letter sequence *t-a-b-l-e,* having the same meaning in both, English and French, but being pronounced in very different ways? (Harris, 2000, p. 92) To answer these questions, Harris distinguishes between a so-called notational and an expression system. He thereby modifies Goodman's theory of notation which Harris calls a "fixed-code-theory": "Goodman himself seems to regard his distinction between notational and non-notational systems as a more satisfactory replacement for the familiar distinction between digital and analog." (Harris 1996, p. 1561) That is why Goodman is not able to explain how an analogue

[5] Unlike the Greek alphabet, Arabic and the Hebrew syllabaries use only consonantal signs. The particular combination of consonants within a written text allows to always identify the correct vowels of the spoken word. Christian Stetter presents an interesting argument why the Greeks had to introduce separate signs for vowels: Ancient Greeks had no problems with the Phoenician syllable as long as they used it for the purpose of trade. But efforts to use it for writing everyday language were confronted with the central problem that in Greek language vowels are not clearly identifiable from the combination of consonants. Therefore, it was necessary to introduce step-by-step elements which later were called vowels. Comp.: (Stetter, 1997, p. 56-64).

system like everyday language can be transformed into writing. It is this question which Harris wants to answer. To him, a notation has to be understood as a finite repertoire of signs, based on an internal system. The most familiar examples in Western culture of such internal systems are the Greek alphabet with its typical order of letters and Arabic digits in their numeric sequence from 0 to 9. The elements of a notation are graphic marks – "graphies", in french (Harris, 1993, p. 37) - defined by their visual form and their position within the system.[6] It is decisive that a notation is autonomous from the expression system, i.e. the idiom in question.[7] A writing system is a correlation between two graphic system: (i) an alphabet with discrete elements, letters, and (ii) recombinatorial sequences of these letters which form the words of the language. This fundamental differentiation holds for writing but not for speech.

> „The difference […] highlights a fundamental asymmetry between the structure of a spoken language and the structure of the corresponding written language […] a written English sentence, such as *The cat sat on the mat* is based on (and is only possible because of) the application of a notation, i.e. the alphabet, whereas there is no such system underlying the corresponding sentence in spoken English at all. Some linguists would claim that the basic units of a spoken language (at least on the level corresponding to the use of alphabetic characters in writing) are its phonemes. Even if this claim is accepted, Harris would deny that the phonemes of a language constitute an oral notation. Their structural role cannot be parallel to that of alphabetic characters, even though it might be possible in principle to set up a writing system in which each alphabetic symbol corresponded to a single phoneme in the spoken language. Phonemes, if they exist, cannot be divorced from the expression system (i.e. spoken language) in which they occur." (Harris, 1996, p. 1564)

The proposed definition for notations as presented by Harris makes it possible to explain further questions like the following: If one asks after the identity of a handwritten letter/character – is it 'l' or 't'? - one refers to the level of notation. The question can be answered by referring to the position of the graphic sign within the internal position of the system. On the other hand, questions concerning the correct spelling of a word address the expression resp. writing system (Harris 2000, p. 91). Using an almost identical repertoire of signs – the Greek alphabet – the spelling of the homographic example >table< follows the orthographic rules of the respective language (e.g. the addition of accentuation marks in French). The result is one and the same word occurring in two

[6] In a virtually untranslatable passage Harris (1993) defines notations as follows: „ […] une notation est un inventaire de graphies qui peuvent servir à fournir les signifiants des signes écrits, et dont l'ensemble constitue un cadran emblématique. Une formulation appelle trois remarques. D'abord, elle laisse ouverte la possibilité de choisir les unités d'une notation comme unités d'expression, de telle sorte qu'on établisse un isomorphisme entre les deux structures. Ensuite, la définition proposée n'implique pas du tout que pour écrire il faut toujours une notation. Tout au plus, elle suggère que, dans la taxonomie des écritures, il y aura une place importante réservée pour les écritures à notation. En troisième lieu, elle ne cherche pas à marquer les limites précises des formes que peut emprunter l'écriture. Néansmoins, elle introduit un concept qu'il faudra admettre tôt ou tard au cours de ce genre de recherches." (p. 44)

[7] Harris' argumentation is focused on developing a detailed understanding of writing systems with respect to their relation to spoken language. His theoretical approach cannot be applied to signs in general, for example, to iconic signs.

languages, English and French, denoting the same object, yet pronounced quite differently.

