René Thom's Semiotics and its Sources

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This paper introduces to the sources of René Thom's theory of meaning. It does so in an almost systematic, yet unhierarchical manner, by way of encyclopedic entries, as it were. However, the first four entries address the way in which Thom developed his catastrophe semiotics on grounds of his morphodynamical investigations in biology. This reflects, of course, our understanding of Thom's semiotics as being deeply rooted in his mathematical and biological thinking. We do evidently not claim to be exhaustive, as will be clear form our closing statements, but we do hope and aim to capture essential influences on René Thom's original, both genetical and structural determination of meaning, the nature of meaning, and the naturality of meaning – thereby also providing an understanding of the original synthesis which Thom's semiotics constructs from these sources..

Mathematics, Biology, and Meaning

As an integral part of his famous Theory of Catastrophes, René Thom developed from the mid-60s and onwards, a semiotics. This semiotic theory develops out of the basic ideas of Catastrophe Theory (CT) to draw inspiration from a long series of theoretical sources in biology, philosophy, linguistics, semiotics, etc. This development has the main character that while the decisive impetus of Thom's semiotics comes from the mathematical-biological kernel of CT, the further development of the theory draws on an eclectic amount of inspiration from different sources. Main such sources are biologists such as C.H.Waddington, Jakob von Uexküll, Kurt Goldstein, Max Delbrück, Konrad Lorenz, d'Arcy Thompson, linguists such as Lucien Tesnière, Roman Jakobson, Kenneth.L. Pike, J. Ross, Hansjakob Seiler, philosophers such as Aristotle, Kant, Husserl, Charles S. Peirce, psychologists such as Wolfgang Köhler, and sociologists and anthropologists such as Frazer, Durkheim, Lévy-Bruhl and

Gilbert Durand.[1] In this paper, we shall try to provide an overview over the most significant sources to René Thom's semiotics for two purposes: 1) to demonstrate and fine-tune his place in the recent developments of semiotics; 2) to argue for the originality and fertility of Thom's integrated semiotic speculations, disseminated in various papers and books as they remain. Thom's semiotics is intimately connected to his overall ideas concerning biology and epistemology. In a certain sense, it constitutes an original doctrine of biosemiotics, or, as Jean Petitot has it, a biolinguistics.

Thom once indicated the seminal idea of Catastrophe Theory[2]: he was at a conference at a German castle where he saw a series of large plaster castings depicting the different phases in the embryological development of a frog from fertilized egg and to the grown-up, phenotypical creature. Thom immediately realized that this long process might be described as a continuous topological unfolding of discontinuities in a continuous medium, realizing the final, topologically complex shape which in some sense had been potentially present in the seemingly symmetrical simplicity of the fertilized egg. The egg, hence, was governed by a topological singularity, and the ensuing development could be described mathematically as the successive unfolding of that singularity. The beginning of CT, hence, was based on the idea that the topological structures Thom had studied in differential topology and singularity theory might be applied to the enigmas of phenotypical biological form which during the same period was slipping into the background in the focus on the genotype after Crick and Watson's DNA discovery. The mathematical core of CT is the so-called "splitting lemma" which states that in complicated differential equations in many variables, the singularities or the catastrophic points may be encapsulated in a small number of these variables. This lemma is essentially based on genericity arguments (it is improbable that many different variables stably reach non-generic catastrophic values at one and the same time). This gave Thom the basic idea in CT: viz. that in complicated processes in biology (and, later, in

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[1]   This indicates only main inspirations. Many more such influences can be traced, both negative and positive, such as biologists like Cuvier, Geoffroy Saint-Hilaire, Goethe, Lamarck; philosophers like Carnap, Cassirer, Derrida, Frege, Heidegger, Nietzsche, Leibniz, Russell, Stumpf, Wittgenstein; the linguists Benveniste, Chomsky, Granger, Greenberg, Harris, Sapir, Whorf; mathematicians as Brouwer, Riemann, Poincaré, Weyl, Zeeman, theorists of science like Boltzmann, Cavaillès, Cohen, Pierre Delattre, Hertz, Gerard Holton, Jean Largeault, Jean Petitot, Popper, Charles Renouvier; semioticians as Eco, Hjelmslev, Propp, Sebeok; psychologists and sociologists as Freud, Lacan, Lévi-Strauss, Weber. We shall intermittently touch upon some of them in what follows.

[2]   Personal communication.

semiotics, sociology, anthropology, etc.), any abrupt changes taking place have their background in few variables only and may hence be charted independently of the complexity of the underlying process. This is why CT is essentially a phenomenological theory: it claims that in many interesting cases in biology, it is possible to bracket the detail of the underlying biochemical process and describe only the set of possible discontinuous changes ("catastrophes") on the surface level. The possible inventory of such sets of abrupt changes would then reduce to the seven "elementary catastrophes"—the simplest set of discontinuities in continuous, differentiable functions. These seven catastrophes are the only such sets of discontinuities which result from four or less variables only. This argument, thus, initially depends on a basic spacetime realism, taking four simultaneous variables to correspond to one dimension each. This argument, of course, restricts the scope of the theory to the realization of the catastrophes in spatio-temporal form. Later, Thom was influenced by his British colleague Christopher Zeeman to modify and generalize this idea in a very important manner: to apply the CT formalism to the black box metaphor of system theory. If the underlying complex continuity was seen as a black box, the catastrophe variables need no longer be tied to spatiotemporal dimensions but might refer to any set of coexistent variables, and the resulting catastrophes hence taking place not in spacetime only (like optic caustics or embryology), but on all levels of more or less abstract behavioral spaces it is possible to chart in the scope of the theory, thus opening CT to modeling different behavioral discontinuities in biology, semiotics, sociology, political science etc . The base, however, remained: that CT permitted the distinction between the whole of a complex process, involving all variables and processing continuously in a slow dynamics, on the one hand—and the small, discontinuous part of the same process, involving few variables only and charting the quick, catastrophic changes of behavior. Zeeman's idea implied that the latter, catastrophic part of the system's behavior might even be described without any reference at all to the underlying dynamic and to the character of the variables involved. This gave CT the character of a phenomenological theory describing surface behavior of very different systems irrespective of their underlying physical or other substrate and immediately gave the theory a semiotic aspect: the possibility that stable aspects of the discontinuous surface phenomenology served as signs referring to the underlying more complex process.

C.H.Waddington

Thom's immediate application of catastrophe theory, however, concerned biology, and in a basic sense his semiotic core ideas spring out of catastrophe theoretical biology. One of Thom's basic inspiration was his friend C.H. Waddington and his concepts of "chreod", "canalization", and "epigenetic landscape".[3] Waddington coined this concept cluster in order to describe the epigenetic development of organisms which he did not see as an immediate effect of the genetic code. His idea was that the developmental possibilities inherent in the metabolism of the fertilized egg could be described by a landscape of potentialities where the development followed stable pathways of lowest energy — so-called "canalization" — what we would nowadays describe as the attractors of the dynamic system of metabolism. This model unites local determinism with global indeterminism on isolated spots in the landscape where the paths of lowest energy branch. (Fig. 1)
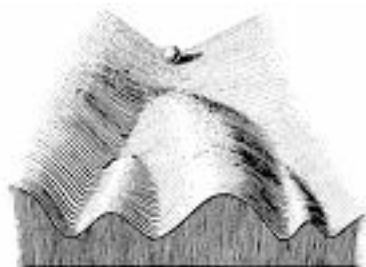

Figure 1 Waddington's epigenetic landscape. The path followed by the ball represents the development of an organ with its potential alternatives (branching points). As the ball rolls down it will meet a first alternative toward the left or the right, etc. Along each channel it will again be met by left/right alternatives at local bifurcation points.

Waddington's idea was that the function of genetic information was to influence the path taken at such bifurcation points — as a counterargument against the developing Neo-Darwinist doxa claiming that genetic information was in some sense the only and effective cause of the whole ontogenetic development. Waddington's model thus aimed at integrating metabolism (the general "landscape") and genetic information (determining the path at bifurcation points in

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[3] Waddingtonian ideas feature prominently in Thom's chef-d'œuvre *Stabilité Structurelle*, and during the writing of this work in the mid-60's Thom was in close contact with Waddington. Later, Thom summed up this inspiration in a short paper " "An inventory of Waddingtonian concepts" (Thom 1987b).

that landscape), and his concept of "chreod" now referred to the tree structure of a distinct bouquet of such branching pathways in the landscape.[4] Thus, Waddington's landscape model offered a general geometrical, if speculative and non-specific, model which 1) gave an idea of how development integrated local determinism with (restricted) global indeterminism given by the set of branching possibilities, and 2) provided a model for the differentiation process taking place during epigenesis where the initial undifferentiated fertilized egg in the course of successive generations of cell division differentiates into the around 300 highly different cell types in the mature organism; the branching points now being interpreted as simultaneous different pathways for different cell lines.[5] It is obvious how Thom saw the possible topological applications of his model. Waddington's potential landscape as such formed the catastrophic surface of the vast underlying complex continuity of metabolism, and the bifurcation points between pathways constituted the non-generic catastrophe points of the surface. Thus, Thom saw the possibility of CT providing parts of a Theoretical Biology, that is to say furnishing biology with qualitative mathematical models and morphological concepts ("chreod", "canalization", "landscape", "pathway", "branching point", etc.) transgressing the purely biochemical and genetic level. Especially the issue of cell distinction occupied Thom who had the idea that the spatial arrangement of cells and organs in the organism and their differentiation into subtypes formed two aspects of the same basic topological process. This immediately had semiotic implications because cell subtypes (different muscle cells, nerve cells, skin cells, bone cells, etc.) have immediate "semantic" interpretations tied to the purpose of the corresponding organs. This is why Thom's semiotics begins already with ontogenetic biology.

