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W o l f g a n g W i l d g e n

The phenomenology of symbolic forms (Cassirer) and geometrical reductionism (Klein, Leyton)

1. Symbolic phenomenology in its historical context

Major impulses for a phenomenology of vision at the end of the 19th and the beginning of the 20th century came from experimental psychology (cf. the work of Helmholz and Hering). Hering's book "Grundzüge der Lehre vom Lichtsinn" (1905; English translation: Elements of a Theory of Visual Perception) demonstrated that perception depends on intellectual perspectives, intentional orientations, contexts of expectation. The psychology debate in the philosophy of mathematics (mainly in Frege's work) uncovered the inconsistency of J.S. Mill's sensualistic theory of mathematics and thus cleared the scene for a new type of analysis.

In 1907 Edmund Husserl gives a rich analysis of visual perception and its contribution to the constitution of object and space in "Ding und Raum". The perceptual integration of retinal fields and flows into a percept may be generalized to the formation of concepts. In 1901 Husserl discusses in his "Logische Untersuchungen" the relation between parts and wholes, between independent and dependent parts and the question of compositionality in concepts. On this basis, he formulates laws for the constitution of the relation between sign, meaning and object, i.e., the constitution of semiotic complexes, and he relates these laws to the laws of constitution already observed in the case of perception. He states that the (intentional) object is the major control of these processes; in modern terms we could say it guarantees the stability of the process. Husserl points to the invariance of concepts under different acts of expression and interpretation; this opens the way for the intersubjectivity of concepts observed in language and science. In his later work Husserl uses the method of "eidetic variation" as the proper dynamics in the explication of spontaneously formed concepts.[1] Due

[1] I thank Martina Plümacher for comments on my paper.

to the fact of their infinite variation in context and use concepts must be open and are only restricted by the intentionality of the human life-world.

Cassirer who continues the Neo-Kantain tradition of the Marburg-school which chooses scientific knowledge as the central scopus of epistemology (and not psychology as Husserl does in the tradition of Brentano) develops a theory of concept formation which is compatible with Husserl's "Logische Untersuchungen", insofar as it considers abstraction in concept formation as a central procedure:

> No longer a uniform and undifferentiated attention to a given content, but the intelligent accomplishment of the most diversified and mutually independent acts of thought, each of which involve a particular sort of *meaning* of the content, a special direction of objective reference.[2]

Cassirer understood Husserl's position in the "Logische Untersuchungen" (Husserl, 1901) as a philosophical reaction to Frege's anti-psychological position in logics.[3] Starting around 1921 he developed a new concept of symbolic relevance/meaning (called "symbolische Prägnanz" by Cassirer) which goes beyond the concept of "Prägnanz", defined by the Berlin school of gestalt-psychology (Köhler, Wertheimer, Koffka).[4] Symbolic "meaning" (as I will call it in the following) unites a perceptual experience with a specific non-perceptual sense; perception is cognitively articulated, it gets its place in a semantic system (cf. also Plümacher, 2003: 96 f.). Cassirer rejects any kind of mechanism which fills "sense" into some independently achieved experiental form, i.e., he negates the traditional dichotomy of content and form).

On this basis, he arrives at the notion of "representation" ("Repräsentation", which includes intentionality) as formation of a holistic gestalt which integrates experiental content into objectively meaningful entities.

> In any case, one has a holistic image ("Anschauung"), which presents itself as an objectively significant whole, as filled with objective ("gegenständlich") 'sense'.[5]

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[2] Cf. Cassirer, 1923/1953: 25. He refers in footnote 15 to Husserl's "Logische Untersuchungen", vol. II, 2.

[3] Husserl was first a critique of Frege's "logicism", but he later revised some of his criticisms (cf. Plümacher, 2004, where the intellectual relations between Husserl's and Cassirer's philosophy are explained, and ibidem: 39-51 for a discussion of Husserl and Frege on arithmetics). Cassirers relation to psychology is treated in Plümacher 2003.

[4] Cf. For a discussion on "Prägnanz" the number forthcoming in 2005 of "Zeitschrift für Semiotik" edited by Martina Plümacher and Wolfgang Wildgen.

[5] Translation by W.W. of the original citation: "Immer ist es vielmehr eine geformte Gesamtanschauung, die als objektiv-bedeutsames Ganzes, als erfüllt mit gegenständlichem ‚Sinn', vor uns steht."

In his further development, Cassirer performs a "semiotic" and even a "cultural turn" which creates a specific distance to Husserl's phenomenology.[6] As the first volume of his "Philosophy of Symbolic Forms", on language and his revitalization of Humboldt's ideas show, he shifts from perception, which is considered to be the base-line of symbol-formation, to language, myth, art, and other symbolically organized fields of culture (cf. Cassirer 1942/1989: Zur Logik der Kulturwissenschaften; and Cassirer, 1944a: An Essay on Man).[7] The "phenomenology" specified by Cassirer is therefore of primary interest for a theory of meaning in linguistics and in other humanities.

Parallel to this line of thought, Cassirer was since his time in Marburg fascinated by the new mathematics, mainly non-Euclidean geometries and new physics, i.e., Einstein's theory of relativity. This life-long occupation distinguishes his thinking from the mainstream of European phenomenology (Husserl), of existentialism (Heidegger), and other authors, like Merleau-Ponty, in this tradition.[8] Cassirer, who came back to the topic: geometry versus psychology of perception after 1936 (cf. Cassirer, 1937/1999, 1944b, 1945) adopts a position which is less radical than Husserl's transcendental phenomenology, but shares with it a certain skepticism as to the applicability of mathematical geometry (geometries) in a theory of perception. This question will be discussed and described in the last sections.