Harries understands language and writing – expression system and notation – as two different semiotic systems; he criticizes de Saussure for not differentiating sufficiently between the characteristics of spoken and written signs. In contrast, the German linguist Christian Stetter goes beyond this position when he asks if it makes sense at all to consider language as a system of signs. He, like Harris, calls the phonematic principle an "orthographic myth" (Stetter, 1997, p. 51, translation UR) an "illusion produced by the principles of Greek alphabet" (Stetter, 1997, p. 54, transl. UR). Stetter posits the necessity of readability (*Lesbarkeit*) as the main principle of written language. To be able to read and understand written words is paramount: "The letters of an alphabet are not used and had never been used to denote sounds when the alphabet had been developed, but they had been exclusively introduced in order to make words and texts easily decipherable." (Stetter, 1997, p. 59, transl. UR). In this respect, the central demand of a system of written signs (Harris' expression system) is fulfilled if it shows the necessary internal differentiation for identifying the words of a language. From this perspective, the process of transforming a language towards literacy is reciprocal, it is a permanent process of assimilation and transformation. What does reciprocity mean in this context? On the one side, we see a continuous process of differentiation at the level of what Harris calls notation; on the other side, this development is accompanied by a permanent standardization of spoken language. Only under these circumstances and, in consequence, on the basis of fully developed grammatical standards, is one able to use literary language as means for objectifying language in general.

More radically than Harris, Stetter differentiates more strictly between language and literacy. He follows Austin and Grice in taking language as a form of action. He sees it as a means to create understanding (between communicating parties). Finally, at this point, we are able to state concisely whether words can be artefacts and if so, how. According to Stetter, a reifying conception of words is only available on the basis of a given writing system, for this is what enables us to isolate words and classes of words as syntactic entities. There is no need to reassess this feature of a writing system as a kind of deficiency or aberration from a known or unknown origin. Writing systems function as a tool which provides the requirements for a scientific approach to language. The word as a linguistic sign is a scientific or theoretic entity; it cannot be considered an artefact quite yet.

III

The last step of my argument consists in establishing the difference between the idea of algorithms as machines and the idea of calculus as a medium. At the beginning of this article I pointed towards the necessity to clarify the meaning of the terms 'technical' and 'artefact' with respect to words and formal systems. The meaning of the Greek term *technê* comprises not only (i) the output of technical processes, but also (ii) the use of tools and machines as means for producing artefacts. Furthermore, (iii) *technê* also

denotes the established practices of using these means, *i.e.* traditional, professionalized and self-evident processes of fabricating things. As Wittgenstein put it, rule-following cannot be realized by only one person, once. In the same way, craftsmanship can be understood as following a variety of practical rules in a methodical order. The last aspect of *technê* (iv) refers to the different kinds of handling artefacts – we deal with the objects of everyday life in a different way than with works of art (Hubig, 2006, p. 261-265).

Moreover, technical activities are, and this observation has been stated before, language independent, just as the symbols of formal systems. Technical activities are procedurally encoded. Naturally, we can have a conversation while painting the garden shed to escape the boredom. Similarly, a master will explain to the trainee how to hold a hammer and how to move it efficiently. But for technical activities in general this kind of language involvement is not constitutive; it is a mere epiphenomenon. Peter Janich[8] understands technical actions as non-verbal, manual operations which are subject to the "principle of methodical order" (Janich, 1996). He seeks to reinterpret natural sciences, most notably physics, as first and foremost practical activities, involving skills and techniques – "knowing how"- rather than purely theoretical, abstract, verbal ways of "knowing that". Poietic activities in this sense – from the Greek word *poiesis* – refer to types of activities which can be executed without being essentially linguistic.

From this perspective, the early arithmetical method of using *psēphoi* is poietical: the process of placing stones in a rule-based manner produces the intended objects, namely, quantities. This interpretation can be extended to formal systems. They can be regarded as *syntactical machines*, logical or mathematical operations are purely mechanical procedures. A distinctive feature of machines is that they are working autonomously: it is impossible to intervene or to take corrective action while they are at work (Hubig, 1995, p. 55). This characterization of machines is applicable to algorithms. They are taken to be a procedure determined by a finite number of steps.

So far, three major models of the computability of functions have been proposed: (i) Church's lambda-calculus, (ii) Turing-computability, and, (iii) Post's canonical system. These models have been proved mutually equivalent (Thiel, 1995, p. 249). Post's model enables us to mutually define the concepts of a formal system and of mechanical operations: operations are called 'mechanical' or 'recursive' if they can be undertaken by a formal system. Turing, in turn, reformulated the concept of countability as the equivalent of being 'computable by a Turing machine' (Heintz, 1993, p. 89). And Church's thesis says that for each algorithm it is possible to specify a Turing machine which realises this individual algorithm. In consequence, the two characteristics of algorithmic operations, namely elementariness and determinacy, lead to the equivalence of being mechanical and being computable.