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[4]   In *Stabilité Structurelle*, Thom presented a generalized notion of chreod relevant for all dynamic processes, but later he claims both Waddington's concept and this model were doomed from the beginning because of the impossibility of making them quantitative (Thom 1987b). This conclusion might seem strange, given the deliberately qualitative, non-quantitative character of much of CT in general. On other occasions, indeed, Thom seems rather unaffected by the non-quantitative character of the CT models. He often remarks that Zeeman was wrong in assigning such properties to them while remaining himself quite satisfied with their qualitative nature. The position is summed up in the title of his 1993 book *Prédire n'est pas expliquer*, that is: to predict (in terms of quantitative models) is not to explain (qualitatively)..

[5]   As Thom also recognizes, there are thus two different interpretations of the bundle of pathways in the epigenetic landscape. One is temporal, the branching points indicating different parallel temporal development possibilities where the realization of one rule out the other(s). The other is spatial, the branching points now indicating a spatial splitting of the process into subprocesses, so as for instance different cell types.

One of Thom's greatest achievements—according to his own judgment—is thus his semiotic interpretation of the earliest phases of epigenesis, leading from the sphere- and later ball-shaped morula over the cringing-in process to the bell-shaped blastula providing the first primitive inner-outer distinction in embryological development. From this, gastrulation takes place when the two germ "leaves" of the blastula are supplemented with a third, intermediary germ leaf. The innermost germ leaf of the gastrula now develops into the digestive tract, the intermediary leaf develops into the bone-and-muscle systems of the body, while the outer leaf develops into the brain and nervous system. During gastrulation, the intermediate leaf stretches out from the inner leaf and connects to the outer one—which Thom interprets as the hungry digestive tract which by means of the muscle and bone system catches a prey in the outer world (the prey being represented in the nervous system). Thus, the very intentionality of the organism is, according to this interpretation, already instantiated in the relation between the three parts of the gastrula in early epigenesis. Moreover, this form also instantiates the basic syntactic molecule in linguistics, the SVO formula, paving the way for Thom's idea that the understanding of a sentence is the unfolding of the simple form of the linguistic signifier into a tree structure, homologous to the unfolding of the fertilized egg in embryogenesis (and mirror-wise, the syntactic expression of a content as the "packing down" such a tree to germ form). In general, then, Thom has the idea that each bodily organ forms a stable threshold value in the unfolding topological shape of the body, so that each organ from the beginning is integrated as a specific phase in metabolism, regulating discontinuous catastrophic processes in the organism. This later becomes important for Thom's general interpretation of nouns in linguistics (see below). Metabolism thus becomes very important for Thom's outline of a theoretical biology: organs are seen as stabilizers facilitating catastrophic transformation processes in the organism without endangering its overall stability—the general stability of the organism in contrast to the ongoing chemical process of metabolism being the number one question in biology according to him. Thom's general idea of an animal, then, is that it is a complicated metabolism having a relatively small number of stable states. One such state is when all its basic needs are satisfied, but as soon as the animal due to ongoing metabolism lacks water, food, safety, sleep, sex, the state of the organism deteriorates to a lower stable state from which it has to perform a specific, catastrophic action to return to the optimal state. If it does not succeed, an even lower stable state awaits it in the limit: death. Biologic metabolism is thus intertwined with the characteristic behaviors in which the animal must indulge in order to protect and continue metabolism—behaviors which have a characteristic discontinuous

character (preying, mating, drinking, sleeping ...) and which may be described in simple catastrophes pertaining to the macroscopic state and behavior of the organism.

This is also why some of Thom's most important semiotic inspirations in his "biolinguistics" stem from early ethologists such as Lorenz, Pavlov, and von Uexküll.

Thom's theory of the sign

Thom's theory of the sign consequently differs much from the structuralist ideas of the arbitrary connection between signifier and signified, expression and content. To him, rather, signs are generally motivated: the signifier is motivated by its signified because of basic biological efficacity, and arbitrarity effects as found in language are derivative and later than the basic semiotic motivation. Signs emerge from animal behavior related to the large types of behavioral regulation (discovery of prey and predators, recognition of sexual partners, etc.). When the tick smells the butyric acid molecules announcing the presence of a mammal or when the predator recognizes the profile of its prey, the signifiers involved are engendered by their signifieds, Thom will say. The signifieds, however, are not only the mammal and the prey, respectively, because they are only rendered significant/they only carry meaning by virtue of the whole setting, by the whole functional circle involving them, as von Uexküll would have it (see below). It is rather the whole dynamic complex of the predator and the prey taken together which is the signified that engenders the signifier, in the same way as it is the whole epigenetic landscape of ontogenetic development which engenders the significant aspects which are the organism's organs. Thus, Thom's distinction between signified and signifier is built on his basic CT idea of the distinction between the underlying, slow, continuous dynamics which contains as an aspect the phenomenal, fast, discontinuous dynamics. The catastrophic surface is engendered by the underlying dynamics in exactly the same way as the signifier is engendered by the signified—in that way the whole of CT already forms a semiotics. It is the fact that the same basic processes give rise to the same typical catastrophic surface behavior which makes it possible for that surface behavior economically to function as a sign, making it possible for other complicated systems to relate to it in a simple, catastrophic way. This lies behind many of Thom's central dicta (say, "When you use the word information, you should rather use the word form" because it is the propagation of

characteristic surface catastrophic form from one system to the other which constitutes information). This also lies behind Thom's basic distinction between nouns and verbs; the latter being basically characterized by referring to typical interactions between actants, while nouns refer to the actants as such. This is why Thom may say seemingly strange things such as that all nouns are basically animals (they are characterized by the different stable states they may change between, and by the kind of characteristic actions (describable by verbs) they may perform to so change between stable states). Thom tried formally to base this sign concept in a model where signs are seen as the propagation of simple, catastrophic forms between metabolic systems. This entails some interesting ideas: 1) the sign being necessarily energetically "small" in comparison to the involved systems, 2) the affected system necessarily possessing a receptor part with a high degree of sensitivity which may easily be coupled with the sign—as well as an "amplifier" able to pick up and reinforce such signs from the receptor system, 3) the necessity of a stable—non-chaotic—coupling between the two communicating metabolisms, necessitating the (relative) simplicity of the sign as well as its structurally stable character.

Jakob von Uexküll

The German-Estonian biologist Jakob von Uexküll appears early in Thom's semiotic essays. In fact as early as in the path-breaking "Topologie et signification" from 1968 where he is mentioned along with Kurt Goldstein as the main introducer of the concept of signification in biology prior to the DNA discovery. Their efforts "pour reconstituer les unités significatives du comportement animal ou humain" (in view of reconstituting the significant units of animal or human behavior) are, however judged too finalistic. In *Structural Stability and Morphogenesis* (Thom 1972, English translation 1989), this judgment seems changed, and especially Uexküll's late *Theory of Signification* is referred to. Uexküll is quoted for the idea that

> The mechanism of any machine—consider for example a watch—is always built up centripetally, meaning that the various parts, the cogs, springs, and fingers, must first be completed and then mounted on a common support. As opposed to this, the growth of an animal, for example of a *Triton*, is always organized centrifugally from its germ which first develops into a gastrula, and then constantly sprouts organ buds. There is an underlying construction plan in both of these cases; for the watch, the plan controls a centripetal process, in the *tri-*

ton, a centrifugal process. It seems that the parts are assembled according to diametrically opposite principles. (Thom 1989, 254))

The idea is that animals and machines share the same, basically teleological nature, but have quite different construction principles; the former being centripetal in the sense that all parts must be produced before assembly, while the latter are centrifugal because epigenesis takes place by the unfolding from a germ in successive distinctions creating the single organs so that parts are continuously differentiated out of a pre-existing whole.

Only later, Thom widens the reference to Uexküll's theory of signification, most often in connection to his own development of the doctrine of "saliency" and "pregnancy" (see below). Saliencies are perceived physical Gestalts while pregnancies are biological significations which an organism, for innate or conditioned reasons, may ascribe to such salient forms. Pavlovian conditioning, now, is described as the possibility of associating a new saliency (the bell sound) with a pregnancy-bearing saliency (feeding), thus investing this pregnancy in another form, causing appropriate action to be performed (salivating) when the new saliency only is presented. (Thom 1981). The original pregnant form (the presence of edible objects) is seen as significant in the sense of von Uexküll's theory of certain objects possessing biological signification for an organism (cf. Thom 1986)—because the perception of such forms triggers large scale hormonal and motor reactions in the organism. Pregnancies may thus spread in chains of associations from one saliency to the next—by the Frazerian laws of similarity and proximity—so that pregnancy may spread "in the phenomenal field of experienced forms as an invading fluid which propagates through the those cracks in the field which are constituted by the salient forms."[6]

Uexküll's theory is his famous "functional circle" which places the organism in the flux of two types of signs, the incoming "Merkzeichen" (perception signs), the outgoing "Wirkzeichen" (action signs), related to the same object which the organism only keeps contact to through these signs. Thom does not explain this theory in detail, but it is evidently the idea that the organism is able to respond adequately to a few select environment objects to secure its own stability only if it is able to interpret the relevant perception signs and respond with the relevant action signs. Uexküll's tick description is—just like in Uexküll himself—taken as the prototypical example, and Thom repeats it on several occasions. Uexküll's import on theoretical biology is identified with the

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[6]   "[...] dans le champ phénoménal des formes vécues, comme un fluide invasif qui se propage à travers les fissures du champ que constituent les formes saillantes." [6] (Thom 1991a, 68).

