Semiotics and Catastrophe Theory

Catastrophe Theory and Semio-Narrative Structures[1]

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For Angelo Fabbri
in memoriam

I. CATASTROPHE SCHEMATISM AND STRUCTURALISM

By resolutely venturing into the ontological, methodological and epistemological labyrinth which separates the humanities from the exact sciences — an infernal maze that Michel Serres judiciously compared to the North West Passage — this work set out to demonstrate how and why *Catastrophe Theory* (C.T.) is adequate to *mathematize structural phenomena* and, in particular, the Greimassian theory of *semio-narrative* structures (the discursive-figurative level is not taken into account here). Its aim was to investigate the signification and the impact of the (unusual) implication of *geometrico-topological* intuitions in the semio-linguistic domain; to establish in a *critical* (from a Kantian and Husserlian perspective) way the conditions for the possibility of *constituting* structural *objectivity*; and to recast structural theory, which until now has remained descriptive much in the way of a "*physics*", of a "physics of Meaning", by developing *a priori* (categories and principles of experience) constituting structuralism conceived of as a *regional ontology* in the form of mathematical models. By a "physics" I understand an explanatory mode in which the assigning of *mathematical* contents to primitive concepts ensures their *objective value* by becoming determinant for the *being* of the phenomena.

Now something strange has occurred with respect to structuralism. In all the concrete domains where the notion of structure has an incontestable experimental validity and happens to be essential for the understanding (if not the explanation) of empirical phenomena, there exists a sort of *antinomy* between its categorical content and the formalisms used to formalize it. This constitutes a major epistemological obstacle, explaining why, even though it happens to be a rational concept, until now the concept of structure has not acquired an authentic objective value and has constantly drifted toward metaphysical, dialectical and dogmatic usage. Let me quickly give a few examples.

i) In biology, the structural point of view attempts to constitute the object as an *autonomous* object, as a structural and functional unity, as a totality which is self-organized by a system of internal relations, in short as something different from the pure expression (epigenetic) of its genetic control. From Geoffroy Saint-Hilaire to Waddington, including Goethe, Driesch and d'Arcy Thompson, all of these investigators attempted to reach a monist and rational understanding of the biological forms and processes of *morphogenesis*. They strove to understand how phenomenological features, such as equipotentiality, equifinality, self-regulation and structural stability, impose what could be called "syntactic" constraints on morphological order. To do this, essentially they had to understand how functional tissues differentiated by the catastrophes of embryogenesis depend upon *their spatial position*. If structure exists, it is because the parts of the whole are reciprocally determined by means of a dynamic process defining the *positional values*. This is what Geoffroy Saint-Hilaire called the *principle of connection*.

ii) We discover an analogous problem in the domain of perceptive organization as it is understood from the physico-phenomenological point of view of Gestalt-theory. Here too, against the atomistic conceptions of sensations and the reduction of perception to an apprehension of relations, one has to understand the existence of Gestalten, that is to say organic wholes which are individuated in a spatio-temporal field of representation and controlled by external stimuli. In order to do so one needs to understand how connections pre-exist their analysis as terms and relations and hence organize unities which are articulated where the value of the parts is *a function of their position*.

iii) In linguistics, and first of all in phonology, structuralism conceives of phonemes (form of expression) as discriminatory abstract units which are

classes of equivalence of allophones (substance of expression) defined, also, by a principle of connection. As *formal* entities, phonemes are *positional values* which have a linguistic reality and these values are organized into *paradigms* and *categorize* audio-acoustic continua, the reality of which is on the contrary psycho-physique. A paradigmatic system is therefore not a set of relations existing between pre-existing terms or elements. The ontological primacy of form over substance signifies that value is a purely positional identity, defined *negatively* by its conflict with the other values of the paradigm. It is in this sense, that for Saussure and Jakobson, position constitutes the formal reality of the linguistic element.

iv) Still in linguistics, but this time in the domain of structural syntax, through reduction of the lexical combinatory and the grammatical transformations, we reach the schemata of articulation between places which, as C. Fuchs and M. Pêcheux noted regarding A. Culioli's lexical schemata, independently of the semanticism of the units which are assigned, signify in relation to one another. Defined by connections (this time in the sense ascribed by Tesnière) and *semantic* actantial relations which express the form of content, determining the grammatical function of the terms that the former link together and independent of the lexical investments, the *proto-grammatical* being of these places is purely *positional*. It "precedes" (in the sense of the generative trajectory) the distinction between syntax and semantic. It manifests a *formal semanticism* which we propose to call a *local content* and whose mathematical formulation undoubtedly constitutes one of the central difficulties of linguistic formalization.

v) In the theory of semio-narrative structures, finally, the structural primacy of relational form is asserted both on the semantic level of fundamental taxonomy and the syntax of the actantial model. The problem then becomes one of understanding the *conversion* of the first into the second, that is to say the projection of the paradigmatic onto the syntagmatic.

In all these domains of regional ontological structure, a *one and the same* notion of structure is at work. It has a precise *categorical* content. In fact, it functions as a *noematic meaning* categorically determined and *constituting in their meaning as object* a class of heterogeneous phenomena linked through the synthetic unity of a same *apperception*. The critico-phenomenological problem, in the sense of a transcendental logic oriented on the objective content of knowledge, in short, the central *theoretical* problem of structuralism is the following: what mathematical content must be assigned to the category of the relation in order to be able to

mathematize in agreement with the "things themselves" the basic structural concepts of articulation, connection, difference, reciprocal presupposition and positional value? Only such a *schematization* — in the Kantian sense of a construct of concepts in the form of a mathematically determined intuition — can permit the *legitimate* foundation of a "mathematical physics" of structures.

But according to what we have just said, since Structural Transcendental Esthetics could only take the form of an Esthetics of position, such a schematization depends *a priori* on the establishment of a *geometry of positions* which enables one to model the diverse empirical phenomena so subsumed, that is to say to account for the Gestalt unity, for the dynamic organization, for the stability and the closure of the elementary structures (considered as natural, objectivizable *phenomena*), as well as for the constraints imposed on their combinatory. It depends on an authentically structural general Dynamics, an *Analysis situs*.

Now, as Buffon and Kant remarked, and after them Husserl, such an Analysis situs was totally lacking in the mathematical sciences. It remained a "lost" science which resulted in the major epistemological obstacle against the constitution of structural objectivity and compelled structural doctrines to oscillate between three equally unsatisfactory positions: i) reductionist positions which reduce the structural phenomena to complex psychological phenomena whose noematic meaning of objectivity and apperception are already constituted; ii) the idealist-holistic-vitalistic positions which attribute the structures to supra-sensible "formative forces" and which claim to use the *noumenal* concept of organization as a determining concept; iii) the formalist positions which, wishing to mime the Hilbertian axiomatic, seek to substitute formal systems of relations to structures.

In the sciences of language, the formalist position is dominant. Founded on the "fallacious" evidence, imposed by logical positivism, that mathematics are a language, and inspired by relations between syntax and semantics which theoretically exist according to the models, they uniformally and systematically reduce the structures to literal syntactic assemblages reifying the connections and the differential qualities constituting values. Now, as the founders of Gestalt-theory had already asserted, such a reification destroys the "organicity" of the structural connections. It therefore destroys the set of phenomenological-eidictic characteristics specific to structures. In order for a regulated manipulation (a calculation of the aggregations of structures reduced to literal assemblages) to have

a real meaning, then the *meaning of the being* of the phenomenon of "structure" has to have been previously defined phenomenologically. If the metaphor were acceptable, we could say that the "chemistry" of complex assemblages must be constrained by a "physics" of elementary structures. We are therefore justified in saying that as regards structure, *formalization* (in the naive formalist sense in which it is generally taken) *is radically different from a mathematization which is true to the things themselves*. It is as though there were an *antinomy* between the formal treatment of structures (no matter what formalizations are used, from universal algebra to the theory of topoï including robotics) and their "physical mathematization". The former refers in one way or another to a *formal logic* of the terms and the relations, to an algorithmics, whereas the latter on the contrary refers to a dynamic *topology* of places and connections.