We can now combine these mathematical observations with our previously established view of technical acts as poietic in order to address the question whether words can be artefacts. Both approaches describe non-verbal processes and activities. The

[8] Peter Janich is a representative of Methodological Constructivism, an approach to philosophy of science in the tradition of the Erlangen school of constructivism.

results of algorithmic processes can be taken as products of a mechanical process and as such can be called an artefact. But these results are not words because they are not imbued with meaning, they "say nothing".

However, a calculus can serve as much more as just a syntactical machine. A calculus is constituted by an alphabet, by axioms and the rules of deduction. Similar to algorithms, sentences can be derived by syntactical means, namely by transforming chains of symbols. In contrast to algorithms, the sequence of derivative steps is not strictly determined. Once a calculus has been developed, it can be variably applied: it can map out other fields of investigation, like natural numbers, linguistic expressions, or ontological entities, for example. The success of Analytic Ontology is based on its use of formal methods in ontological reflection. Here, the formalisms are used as means to (re)construct scientific theories for their deeper understanding. Erlangen constructivism, specifically in its formulation by Paul Lorenzen, is another example for a formal approach to science. Here, syntactical operations constitute formal rules and these rules are considered to be exemplary for all possible rule, specifically in mathematics and logic.

Therefore, a calculus can be understood as a medium. For a long time, communication theory had been dominated by positions that understand media primarily as material sign systems.[9] Often, the proponents of these positions were committed to the above-mentioned philosophy of Jacques Derrida. They emphasized the material character of signs in contrast to an assumed phonetic purity of voice and word. But this is a very narrow interpretation (Hoffmann, 2002). A broader conception combines reference to the material elements with an account of the rules of their combination and application. Then, and only then, can we distinguish between a concept of a medium$_1$, which comprises the material elements, and the concept of a medium$_2$, which represents the unity between material components and the rules of their combination (Ramming, 2006, p. 49-58). The above presented conception of writing systems as introduced by Harris can be interpreted in this sense: A given notation, such as the Greek alphabet, is a form of a medium$_1$; and its modification for codyfing a specific natural language is a form of the medium$_2$. Along the same line, the example of Greek *psēphoi*, can be analysed in its double sense of mediality: material objects, such as calculi, can be identified as medium$_1$, and they are applied by following specific rules. It is decisive that there are several options to devise rules for the use of *psēphoi*. This explains why we find different kinds of arithmetics in the historical areas of Babylon, Egypt and Greece, for example (Damerow & Lefèvre, 1981).

At this point, a terminological clarification about the difference between a means and a medium is in order. Means are used in order to achieve a goal. In contrast, the term 'medium' includes the multitude of possible uses, affordances, the medium provides. The American philosopher John Dewey differentiates between external and internal means, calling the latter also medium. In his words, external means are

"… *mere* means …, usually of such a sort that others can be substituted for them; the particular ones employed are determined by some extraneous considerations … But

[9] For a representative discussion of this topic comp. (Gumbrecht & Pfeiffer, 1988).

the moment we say 'media', we refer to means that are incorporated in the outcome. Even bricks and mortar become part of the house they are employed to build; they are not mere means to its erection. Colors *are* the painting; tones are the music. A picture painted with water colors has a quality different from that painted with oil. Esthetic effects belong intrinsically to their medium; when another medium is substituted, we have a stunt rather than an object of art." (Dewey, 1934/2005, p. 205)

These considerations are not only interesting for analysing art, they are also helpful for our understanding of how we deal with technical artefacts[10] or symbols. I would like to apply the distinction between means and medium one more time, this time to the example of ancient calculi: They are used to achieve a certain goal, such as registering goods, or, more abstractly, for constructing figured quantities (*figurierte Anzahlen*) as in the Pythagorean proto-theoretic arithmetic. Within these practical contexts, they are used as pure means. However, they are more than this. As material objects, they are indispensable for enabling these kinds of practices (as has been discovered by research to the history of calculating systems). Specific actions are based on the availability of specific means, and thereby, the means turn into a medium. But means as a medium are not exclusively intrinsic means, as Dewey proposed. Their characteristics as a medium also comprise an immanent possibility to initiate further developments (Hubig, 2006; Ramming, 2008). For example, the introduction of the Arabic system of numerals combined with a system of decimal numeration marks the beginning of mathematical operations with written symbols. This is not trivial; it was the beginning of a process by which the practice of formulating mathematical problems by written texts had been superseded by formal representations. A further step in the abstraction process of mathematics was the introduction of alphabetic letters into algebra. This step represents the necessary precondition for formulating indefinite numbers within a calculus. In both cases, the newly introduced systems of symbols must be considered as more than pure means of computing and calculating: they are inner means that have to be considered as the preconditions for the formulation of new forms of arithmetic and algebraic practice.[11]