Husserl's position in "Ding und Raum" (English translation: Thing and Space) applies the method of Cartesian reduction (to the Ego), in a way which is more radical than in Descartes' own philosophy. In this context, it may be remembered that Descartes' algebraic formulation of geometry is the base-line from which the new geometries culminating in Klein's Erlangen program were derived. In this sense both Husserl's transcendental phenomenology and Klein's Erlangen program are radically Cartesian. In Husserl's "Ding und Raum" geometry is only considered ex negativo. In the context of transformations of the "oculomotoric" field many transformations considered in Klein's Erlangen program reappear: parallel translation,

[6] Cf. Wildgen (2003) for the relation of Cassirer's philosophy of symbolic forms and contemporary linguistic theory.

[7] As Plümacher (2004: 78-92) shows, Husserl abandoned a more semiotic line of thought in his manuscript written in 1890 "Zur Logik der Zeichen" (On the logics of signs). In his writings around 1893/94 he returned to the representational nature of perception and later to logics. The basic barrier was that language can neither be understood as a blind mechanism (in terms of psychological associations) nor as a fully constructive system like logics. A similar dilemma opposed behaviouristic and mentalist linguists in the U.S.A. fifty years later (cf. Chomsky's "revolution").

[8] Cf. Per Aage Brandt's analysis (this volume) of very basic bifurcations in the history of epistemology related to Spinoza. In this context one could consider the contribution of Giordano Bruno (another "monist"). The topic of imagistic representations may even be related to the antique tradition of artificial memory ("ars memoriae") which links the phenomenology of space (in which an author lives) and the representational architecture of his memory (cf. Wildgen, 1998).

continuous scale transformation, rotation (and additionally coverage; cf. Husserl, 1907/1991: 235 ff.). Nevertheless, the analogy to geometry is globally rejected:

> A new dimension, which generates the thing from the picture and from the oculomotor field the space, does only enable the multiform system of stretching. A new dimension does however not constitute an analog to geometry. A parallel displacement of the plane „generates" the space, as the geometer says. However, it does probably not give good sense to call this a parallel displacement of the oculomotor field, as if the „oculomotor field" is subordinated to the space of things.[9]

One century later, we see that theories of vision and perception and computational models have been able to make sense of geometrical (topological) procedures and that no successful way to elaborate our understanding of visual perception on the basis of transcendental phenomenology has come forward. This is at least an indication that Cassirer's less radical position and his integrative strategy was and still is promising.

2. Cassirer's contribution to a phenomenology of symbolic forms and its consequence for a theory of language[10]

For Ernst Cassirer the symbolic is by definition an activity of creative form giving. The symbolic forms are manifested in the areas of phonetic language, myth, art, technology and pure knowledge (reine Erkenntnis). This plurality of types of symbolic forms functions as a kind of medium (Medium, Vermittlung) between the objects and the human being (ibidem: 176).

> … they designate thereby not only negatively the d i s t a n c e , into which the object moves relative to us, but they also create the only possible, adequate m e d i a t i o n and the medium, by which any kind of intellectual being may be seized and understood. (Translation by the author.)

The symbolic forms establish an intermediate domain, subdivided by different types, in a field between the ego and the outer world. A vector in this field, which transforms passive "pictures" received by the senses into something, which is actively formed by the mind,

[9] Translation by the author of the passage: "Eine neue Dimension, die aus dem Bild das Ding schafft und aus dem okulomotorischen Feld den Raum, ermöglicht erst das vielgestaltige System der Dehnungen. Eine neue Dimension besagt hier aber nicht das Analogon der Geometrie. Eine Parallelverschiebung der Ebene ‚erzeugt', wie der Geometer sagt, den Raum. Aber von einer Parallelverschiebung des okulomotorischen Feldes zu sprechen, als ob das ‚okulomotorische Feld' den Dingraum sich als Fläche einordnete, das gibt wohl keinen guten Sinn." (ibidem: 236.)

[10] Cf. Wildgen (2004b: chapter 9) for a fuller treatment of the topic of this and the next section.

defines the typical character of the symbolic form. The force of this formative process transforms the perceptual content into a symbolic content.

> In it the image has ceased to be just something received from outside; it has become something shaped from within, in which a basic principle of free form-giving has been efficient. (ibidem: 77; translation by the author.)

The basic polarity between self (consciousness) and object is further complicated by the fact that the rather static objects are "represented" by a steady flow of processes in consciousness. This basic difference precludes any kind of mapping or pictorial representation between the two extremes of the field.

If the formation of symbols is the general type of symbolic activity, the diverse "symbolic forms" are the genres. The set of genres is neither invariant in time nor does it strictly follow an evolutionary scale. Thus, the basic symbolic forms, which Cassirer treats in the first two volumes of his "Philosophy of Symbolic Forms", i.e., language and myth, are the first genres of symbolic behavior. If we start from a flow of thought, from a continuum between the subject (of experience) and the object, then rituals and mythical beliefs create a symbolic organization of this continuum without cutting it into pieces. The symbolic form "myth" does not represent, it presents. Thus, the name or picture of a god, the magical or ritual formula does not stand for something named, it calls it into presence, has a causal impact on it, is a proper part of it, by which humans are able to control it. Expressivity is not separated from the body, which is a natural support of quasi-physiognomic signs and these signs cannot be manipulated at will, are not variable, not reflexive in their usage. Cassirer links mythical thought and symbolism with the function called "Ausdruck" (expression).[11] The reference of linguistic symbols (to something ontologically different), the variability (arbitrariness) of the attribution of sign and referent and the "ability to isolate relations — to consider them in their abstract meaning" (Cassirer, 1944a: 38) is (still) absent.