As we asserted from the outset, because of the lack of schematization, we can see that the problem is that the categorical notion of structure does not, strictly speaking, have an objective value. Although it is empirically conditioned, although it is necessary for the intelligibility of biological, perceptual and linguistic phenomenon, as Kant affirmed in the Third Critique, it is simply a product of thought which originates within the reflexive faculty of judgment. Thus, all structural "physics" presuppose that initially we were able to ensure the ontological promotion of concrete structures as *phenomena* as well as the objective value of structural categories. We are subsequently inevitably brought back to the question of knowing how, though they be discursive, categories can be *constitutive* of the object-being of the phenomena they subsume. This problematics is of a *critical* nature and that is why, in my opinion, a structural "physics" can be founded only on a *schematization* of structure.

Returning to the motif of schematism, obviously we do not propose to follow the Kantian text to the letter. What we wish to do is to bring to the fore the fact that there exists no possible direct application of mathematics to a field of experience but only applications mediated by *theories* which develop the apriorisms constituting this experience. By introducing the term *intuition* we can express this fact and say that, in order to be able to legitimize rationally (problem of *a priori* validation) the *modelization* of the phenomena of a certain ontological region, it is necessary that the mathematics used develop the intuitions which condition *both* the categories and the appearance (the manifestation) of the phenomena of this region, or, in other words, to be entitled to relate to reality, mathematiza-

tion must, as it were, be "factorized" by means of schematization (cf. Petitot, 1983, a).

Of course, with respect to the actualization of the criticism proposed here, everything depends on the notion of intuition. I have opted for a conception which is neither Kantian, i.e. pure intuitions as forms of sensible intuition, nor Husserlian, originarily giving intuitions which come and "fill" the noematic intentional meanings to objectivize them. I opted for a conception which is close to Albert Lautman's and according to which, categorical, *intuitions are, through an ideal Dialectic, products of the history of mathematical theories themselves*.

My key idea was that, since it offers us the first example of a geometry of position, C.T. enables us to schematize structural categories and therefore, consistent with things themselves, to modelize the phenomena subsumed by them.

In C.T., the schematic construction of structural categories is carried out starting from the intuition of *generalized space*. All functional space of forms on which we know how to define the qualitative kind of elements is canonically endowed with a *classification* of these types and is naturally categorized by means of a discriminatory morphology, by a catastrophic set, stratified in the best of cases, which *geometrically* realizes the classification. Through the intuition of stratification, the general concept of taxonomy results in a *"supplement" of geometry* which enables us to schematize the categories of positional identity, of reciprocal determination, of differentiation, of junction, of discrimination, of stability, of invariance, etc.

In a general way C.T. can be conceived of as a mathematical theory of *critical phenomena*, explaining why and how a system, a black box, whose internal states are controlled by a space of external parameters, can *categorize* its space of control and therefore engender a *morphology*. In my opinion, its primary merit is that it is a *phenomenological* theory which permits integrating morphological appearance with objectivity, thus redefining the primary notion of phenomena. Its next merit is that it *inverts* the relation of determination proper to physics. In physics, one attempts generally to deduce from general laws and principles an *explicit* formulation of the dynamics defining the internal states or the local systems of the envisaged processes. On the contrary, catastrophe strategy introduces internal dynamics only as an *implicit*, as a supposed, and attempts to go back from the apparent morphology, that is to say from the phenomenology, to the

constraints on the implicit dynamics. In this way, structural models where one can *both* affirm the *autonomy* of the morphological level and its syntax *and* its dependence on the physical or psychological determinism of its substrata, are engendered. It is within this critically founded frame that I have attempted to specify the modelizing content of C.T. in the three domains of phonology, structural syntax and semio-narrative theory.

In the domain of phonology (cf. Petitot, 1982, c), the problem is to reconcile, dialectize respectively reductionist, "substance based", points of view concerned with the audio-acoustic and neurophysiological organization of the phonetic substance, and the structuralist, "form based", points of view, affirming the autonomy of the phonological relational form. Experimentally, the link between these two types of conceptions is furnished by the phenomena of *categorical perception* of phonemes encoded in the acoustic signal, as for example the occlusives, that is to say the mode which spontaneously categorizes and *discretizes* perception where the capacity for the *discrimination* of two adjoining stimuli *is subordinated to their identification* as belonging to two different categories. Characterized by the fact that no intra-categorical discrimination exists, these phenomena are perceptive cases typical of critical phenomena, in all points analogous to thermodynamic phenomena of phase transitions. As Kenneth Stevens has explained, they happen because acoustic indices (as the indices of voicing) control percepts which have certain properties of *stability*, in relation to them. In these domains of control (of the external space of the acoustic indices) where there is stability, the deformations of percepts under the action of the variation of the indices are of a qualitative constant nature and that is why there is no intra-categorical discrimination. On the other hand, at the crossing of the borders separating these domains, the qualitative type of the percept is catastrophically transformed.

The introduction of catastrophe models thus permits us to make the theory considerably more specific. It first of all permits us to dialectize the traditional opposition between form and substance of expression. Indeed, insofar as the models integrate phenomenology to objectivity, by them we can make the organization of the phonetic substance and its modelization *equivalent* to the relational phonological form and its schematization. From this perspective, the Hjelmslevian principle of the ontological autonomy of form loses its dogmatic character. It becomes a consequence of the relative independence of catastrophe ensembles in relation to the substrata. Next, the catastrophe approach enables us to understand better the dual dimen-

sion of substitution and the taxonomy of the paradigmatic. In a catastrophe model of the paradigm, the domains of space, defined by the system of thresholds which the catastrophe ensemble happens to be, are *synchronically co-present* positional values. This is the taxonomic dimension. But in each of these domains an internal state is actualized while remaining reciprocally determined in relation to the others which, in turn, are virtualized. *And when we change domains, we change actualized state.* That is the dimension of substitution. Finally, the assimilation of the diagrams of categorical perception to the diagrams of phase transitions leads us to re-interpret a vast experimental corpus from the principle of the scales of phonological dominance, the phenomenon of markedness, the nature of vowel or consonant classifications as well as the ways in which the acoustic indices are integrated in the percepts, come under a morphological analysis of the diagrams, of their singularities and their stratification.