"pregnancy" in Thom's developed version of his theory (see below). The tick waits, according to Uexküll, on a leaf or a twig for the smell of butyric acid which immediately makes it let go and fall in order to hit (hopefully) the fur of the mammal for which the acid served as a sign. With a rudimentary sense of heat, it crawls to the hottest spot on the skin of the animal (where the skin is thinnest) in order to be able to bite through the skin, suck blood and procreate by parthenogenesis. As Thom writes, the reproductive cycle of the tick is thus tied to a very small number of signals (or indices, Thom 1991a - rather, in fact, they will be symbols in Peirce's terminology) which Thom calls "prégnances" in his biological use of the word as opposed to the mere physical Gestalts of saliencies.[7] Only certain olfactory and thermic forms are relevant signs in the tick's *Umwelt*. Thus, the tick example goes to show the degree to which meaning is rooted in early biological development, long before man: "Any stability, any homeostasis in the living being rest on the possibility of almost instantaneous recognizing wchich are of vital importance and of responding adequately to them."[8]

The combination of Uexküll's theory of meaning with the Gestaltist notions of pregnancy and saliency, consequently, gives a biological basis to Thom's theory of meaning, founding, in turn, both his linguistic and his epistemological ideas.

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[7]   Without mentioning it, Thom's distinction between pregnancy and saliency goes into an internal tension in Uexküll's work. In his earlier writings, so as for instance his *Theoretische Biologie* (1920/28), Uexküll saw that higher animals have large capacities for perceiveing "Merkzeichen" *without* any immediate biological signification (as for instance, in their charting and mapping of their environments) while only certain, privileged objects within that environment are able to release the catastrophic activity in the organism and thus qualify as part of the "functional circle" of the animal. In the later *Theory of Signification* (Uexküll 1940), the simple function circle of the tique is taken as prototypical and generalizable for all organisms so that all animal perception is taken to be significant — thereby deleting the earlier distinction between significant and non-significant forms. Thom's development, interestingly, goes in the other direction: while taking the older Uexküll's simplistic theory as his point of departure, Thom, as it were, reinvents the more sophisticated distinction of the younger Uexküll, saliency corresponding to the "neutral" objects of higher animals, while pregnancy is that biological signification which only certain of such objects possess.

[8]   "Toute stabilité, toute homéostasie chez l'Être vivant reposent sur la possibilité de reconnaître quasi-instantanément les stimuli d'importance vitale, et d'y répondre pertinemment." Thom 1991b, p. 2.

Structural Linguistics (Ferdinand de Saussure, Roman Jakobson)

Elmar Holenstein (1992) once reported that Roman Jakobson had considered the three greatest structuralists to be Prince Trubetzkoy, Claude Lévi-Strauss, and René Thom. Thom, in contrast, does not seem to have been sufficiently influenced by Jakobson so as to express any corresponding acknowledgement or gratitude. The same goes for his relation to Saussure (or to any other major structuralist for that matter, with few exceptions, cf. below). In the *Oeuvres complètes* (Thom 2003), Saussure and Jakobson are each mentioned in about 20 texts, and mainly, almost exclusively, in general terms (of the sort "the arbitrarity of the sign" according to Saussure, or "the paradigmatic and syntagmatic axes of language" according to Jakobson, etc.). In fact, when going through his first texts on language, one cannot help getting the impression that first Thom developed his own theory of language (his topological syntax), only upon which he discovered linguistics.

On a couple of occasions however, Thom makes quite extensive use of both Saussure (negatively) and Jakobson (positively) to develop two fundamental aspects of his theory of language, which simultaneously make out two fundamental epistemological problems in linguistics in general: (1) the problem of developing a "morphology of meaning" or (of "the signified" as he puts it with reference to Saussure) in view of establishing an intelligible relation between language as a symbolic form of expression and the contents expressed by language (a "de-arbitrarization" of the sign system, as it were); (2) the problem of overcoming the antinomy between description and explanation, structural and genetic, formal-immanent and causal-transcendent determinations of language. Let us briefly take a look at both of the two issues.

In "Topologie et linguistique" (chapter 11 in Thom 1980a), Thom remarks that if we adopt a Saussurean view on language and thus define it as a system of signs, then only one aspect of the sign seems amenable to objective description, namely the physical one, the signifier, while the signified, being accessible only through introspection, escapes all third person determination. In Thom's eyes, this state of affairs is paradox, if not simply an aporia, insofar as our folk understanding of language and the function which language serves calls for a robust link between what we have in mind (the signified, or our meaning intentions, as Husserl would have put it) and the expressive form that articulates it (the signifier). In short, it seems crucial to determine the passage: signified -> signifier. Now in a Saussurean framework and by virtue of its herostratically famous "arbitrarity of the sign" this issue can simply not be addressed. As Thom con-

cludes, in the last analysis, this dogma entails that everything about language can be described and explained except how and why it articulates meaning.

The problem raised here is probably one concerning the *encoding* of pre-linguistic representations in language. It has two aspects: 1) representations, or the signifiers, are endowed with a form, a structure which precedes their linguistic articulation; 2) if such representations are to be expressed faithfully language must dispose of means (semantic forms) in virtue of which it can express these structures. From such a perspective, the Saussurean transformation from amorphous signified -> formed signifier, which in this framework remains opaque (to say the least), can be readdressed in the following terms: we can consider the level of the signified as a structured domain, a *morphology of meaning*, and thus consider the signified-signifier relation as a *mapping* of this morphology onto the morphology of language. The issue is then no longer addressed in terms of the arbitrary link between signifier and signified, but in terms of a re-articulation of one order in another order. In other words: the fact that the relation between signifier is arbitrary at a local, intra-sign level, does not imply that the relation between the sign system and its object is globally arbitrary, since the former is supposed to simulate the latter. Inspired by Zeeman, Thom has the idea that pre-linguistic content may be seen as a manifold in many dimensions R^n (in turn possibly referring to a state-of-affairs with similar or even greater dimensionality). If such a content is to be linguistically expressed, it must be cut up into R^4 pieces able to be rendered in single minor events. These events, in turn, must be projected onto the linear one-dimensional string of syntax so that formally, the encoding of content is a mapping $R^n \rightarrow R^4 \rightarrow R$, necessarily losing some of the content originally present, in order to attain the simplicity and stability of syntax. This analysis of semantic content into pieces accessible to syntactic representation of course requires a mirror process of synthesis to take place in the receiver.

Now, the semantic forms are the linguistic counterpart to the experienced structure. As regards the crucial representation of events, these are, Thom claims, evoked by the verbs whose schematic meaning simulates the external event type they designate or refer to (cf. below on Lucien Tesnière). Obviously, the validity of Thom's solution to the problem rests on the possibility of producing a consistent determination and delimitation of the semantic forms and their corresponding event types. On the other hand, the way he states the case seems to address a key issue in any research program within semiotics: 1) Man is characterized by his capacity to organize sense data into pre-linguistic representations of the external world which are faithful simulations of core aspects of the spatiotemporal processes they refer to. 2) Whatever the origin of language

is, one of its fundamental functions must have been to communicate relevant information about things and events in the environment. 3) Thus, language must be capable of faithfully describing basic structures of spatiotemporal events and must therefore dispose of means to encode such information (a morphology of meaning). 4) It is one of the tasks of linguistics to explain how the structure of our representations is encoded in language, in terms of a morphology of meaning.

In short, Saussure is the, as it were, negative backdrop of Thom's realistic conception of the relation between language and thought, and between thought and the structural makeup of the objects it refers to. The Saussurean lexicon allows him to stress the difference between the arbitrarity inherent to a morphology of the signifier (in its relation to the signifier), and the motivated nature of the morphology of the signified (in its relation to structure in the environment).

Now, as regards Roman Jakobson, the only time he is invoked in non-general terms and in a rather extensive quotation (something Thom is far from being accustomed to) is in an epistemological discussion which is at the heart of Thom's early ventures into the domain of linguistics. The discussion concerns the classical *Genesis/Geltung* problem (origin vs. validity) and thus addresses the classical antinomy between casual-reductionist and formal-structural approaches to language; an antinomy which Thom, in the vein of Jakobson, sets out to overcome. Roughly speaking, the antinomy—or the aporia—consists in the sorry alternative between considering language

1. as a non-autonomous system and explaining it in terms of some other system of constraining properties (relative to, say, the organism which uses language, its psychology, its (neuro)-physiology; its phonatory and auditory system, its ecology, history and sociology, and so on): in which case the object—Language—is denied any ideal, general properties (it is no object proper, no *Gegenständlichkeit* as Husserl would have put it), and it is as a result reduced to being an epiphenomenon of the positive existence of its material cause;

2. as a self-contained formal symbolic system determinable solely in terms of its own intrinsic relational or structural properties, independently of any extrinsic reality, purpose, function, or relation to other cognitive domains (perception, reasoning): in which case you may obtain a relatively faithful description of language—on the grounds of a purely immanent grammatical a priori—which has a negative counterpart, though: the incapacity of motivating and explaining the emergence and the very nature of the formal

structures governing the linguistic system: ”where do the structures come from?” as Thom enjoyed asking.

It is while evoking the Scylla of reductionism and the Charybdis of autonomism that Thom (1974) refers to Jakobson's cognate concern:

> […] if we do not thoroughly combine the complementary notions of autonomy and integration, our attempt will be led astray: either the prosperous idea of autonomy will degenerate, as all particularisms, into an isolationistic and self-destructive prejudice, i.e. a sort of separatism or apartheid, or we go in the opposite direction, whereby we compromise the sound principle of integration by substituting the indispensable autonomy with an infelicitous heteronomy (or 'colonialism')" (Jakobson, *Essais de linguistique générale*, II, p. 256; our translation).