The third volume of Cassirer's "Philosophie der symbolischen Formen" treats the phenomenology of knowledge and more specifically of scientific knowledge, which is considered as a higher quality (Steigerung) on the scale which separates language and myth. A further loss of the materiality (Entstofflichung) of the sign, a poorer link to sensual

[11] This element of his theory is linked to Bühler and the tradition of Gestalt-psychology (mainly in Graz, cf. Meinong). Bühler (1933) reviews this historical development of "Ausdruckstheorie" discussing the physiognomic theories (e.g., Della Porta), Darwin's book "The expression of the emotions in animals and man" (Darwin, 1872) and other authors of his time; cf. Chapter 3 of Wildgen, 2004b, and Wildgen 2004a.

memories (Anschauung) and a higher degree of separation (Ablösbarkeit) from the (real) objects leads to the field of formal logic, mathematics and mathematical physics and may stand for the scientific revolution initiated by Einstein's theory of relativity and modern quantum mechanics. As a first result, we may consider the following scale:

Perception/Expression (evolutionary starting point)	**Myth < language < science (technique) (main field of cultural evolution)**	Abstract 'pure' meaning (in formal logics and mathematics)

Figure 1: The scale, which organizes the three "symbolic forms": myth, language and science and its boundary conditions.

The specific symbolic forms can migrate on this scale, thus modern myths may be technically produced like war machines, which apply scientific results, and language is relevant not only for the transmission of myth but also for communication between scientists.

3. The role of generalized media in advanced cultures

The symbolic form called "art" (poetry, music, painting, sculpture) does not have a place or a typical range on the scale mentioned above. Referring to the basic functions, expression and representation, aesthetic forms aim at an equilibrium of these functions. In two manuscripts on Language and Art (cf. Cassirer, 1979: 145-195) Cassirer shows that the symbolic form "art" takes another route than language, although it is, in many respects, comparable with it.

> But art and the artist have to confront and solve quite a different problem. They do not live in a world of concepts; nor do they live in a world of sense perceptions. They have a realm of their own. … It is a world not of concepts but of intuitions, not of sense-experience, but of contemplation. … This aesthetic contemplation is a new and decisive step in the general process of objectivation. (ibidem: 186.)

The creation of art depends by its nature on the medium:

> Art is not only expression in general, in an unspecified manner, but expression in a specific medium. A great artist does not choose his medium as a mere external and indifferent material.

In the case of poetry and other types of art which use language as medium, the different functions of language, namely the emotional, descriptive/narrative or enacting (as in speech-acts) define separate media and thus sub-genres. These functionally defined genres cannot be classified by structural criteria (see above); rather, they realize functions which depend on contexts of use (changing traditions, roles of authors and audience, etc.). If these contexts are

properly defined, we may arrive at such traditional notions as poetry, narrative and didactic prose, and drama. As these functions are both cognitively and pragmatically (socially) interdependent, their boundaries are fluid in time and cultural space.

To summarize: The general purpose of symbols to objectivize thought and emotion leads to different symbolic forms which have their proper range of variation, and which may intersect and combine. Nevertheless a fundamental diversity is created. To a certain extent cultural evolution may be understood as a change between symbolic forms and as an internal complexification of symbolic forms.

In the following I shall consider a vein of ideas rooted in Husserl's phenomenology and leading to a philosophy of Lebenswelt (world of life) or of culture (Kultur). For every human in a human society there exists a horizon of understanding, interpretation and action which he or she takes (implicitly) for granted and which cannot easily be transgressed. It has been constituted by historical and cultural processes beyond the life-space of the individual and is thus transcendental, although the individual may (mostly in a minimal way) contribute to its further development. In this sense, the "Lebenswelt" is semi-transcendental (cf. Habermas, 1982, vol. 2: 190). Every thing which may be said or acted is contained in this horizon; the "Lebenswelt" is thus a closed world of semiosis. For humans one may assume that the system of possible meanings has been symbolically reorganized, i.e., "meanings" which were *functionally* closed in the system of animal behavior have been reorganized into a *semiotically* closed system of meanings in the evolution of man. *Semiotically closed* means that the "Lebenswelt" is almost closed, i.e., the changes individuals make are either ad hoc and transient or statistically irrelevant. Still, in the addition (and reinforcing interactions) of billions of actions a statistical flow of the "Lebenswelt" is made possible. This is similar to the temporal stability of linguistic systems which seems to have absolute validity for the speakers of a linguistic community, although the system changes in a historical dimension. These long-range developments will be discussed in the next section.

The proposals for a classification of basic genres in the symbolic organization by Luhmann take as their starting point the "symbolic interactionism" developed by T. Parsons and H. Mead. The systems of "meanings" in symbolic interactionism neither come from the ontic structures themselves (the world) nor from cognitive processes in the individual mind; rather, they are the product of interactions between individuals. If simple interactions in the domain of simple animals, e.g., the exchange of resources and the compensation of mutual needs may

be regulated ad hoc (or by instincts), this is no more the case for humans who for reasons of complexity need a common system of meanings which regulate the exchange or the interaction in general. The analogy of money and language points to the semiotic nature of every social interaction.

In Luhmann's (1975) theory of symbolically generalized media of communication, a square table of basic types, i.e., genres of media, is proposed. Social interaction is reduced to the pair (EGO–ALTER), and the resources exchanged in interaction and symbolically categorized (they are called *codes*) are:

- exchange of values/judgments (truth/language)
- exchange of love/care/empathy (love)
- exchange of property/money/valued objects (possession/art)
- exchange of power/rights (power/law)

The media are specialized codes, which help to resolve conflicts in these interactions and which have been developed in a process of cultural evolution; they allow more complex but still stable forms of interaction. The differentiation and further specification creates a divergence, which requires repair systems; religions are such meta-codes, which try to integrate the divergent media into an imaginary holistic system. Such a meta-medium can only be meta-stable as the media evolve with the societies and their ecologies and thus change the demands for integration to the meta-medium.