It is not surprising that the presented considerations on means and medium can be applied to the calculus. A calculus consists in graphic signs like mathematical and logical symbols ($medium_1$) in combination with axioms and rules of deduction ($medium_2$). As we have seen before, the mere existence of these graphic symbols offers not only means for calculating but is also medium insofar as more advanced kinds of mathematical operations like indefinites can be developed. As we have seen before, a calculus does not comprise a finite sequence of calculating steps.

What results from this for the word as object? Is it an artefact or not? We can, first, note that there is a reciprocal relation between formal systems and natural language. One of the central advantages of formal systems is that they avoid the ambiguity of everyday language. But the subtleties of natural languages are interesting, too, since they contain fine-grained logical differentiations as Gottlob Frege showed in his considerations on logical semantics. We have to state, secondly, that within the context of formal systems

[10] For a detailed theory of medium with respect to philosophy of techniques see Hubig (2006).
[11] A similar argument has been presented by Edmund Husserl in his *Krisisschrift* with respect to the development of modern physics.

it is unusual to talk of a 'word', but to use the term 'expression'. An expression consists of a combination of elementary signs, conforming to syntactic rules. For example, first-order logic accepts the combination 'fx' as symbol for single-digit predicates, but not 'xf'. Ludwig Wittgenstein (1922) in his *Tractatus logico-philosophicus*[12] refers to the visual character of logical symbols when he asserts in 4.022 that a sentence shows what it means. This holds because the logical signs of a sentence indicate the combination of those categories the sentence includes (3.31: the sign of a sentence characterizes its form). Wittgenstein's differentiation between the sign of a sentence (*Satzzeichen*) and a sentence/symbol (*Satz*) shows the two dimensions of a logical symbolism: from the sentence as a sign we can read its categorial structure; the sentence as a symbol refers to possible meanings. The categorial structure of a sentence implicitly points to possible interpretations. In other words: the logical syntax of expressions indicates possible fields of interpretations and excludes others. In consequence, unlike algorithms as syntactical machines, a calculus can be considered as a medium of expression because it expresses possible meanings, possible interpretations. It may seem to be problematic from the perspective of media theory and media philosophy to call a calculus a formal 'language' because of its genuine graphic character. However, in a broader, more general perspective, it makes sense to speak of a calculus as a language because of its representative character. From this follows that we can call the elementary signs of a calculus 'words'.

We can now give a definite answer to the question if words can be artefacts: They cannot. Artefacts are the results of technical and mechanical processes which run autonomously and have to be considered as completely independent of language. The results of totally non-verbal processes cannot produce a linguistic entity. In contrast, words are genuinely verbal. As utterances they are no objects but parts of linguistic-performative actions. They achieve the character of an object when they become elements of a literal language. The elements of formal systems must be considered as genuinly graphic insofar as they do not only underlie syntactical operations but insofar as they provide the medium for the development of such kinds of operations. But insofar as the formal system implicitly indicates possible interpretations, the expressions of a calculus can be called 'words' and this is what constitutes the difference between words and artefacts.

REFERENCES

Austin, J. L. (1962): *How to Do Things with Words.* The William James Lectures delivered at Harvard University in 1955 (J.O. Urmson, Ed.). Oxford at the Clarendon Press. https://pure.mpg.de/rest/items/item_2271128_6/component/file_2271430/content

Damerow, P., & Lefèvre, W. (eds.) (1981). *Rechenstein, Experiment, Sprache. Historische Fallstudien zur Entstehung der exakten Wissenschaften*. Klett-Cotta.

[12] For detailed analysis of Wittgenstein's argumentation from a perspective dedicated to a theory of logical symbols as graphic signs see Ramming (2006), chapter III.

Derrida, J. (1967). *De la grammatologie* [Grammatology]. Editions de Minuit.

Dewey, J. (2005). *Art as experience*. Penguin. [Original work published in 1934].

Fischer, M. (1996). Schrift als Notation [Font as notation]. In P. Koch, & S. Krämer (Eds.), *Schrift, Medien, Kognition. Über die Exteriorität des Geistes* (pp. 83-101). Stauffenburg.