Catastrophe Theory as applied to linguistics is in Thom's view a way of overcoming this state of affairs. On the one hand it supplies with a morphological description, thus doing justice to the phenomenological autonomy of language as a higher order object (again: a Husserlian *Gegenständlichkeit*), on the other hand it is as such a theory that aims at motivating the nature of the morphological structure of language, since the structure is determined in terms of the externally realized and syntactically simulated conflict between two or more forces/actants. As Thom himself claims:

> For the catastrophe theoretician the structure is no ”*a priori*" fact, it does not belong to some Platonic empyrean. It is a direct result of the conflict between two (or more) forces which generate and sustain it. This makes it possible to develop a classification of forms as well as an algebra, a combinatorial system of forms on a multidimensional space […] We are now close to perceiving the outline of a dynamic structuralism which reintegrates causality and time and thus appears as a general theory of forms which is independent of the specific nature of the substrate space" (Thom 1974, p. 245, our translation).[9]

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[9]   Pour le théoricien des « catastrophes » la structure n'est pas donnée « a priori », elle ne sort pas d'une empyrée platonicienne. Elle est directement issue du conflit entre deux (ou plusieurs) forces qui l'engendrent et la maintiennent par leur conflit même. Ceci permet de développer une classification des formes, ainsi qu'une al- gèbre, une combinatoire des formes sur un espace multidimensionnel ; ainsi, les possibilités de l'approche structurale se trouvent-elles considérablement augmentées, et en expliquant la morphologie par un dynamisme sous-jacent, on peut rompre l'antinomie des tendances réductionniste et structurale. On peut, en e et, faire une théorie rendant compte des mécanismes de cause, et classifier les formes archétypes qui passent par couplage causal d'un substrat à un autre. Ainsi, s'entrevoit la possibilité de créer un structuralisme dynamique, qui, réintégrant la causalité et le temps, se présenterait comme une théorie générale des formes indépendante de la nature spécifique de l'espace substrat."

Lucien Tesnière (and Aristotle)

Thom endorsed a basic form of Aristotelian realism throughout his whole intellectual life. This is, of course, explicitly the case in his *Sketch of a Semio-Physics* (Thom 1988) and its outline of a common sense ontology based on a reinterpretation of Aristotle's Physics as a charting of naive physics, but it is already key to his early conception of the relation between mind and matter. In his view, perception is a question of *extracting form* or *structure*, i.e. *morphological information*, from the matter in which it is realized. Perception is, roughly speaking, a "transfer of form" from matter to mind, and this is indeed to be taken in a literal, strong sense: the state into which the mind stabilizes, corresponding to the understanding of the experienced object, is a state which rests on the same structure than the object itself; to perceive is to take in a form from one domain, the physical realm, a form, which is then re-unfolded in another realm or domain, the soul or the mind. Hence, Thom's Aristotelian punch line: "the message which has an autonomous meaning inherits its structure from the external catastrophe it intends to mean" (Thom 1972, p. 329); the *content* of the intentional act is thus claimed to possess the same structure as the *external object* it refers to. This entails that the meaningful representational states in the brain are governed by the same morphogenetic principles than the phenomenal manifestation of their reference objects (things and processes). If this is so—that is if such Aristotelian hylomorphism obtains, then, obviously, a major task consists in laying down the types of structure (or catastrophes, to use Thom's term) which organize the interaction between spatial entities and thus make out the scaffolding of those general processes and events humans perceive and conceptualize. In its semiotic versant Catastrophe Theory sets out explicitly to establish this: it aims to lay down the principles which govern the semiotic interface between phenomenal forms and representational forms.

Now, this formal isomorphism between the structure of objects (in the broad sense, including event types) and the structure of perception transposes directly to Thom's topological theory of language. The structural form of the object is not only re-unfolded in content of perception, but also in and by the structure of the symbolic system in which such contents are expressed, i.e. language. In other words, Thom claims that the principle organizing the combination of meaning-carrying units in language corresponds to the principle underpinning the configuration of phenomenal parts into intelligible wholes in perception. The rationale of this claim is biological: it seems sensible to suggest, as Thom says (1980a: 180), that language has evolved from the necessity of (or the advantage inherent in) conveying to others the significant changes

(i.e. the catastrophes) in the environment. This entails—as Thom with no further argument asserts—that the syntactic structure "naturally" reflects the dynamic structure of the external catastrophe. But how, then, is the dynamic structure of the external catastrophe actually encoded in language? To which extent can it make sense to claim that one and the same principle of organization should be active in two realms as apparently different as the linguistic and the perceptual?

Here, Thom is standing on the shoulders of the founding father of modern syntax, Lucien Tesnière (1893-1954), who in 1934 published the article "Comment construire une syntaxe" which preceded his monumental work on structural syntax, posthumously published in 1959 with the title *Eléments d'une syntaxe structurale*. As a matter of fact, Tesniére counts among the most important linguistic influences on Thom, as he puts it rather bluntly: "Personally, only two linguists have taught me something: Lucien Tesnière (Bloomfield's contemporary as regard his use of graphs) and Hansjakob Seiler, German linguist who founded a universalist group in Köln."[10]

In the following we shall very briefly present some of the tenets of Tesnière's syntax, establish the affinities to Thom's topological syntax as well as point to a couple of differences.

Tesnière defines syntax as a system of dependence relations with superordinate and subordinate lexical entities. Syntactical analysis, thus, consists in laying down the hierarchy of connections between lexical entities in a sentence. In 'my old friend', 'friend' is the superordinate word, whereas 'my old' are the subordinate terms ('old' being the superordinate of 'my'). In 'my old friend Alfred reads a book', the highest superordinate term is 'reads', whereas 'Alfred' and 'book' are the immediate subordinate words with each their subordinate expressions. Now, key to Tesnière's theory of syntax is the notion of *valency*. As just suggested, Tesnière places the verb or the verbal "knot" on top of the hierarchy of connections. It is the core element of linguistic expressions and Tesnière defines it in terms that are readily transposable to recent grammars' use of argument-role structure and the like. "The verbal knot," Tesnière says, "expresses a real small drama. As a drama it indeed comprises a process, and most often actors and circumstances." (Tesnière, 1959: 102, our translation). Now, the number of "actors"—or to use Tesnière's own and in continental

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10   "Personnellement, seuls deux linguistes m'ont appris quelque chose : Lucien Tesnière (contemporain de Bloomfield pour son emploi des graphes) et Hansjakob Seiler, linguiste allemand qui a fondé un groupe universaliste à Cologne" (Letter to Monsieur Lekkari,Abdelbasset, March 26th 1991; Inédits 1991, p. 105, in Thom 2003).

semiotics widespread term: "actants" (semantic roles)—attached to a verb defines its "valency" or argument-structure. Two elements connect directly to Thom's topological linguistics as developed in e.g. (Thom, 1980a, originally 1971).

a) The structural principle of combination underlying both Tesnière's and Thom's theory of syntax is not purely formal-linguistic. Linguistic entities are not combined by virtue of their categorical form (analytically attributed with some valency), rather they are combined correlatively to the schematic content expressed by the verb: it is, thus, not a formal property of the verb "give" that it has a trivalent structure (giver -> gift -> givee), it is a (real formal) property of the scene it refers to. Part of Tesnière's legacy in Thom could indeed be defined in terms of the intrinsic semantic import of syntax. Here, syntax is less a principle for the linearized combination of lexical entities by virtue of their categorical form than it is a principle for the configuration of lexical entities by virtue of their semantic structure. Seen from the point of view of contemporary cognitive linguistics (Talmy 2000, Langacker 1987-1991), both Tesnière and Thom more or less explicitly anticipate the crucial intermediary schematic level, shared by both language and perception: accordingly, verbs evoke a schematic representation of a "small drama" or express as their genuine content the "phenomenological catastrophe" in the scene they designate: syntax simulates the interaction between spatiotemporal actants. This also tends to motivate the strong constraints syntactic structure is submitted to, as we suggested above: if the highest value of verb valency is 4, this is, according to Thom, due to the fact that the interactions they represent are themselves constrained by the maximum number of simultaneous minima in the seven elementary catastrophes. Thom's theory thus provides a sort of minimalist cognitivist idea; however, this aspect of his theory—the outline of a schematic ontology roughly defined in terms of the 7 elementary catastrophes and the archetypal graphs— is exactly what has lead to Jean Petitot's reframing and re-elaboration of morphodynamic semiotics in view of hooking up the "deep" morpho-topological structures that Thom laid bare with the "shallower", but descriptively much more efficient conceptual schemata developed in cognitive science.

b) More technically, Thom's linguistic theory could be characterized as a topological schematization of the concept of valency. Thom construes Tesnière's connexion between actants in terms of positional connexions between places occupied by actants in an abstract space (to this, cf. Petitot

1985, 1992, 1995). The structural connexions underpinning surface syntax which Tesnière defined in terms of his "stemma" are thus redescribed by Thom as positional configurations: a trivalent verb consequently encodes a connexion between three positional actants. Such positional configurations are limited in number since there is a limited number of possible undecomposable interactions between actants. Thom's well-known archetypal graphs or interactional graphs are models of the fundamentally possible forms of interaction between actants. His aim is therefore to objectively determine the nature and number of event types expressed in and by language. If according to Thom, the message inherits the structure (the catastrophe) of the state of affairs it refers to, then, at a global level, this structure exerts a strong constraint on language: indeed, the nature and limits of event types necessarily defines the nature and limits of linguistic combination of meaning units. The set of event types (catastrophes) serves as a global characterization of the sentence structure in general. At a local level, in any given expression, a verb can be said to unfold a schematic landscape with actants interacting in a general way (the *interaction type* of the verb) and comports a specification of the interaction (the *action type* of the verb, as it were): the archetypal graph captures, of course, the general schematic make-up, say of a *transmission* type, whereas the particular verbs provide the concrete flesh: 'give', 'hand', 'send', 'offer', 'donate', etc. The *interaction type* provides the global structural unity of the expression; the *action type* its local specificity.