Language seems to be a medium beyond Luhmann's classification insofar as it not only is implied in the medium truth/language/value and power/law but also has specific sub-functions which contribute to the media love (emotional function), and possession/art (language as social stigma and the aesthetic function of language). In the case of art one may add that although language may resemble law insofar as its grammar has rules which must be followed, it tends to go beyond rules, to explore new fields of meaning, to move into domains not yet codified by rules. In situations where no common linguistic code exists, e.g., in communication with infants and foreigners who don't share a language with the speaker, basic linguistic capacity still enables a larger amount of emotional, social and (partially) referential communication.

The non-linguistic codes: love, possession and power/law had evolutionary precursors related to sexual choice, access to food-supply/water/protection and status in animal groups (with territorial control). A code could only develop after the symbolic capacity had evolved and a degree of consciousness had been reached. In conclusion, we may say that language (discourse) has different functions corresponding to basic media of social interactions. Further differentiations of media/genres are possible and may interact. Thus, in the choice of a lover/friend economical aspects may be relevant, status (power) may be sexually attractive and information status (education) may be a criterion of partner choice or give access to wealth (possession). Information (truth/falseness) may depend on beliefs (religion) and these on power. In general, a set of prohibitions can limit the convertibility of semiotic genres. What is basic are the functions which are fulfilled and the complexity/stability of social systems enabled by a differentiated system of semiotic genres.

4. The hidden evolutionary dimension of phenomenology

Darwin's theory of evolution was already common knowledge in the scientific discussion at the end of the 19th century, although controversies with religious circles continued. In his manuscript "Zur Logik der Zeichen" (Husserl, 1890/1970) Husserl made some reflections on the origins of sign behavior: All animals react to phenomena which may be interpreted as signs of existentially relevant objects or situations; this may be called the starting point of semiosis. If they are able to learn, they chose causal or regular connections between parts of situations as sign of the whole. Communication via signs presupposes, however, a consciousness of signs ("Zeichenbewusstsein") and further evolutionary steps ask for the awareness of regular effects of intended sign use. This could be understood as a basic reflection on the origin of semiosis. Nevertheless, Husserl continues to discuss semiotic questions in terms of psychology and (philosophical) epistemology and thus misses a semiotic philosophy.[12]

In his "Essay on Man", Cassirer argues on the basis of contemporary results on the "mentality of apes" (cf. Köhler, 1921) that in animal behavior we find only signals but not symbols, that the animal possesses a practical imagination and intelligence, whereas man alone has developed a new form: "a symbolic imagination and intelligence" (Cassirer, 1944a: 33). The

[12] The view, that the relevance for survival of objects and situations referred to by signs is the starting point of semiosis is also shared by René Thom in his "Sémiophysique"; cf. Wildgen (2004c).

major developments in zoo-semiotics came after Köhler (1921) and have shown that under the specific conditions created by man, higher apes can learn to communicate symbolically at the level of a two or even three year old child whom we would consider to have language. Even birds are able to categorize different objects, to learn songs, to create variable codes (dialects), etc. Consequently, the range of symbolic forms and genres has to include zoosemiotic systems. On the other end of the evolutionary scale one finds the development of mathematics and scientific knowledge in the first civilizations of the Near East, in India and in China. Mythical codes (belief systems, rituals, dances) could have existed before and at the same period that witnessed the growth of a full-fletched phonetic language (cf. Wildgen, 2004b: chapter 8). As we can only infer the existence of myths from art or mythical texts, the position of myth is the most questionable one.

There is an apparent relation between art/objects of value (e.g., rare objects) and money, which was not mentioned by Cassirer but was emphasized by Luhmann. Economic and artistic values may in fact be opposed to language on another scale, which separates the rules and procedures valid inside a community and those which allow for interaction and communication beyond the community. The exchange of goods which requires a system of common values and which ultimately led to the appearance of money as an economic medium is necessary for interactions with neighboring or foreign communities. The same is true for art (and rare objects) which may be accepted at least in much larger areas than those covering a dialect or local language. In a similar vein, "love" is a medium, which tends to go beyond established frontiers. All media tend in the course of cultural evolution to loose their local restriction. This is true for languages, which tend to become fewer in number (although the number of speakers increases dramatically) and to have larger areas of distribution and for laws, which are adapted to international standards. The same is true for money and art. These common dynamics point to the fact that all these phenomena are members of one big family of phenomena which can be called "symbolic forms" and that they should be analyzed in the framework of one integrated theory of symbolism.

The differentiation of generalized media of communication starts (if we follow Luhmann, 1975) with the first civilizations (e.g., the Mesopotamian and the Egyptian). It is, however, obvious that the media called love, power, possession, truth must have existed before the classical civilizations, although their complexity probably did not require the institutional stabilization of specific codes. Even a socially organized group of bonobos shows bondages

(coalitions) of friends, levels of power, privileged access to resources and standards of communication. If one considers the very general system of interactions and selections in Luhmann's system, one wonders if it could not be applied to any socially organized group of living animals having an awareness of the other; i.e., which are able to distinguish categorically between EGO and ALTER, i.e., which reaches the basic level of social consciousness.

The intuition of Luhmann that larger civilizations (after the Neolithic period) create a specific level of generalized media can be used to conceive a future level of human (cultural) evolution. The increase in social complexity, the creation of specific institutions for the control and elaboration of myth, ritual, art, technique and later writing inaugurated a first post-language evolution stage, in which more abstract, more global systems evolved. Examples are the classical (written) religious codes which integrate a variety of mythical contents into a new, more coherent and compact corpus. Technology and science in Egypt and Mesopotamia and mathematics in India and Greece opened the way for further reorganization of the symbolic forms. If Husserl's transcendental phenomenology is a radical variant of Descartes' "Cogito ergo sum" which puts intellectual subjectivity, cognition in the center of any (human) knowledge (cf. Husserl, 1907/1991), Cassirer tends to decentralize the Ego and to conceive of symbolic objectivation, which is rather constitutive for the culture in which Ego lives. As cultures are historically shaped entities, Cassirer's move tends to consider the genesis of a culture as a precondition for the more specific development of Ego. In this retrograde move, the individual Ego in his hic et nunc situation disappears more or less, his individual world merges with a broad stream of evolving beings and the ecologies, these have been adapted to. This distant view allows to reassess the questions of basic geometrical laws underlying human symbolic behavior and to ask why so many parallelisms between language and shape perception exist (cf. the work in cognitive semantics and Wildgen 1994: chapter 1). The evolving cognitive systems does not only search for invariants for its own comfort, the ecology to which it is adapted is itself full of statistical noise, chaos *and* insular regularity, recurrence, i.e., invariance. Geometry and stability theory are a kind of tertium comparationis, they mediate between two basically different systems, the "world" must be grasped by the human mind and human action must apply to the world. The mind thus stands at the limit, the transition between the individual body and the world. The same is true for natural language, but the physical ecology and its control are much less important in the case of language. In the foreground stand social communication, socio-emotional management, social intelligence,