Now as far as structural syntax is concerned (cf. Petitot, 1982, d), the catastrophe approach permits us to solve one of the principle difficulties encountered by *actantial and case* conceptions and the theories of verbal *valence*. As we have said above, we encounter schemata of connections distributing places the semanticism of which is not substantial but *formal*, at a pre-lexical and pre-grammatical level, that is to say at a proto-linguistic level where the automatisms of competence have not yet taken effect. These schemata come under the *form* of content and the problem raised in treating them using structural "physics" is not a problem of formal translation, of combinatory complexification and of recursivity, but, on the contrary, a problem of closure and of self-limitation. Under the pretext that these primary relations select semantic roles, case theories define them in a *categorical* way by attributing a *notional* content to the deep cases. But consequently, as Fillmore has noted, there no longer exists a *principle* for deducting universal cases. This is why case theories oscillate between, on the one hand an overgeneralization of the notions, which permits considering them as universals and, on the other, an over abundant specialization that allows making of them discriminatory syntactic functions of utterances. In relation to this conflictual situation, catastrophe schematization introduces a new governing idea which consists in reducing actants to the pure principle of identity which *localization* happens to be and making pure positional proto-actants of them. As René Thom has shown, it then becomes possible to derive a principle of case deduction from the theorem of classification of elementary catastrophes. After such a deduction, case universals are no longer categorical notions but pluri-actantial Gestalten, *syntactic*

morphologies of interaction between proto-actants, which finally allows us to arrive at a *configurational* (and no longer categorical) definition of semantic roles. The reduction of case semanticism to formal semanticism can then be interpreted by saying *that the contents which are so defined configurationally are purely local*, that is to say relative to the morphology in question. Obviously, afterwards the proto-actants are specialized and become animate or inanimate actants, places, influences, etc. And hence we encounter the *multi-case* descriptions such as those advocated by Anderson. Catastrophe schematism of deep actantiality also encounters and confirms a classical hypothesis, that is to say a *localist hypothesis*, according to which there exists an equivalence between the abstract and grammatical use of cases and their concrete and local use. One should not see here the surreptitious re-introduction of the reference of language to the world, *but a decisive principle of the conditioning of syntactic forms by the a priori of objectivity*. But it is perhaps in the mathematization of Greimassian semio-narrative theory that catastrophe schematism becomes most operational.

II. TOPOLOGY OF THE SEMIOTIC SQUARE

Let us now specify, without however going into detail, the nature of the catastrophe modelization of the semio-narrative structures. Let us begin with the topology of the semiotic square seeing it in terms of its form as the archetypal paradigmatic articulation, as an elementary universal morphology developing a semic category. Its "morphogenesis" is modelized by a "procession" of elementary catastrophes (E.C.).

First of all, let us very summarily evoke the main lines of E.C.T.[2] An E.C. is a simple differentiable model of the system whose internal states are competing to be actualized. We suppose:

i) that the internal states of the system S under study are the local minima A, B, C, etc. of a potential function f, characteristic of S and defined on a phase space M, or *internal* space;

ii) that there exists an instance of selection I (this is what Thom calls a convention) selecting from possible internal states the *actual* state of S, by virtualizing all the others;

iii) that the potential (and subsequently the internal states) depend upon a control, that is to say a multi-parameter w variant in a space W, or *external* space. The characteristic of S is therefore in fact constituted by a *field* $W \longrightarrow fw$.

By virtue of these three hypotheses, for each internal state X of S there will exist a domain (open in the topological sense) U_X of the external space W which will be its domain of actualization that is to say the set of values w of the control for which S *stably* occupies X_W. In this sense, catastrophe models are very generally and very exactly, models of paradigms (in the structural meaning of the term) with respect to their dual dimension of substitution and taxonomy. When we pass from the domain U_X to another domain U_Y, there is a transition of the determination X to the determination Y, X being virtualized. That is the dimension of substitution. But as the various domains U_X share W, all the determinations are reciprocally determined and co-exist. They are co-localized in W as positional values. That is the dimension of taxonomy. In W, the respective values U_X U_Y, etc. of the terms X, Y, etc. are defined by their very conflict.

Let then K' be the closure of the points w of W for which the potential f_W is structurally unstable. From K' we can derive a closed K, called a *catastrophe ensemble* of W, which is the complementary of the union of the U_X's and thus ensures its division. It is in crossing K that the system S abruptly changes — catastrophically — internal state. K (and therefore the U_X) obviously depend upon the convention I which has been chosen. There exist two extreme conventions. According to the first, or Maxwell convention, S always occupies its absolute minimum. The catastrophes associated with it are said to be catastrophes *of conflict*. According to the second, called the convention of perfect delay, S occupies a local minimum as long as it exists. It makes the actual state depend upon the *history* of S (phenomena of hysteresis). The catastrophes associated with it are said to be those of *bifurcation*.

The advantage of the E. C. is that, since the internal states are defined by a potential (and not by a more complex dynamics), the partitions (W, K) have — we are dealing here with a deep theorem — a "proper" geometry, which can be described algebraically. Set K is not chaotic. It defines a "geography" where the domains U_X are separated by boundaries as in figure 1. These boundaries correspond to the sticking together again of subspaces of decreasing dimensions with instabilities of a degree increasing with the internal potential f_W. We can then say that K is *stratified*. For example, at a triple point α (stratum of dimension O of K in fig. 1), a stratum connecting three domains (U_A, U_B, U_C), the potential $F\alpha$ is more stable, more singular, that at a point β belonging to a stratum (of dimension 1 in fig. 1) connecting the two domains. The geometric concept of stratification schematizes the categorical concept of paradigm.

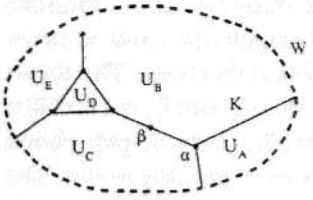


Figure 1.

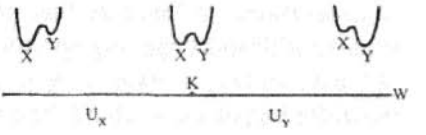


Figure 2.

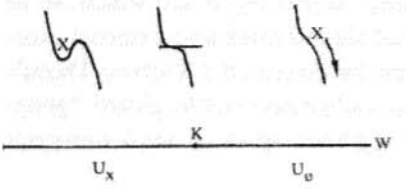


Figure 3.

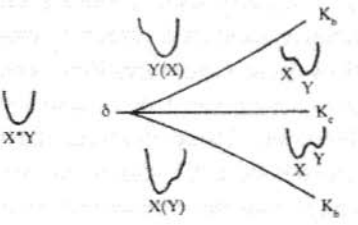


Figure 4. The cusp as schema of dialectic conflict. X(Y) signifies that the term X has "captured" the term Y and X*Y symbolizes the synthesis (static fusion) between X and Y.

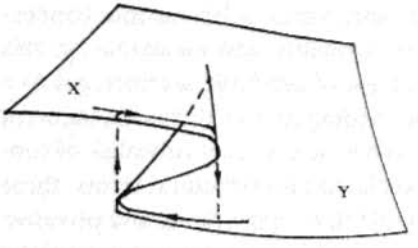


Figure 5. If we carry on a vertical axis above W the minima and the maximum of the potential f_w of figure 4, we obtain a buckled surface whose apparent contour on W in the direction of the vertical projection is the cusp K_b of figure 4. The "metabolic fusion" of X and of Y corresponds to the cycle of hysteresis indicated in the figure. It alternately exchanges X and Y.

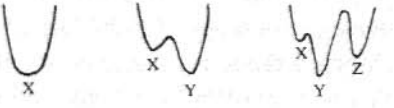


Figure 6. Potentials of compact catastrophes. They are all "wells" "trapping" the determinations within the sides.

E.C.T. brings all the strengths of mathematization to these intuitive considerations, in this case that of the theory of singularities and of structural stratification opening up onto a *geometry* of stratifications. The thrust of f in a family f_W of external space, dotted space (W,O), with f_O = f is called the unfolding of a potential f. The stratification (W, K) in the neighborhood of O is called *local model* and we say that f_O = f is its *organizing centre*. The fundamental result is that, we can *explicitly* associate a local stable model (W, K), which is unique, though not isomorphic, called its *universal unfolding*, to each instability of such a potential f. Each singularity of f generating an instability spontaneously has a tendency to unfold, that is to say to stabilize itself in a family f_w engendering a local model (W, K) and among all of these unfoldings there exists one which is privileged and which, so to speak, *expresses* f in a dialectic of internal singularities and external morphologies. These universal unfoldings can be classified (Whitney-Thom's theorem of E.C. classification) and all paradigmatic stable global "geography" can be considered as a sticking together again of local universal models.