It is easy to evaluate the extension of Tesnière's influence on Thom, but it is difficult to assess its depth. On the one hand, Tesnière is the most recurrent reference in Thom's semio-linguistic writings: he appears for the first time in the seminal "Topologie et signification" (1968, reprinted in Thom 1980a), never to disappear again (Thom still warmly refers to Tesnière and the influence he exerted on him in his 1997-talk "Graphes-Signaux-Prégnances"). Moreover, there are, as we have just suggested, important analogies between Tesnière and Thom. Firstly, of course, both rest on a mereological-semantic definition of language structure in terms of dependency relations between superordinate and subordinate parts (with the verb as the kernel and other word classes as satellites hooked onto it)—i.e. they both marshal they idea that in language the structural configurational order prevails over the linear, combinatorial order.[11] Secondly, and perhaps less known, Thom has acknowledged his

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[11]   Tesnière's syntactical structure has an evident semantic ground insofar as its argument" or "actant" structure is relative to the type of event it refers to; it is therefore not a simple ana-

"diagrammatical" depth to Tesnière to the extent that the Strasbourg linguist was the first to propose "*a graph based structural* explanation of grammatical structure," that is to say a schematization of sentence structure that does not simply mirror or reproduce its linear order.[12]

On the other hand, however, Thom's own theory of syntax is quite rudimentary with respect to Tesnière's detailed descriptions and fine-grained distinctions. His references to Tesnière are in almost all cases general in scope and basically boil down to simply evoking Tesnière's concept of valency.

It seems thus sensible to contend that Thom's theory of language is kindred, intellectually affine with Tesnière's, but not built on his grounds. In fact Thom's assumptions as regards language are, both generally (for example, as to the relation of language to perception and the formal structure of the phenomenal world) and internally (as to its own formal make-up) a direct consequence of his ontological commitment. In other words, with our without Tesnière, Thom would most probably have come up with the same sort of theory. Once you claim that the central issue to be addressed within linguistics is how language can syntactically simulate the structure of the events it refers to, and once you claim that these event structures cluster in determinable types, then the rest follows: there must exist recurrent semantic forms which can re-articulate this interactional structure, and there must exist lexical entities in charge of expressing this sort of content, viz. verbs. In contrast to Tesnière — who was busy doing other things — Thom explicitly aims at bringing linguistic structure back to the world.

Saliency and pregnancy (Wolfgang Köhler)

The development of Catastrophe Theory is known to constitute the first part of Thom's philosophy of nature. The concept of pregnancy is, along with its coun-

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lytical property of a given categorical form: the ditransitivity of the verb "give" is something proper to the kind of event it refers to, not an *a priori* property of that verb as a categorical form.

[12] Cf.: "Des théories linguistiques que j'eus l'occasion de rencontrer, celle de Tesnières m'avait particulièrement plu. Car ce fut la première à expliquer la structure grammaticale par une *structure en graphe* de cette partie du discours qu'on appelle usuellement la *phrase*" (Among the linguistic theories I had the occasion to encounter, I was particularly fond of Tesnière's. It was indeed the first to explain the grammatical structure of the part of discourse we usually call the *sentence* by a graph structure(Thom 1997, p. 31).

terpart "saliency", the pillar of what he himself called his "second philosophy", that is to say the one devoted to the characterization of the "intelligible ontologies" and relaxing the dependency on the mathematical formalisms of the original Catastrophe Theory (Thom 1988 is the main reference as regards this endeavor). Three things should be mentioned in this respect: (1) Thom introduces the notion of pregnancy, albeit not saliency, in the heyday of Catastrophe Theory, cf. for example the article "De l'icône au symbole" from 1973 (Thom 1980; Eng. transl. 1985). We are consequently dealing with a constant in Thom's work, perfectly compatible with the basic catastrophe-theoretical framework.[13] (2) However, in "De l'icône au symbole" (1980a, originally from 1973), Thom distinguishes between biological pregnancies (i.e. the capacity of a form to evoke other biologically significant forms) and physical pregnancies (i.e., the intrinsic, salient, structural stability of a form). The notion of biological pregnancy clearly anticipates the conception of pregnancy Thom will marshal in the 1980s, so that biological and physical pregnancy simply correspond to the later notions of pregnancy and saliency, respectively. (3) Whereas Thom's own use of the concept is perfectly clear, the relation between Thom's understanding of "pregnancy" and its Gestalt-theoretical origins in Max Wertheimer and Wolfgang Köhler (Thom's main, if not simply only reference in this respect) remain rather unclear.

The text "Prédication et Grammaire Universelle" (Thom, 1980b, but written and presented in public in January 1978) seems to be one of the very first to introduce the notion in its by now classical conception: "Let's say that a spatial form (F) is 'pregnant' if its perception causes great physiological or behavioral response in the observer (human or animal!)" (Thom 1980b, p. 3). However the first text to be systematically devoted to this topic is probably "Morphologie du sémiotique" (from 1981, reedited in Thom 1992). Here Thom defines saliency

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[13]   This is indeed worthwhile mentioning since sorry attempts have been made—perhaps even to some extent by Thom himself—to pull down an iron curtain between the "structural" catastrophe theoretical period (with its Heraclitean emphasis on the stabilizing *logoi* sustaining the order of the phenomenal world and its representations) and the post-catastrophistic period with its Parmenedian emphasis on the continuum and the slow flow of pregnantial meaningfulness. As an argument against this specious divide one could point to Thom's all as constant emphasis on the interdependency or fundamental correlation of discontinuity and continuity: meaningfulness implies necessarily morphological detachment and saliency, which then in turn is necessarily a detachment from and thus an articulation of a continuum. So even though, at least from the 1980s and on, Thom assigns ontological primacy to the continuum, obviously he still holds that any theory of form, any morphology in whatever domain, must rest on the irreducible distinction between regular and irregular points, and hence on the concept of discontinuity.

as a distinct, detached phenomenon; a visual form is an epitome of this, but an acoustic phenomenon would do all as well, a tactile too. A salient form may take on a specific signification for a biological organism, i.e. provoke a hormonal reaction and an emotional response. This is, as already mentioned, what Thom understands by the pregnancy of a saliency. So the prey of a hungry predator is highly "pregnant" for the predator. Essentially, this sense of "pregnancy" is how French and English dictionaries define the expression (as "fullness" or "richness" in a lot of different respects). It means something very different in its German version, in a sense it even means the inverse here, namely "concise", "precise", "clear". Now, this would be anecdotic if, on two occasions, Thom himself had not referred to Wolfgang Köhler and Gestalt Theory as the origin of the concept such as he uses it. First in the mentioned article from 1973: "The fact that a theory of the pregnancy of forms is possible was the essential doctrine of Gestalt Theory that W. Köhler marshaled with courage and lucidity" (Thom 1980 (1973): 264). And *bis repetita* many years later where Thom in a footnote remarks that his use of the term is "obviously" an upshot of to the German "Prägnanz", due Gestalt Theory in general and Max Wertheimer and Wolfgang Köhler in particular (Thom 1988, 32 note 4).

The latter quotation of course echoes the former, yet none of them justifies Thom's claim to the effect that he uses the concept of pregnancy in Wertheimer's or Köhler's sense. Wertheimer's laws of *Prägnanz* (Wertheimer 1923) are indeed principles ruling the organization of forms on purely perceptual grounds, independently of all biological interests and categorical meaning. These principles, which govern the "grouping" of qualities according to proximity, color, closure, size, orientation, "good continuation," etc. do, of course, have a biological rationale: they further fast object recognition, but they do not concern an animal's chemical and emotional reaction to what it perceives—its tendency or not to consider a given form as biologically significant—and for this reason they do not sustain pregnancy in Thom's sense. Rather, *Prägnanz* in Gestalt Theory strictly applies to saliency as Thom defines it: they are the laws that explain how qualities are grouped and organized so as to form detached figural wholes in perception. Notice also that the prime property of pregnancy according to Thom is its unbounded, continuous "flow" character, whereas the prime character of gestaltic *Prägnanz* is its closed, discontinuous character. The "flow" is, as it were, what makes it possible for pregnancies to invest *Prägnanzen*; the latter's discontinuous, bounded character is what makes it possible to contain the former. This is by the way probably the reason why Thom, in his 1987-paper on the epistemology of evolutionary processes, explicitly notes that

he uses the term "pregnancy" in the French sense of "prégnance" (Thom 1987a, note 1).

The concept couple plays a central role in Thom's idea of "ontologie intelligible", his formal requirement for any regional ontology, as it were. The idea is that any ontological domain must possess concepts of these two types; simple, stable, spatially well-defined forms (saliencies) and meaning-bearing forces able to propagate between saliencies and to inhabit and modify these saliencies in stable and characteristic ways (pregnancies)—so to speak forms and forces, to put it crudely. The very notion of "intelligible ontology" is, of course, in some sense a *catachresis* uniting epistemology and ontology in one expression. Thom's basic realism, however, seems to preclude a pure epistemological reading of it, pointing rather to his idea that all ontologies *must* be understandable because of their necessary inclusion of these two elements. To that extent, Thom's use of the word couple, while originating in Gestalt psychology, takes it far beyond that in order to form the basis of an audacious general principle of formal ontology. The intertwinement between epistemology and semiotics indicated in Thom's famous motto "What must be sought is a theory of language which immediately involves a theory of knowledge" ensures that this "intelligible ontology" is tightly connected to his semiotics: the duplicity of saliency and pregnancy in ontology is mirrored by the duplicity of noun and verb in linguistics.

Kenneth L. Pike (emic/etic)

Kenneth L. Pike plays an episodic role in Thom's theory of language. Roughly speaking, Pike simply provides him with a distinction (emic vs. etic) which Thom, in turn, adapts to his own framework in order to capture a property of language that he considers as a grammatical universal, namely the distinction between more speaker independent or "emic" entities in contradistinction to the "etic" features of language which are more speaker dependent. The emic-etic terms constitute each their pole on one of the axes which organize and structure the universal categories (word classes) of grammar. At one end, the emic end, we thus have the most speaker independent terms: the epitome of which are Nouns. Thom considers them as quasi-organisms possessing their own regulation system, with external limits protecting their signification against "aggressions" from cognate terms pertaining to the same semantic domain or network of systematically correlated terms. The signification of a concept has thus a

wide temporal scope, it is unlikely to undergo changes, and it is, in its default understanding, quite autonomous with respect to the pragmatic situation of communication. At the other, etic end we have the fundamentally speaker dependent categories, such as deictics, whose meaning is unilaterally dependent on speaker's and hearer's spatiotemporal anchoring. A couple of variations notwithstanding, Thom parses the whole continuum from emic to etic in the following way: nouns, verbs, adjectives, possessive pronouns, numerals, and deictics (Thom 1978a, 1980b; Pike 1971).