i.e., the functional mapping between context and language and context and perception is different and this difference is a product of evolution. Moreover the human mind implies an evolutionary hierarchy: Perception (and motor programs) are much older; we can link the specific human modes of perception and action to upright walk and perception during horizontal locomotion (probably since the australopithecines). Language is a rather recent phenomenon: a protolanguage with an enlarged lexicon appeared probably 2 my BP, a high-level syntax (with a complex lexical organization) ca. 400-200 ky BP (BP=before present; cf. Wildgen, 2004b: chapter 8). In the intervening period, the criteria of selection had shifted from ecological and sexual selection to social and communicational selection.

5. The symbolic form 'language' and modern applied geometry/topology

The symbolic form 'language' occupies a place in the central field of a scale which has perception on one side, modern mathematics on the other (cf. Figure 1). Therefore it is neither necessary nor possible to reduce language to perception nor to mathematics. Nevertheless, the basic principles of form-giving define a tertium comparationis, they allow for a transfer from one scalar position to the other. As the different symbolic forms have specific conditions of organization, economy; specific virtues, and defaults such a transfer is risky, it may create illusions of understanding, induce mismatches, etc. In sum, it is a difficult enterprise, but still a rewarding one. I shall first describe the role of geometry (in the sense of Plato, Euclid until Kepler), the crisis of Euclidean geometry, and the relation of Thom's theorem to Platonic planes and solids, order to show that the history of geometry is also the history of semiotic abstraction and that advances in geometry (later topology and differential topology) helped to bridge the gap between perception and an intellectual understanding of the world..

5.1 The success of the Platonic program

In Platon's dialogue, Timaeus, a theory of the material universe and of the mind, is developed which starts from triangles, constructs the five Platonic solids and associates them with the four elements and the universe as a whole. The constructional plausibility of this idea lies in the fact that regular surfaces (triangles, squares, pentagons) make up the surfaces of the five Platonic solids and that space may be filled with tetrahedrons (pyramids), octahedrons or

cubes; i.e., one can 'think' such a construction.[13] This mathematical knowledge was not only based on the practice of Egyptian geometers and architects, it had also a tremendous technical success, when Archimedes constructed a series of new machines in the defense of Syracuse. In the Renaissance, 'applied geometry' was a basic tool of scientists and engineers. Johannes Kepler even tried to demonstrate that the astronomy of Copernicus follows a Platonic type of construction. His model even fitted the available data: The mean distances between the orbits of the planets known in the time of Kepler correspond with the distances between the spheres which surround the platonic solids (cf. figure 2).

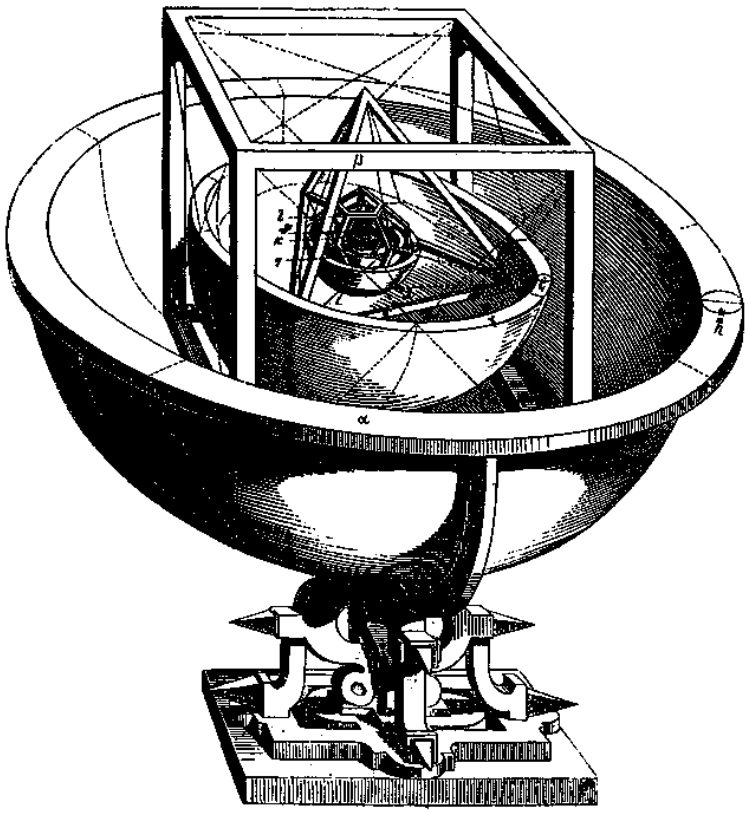

Figure 2: Kepler's reconstruction of the planetary system of Copernicus in 1596.