The application of E.C.T. to semio-narrative structures rests upon the postulate that, as non specified and formally symbolizable by a letter (X, Y, S, s, etc.), a determination (a seme or actant for example) positioned in a structure y occupies a place the regulation of which (the *logos* in Thom's sense) is of minimal complexity, i.e. a minimum of potential. By *converting* literal identities into positional identities and formal relations into connections while remaining at a *same level* of formality and elementarity, this postulate allows us to go from a formal logic of symbolic assemblages to a dynamic topology of unfoldings. Now, according to a fundamental theorem (Morse's theorem), there exist only two types of E.C., catastrophes of conflict and catastrophes of bifurcation. Translated into structural terms, these respectively correspond to Jacobson's qualitative oppositions and privative oppositions. Every elementary structure (and in particular the semiotic square) would be a combination of these. The essential contribution made by C.T. is that it shows, on the one hand, that to be structurally stable, such compositions are subjected in their combinatory to determining *constraints* and that, on the other hand, their geometric complexity quickly becomes very great, "elementary" here can in no way be equated with "trivial".

II.1. Conflict and Qualitative Opposition

Let us consider the catastrophe of conflict of minimal complexity (cf. fig. 2). *This catastrophe corresponds to the schema of the qualitative opposition*: it allows us to give a *topological* meaning to the primary concepts and to its constituent categories. i) Originally, the determinants X and Y are not given as discrete. Their identity is not first of all literal but purely positional. It is defined by their place (internal positioning). ii) The places are defined by the potential characteristic of the structure. They have meaning only in relation to it (local minima) *and do not exist in isolated state* (structural axiom). iii) The domains of actualization U_X and U_Y of X and Y (positional values) are co-localized, co-situated in an external (ideal) space W (external positioning). *Their identity is therefore purely topological and relational*. iv) The relation of *presupposition* is schematized by the relation of dominance of the places (actualized, X virtualizes Y and reciprocally). Co-localized in W, X and Y are therefore in a relation of *reciprocal presupposition*. v) Separated by the threshold K, X and Y, or more precisely their values U_X and U_Y, are in a dual relation of *conjunction* and *disjunction*. The conjunction is the *connection* of U_X and U_Y in W. As far as disjunction is concerned it is identified with the catastrophic point K which disconnects W. Categorized by K, differentiated, W is an ideal space *of junction*, "the structural space" (the local paradigmatic system) of the qualitative opposition.

From this simple example, we can clearly see the aporia which the *discretization* of the topological schemata of the structural connections result in (what we called the antinomy between the formalization and the "mathematical physics" of the structures). To make the catastrophe of conflict discrete is indeed : i) to foreclose the generative potential, thus the places of the units, thus their positional values; ii) to obliterate the organizing centre K; iii) to disconnect W into its two domains (related components of W-K) U_X and U_Y having become independent; iv) to label each of these domains with a discrete unit; v) to translate the connections in terms of formal relations. In this conversion, *everything that is part of structure is nullified*.

II.2. Bifurcation and Privative Opposition

Let us now consider the catastrophe of bifurcation of minimal complexity called *fold* catastrophe (fig.3). *This catastrophe is the schema of the*

privative opposition. It schematizes the appearance or the disappearance of a determination and hence introduces *dynamic genesis* into structural synchrony. By the *asymmetrical* nature of the interface K which differentiates W into two domains U_X and $U_\emptyset$ respectively corresponding to the presence and the absence of X, it allows us to understand how a place can have a relation of reciprocal presupposition and of conjunction/disjunction with its own absence. In so doing, it enables us to solve the delicate and controversial problem of *the semiotic (non logical) status of negation*. In fact, semiotically speaking, that is to say within the framework of a dynamic positional topology, negation has no status, except if one interprets it as illocutionary negation. It translates an absence of place into an operation on the discrete units. In other words, negation is not a primary semiotic notion but a secondary logical notion and in a certain way all "dialectical logic" consists in regressing from it to a primary negativity constituting entities and which is a trace, in their entities, of their genesis. We are dealing with a general principle here which we will encounter on other occasions. The catastrophe schematization of structures make a *conflict* appear between the local contents of places (their positional value) and the *identity* of the discrete determinations which can invest them. *There exists a negativity constitutive of the topological immanence of structures*, a negativity which "dialectic" interprets in terms of *substance* of content whereas it actually depends *upon form*.

II.3. The Cusp and Difference as Dialectical Conflict

As a taxonomical model, as a local paradigmatic system, the semiotic square links a qualitative opposition X/Y to two *privative* oppositions X/Ø and Y/Ø. In terms of dynamic topology, this signifies that this is the schema of a relation of contrariety governed not only by the interdefinition and the reciprocal presupposition of the terms but also by their genesis. But the colocalization of the three elementary schemata X/Y, X/Ø, Y/Ø in the same structural space *must not be confused with a simple combinatory*. It must be realized as an *irreducible* elementary structure deploying an organizing centre which itself is irreducible.

The most simple schema which we can propose for the "dialectization" of a conflict X/Y is that of a *cusp* whose external space W is of the dimension 2 (fig.4). Accepting as sub-schema the schema of qualitative opposition X/Y, it begins *by developing this opposition as a true "morphogenesis", that*

is to say by developing the relation which constitutes it. But the genetic function which it includes is not yet that of the determinations X and Y. It is only that of the *threshold* K_c disjoining-conjoining them. In other words, it schematizes the dynamic *differentiation* of a fusional determination X*Y.

However, as limited as it may be, this schema of the cusp already allows us to make some remarks of not insignificant semiotic scope.

i) The point δ where the threshold K_c disappears is the analogue of what is called a critical point in phase transition theories. Its existence (which is characteristic of the cusp) implies the phenomenon which Thom calls *confusion* of the determinations or *static fusion*: whether we leave the domain of bi-modality (of conflict) X/Y by one or other of the branches of the cusp K_b we are in the presence of *opposite* isolated determinations, either X, or Y. But these autonomized determinations occupy *one and the same domain*, the exterior of the cusp being topologically *connex*. This means that, contrary to a schema like that of simple conflict or of ternary conflict organized from a triple point, *the schema of the cusp cannot be broken down into discrete elements*. It includes a *dialectical effect of identity* which manifests itself semiotically by the existence of *neutral and/or complex terms*.

ii) The synthesis (static fusion) X*Y is *both* a neutral term and a complex term. This depends on the oriented *direction* on K_c. If we move from X*Y to X/Y, X*Y acquires the status of the neutral term "neither X nor Y". If, on the contrary, we move from X/Y to X*Y, X*Y then acquires the status of complex term "both X and Y".

iii) The static fusion X*Y can be interpreted semiotically in a somewhat different way by saying that, when its place bifurcates, X (respectively Y) disappears as the presupposed of Y (resp. of X) and that, at the same time, Y (resp. X) is "absolutized", its content is *infinitized* in the mode of an idealization Y_∞ (resp. X_∞). The schema of the cusp would then describe the identification $X_\infty = Y_\infty$ that is to say, so to speak the *projectivization* of the semantic axis X/Y. This fundamental semiotic process has been known since Nicolas de Cuse as *coïncidentia oppositorum*. It pervades the dialectic.

iv) In addition to static fusion, the schema of the cusp has a second type of synthesis, called by Thom a *metabolic fusion* and formally analogous to Bateson's famous "double bind" (fig. 5). Whereas static fusion, though transgressing the principle of identity, can be described as a quasi algebraic "operation", metabolic fusion has meaning only from a catastrophic perspective.