Algirdas Julien Greimas

The founding father of European post-Hjelmslevian semiotics, A.J. Greimas, is only sparsely mentioned in Thom's work (The CD-Rom containing the complete works of Thom notifies 14 references, of which many are purely incidental). He seems to have had no import on Thom's semiotics—quite contrary to what was the case for Thom's disciple Jean Petitot—and the only aspect of his work which Thom refers to (with no bibliographical specifications) is the "semiotic square" (the first attested reference to it appears in an essay entitled "Modèles mathématiques de la morphogenèse" from 1971, partially included in the 1974-version of the book with the same name and left out of the 1980-version). Here Greimas' semiotic square is qualified as one of those "very gross objects" which the structural methods within the human sciences use to do their formalizations.

Thom mainly deals with the square in its narratological version, i.e. as a formalization of an ordered, cyclic sequence of transformations of states or narrative turning points (naturally interpreted as "catastrophes"). His reinterpretation of it consists 1) in stripping the semiotic square of its " logical clothing" ("Structure cycliques en sémiotiques", Thom 1992, p. 73), by 2) proposing a dynamic modeling of its formal, logical scaffolding in terms of the cyclic hysteresis-structure described below. [14] Though there does not seem to exist any deep theoretical affinities between Thom and Greimas, the project of developing dynamical interpretations of the formal models and, already sketched in the above mentioned article from 1971, has of course a major historical significa-

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[14] This example of topological schematization of logical structure is a constant in Thom's thinking: no matter the domain (mathematics, philosophy or linguistics), the aim "is not to provide Geometry with a logical foundation, but to found logic [*le* logique] on Geometry" (Thom 1988, p. 16).

tion: it anticipates Jean Petitot's general schematism and naturalization of structure which initially was fulfilled in terms of a topologization of the semiotic square (Petitot 1982, 1985, 1992).

Joseph Greenberg

It seems natural that Joseph Greenberg's search for linguistic universals should appeal to a semiotic theory with the universalist and realist ambitions like Thom's.

Especially Greenberg's basic syntactic typologies (SVO, SOV, etc) prompt Thom to launch a detailed theory of sentence construction and understanding ("Sur la typologie des langues naturelles" (from 1970, reprinted in Thom1980a)). As mentioned above, the initial idea was that a complex signified be decomposed in (at most) four-dimensional units. How are these units now further syntactically analyzed? Thom's idea is that the relevant manifold is subjected to analysis by the continuous lowering of one parameter, counting the attractor minima as they are reached, thereby generating a tree structure (somewhat like the possible tree structure in a chreod section of a Waddington landscape)—this tree structure now forming the relevant syntactical tree for expressing the content in question. Following Tesnière, the most basic part of such trees will be the verbal part, privileging the VOS structure (rarely realized in reality) from the sender's point of view -because the information of the verb kernel of an utterance gives access to the scene connecting the actants and circumstants. The reason this syntax is not realized, Thom argues, is the receiver's point of view for which the opposite order SOV is the most natural, with VSO and especially SVO as compromise possibilities. The receiver's first interest is taken to be S – who is responsible for the action presented in the sentence, an important issue in the prototypical case where the sentence relates to states-of-affairs in the immediate space-time surroundings of the interlocutors. This also prompts Thom to his analysis of the genitive: in expressions like "Le chien de Jean", X's Y, Jean (X) is "semantically destroyed" because the whole of the expression refers to a dog, and only Jean's ownership is left of him in the expression. The genitive thus makes room for any possible relation between its two relatees and only indicates their coexistence in some space—and thus facilitates abstract thought as liberated from any particular actant graph—: one of Thom's ideas as to the human semiotic privilege over animals which are sup-

posedly always caught in the actual actant graph of their present behavioral purpose.

Peirce

References to Peirce's work occur stably in the later Thom. Among Peirce's detailed philosophy, they refer to two themes especially: Peirce's doctrine of categories and the most well-known taxonomy of his semiotics, that of icon-index-symbol. The initial reference to Peirce takes place in the 1972 paper "De l'icone au symbole" (in Thom 1980a) which outlines a whole theory of the man-animal difference on the basis of an interpretation of that "second trichotomy" between icons, indices, and symbols. This triad of concepts distinguishes between the three ways in which the object of the sign may be indicated, namely either by means of similarity between sign and object, of an actual connection between them, or of a habit or convention. Thom's basic observation is that all three of these are present already in animals, taking the roots of rationality beyond any simple idea of a sharp borderline between man and animal. Thom argues for the importance of iconic signs——as against a tendency to see them as trivial——because even simple images contain a tension between reversibility and irreversibility. Images are irreversible because some information is lost in the mapping, and the same image may refer to several objects, and, conversely, the signified engenders an indefinite number of such signifiers of itself. On the other hand, a restricted reversibility is possible because, in some cases at least, it is possible stably to recover the signified from the signifier. The information thus recoverable is that which is structurally stable and hence able to survive the noise inherent in any transaction— the physically pregnant features (the later saliencies). Indices have the biological importance of leading, spatio-temporally, to the object (important in the case of biological significant objects, of course) and indices for that reason have the ability to form chains (if one index leads to another which leads to the object), founding associationism. Symbols, finally, are tied to the threshold points between two attractors in the life of the animal where a decision must be made whether to pursue the regulation leading into the other attractor or not: here attractive and repulsive symbols lead in each their set of attractors. How can the purpose of the sign engender its morphology?—This is, to Thom, the basic question of semiotics as such (or, as he here says, of semiology). The answer is "the principle of the backwards path" which takes 1) the spatio-temporal localization of the sign as first prereq-

uisite: the sign informs about the localization of the object, 2) aspects of the virtual result of the encounter of the object (the cranium as a sign of danger, knife and fork as a sign of a restaurant coming up) which is projected "backwards" toward the sign interpreter. The multiple possibility for such aspects– and in general the multiplicity of different indices referring to any catastrophe, such as the different pieces scattered in the road after a traffic accident– accounts, in Thom's view, for the Saussurean arbitrarity of the signifier. Thom's interpretation of the icon-index-symbol triad is developed further in Thom 1980c, where the vector leading from signifier to signified is considered in relation to time. The three Peircean sign types are taken, not unrelated to Peirce's theory, to refer to the signifieds in the past (index), present (icon), and future (symbol)[15], respectively, which gives Thom the occasion to argue against theories privileging the signifier over the signified or even reducing away the latter (deconstructionism, Hilbertianism). Symbols are taken to arise out of the chain-forming capabilities of indices along with a temporal reversal (Pavlovian conditioning again taken as prototypical example), conforming, as it were, to Peirce's idea of the symbol's "esse in futuro". Both papers terminate with speculations about the difference between animal and human semiotics, claiming that the latter is characterized by the weakening of the source forms of biological pregnancies so that disinterested representations and the long, branching chains of human sign use arise. This part of Peirce's influence thus serves to detail the sailence-pregnancy hypothesis.

The other Peircean influence thus concerns Peirce's category table—Firstness-Secondness-Thirdness—which catches Thom's interest in connection with cognitive and linguistic universals. Thus, Thom has an idea, foreign to Peirce, that there is a general syntax of thought and expression following these categories:

> "Firstness, Secondness, Thirdness. Exemple français : ça sent le brûlé.
> La triade peircéenne Qualisign—Sinsign—Legisign comparée à
> Prégnance—Saillance—Concept (Nom)." (Firstness, Secondness, Thirdness. French example: It smells like burnt. The Peircean triad Qualisign—Sinsign—Legisign compared to Pregnancy—Salience—Concept (Noun) ("Reflexions sur le continu de Hansjakob Seiler", 1992, 2, in Thom 2003)

The idea is that "Ça" (it) represents undifferentiated Firstness, "sent" (smells) indicates the Secondness catastrophe of perception confronting subject

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[15]   Points also developed in "Morphologie du semiotique" (1981, in Thom 1992), and "Mathématique et sémiotique" (Thom 1981).

and object and "le brûlé" (burnt, however nominalized in French) specifies the kind of Thirdness regularity encountered in the perception—while Peirce's First Trichotomy is taken to reflect the process of making a stable concept type out of what was first only a vague pregnancy.

These ideas, however interesting, are not further developed, and occur as clarification attempts in the context of Thom's discussion of the second linguist, besides Tesnière, who influenced him the most, the German universalist linguist Hansjakob Seiler with whom Thom collaborated during many years.

Hansjakob Seiler

One of Seiler's main ideas is that of linguistic *continua* orienting and governing a long range of linguistic phenomena. Seiler has an example of the continuum from Deixis to Predication which Thom very often cites, viz. the long German chain of predicates: "Diese erwähnten zehn schönen roten hölzernen Kugeln" ("These above-mentioned ten beautiful red wooden balls").[16] The idea is that in such an adjective series, other constraints on syntax vanish, so that an underlying continuum going from subject towards object becomes visible; the adjectives spontaneously placing themselves on such a continuum going from the most subjective: deixis, and to the most objective: the noun, over adjectives referring to discourse, number, subjective and objective qualitites. Thom's reinterpretation of this continuum goes as follows:

> "It seems to me that the fundamental findings of Professor Seiler, about the continuum of determination could be stated as follows: any place in the standard syntactic tree which gives rise to a subordinate predication may be exploded into an auxiliary continuum (a "technique"); this technique then involves an arbitrary number of terms, but the ordering of these terms is not arbitrary, it is governed by order associated to the semantic nature of the corresponding invading "pregnancy".