Goodman, N. (1976). *Languages of Art. An Approach to a Theory of Symbols*. Hackett.

Gumbrecht, H. U. & Pfeiffer, K. L. (eds.) (1988): *Materialität der Kommunikation* [Materiality of communication]. Suhrkamp.

Harris, R. (1993). *La sémiologie de l'écriture* [The semiology of writing]. CNRS Editions.

Harris, R. (1996). Writing and Notation. In H. Günther, Hartmut & L. Otto (Eds.), *Schrift und Schriftlichkeit: ein interdisziplinäres Handbuchinternationaler Forschung. Writing and its use: An Interdisciplinary Handbookof International Research, vol. 2* (pp. 1559-1568). de Gruyter.

Harris, R. (2000) *Rethinking Writing*. The Athlone Press.

Havelock, E. A. (1963). *Preface to Plato*. Harvard University Press.

Heintz, B. (1993). *Die Herrschaft der Regel. Zur Grundlagengeschichte des Computers* [The rule of rule. On the basic history of the computer]. Campus.

Hoffmann, S. (2002). *Geschichte des Medienbegriffs (= Archiv für Begriffsgeschichte)* [History of the concept of media (= archive for the history of concepts)]. Felix Meiner.

Hubig, C. (1995). *Technik- und Wissenschaftsethik. Ein Leitfaden* [Technology and science ethics. A guide]. Springer.

Hubig, C. (2006). *Die Kunst des Möglichen I. Technikphilosophie als Reflexion der Medialität* [The art of the possible I. Philosophy of technology as a reflection of mediality]. transcript.

Janich, P. (1996). *Konstruktivismus und Naturerkenntnis. Auf dem Weg zum Kulturalismus* [Constructivism and knowledge of nature. On the way to culturalism]. Suhrkamp.

Koch, P. (1997). Graphé. Ihre Entwicklung zur Schrift, zum Kalkül und zur Liste [Graphé. Your development into writing, calculus and list]. In P. Koch & S. Krämer (Eds.), *Schrift, Medien, Kognition. Über die Exteriorität des Geistes* (pp. 43-81). Tübingen: Stauffenburg,

Krämer, S. (1991). *Berechenbare Vernunft. Kalkül und Rationalismus im 17. Jahrhundert (Quellen und Studien zur Philosophie Bd. 28)* [Predictable reason. Calculus and Rationalism in the 17th Century (Sources and Studies on Philosophy, Vol. 28)]. de Gruyter.

Krämer, S. (1996). Sprache und Schrift oder: Ist Schrift verschriftete Sprache? [Language and writing: is writing written language?] *Zeitschrift für Sprachwissenschaft, 15*, 92-112.

Nissen, H. J., Damerow, P., & Englund, R. (1991). *Frühe Schrift und Techniken der Wirtschaftsverwaltung im alten Vorderen Orient. Informationsspeicherung und -verarbeitung vor 5000 Jahren* [Early writing and techniques of economic

administration in the ancient Near East. Information storage and processing 5000 years ago] (2nd ed.). Franzbecker.

Ong, W. (1982). *Orality and Literacy. The Technologizing of the Word*. Routledge.

Ramming, U. (2006). *Mit den Worten rechnen. Ansätze zu einem philosophischen Medienbegriff* [Count on the words. Approaches to a philosophical concept of media]. transcript.

Ramming, U. (2008). Der Ausdruck >Medium< an der Schnittstelle von Medien-, Wissenschafts- und Technikphilosophie [The Expression >Medium< at the Interface of Media, Science and Technology Philosophy]. In S. Münker, & A. Roesler (Eds.), Was ist ein Medium? (pp. 242-249). Suhrkamp.

Schmandt-Besserath, D. (1979). An Archaic Recording System in the Uruk-Jemdet Nasr Period. *Journal of Archaeology, 83*, 321-344.

Schmandt-Besserath, D. (1981). From Tokens to Tablets: A Re-evaluation of the So-called 'Numerical Tablets'. *Visible Language, 15*, 321-344.

Stetter, C. (1997). *Schrift und Sprache* [Writing and language]. Suhrkamp.

Thiel, C. (1995). *Philosophie und Mathematik. Eine Einführung in ihre Wechselwirkungen und in die Philosophie der Mathematik* [Philosophy and mathematics. An introduction to their interactions and the philosophy of mathematics]. Wissenschaftliche Buchgesellschaft.

Wittgenstein, L. (1922). *Tractatus Logico-Philosophicus*. Routledge and Kegan Paul.

Wittgenstein, L. (1953). *Philosophical Investigations*. Macmillan Publishing Company.