II.4. The Swallowtail and the Deixis

In order to account for the privative oppositions X/Ø and Y/Ø , we have to complexify the cusp (all the while maintaining its irreducible character). In fact, the latter is a "compact" catastrophe where, when a determination bifurcates, it is necessarily captured by another since the lateral branches of the potential are "ascendent" and make a "well" (fig.6). In order, for example, for the genesis of Y to become possible, it is necessary that the corresponding minimum be able to bifurcate not only towards X as it does in the cusp but also on a "descending" branch towards an empty space "beyond the frame" which we shall note by Ø. This requires a "decompactification" of the cusp introducing a new threshold separating Y from Ø (fig. 7). According to the classification theorem of E.C., the irreducible catastrophe organizing potentials of the type appearing in fig. 7 is the *swallowtail*. This is a catastrophe the dimension of which is 3 and the geometry of which is already quite complex. Fortunately it is faithfully represented by some of its plane sections (fig. 8). The relations X/Ø, Y/Ø and X/Y are sub-schemata of the swallowtail (fig.9). We should insist upon the fact that we are not dealing here with a combinatory, but with a co-localization which consists in thrusting connections into an autonomous, organic, irreducible archetypal relationship. As the swallowtail schema includes the cusp (point Γ_2 of fig. 8), it gives a model of static fusion (*coïncidentia oppositorum*) X*Y and therefore of a neutral/complex term. It also includes a stratum corresponding to the genesis of Y from Ø in the presence of X. But it does not include a stratum corresponding to the genesis of X from Ø *in the presence of Y*. The genesis of X takes place *starting from Y* and that is why we propose to interpret it as a phenomenon of *marking*. This *dissymmetry* between X and Y is characteristic of the swallowtail (fig. 10). What the swallowtail adds to the cusp Γ_2 is essentially the point B_1 (called beak point) where the stratum of conflict X/Y meets the stratum of the genesis of Y. We shall see that this point is the organizing centre of the relation of implication $\overline{Y} \longrightarrow X$.

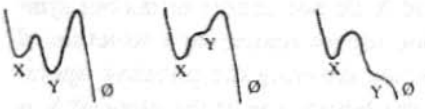


Figure 7. "Decompactification" of the cusp permitting Y to bifurcate not only toward X but also towards Ø.

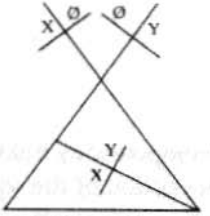


Figure 9. Co-situation of the subschemata X/Ø, Y/Ø, X/Y in the schema of the swallowtail.

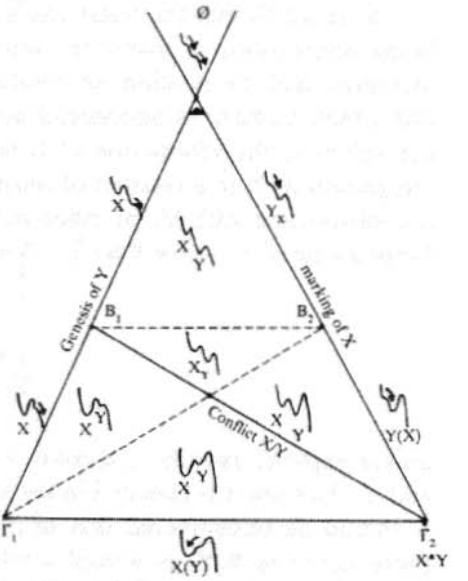


Figure 8. The swallowtail as schema of the relation between two determinations. Y(X) [resp. X(Y)] signifies that Y has "captured" X (resp. that X has "captured" Y).

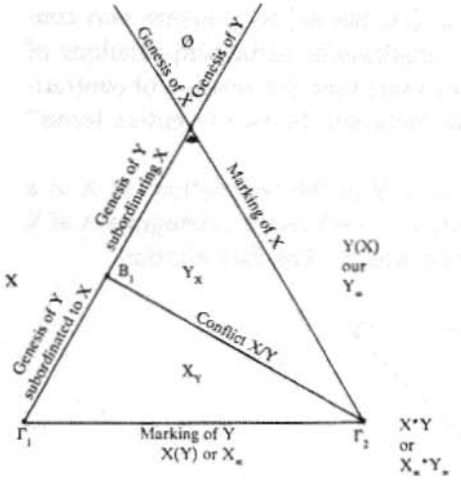


Figure 10. The local contents of the schema of the swallowtail.

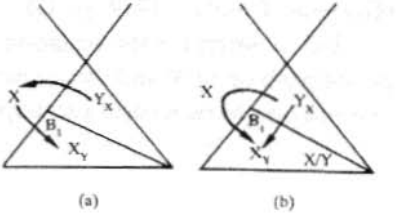
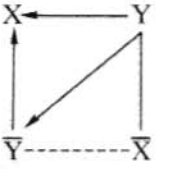


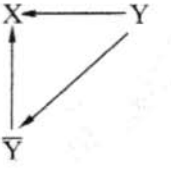
Figure 11. (a) The negation $Y \rightarrow \overline{Y}$ as path $Y_X \rightarrow X$ and the implication $Y \rightarrow X$ as path $X \rightarrow X_Y$.
(b) the factorization $Y \rightarrow \overline{Y} \rightarrow X$ as bypassing beak point B_1.

If we admit that the notations $\overline{X}$ and $\overline{Y}$ do not denote terms but symbolize bifurcations of places, the semiotic square remaining a structure of *two* terms and the relations of contradiction covering the privative operations, then we have to understand how the bifurcation of the place of Y is equivalent to the affirmation of X and how in turn the latter implies the integration of X in a relation of reciprocal presupposition and of conjunction-disjunction with Y. In other words, we have to understand how the *factorization* of $Y \longrightarrow X$ by $\overline{Y}$: $X \longleftarrow Y$



makes explicit, expresses, unfolds, deploys the presuppositions linking X and Y. This point is essential in the Greimassian conception of the square. It should be remembered that in order to ensure that the relation S_1/S_2 (here noted as X/Y) is indeed a relation of difference on the ground of resemblance (of conjunction/disjunction), it must be engendered as such and, following Greimas, we must begin with X and Y, negate them ($\overline{X}$ and $\overline{Y}$) and consider the assertions transforming $\overline{X}$ into Y and $\overline{Y}$ into X (implication). If there is a double assertion then we can say that the gap X/Y effectively constitutes a semic category: "two parallel operations of negation, carried out on the original terms [enable us] to generate two contradictory terms and (...), then, two implications [establish] relations of complementarity, by determining at the same time the relation of contrariety which has also become identifiable between the two primitive terms" (Greimas, Courtés, 1979, p. 33).

Let us interpret the negation $Y \longrightarrow \overline{Y}$ as the "revelation" of X as a presupposition of Y and the implication $\overline{Y} \longrightarrow X$ as the reintegration of X in a relation of reciprocal presupposition with Y. The factorization



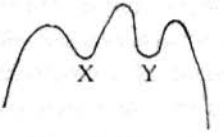
can then be interpreted in the following way (cf. fig. 11) : $Y \longrightarrow X$ corre-

sponds to the passage from the domain Y_X (where Y dominates X) to that of X_Y (where reciprocally, X dominates Y) *by a crossing through* the stratum of conflict X/Y. The concatenation $Y \longrightarrow \overline{Y} \longrightarrow X$ corresponds on the other hand to a passage from Y_X to X_Y by *bypassing the beak point* B_1 crossing and recrossing the stratum of the genesis of Y.