> The order seems to be the following:

- − Subjective generated pregnancies, originated by the speaker as: deixis.
- – Mental pregnancies associated to subjective appreciation of the speaker
- (subjective adjectives)
- – Physical qualities of accidental nature (e.g. color) (objective adjectives)
- – Material nature

[16]   Cf. W. Wildgen 1999.

Genitive—spatio-temporal localization" (Thom 1983c, 254).

Thom's claim is that this continuum of Seiler's no less than solves Kant's classic issue of schematism by continuously connecting subject and object. Thom's central claim is that this subject-object continuum is identical to the emic-etic axis (see above) but independent of another dimension which he sometimes attempts to describe as the continuum of semantic complexity, necessitating a two-dimensional representation of universal grammar which he gives several different outlines of ("La double dimension de la grammaire universelle", 1978a; another takes the degree of freedom of pregnancy propagation to substitute for semantic complexity, "Contribution", 1983; in Thom 2003) without necessarily assuming that two dimensions may be sufficient. The general idea, thus, is that universal grammar requires a number of independent continua for its description. The existence of such overarching continua makes Thom state his anti-formalist credo as to syntax: "The generativity of generative grammar (Chomsky's competence) is probably no more than a formalistic illusion." (Contribution 1983, p.12; in Thom 2003).Seiler's theory thus permits Thom to embed his syntactical deliberations as motivated by overarching structures of semantic continua and leads him to many further interesting hypotheses, partwise in collaboration with Seiler.

The anthropology of hunting—Gilbert Durand

In the semantic end of Thom's semiotics lie his surprising reflections on animal hunt as involved in the origins of symbolism. The main ideas rest on an Uexküll-like idea of the circular structure connecting animal metabolism with outer action, locating signs in the animal's search for prey. The animal must be capable of recognizing certain signs for its prey (predators, sexual partners, rivals, etc.), and thus also be able to imagine and fantasize about these Gestalts:

> However, there can hardly be any doubt about the fact that any animal "fantasizes" its preys (and its predators), for otherwise it would be unable of recognizing them. The imagined "Gestalt" most certainly precedes and shapes the real Gestalt (as it is by the way shown in animal etiology by the phenomenon known as "supranormal" releasers).
> (Thom 2003: Letter to Gilbert Durand Jan. 27 1976, Inédits 1976; in Thom

2003)[17]

Gestalts which have a certain idealized quality documented by Lorenz' famous discovery of "supranormal releasers" like the artificial version of the seagull mother's beak with two red spots (real seagulls having only one), able to arouse the young more than any empirical beak. During the three consecutive versions of the chapter 10 of *Stabilité structurelle* (the French 1972 version, the English version, and the French 1977 version), Thom refines this basic idea, and in "Les racines biologiques du symbolique" (Thom 1978b), integrating a model based on a cyclic path around the organizing center of a Fold catastrophe on the one hand with, on the other, the French philosopher and anthropologist Gilbert Durand's doctrine of symbolism in his *Les structures anthropologiques de l'imaginaire* (1960). The former part follows the below model:

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[17]   "Il ne fait guère de doute, cependant, que tout animal "fantasme" ses proies (et ses prédateurs), sans quoi il ne pourrait les reconnaître. Très certainement, la "Gestalt" imaginée précède et "informe" la Gestalt réelle (comme le montre d'ailleurs, en éthologie animale, le phénomène bien connu des déclencheurs "supranormaux")."
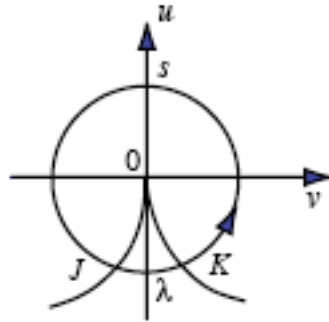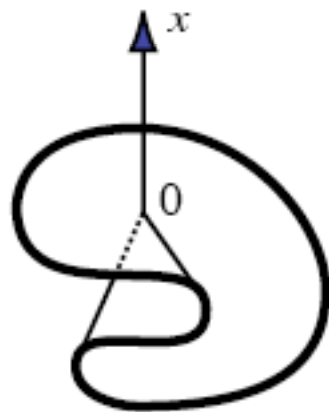
Figure 3.

Figure 4.

Figure 2 Thom's hysteresis model

These two figures show - the circular process changing between the pres-
ence of one and two actants, respectively. The upper figure shows the basic
catastrophe "cusp" (the pointed figure consisting of two discontinuity lines
meeting at the origo). The circle indicates the movement in the cusp landscape,
and points J and K indicate the two catastrophe points where the circular trajec-
tory intersects with the cusp. Inside the cusp, that is between J and K, two mi-
nima exist which in Thom's interpretation corresponds to two actants. Outside
the cusp, only one minimum exists. These minima, in Thom's interpretation of
the hunt, now correspond to the predator and the prey. The lower figure shows
the cusp as the projection of a fold onto the u,v plane of the upper figure of the

fold. The bold line indicates the circular trajectory in the fold landscape - and the two catastrophes occur where the trajectory shifts direction in the folding-in of the circle. In the upper figure, the phases of the hunt are as follows: in its hungry state, the animal is between the v-axis and the point J on the trajectory. Only one minimum exists here, corresponding to the predator, alienated in the image of its prey. J constitutes the perception catastrophe where the image acquires outer existence in a prey and the hunt begins. During the hunt, in the phase between points J and K, two minima exist, corresponding to both predator and prey. The chase culminates in the capture of the prey in K, after which alienation ceases. Now in the post-K phase, the predator consumes its prey and thus becomes one with it, only one minimum again exist. In the upper part of the tracjectory, the predator sleeps and digests its prey and so wakes up again, hungry and again alienated, and the process starts over again. Thom's interpretation of Durand now finds the roots of daytime symbolism in the J-K section inside the cusp with its clear, binary predator-prey distinction, evident valorisation and themes like friend-foe, war, victory, defeat, etc. The other, upper, part of the cycle, then corresponds to nighttime symbolism with blurring of binary categories, identification of predator and prey, dreamlike descent into another worlds, etc.

It is based on the idea that there is a tension between two different identity notions in biology–the persistence of the animal subject as opposed to its repeated, different actions. The idea of such a tension rests on the unspoken presupposition that animal minds are tied to the present now and hence must change according to the behavior type they indulge in. Therefore, the spatio-temporal identity of the animal is opposed to the different mental-behavioral "identity" states of the animal. In the model, this conflict of identities is construed according to the following interpretation of the path indicated: in the phase of the path approaching the catastrophic part, the animal is alienated by the image of the prey, it is dominated by the urge to find a real counterpart to match the image. The first catastrophe indicates the actual perception of prey fitting the image, and the short interval to the next catastrophe is the hunt where the animal has regained its proper self. The second catastrophe indicates the second discontinuity: the catching of the prey; doing so the animal finally reaches the normal state and becomes its satiated self. During sleep, in the smooth half of the pathway, the animal gradually again, by means of digestion, internalizes the prey: it becomes its own prey, as Thom liked to put it. And when it wakes up hungry, alienation is active again. Durand's doctrine distinguishes between by a diurnal and a nocturnal symbolism in human imagination which Thom identifies with the two separated phases of the cycle. The hunt

corresponds to Durand's daytime symbolism, covering rise, fight, and victory–
or being hunted, if the identification goes with the prey–in general, this symbol-
ism is articulated in clear binarities. The digestion phase now corresponds to
Durand's nighttime symbolism, covering the *coincidentia oppositorum* where
the two sides of binarisms flow into each other, an imagery of descent into un-
clear worlds of subjective dissolution dominate. Finally, the structure taken as a
whole may give rise to cyclic imagery, exchange and dialogue ideas. As is evi-
dent, the whole model is at the same time taken, once again, to mirror embryo-
genetic structures, the clear distinction between predator and prey being analo-
gous to endo- and ectoderm.

The biological semiotics integrating Peirce, Gestalt Theory, and embryol-
ogy is here extrapolated to constitute a basis for general anthropological im-
agery involving the destruction and resurrection of the self.

Different small influences

In addition to the main inspirations which we have charted here, a series of
smaller ones may be listed. A negative one is Jacques Derrida, highlighted by
the fact that Thom was among the originators of the 1992 protest address
against his nomination as a honorary doctorate at the University of Cambridge
(along with Quine, Ruth Marcus, Barry Smith, David Armstrong, and others),
and in Thom's works the idea that one sign, allegedly, refers to the next in a
never-ending sequence is taken as the opposite to his own realist semiotics: "a
theory that is very popular in the Parisian salons claims: 'there is no signified,
only signifiers; each sign refers to other sign in an endless regression' " ("De
l'icône au symbole", Thom 1980a).

Edmund Husserl is sometimes referred to as a subjectivist who, along with
Heidegger, has destroyed French epistemology, at other occasions he is recon-
sidered as anticipating Thom's theory of the basic status of hunt and caption
(*Erfahrung und Urteil* is interpreted as saying that "recognizing the object is
nothing but grasping it" ("Temporal Evolution of Catastrophes", Thom 1973, p.
42)), or he rightfully defends Euclidean geometry as the necessary basis of all
other geometries, or he is taken to support the idea that the recognition of a
shape constitutes consciousness rather than the opposite (also with reference to
Erfahrung und Urteil, cf. "Préhension et perception", 1992, p. 165). Apart from
being used as a subjectivist scoundrel, Heidegger is mostly credited with the
one-liner "Die Wissenschaft denkt nicht" and its subsequent "and it is not its

purpose either." which Thom quotes with negative acclamation, complaining about this divorce between (rigorous) science and (meaningful) philosophy.