The quasi-eternal truth of Euclidean geometry became so evident after Newton's physics, and Kant's epistemology that it was almost a scandal when non-Euclidean geometries were proposed by Riemann and others. In 1872 Felix Klein established them as the backbone of a new program of mathematical physics and other natural sciences. Non-Euclidean geometry became one type among others on a scale ranging from the hyperbolic to the elliptic geometries. The new conceptual center was found in group-theory, because different

[13] The construction of the soul remains rather obscure to the modern reader of Plato and the use of four solids for basic types of elements (in a modern view chemical molecules or physical atoms) and one for the universe as a whole looks much too speculative to modern minds. In the context of antique and medieval physics and alchemy it was, however, rather plausible.

geometries allowed different types of transformations and equivalences (in topology a square equals a circle, a cube equals a sphere, etc.). In this context, symmetries became the signature of nature. Basically, the Platonic strategy could be saved by Klein's reformulation. To understand nature, one had to understand the type of geometry at work, its regular compositions and symmetries. This was the state of the art in 1872, when Poincaré started the analysis of stability in dynamical systems.. In the 1960s René Thom and others found and finally proved the classification theorem of catastrophe theory. Slodowy (1988: 77 ff.) showed that there is a correspondence between (Platonic) polyhedrons and symmetry groups, between Kleinian singularities and elementary catastrophes. I cannot go into this very complicated matter, but as a result we can say that the Platonic program, which had reigned for more than two millennia, was first generalized by the Kleinian program (1872) and later by catastrophe theory (based on insights of Poincaré). In all cases, interesting applications to the sciences were the immediate outcome.

5.2 Klein's theory of invariants and Cassirer's critique of its application to perception

In terms of a theory of perception and language, this means that:

a) The search for invariants by Klein may correspond to the extraction of object-entities from variable shapes in perception and to the formation of object concepts in semantics.
b) The catastrophe theoretical classification of stable process-scenarios may correspond to the perception, segmentation and recognition of basic events and actions and to the conceptualisation of valence patterns in sentences with a dynamic verb (Thom's conjecture).

Both directions of research argue in favor of geometry/topology as a fundamental source of principles operative in perception and symbol-formation (i.e., in language). This line of thought (in the state of Klein's program of 1872) was criticized by Cassirer. In the view of Cassirer, geometry is a relevant content first in *one* symbolic form, i.e., that of knowledge/mathematics. The phenomenology of knowledge ("Phänomenologie der Erkenntnis") is more specific *and* more general than the phenomenology of language insofar as language is an organon (tool) for many other goals. It enables us to penetrate intuitively into the ecology of man (also in myth, art, technique, ethics). The formal 'languages' of science have more specific (and restricted) purposes and devices which go beyond natural language. Therefore Cassirer's pluralistic view of symbolic forms forbids an easy

identification of mathematical geometry/topology and the conceptualization of space and process in language. But it does not forbid the transfer between different symbolic forms. Yet, the possibilities of comparison and transfer are an empirical question and not given a priori by the prominence of one of the symbolic forms or of perception and immediate experience. Moreover, the undeniable successes in the application of mathematical concepts to the natural sciences are no guarantee that they can be applied to the parallel symbolic forms. In an article published one year before his death, Cassirer shows that perception and Klein's geometry have many features in common, e.g., transformation, invariance, choice of the geometry (Euclidean, affine, projective, etc.). The search for invariance is a basic goal in both fields. The interaction of both fields may be exemplified by the work of the psychologist/physiologist Helmholz, who considered Riemann's mathematical results since 1868, and the mathematician Rieman, who was stimulated by earlier ideas of the psychologist Herbart. But Helmholz' search for a synthesis had to be corrected from both the psychological *and* the mathematical perspective.

> Just as Hering had to correct it from the standpoint of psychology, thus Poincaré had to correct it from the standpoint of geometry. (Cassirer, 1944b: 18.)

Cassirer hoped that the concept of invariance and group have enough power to be applied both to geometry *and* to the perception of shapes. This basic process enabled by the successful search for invariants is called 'objectivation' by Cassirer (ibidem: 20).

The evolutionary considerations above point to a fundamental relation between basic structures of space and time (their geometry), the phenomenology of human beings, and the symbolic forms (generalized media) they invent. If Euclidean and other geometries show up to be basic in physics, the poorer and more abstract topological invariance is a better candidate in symbol and concept formation. If perception is inhomogeneous as to its allowed transformations (e.g., depending on the distance of perceived objects), then language should be rather diverse or even incoherent in the application of geometrical invariants.

5.3 Singularity theory and the search for invariants

A straightforward solution for this problem has been found in singularity theory. One considers only the *local* neighborhood of a singularity (nonlinear change) and treats global analysis in a second, much more difficult step. If visual perception is able to compute a rather global visual field out of many visual-ocular sub-fields (as Husserl showed) by using a strategy of blending, overlapping maps, etc., this would roughly correspond to global analysis

where local environments are “glued” together and fitted into a mosaic of local maps. In language even this type of total, unitary representation seems to be difficult to achieve. Linguistic gestalts, e.g. texts are rather an ingenious kind of patchwork. If geometrical integration is low in language, there are other principles applying temporal (causal) order, logical/rhetorical relations and evaluative scales which can do the job of integration. The outcome is however in no way comparable to our perceptual field after a series of ocular motions and invariance calculations in the visual cortex.

It is good fate that we are not left with Euclidean geometry, have the choice of different geometries, of topology and differential topology, stability and bifurcation theory, global analysis, etc. Historically this is not just luck, because there was since Descartes and Kant an increased interest in the mathematical modeling beyond physics, in chemistry, in psychology, linguistics, sociology, and even in (analytic) philosophy. The relevant mathematics evolved just in time and this was a opportunity for the humanities. As the application of Thom’s program has been described in prior work by the author (Wildgen, 1982, 1994) and others (Petitot, 1992, 2004 and Brandt, 1992) I will not specify it here. In the next section I will compare basic hypotheses of Thom with proposals made by Leyton. In spite of all technical advances, the application of mathematical tools still is exposed to the philosophical critique made by Cassirer. It remains an *empirical* question, if and to what extent, in which sub-field mathematical models can give new insights and channel further developments.