Thus, on the basis of the qualitative opposition X/Y schematized by simple conflict, the morphogenetic development of the square takes place *through the progressive adjunction of new organizing centres* (cf. fig. 10): i) the dual point $\triangle$ organizes, independently from one and other, the genesis of X and Y; ii) the cusp Γ_2 organizes the conflict X/Y and its neutral/complex term; iii) the beak B_1 organizes the implication $Y \longrightarrow \overline{Y} \longrightarrow X$. By progressively developing into a semiotic square, a semantic axis thus remains a qualitative opposition having *two* terms. But, thrust into a "procession" of relational schemata progressively complexifying local contents, it "externalises" the "organic" network of presuppositions which govern it. According to the particular dialectic of local and global which is specific to unfolding, these successive groupings of organizing centres *do not put into question its irreducibility*.

II.5. The Dual Butterfly and the Semiotic Square

The swallowtail catastrophe enables us to schematize "half" a semiotic square. In order to attain the full development of the square, it must be *made symmetrical* and to do so we must consider potentials of the type



allowing not only the genesis of Y from Ø in the presence of X but also that of X from Ø in the presence of Y. These potentials correspond to the *dual butterfly* which, it should be noted, is *the most complex* of the E.C.'s. articulating two determinations. The geometry of the butterfly is too complex to be described here. We shall limit ourselves to indicating that its external space being of the dimension 4, reducible to 3 by appropriate sections, the schematization of the square derived is given by a *sequence* of sections and is thus *both synchronic and diachronic*. In the case of the butterfly, there exists a *"temporality" internal to the structure*, a temporality

which, without paradox, can be qualified as "synchronic". Linked to the *dimensionality* of the structural space in question, it *accounts for the canonical linking of the sequences proposed by Greimas* (the "figure eight" trajectory of the object of value at the level of the anthropomorphic syntax). Consequently, in the catastrophe schematism, *axiology is polarized in the external space of the dual butterfly*, a polarization which governs its "synchronic" temporality.

II.6. Equivocity of the Connections and Deployment of the Presuppositions

If, I have rigorously denounced the formalist point of view in semiotics, it is in particular because it makes us consider as obvious that, if two terms X and Y are linked by a certain relation R, then the latter can be defined by formal properties, because it *is univocal*, the utterance (X, Y) can be verified or falsified. Now, as far as I am concerned, this "evidence" inherited from the logical theory of models is fundamentally wrong from a structural perspective. As a matter of fact, every relation in the structural sense of the term, every connection, is *equivocal*, its equivocity does not concern its nature (a qualitative opposition is univocally a qualitative opposition) *but the possibility of more or less rendering explicit, of expressing, of unfolding, of deploying the network of its presuppositions*. It is in this sense that, as part of the form of content, a relation can *develop*. During such a development, an elementary structure *is not complexified in the sense of the combinatory*. The number of terms that it articulates remains constant. *It is the morphology of the mode of articulation which is complexified*. As in embryogenesis, the development of a structure corresponds to the morphogenetic development of its type of articulation. It is its schema which, following a genetic trajectory, is progressively transformed and enriched, therefore equally its correlative local contents, therefore their operation on the substantial semanticism, and therefore, when all is said and done, *meaning in its apprehension*.

II.7. The Reduction of the "Horizontal" Conversion

The fact that, because of the irreversibility induced by the axiological polarization of the external space, the schematization of the square by the dual butterfly is intrinsically dynamic *allows linking the evenemential syntax*

to the fundamental taxonomy catastrophically schematized. The syntax of the operations whose only role in the generative trajectory is to ensure mediation between fundamental semantics and anthropomorphic syntax can consequently be eliminated. But the question remains obviously of understanding how, through a "vertical" conversion, the semiotic square can be translated into actantial syntax.

III. THE ACTANTIAL MODEL AND FORMAL CONVERSION

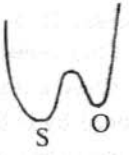
The operation which we propose to call *formal conversion* consists simply in passing from a taxonomic and paradigmatic reading of the catastrophic schemata to an actantial and syntagmatic reading. It is "formal" insofar as it takes into account neither the projection of the semantic onto the syntax, nor the substantial importance of the intero-ceptive deep semes invested in the object-values. It is therefore complemented by i) first of all a conversion which we call *conversion by duality* which concerns conversion proper of the semantic values into object-subject conjunctions and therefore of morphologies of *semantic* articulations into actantial *syntactic* relations; ii) then a conversion which we call a *meta-psychological conversion* (in a neo-freudian sense), which concerns the intentionality of the subjects as subjects of desire, their modalization, and the origin of the "aura" of object-values (axiologization, ideologization, thymic investment and proprioceptivity).

III.1. The Syntagmatization of Actantial Paradigms

Structural, topological and actantial, Greimas's anthropomorphic syntax is an evenemential syntax of action concerning the operation of subjects of doing on subjects of state (possibly joined together). Just as in case grammar, actants are defined in a relational and configurational manner, as places or deixes, in short as pure positional values. This implies that the actants do not exist in an isolated state. Pure formal syntactic units, they subsist only through their connections. We thus have to consider the elementary structures of actantial interaction as true paradigms and to schematize them by E.C.'s which we interpret as local systems (minima of potential) as actants. The relations between these syntactic paradigms and those of fundamental semantics are the object of conversion by duality.

Now one of the principle interests of E.C.'s as models of paradigms is that it is very easy to carry out syntagmatizations of them. All one has to do is *to cover paths in the external spaces*, the crossings of the various catastrophic strata being interpreted as *events* making actants interact among themselves. This is Thom's *actantial graph* method allowing us to construct *scenarios* from E.C.'s (cf. Thom, 1975 and 1983).

Let us consider for example an utterance of doing of the type "realization" transforming an utterance of state of disjunction subject-object $S \cup O$ into an utterance of state of conjunction $S \cap O$. Such an utterance syntagmatizes in a certain mode the actantial paradigm S-O. Possibly thrust as a sub-schema in a catastrophic schema, the latter is governed by potentials of the type



The transformation $S \cup O \longrightarrow S \cap O$ is then described by a "capture" (fig. 12) type path. We should note: i) that, synchronically, at the level of the paradigm, the underlying taxonomic relation is schematized by the catastrophe of bifurcation K; ii) that, by introducing time, the crossing of K converts this taxonomic relation into *a syntactic event* of capture; iii) that the *meta-verb* "doing" carries out a transformation of the states $S \cup O \longrightarrow S \cap$ equivalent to the *proto-verb of action* "to capture".

This simple example, which is easy to generalize, shows that the E.C.'s are *by construction* modes of projection of the paradigmatic onto the syntagmatic. As soon as one introduces paths in their external spaces, the taxonomic synchronic relations constituting them are *ipso facto* diachronically converted into sequential chains of syntactic events. As stated by Greimas, there thus exists *both equivalence* between the paradigmatic and the syntagmatic, this equivalence being the one existing between a structural space and the paths which can be followed to identify it, *and supplement* of the syntagmatic over the paradigmatic for, in general, there exist *several non equivalent ways* to follow such paths. This simple observation allows us to resolve the major difficulty raised by Paul Ricœur regarding the Greimassian conception of conversion (cf. Ricœur, 1980).

It seems to me that one of the principal interests of formal conversion is that it allows us to attain *a schematization of syntactic doing*. Doing corresponds to taxonomy including time. It is simply the meta-verbal formulation of the principle of formal conversion. Such a definition enables us to resolve the second difficulty raised by Ricœur concerning the impossibility of equating, as Greimas nonetheless does, on the one hand *syntactic* doing "which reformulates the syntactic operations in an anthropomorphic language" and, on the other hand, *generic* doing which is the "formal term substituted for all the verbs of action". Such an equivalence is indeed difficult to admit in a formalist conception where the semiotic square is converted into a *logical* syntax of operations. In the catastrophe conception where, as we saw in II.7, we can do without a syntax of operations, it is on the contrary not only acceptable but can even be "proven". There does exist an equivalence between syntactic doing and a generic doing if we posit that the generic doing in question *is the formal term substituted for all the proto-verbs of action which convert the organizing centres of the taxonomic relations into syntactic events*.