Bernhard Riemann is several times quoted for the idea: "....Riemann, who 'comitted' a few philosophical pages, in which you encounter the following essential idea: if a mental process, taken in its neurophysiological reality, is described by a set, a variable variety W(t) of the space of neurophysiological states of the brain, then the (subjective) signfication of that process is defined by the form (in a sense which is still be made clear) of the variety W in the space of the states" (Thom 1983, p. 195)[18] – a very <mark>catastrophe-theoretical</mark> idea indeed; that the signification of a thought is constituted by the form of the underlying neurophysiological process. A related idea is Paul Valéry's idea from *Eupalinos* which Thom quotes over and over; here Socrates is portrayed as saying that a forme is geometrical if it can be finitely described in few words; which basically means that relative geometrical simplicity and the ability to serve as symbol are related.

In the epistemological end of his semiotic musings, Thom often refers to the theorist of science Gerard Holton and his doctrine of "themata": i.e., his ideas that scientific discoveries are often prompted by deep epistemological (and unsolvable) thematic tensions such as unity-diversity, order-disorder, permanence-change, simple-complex, holism-reductionism, formalism-empiricism, conventionalism-realism, continu-disconitnu, etc. This basic semantic inventory for scientific (and other) imagination leads Thom to his doctrine of "*apories fondatrices*", the idea that different scientific disciplines have, as their organizing center, an unsolvable antinomy (tied to its partition in saliencies and pregnancies, forms and forces) constantly urging scientific discovery onwards (geometrical continuity vs. algebraic discontinuity in mathematics, empty space vs. physical entities in physics, metabolism vs. organismic stability in biology, the semiotic inability for sign systems to talk about their own foundation in linguistics etc.). The overall conclusion being:

At any rate, the only way we can attain an explanation, a generation of empirical diversity from one unique principle is by resorting to a process of emanation, of "procession", as the Neo-platonicians saw very well. If this process is assimilated with a propagation of pregnancy (accompanied by a convenient oscillation between saliency

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[18]   " Riemann, qui 'commit' un petit nombre de pages philosophiques, dans lesquelles on peut trouver cette idée essentielle : si un processus mental, dans sa réalité neurophysiologique, est décrit par un ensemble, une variété va- riable W(t) de l'espace des états neurophysiologiques du cerveau, alors la signification (subjective) de ce processus est définie par la forme (en un sens à préciser) de la variété W dans l'espace des états."

and pregnancy), we will be led to look for the "source forms" of this pregnancy: a black hole which can only be filled by a fantasmatic image, a local and temporary solution of the founding aporia) (Thom 1992, p. 481)[19]

Explanation must take the shape of the propagation of pregnancies across saliencies, and the relevant science is tempted to the impossible task of finding the unitary origin of that pregnancy. Thom later discovers (from Jean Largeault) that largely similar ideas had been proposed by the French Neo-Kantian Charles Renouvier already in his *Les Dilemmes de la Métaphysique Pure* from 1901.

Concluding remarks

Our intention has been to introduce to the major sources of Thom's semiotics and the way they fit into his original biosemiotics or biolinguistics. Thom's semiotics develops from its topological and biological core to span linguistics and epistemology, semantics and ontology, and during unfolding it grafts upon this germ a growing number of influences, adding to both the richness, the complexity and the inner tensions of Catastrophe Theory semiotics.

References

Durand, G. 1960. *Les structures anthropologiques de l'imaginaire*, Paris, Dunod.
Holenstein, E. 1992. (interview with Roberto Benatti) Phenomenological structualism and cognitive semiotics, *Scripta Semiotica* (1).
Holton, Gerald. *Thematic Origins of Scientific Thought: Kepler to Einstein*. Cambridge, MA: Harvard University Press, 1973.
Jakobson, R. *Essais de linguistique générale*, t. I-II. Paris: Minuit.
Peirce, C.S. 1931-58. *Collected Papers*, London: Thoemmes Press.
Petitot, J. 1985. *Morphogenèse du sens*. Paris: PUF.
Petitot, J. 1992. *Physique du sens*. Paris: Ed. du CNRS.

[19]   Dans tous ces cas, le seul espoir d'arriver à une explication, un engendrement du divers à partir d'un principe unique, est de faire appel à un processus d'émanation, de procession comme l'avaient bien vu les néo-platoniciens. Si ce processus est assimilé à la propagation d'une prégnance (assortie d'une oscillation convenable entre saillance et prégnance), on sera ramené à chercher les « formes-sources » de cette prégnance : un trou noir qu'on ne pourra jamais remplir que par une image fantasmatique, solution locale et temporaire de l'aporie fondatrice."

Petitot, J. 1995. Approche morphodynamique de l'iconicité des stemmas. In F. Madray-Lesigne and J. Richard-Zapella (eds.), *Lucien Tesnière aujourd'hui*. Louvain: Editions Peeters.: 105-122.

Pike, Kenneth L. *Language in a unified theory of the structure of human behavior*,   2nd rev. ed., The Hague [u.a.]: Mouton, 1971

Renouvier, C. *Les Dilemmes de la Métaphysique Pure*, Paris.

Saussure, F. de, 1915. *Cours de linguisitique générale*, Paris, Payot.

Seiler, H. 1995. Diversité des langues et conceptualisation : le cas de la détermination nominale, *Intellectica*, 1/20: 127-137

Stjernfelt, F. 1992 *Formens betydning. Katastrofeteori og semiotik* ("The Meaning of Form. Catastrophe Theory and Semiotics") Copenhagen: Akademisk

Stjernfelt, F. 2007 *Diagrammatology. An Investigation on the Borderlines of Phenomenology, Ontology, and Semiotics*, Dordrecht: Springer

Tesnière, L. 1959. *Eléments de syntaxe structurale*. Paris: Klinksieck.

Thom, R. 1972. *Stabilité structurelle et morphogenèse*.

Thom, R. 1973.L'évolution temporelle des catastrophes. Collection *Applications of global analysis, I. Symposium Utrecht State Univ.*, Utrecht, 7-9 février 1973: 61-69. Comm. Math. Inst. Rijksuniv. Utrecht, **3**, 1974.

Thom, R. 1974. La linguistique, discipline morphologique exemplaire, *Critique* (322), 235-245.

Thom, R. 1978a. La double dimension de la grammaire universelle. *Circé*: 78-90.

Thom, R. 1978b. Les racines biologiques du symbolique. *Circé*: 40-51,

Thom, R. 1980a. *Modèles mathématiques de la morphogenèse*. Paris: Christian Bourgois.

Thom, R. 1980b. Prédication et Grammaire Universelle. *Fundamentae Scientiae* 1/23: 23-34.

Thom, R. 1980c L'espace et les signes, *Semiotica*, **29**, 3-4: 193-208.

Thom, R. 1981, "Mathématique et sémiotique", in Thom 2003.

Thom, R. 1983a *Paraboles et catastrophes*. Paris: Flammarion.

Thom, R. 1983b. La modélisation des processus mentaux. In *Fonctions de l'esprit*, Paris: Hermann: 192-206.

Thom, R. 1983c. Transitivity Continua and Prototypicality. In H. Seiler & G.

Brettschneider eds. *Language Invariants and Mental Operations*. Tübingen: Günter Narr Verlag: 256-263.

Thom, R. 1986. Les chemins du sens à travers les sciences. *Sciences et Symboles*, Colloque de Tsukuba, 6-10 novembre 1984, M. Cazenave, éd., Paris, Albin Michel: 361-380.

Thom, R. 1987a. Epistemology of evolutionary processes. In W. Callebaut & R. Pinxten (eds.). *Evolutionary Epistemology*, D. Reidel Publishing Company: pp. 97-105).

Thom, R. 1987b. An Inventory of Waddingtonian Concepts. Conference at the Waddington Memorial Conference, Oaxtepec, 1-5 septembre 1987, Mexique. *Theorical Biology. Epigenetic and Evolutionary Order from Complex Systems*, B. Goodwin & P. Saunders eds., Edinburgh, Edinburgh University Press:1-7. (In Thom 2003).

Thom, R. 1988. *Esquisse d'une sémiophysique*. Paris: InterEditions.

Thom, R. 1989. *Structural Stability and Morphogenesis*. Rdwood City, California etc.: Addison-Wesley Publishing Company, inc.

Thom, R. 1991a. Saillance et Prégnance. *L'inconscient et la Science*, R. Dorey éd., Paris, Dunod: 64-82.

Thom, R. 1991b. Relativité du Vrai, Relativisme de l'Intelligible, *Epistemologia* 15 (1): 3-20.

Thom, R. 1992. *Apologie du logos*. Paris: Hachette.

Thom, R. 1993. *Prédire n'est pas expliquer*, Paris: Flammarion.

Thom, R. 1997. Groupes-Signaux-Prégnances. (Document nb. 4.2, "Inédits 1997", in Thom 2003.

Thom, R. 2003. *Oeuvres complètes*. CD-ROM edited by Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France.

Uexküll, J. v. 1920/1928. *Theoretische Biologie*. Berlin: J. Springer.

Uexküll, J. v. 1940. Bedeutungslehre (= Bios, Abhandlungen zur theoretischen Biologie und ihrer Geschichte sowie zur Philosophie der organischen Naturwissenschaften. Bd. 10). Leipzig: Verlag von J. A. Barth.

Waddington, C.H. 1957. *The Strategy of the Genes*. London : George Allen & Unwin.

Wertheimer, M. 1923.Untersuchungen zur Lehre von der Gestalt II, in *Psycologische Forschung*, 4: pp. 301-350. Translation published in Ellis, W. (ed.) 1938. *A Source Book of Gestalt Psychology*. London: Routledge & Kegan Paul: pp. 71-88.

Wildgen, W. 1999. *De la grammaire au discours. Une approche morphodynamique*. Bern-Berlin-Wien: Peter Lang, 1999.