5.4 Leyton’s “generative geometry” compared to Thom’s hypothesis about valence restrictions

If Cassirer was skeptic about a full application of Klein’s invariant theory to human perception, Leyton tried to put Klein’s program from the head to the feet. I shall therefore consider his proposals for a geometry of information in visual perception and language as a proposal for a formal (geometrical) analysis of the phenomenology of symbolic forms. In his book “Symmetry, Causality, Mind”, Michael Leyton introduced a concept of information based on causes and the recovering of a causal chain (this could be called an indexical theory of the sign in Peirce’s sense). In his latest book “A Generative Theory of Shape” he argues (in chapter 22: “Against the Erlangen Program”) for a new, even opposite strategy. I will comment his main arguments because they concern basically any geometrical or topological model in the sciences dealing with meaning and information.

Leyton's basic idea is that symmetric and regular forms (visual shapes and meaningful forms, i.e., symbols, words, etc.) are so neutral and invariant that they are devoid of specific information. Information comes about, if these archetypical forms are transformed, if symmetry is broken, etc. It is the history of these changes of an archetypical form which accumulates information. He writes:

> Klein defines geometry as the study of invariants under transformation groups. The phenomenon of invariance is really one of *memorylessness*, as follows: When one applies a transformation to an invariant, one will not be able to recover the transformation from the invariant. In other words, an invariant is not a memory store for the transformation. (Leyton, 2001: 495.)

In his definition of "Generative Geometry" Leyton equals a geometry with recoverable transformations with memory:

Geometry ≡ Memory Storage

I will show in the following that applied to language this program, which in Leyton (2001) is mainly applied to visual perception, robotics, and computer-aided design (cf. ibidem: VI), is basically a variant of Thom's program of morphogenesis of meaning (cf. Wildgen, 1982, and Petitot, 2004). The basic idea of information as causal history developed in Leyton (1992) allows a new analysis of valence patterns, which reformulates major intuitions of Thom's hypotheses. If we take the circle as the ideal (neutral) starting position, its deformation (cf. Figure 2) creates an ellipse (with two centers and two pairs of conflicting forces), then concave indentations from above and below and finally 3 (later 4, 5, ..) identations. I shall apply this type of shape generation to linguistic valence-patterns, where bifurcations (identations) are mapped onto syntactic patterns with 1, 2, 3, 4 (nominal/pronominal) centers (=complements of the central verb or "actants" in Tesnière's terminology).

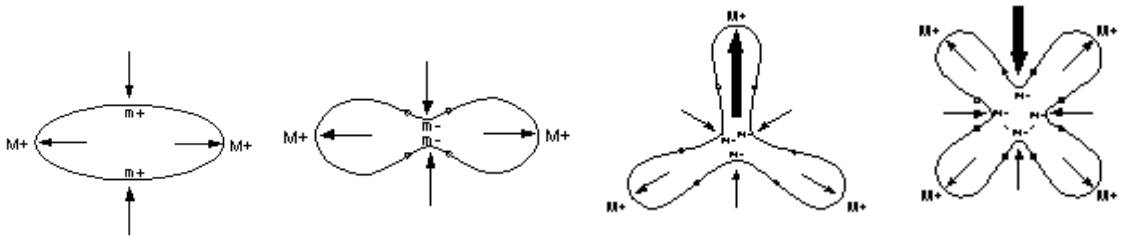

Figure 3: Examples of transformations which produce shapes with 0, 2, 3, 4 indentations (Leyton, 2001).

If a sentence is mono-valent, it corresponds to the situation of the ellipse, as no indentation has yet occurred. The dynamic structure of the ellipse (see the arrows) and the two

geometrical centers match with mono-valent sentences which have one noun phrase as attractor (cf. m+; the convex flattened curve) and one verb (as expression of the deformation; cf. the arrows). As soon as bifurcation occurs, m+ (convex) changes to m- (concave) (cf. Leyton, 2001: 2).

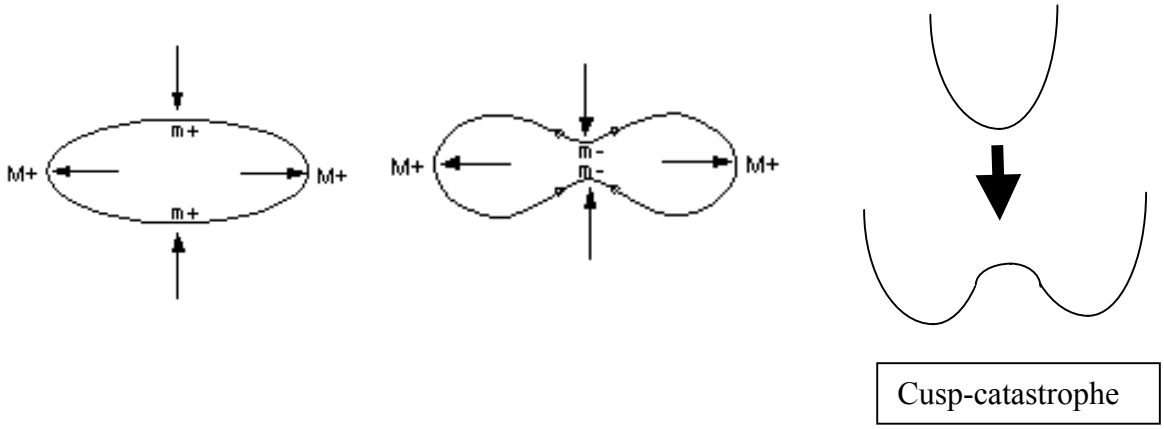

Figure 4: Geometrical analog of bi-valence (cf. Leyton, 2001).