Seen from this perspective, catastrophe schematism confirms (definitively we would like to say) the well founded basis of the Greimassian reduction of syntactic doing to events i) of the conjunction/disjunction subject/object; ii) the polemical conflict subject/anti-subject (theory of performance); iii) the transfer sender/receiver. As a matter of fact, these three classes of events, once interpreted in terms of generic doing, correspond exactly to the *canonical semanticism of the principal actantial morphology archetypes derivable from E.C.'s.*

III.2. The Structure of the Actantial Model

As the base actantial model happens to be the ternary model $S/O/\overline{S}$ (subject and anti-subject competing for the same object), its schematization must resort to the butterfly catastrophe whose geometry is too complex, I should add, to be described here. Let us limit ourselves to representing, with figure 13, a typical plane section.

This catastrophe is *semiotically* (if not geometrically) simple enough to describe since it essentially corresponds to the polemical transfer of an object-value O from an anti-subject $\overline{S}$ to a subject S^3 Let us follow its "synchronic" temporality (cf. II.5). Initially, the relation $\overline{S}/O$ is organized by a cusp ("capture" of O by $\overline{S}$). The action proper is initiated by the appearance

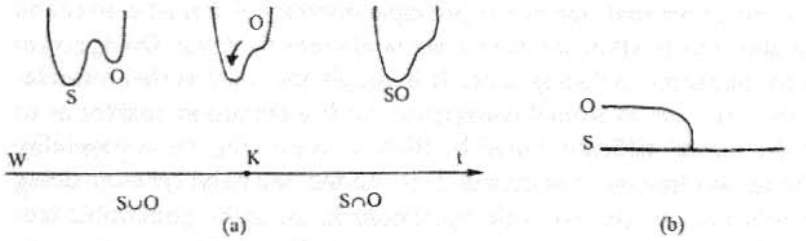


Figure 12. (a) Capture event (conjuntion) S∩O associated with a path in the external space of the cusp of figure 4. (b) The corresponding actantial graph. It is obtained by representing the minima of the generating potential by the points. The actants therefore correspond to the edges and the syntactic events the vertices.

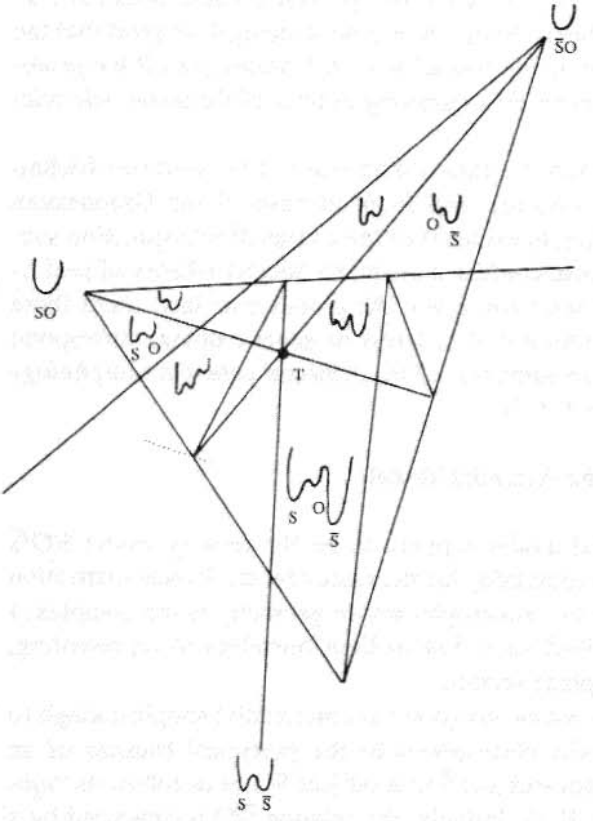


Figure 13. The investment of the butterfly by S, S̄ and O (we only represented a few forms of the generative potential).

of a swallowtail in the zone of the structure where $\overline{S}$ is dominant. The new cusp which is introduced organizes a *virtual* relation S/O ("desire" to free the Princess for example). Next this relation *is actualized* and interacts with $\overline{S}$ in a *ternary* structure of the type represented in figure 13. We can see how in this figure four zones are *co-localized*: i) the central triactantial S/O/$\overline{S}$ zone (with the point triple T); ii) the two biactantial zones of the cusp type S/O and $\overline{S}$/O; iii) the biactantial zone of the conflict type S/$\overline{S}$. Following the "victory" of S over $\bar{S}$ (the principal test of the performance), the cusp $\overline{S}$/O is resorbed and is progressively virtualized in the zone of the structure where S is dominant. It then disappears and is replaced by a final relation S/O ("alliance" hero-princess for example). In principle, such a diachrony is reversible. Its irreversibility is simply the consequence of an axiologization, that is to say of a *polarization* of the structural space (cf. II. 5) making the relation S/O a "repelling" relation and the relation $\overline{S}$/O an "attractive" one.

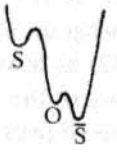
It should be noted that, in the schema of the butterfly, the focalization of the ternary relation S/O/$\overline{S}$ on the conflict S/$\overline{S}$ is framed by two mutually symmetrical sequences where a narrative program of conjunction ($\overline{S}$-O for example) admits the contrary program (S-O) as being presupposed. There thus exists reciprocal presupposition not only of the actants but also of the two subjects' antagonistic narrative programs of realization. This enables us to accede to a schematization of the Greimassian notion of *paradigmatic junction* which designates "the logically necessary concomitance of two utterances of conjunction and of disjunction, affecting two distinct subjects" ($S \cup O \overline{\exists} \overline{S} \cap O$ and $S \cap O \overline{\exists} \overline{S} \cup O$) and concerns the reciprocal presupposition of two competing narrative programs "whose solidarity is guaranteed by the concomitance of the functions" (Greimas, 1973).

It should also be noted that the *geometry* of the butterfly (which is obviously much richer than the simple symbolization of utterances of doing and narrative programs) permits the resolution of another difficulty (also noted by Ricoeur) of Greimassian theory concerning the "equivalence" between *conflict* (binary) $\overline{S}$/S and *transfer* (ternary) $\overline{S} \longrightarrow O \longrightarrow S$. Evidently, just as the junctions S-O do, the conflicts S/$\overline{S}$ constitute *primitive* relations. They must therefore be treated as such and their equivalence with transfers, an equivalence justifying substitution, to concomitances $\overline{S} \cup O \overline{\exists} S \cap O$ and $S \cup O \overline{\exists} \overline{S} \cap O$ of the paradigmatic junction, of implications $S \cup O \longrightarrow S \cap O$ and $\overline{S} \cap O \longrightarrow \overline{S} \cup O$ of the syntagmatic junction, must be "demonstrated". In strict Greimassian theory this is obviously impossible since subjects exist only by their junction with objects, a conflict S/$\overline{S}$ can exist as conflict only between two antagonistic narrative programs

of conjunction. But this becomes possible in catastrophe schematization since *there exists a stratum of conflict S/$\overline{S}$ originating from T*, a stratum which moreover, after the crossing of the stratum of bifurcation of O, becomes a stratum of *pure* conflict (cf. fig. 13).