The bifurcation and the forces in Figure 4 correspond to the dynamical content-type of the 2-valent sentence (e.g., with the verbs: catch, eject, enter, leave, etc. in the centre), the indentation separates two complements of the verb (or "actants" in Tesnière's terminology). The corresponding higher bifurcation pattern for three-valent sentences in Leyton's model is shown in Figure 5 together with the corresponding bifurcation pattern in catastrophe theory (cf. Wildgen, 1982: 42 ff and 1994: 49 ff).

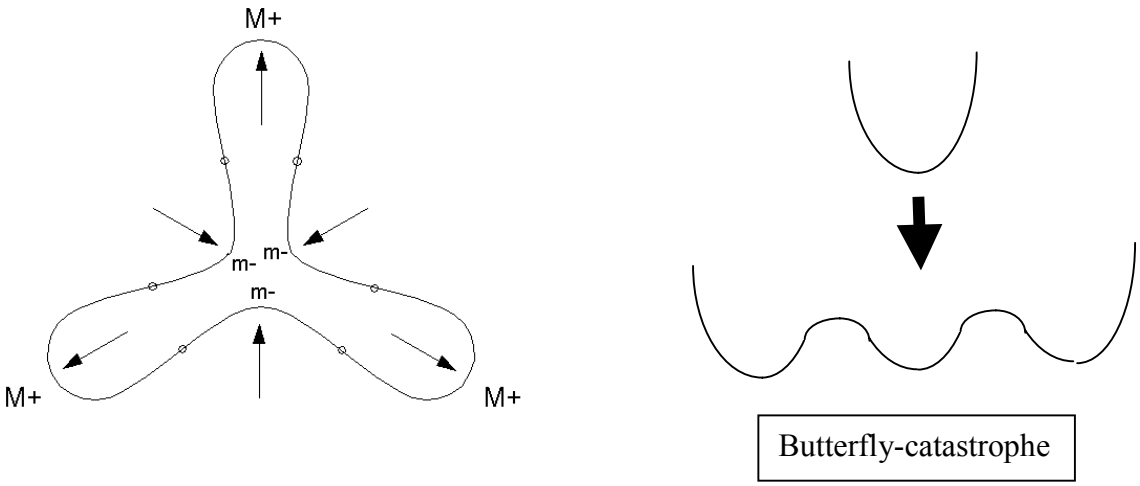

Figure 5: Shape with three indentations and corresponding unfolding in catastrophe theory.

Leyton's basic idea that information is causal history can be captured if the unfoldings with higher complexity in catastrophe theoretical semantics contribute to an unfolding "history". A state would be the zero-level and sentences would accumulate information in their progression from mono-valence to valence three. In an evolutionary context, this hierarchy could explain the transition from a protolanguage to a full-fletched language (cf. Wildgen, 2004b); i.e. at an evolutionary level the progression does not confer concrete information but enhances a schema of organization for possible contents which is more powerful and may integrate more complex information. This interpretation changes, however, dramatically the scope of Leyton's theory of information. The geometrical deformation is not a process valid for actual language use (producing a sentence and understanding it), it rather pertains to the evolution of language. Only indirectly can one consider recapitulations of evolutionary processes in ontogenesis (see Häckel's "law", which is only approximately valid) and possibly effects of this hierarchy in the creative use and further development of linguistic tools (in spontaneous linguistic creativity; cf. Wildgen, 2004b: chapter 6) and in poetry.

5.5 The relevance of invariants in the realm of symbolic forms

Symbolic forms are the stable result of a form-giving process, a morphogenesis in Thom's sense, which operates in a field which first depends on individual cognitive processes, e.g., on brain dynamics, where a steady flow of multi-sensorial inputs, memory retrievals and the construction of imaginary forms contribute to a hyper-complex but unstable product. Only invariants which may be extracted from these dynamics can control stable behavior. In social

communication, the hyper-complex product of interactions must again be reduced by the selection of invariant and stable forms. In this double selection of dynamically simple and stable archetypes, geometry as shown in this section becomes the key to the understanding of symbolic forms. In the frame of a tremendous "explosion" of complexity in the enlarged brain and at the higher levels of social exchange in human societies, the rather simple schemata discussed in this section gain crucial importance. If one neglects the genesis of the symbolic forms and considers just the products, e.g., a word or a basic sentence, the necessity of a geometrical analysis like that of Thom and Leyton seems to be implausible. The deep links between the dynamics of the world (cf. physics), of the mind (cf. neurodynamics), of societies and cultures (cf. socio-dynamics) with symbolic forms like language seem to be irrelevant or non-existent. This attitude made Saussure's dictum that the relation between "signifiant" and "signifié" is arbitrary seem plausible. But it is a garden path of linguistic theory and one has to come back and reconsider the motivations of this relation and finally the morphogenesis which produced it, if one wants to understand language and human cultures in general.

6. Conclusions

The recent history of a philosophy of perception, cognition and language reached a first climax in the work of Ernst Cassirer, who was able to integrate an epistemological debate at the end of the 19th century with mathematical achievements and modern developments in physics and psychology. His philosophy opened the way for a philosophy of culture and later contributions by Luhmann allowed a generalization to the economic, legal and institutional systems of modern civilizations. Cassirer's philosophy also overcomes the subjectivism implied by most of Husserl's phenomenology (and the follow-up system of Merleau-Ponty). As a consequence it allows for a cautious attempt to find basic (natural) laws underlying the creation of symbolic forms. However, Cassirer remains rather skeptic vis-à-vis a geometrical reduction of perceptual mechanism (as in the application of Klein's theory of invariance to human perception). The final section compared two mathematical endeavors which apply more advanced mathematical tools, discovered after Cassirer's death: catastrophe theory (Thom, 1972/1975, 1983) and generative geometry (Leyton, 2001). It is surely a tremendous task to find basic laws underlying the formation of symbolic forms, but it seems to be the only way to achieve permanent scientific progress in this field.

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