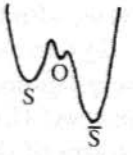
"Equivalence" between the domination of S over $\overline{S}$ and the polemical transfer $\overline{S} \longrightarrow O \longrightarrow S$ can be "demonstrated" in the following way. It is a question of describing a "canonical" path in the external space of the butterfly starting from the cusp $\overline{S}$/O and ending with the cusp S/O by following the "synchronic" temporalization governing the circulation of the object-value O. This path must obviously pass through the ternary zone S/O/$\overline{S}$ which is within the swallowtail. We can say that the conflict S/$\overline{S}$ is expressed by a double intermediary disjunction of O and that the relations of domination between S and S is expressed by differences in the *degrees* of disjunction $S \cup O$ and $\overline{S} \cup O$:

(i)



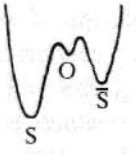
weak disjunction between $\overline{S}$ and O and strong disjunction between S and $\overline{S}$/O.

(ii)



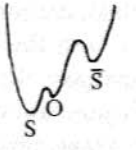
virtualization ("putting into abeyance") of O.

(iii)



performance: domination of $\overline{S}$ by S.

(iv)



re-actualization of O, weak disjunction between S and O and strong disjunction between $\overline{S}$ and S/O.

This "canonical" path γ is represented in figure 14.

III.3. Variants and Transformations

One of the main interests of the catastrophe schematization of the actantial model is to show *that in accordance with its own relational definition*, although invariant, canonical and archetypal, it includes *a variety of variants* and that, a syntagmatic "supplement" emerges during formal conversion. As a matter of fact, the external spaces (W,K) being *multidimensional*, there exist several types of γ paths which are non equivalent with respect to the relation of equivalence called "homotopy", γ and γ' being equivalent if we can deform them one into another without crossing strata

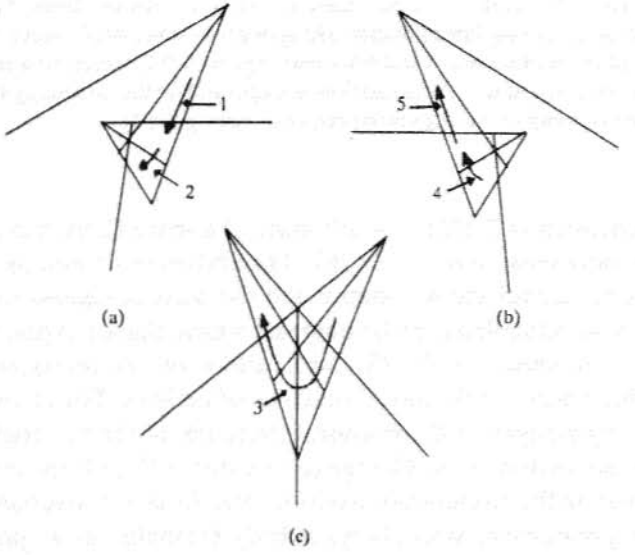


Figure 14. The canonical path of equivalence between conflict and transfer.

(a) 1. Passage from initial disjunction $\bar{S}$/O) to double disjunction (i).
2. Virtualization (ii) of O.

(b) 4. Reactualization (iv) of O after the domination of $\bar{S}$.
5. Passage from the double disjunction (iv) to the final disjunction S/O.

(c) The path γ projected on the central symmetrical section of the butterfly.
3. Conflict S/$\bar{S}$.

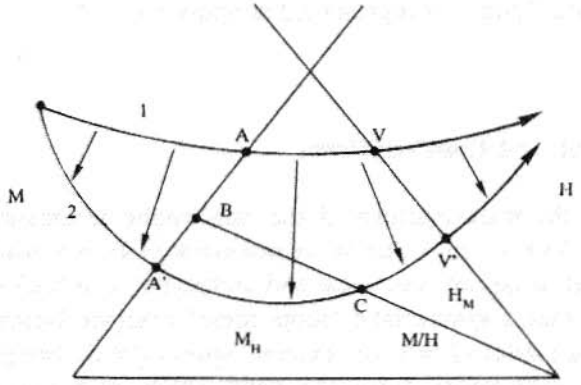


Figure 15. The swallowtail as site of the transformations of the pre-birth and re-birth variations of the Saint-George myth. On path 1, the hero H appears as already dominant (point A) and captures the chtonian dragon M (point V) because of his "superhuman" essence. On path 2, on the contrary, H is a "human" hero, finite and problematized by a desiring intentionality. He appears as dominated (point A'), combat M (point C of the performance) and his victory (point V') is therefore a realization. The historical evolution of the representations is expressed by the homotopy $1 \rightarrow 2$, that is to say, by the crossing of the organizing centre of beak point B.

of co-dimension $\geqslant 2$. (If F is a sub-space of a space E, we call its co-dimension the difference dimE — dimF). The classes of homotopy of the paths can thus be assimilated to *variants* and the *transformations* of variants, in turn, can be assimilated to homotopies which change types, i.e. crossing strata of co-dimension 2. *The singularities of co-dimension 2 are thus organizing centres of the transformations of variants*. For example, as I did show in my analysis of the historical evolution of the pictorial representations of the myth of Saint-George (cf. Petitot, 1979, b), the crossing of the *beak point* by the swallowtail makes us pass from a "superhuman" hero, a divine representative who always-already triumphs, to a "problematical" hero haunted by finitude and engaged, as Sartre showed so well in his analysis of Tintoret, in a doubtful combat. These *semantic effects* are simply pure consequences of a transformation of *local contents* (cf. fig. 15).

IV. CONVERSION BY DUALITY

Formal conversion tells us nothing about conversion proper of fundamental semantics into anthropomorphic syntax and thus of a taxonomic structure with *two* semes into an actantial structure with *three* actants (actantial model). In order to interpret this within the framework of catastrophe schematism, we should make the following two comments: i) if the realization of a seme s (of a value), through conversion, is equivalent to a conjunction $S \cap O$ and its actualization S to a disjunction $S \cup O$, then, in accordance with figure 12, we must identify s with the *maximum* potential separating the basins of S and of O; ii) the semiotic square is schematized by the dual butterfly, the actantial model by the butterfly and we pass from an E.C. to its dual by transforming the minima into maxima and vice versa. We can subsequently propose the hypothesis that the values *are identified with the thresholds differentiating the subject-actants from the object-actants* and that there exists, so to speak, a *duality between values and actants* (hence the name of conversion by duality). In summary, conversion by duality transforms the semiotic square into a *paradigmatic* actantial model and formal conversion syntagmatizes the latter into a set of variants.

V. META-PSYCHOLOGICAL CONVERSION

But there also exists an entirely different *substantial and non formal* dimension to conversion concerning the *intentionality* which governs the narrative programs of realization of values by subjects semiotically defined as subjects of lack, as subjects of quest, as subjects of desire. The question then becomes to know in what measure catastrophic schematism can be developed into an intentional dynamics.

Now, in fact, this becomes possible if, even though only analogically, we resort to the Thomian theory of predation and pregnance.[4] In this theory, René Thom started from the observation that one of the characteristics of animal regulation is to function through *actant catastrophes*, such as those of predation and sexuality, making survival depend on actants other than the self. Relative to the ego, these other actants have the status of *intentional objects*, of "internal" immanent objects in which the former,

as subject of lack, is phantasmatically *alienated*. But as real "external" objects, these are biologically *pregnant* forms (and not only perceptually salient) whose recognition reprograms the identity of the ego and triggers behaviors of attack, flight, seduction, etc. Thom was led to think that this, so to speak *syntactic*, actantial component of biological regulation, as it were, *externalised* the *semantic* component of *metabolism in the mode of a true conversion*. More precisely, his main idea was that the *catastrophes including the actants of regulation realize, in the form of actantial interactions that are genetically programmed, the functional signification of the tissues differentiated by the catastrophes of embryogenesis*. If we agree with this hypothesis, then it is necessary to establish a parallelism between biological regulation and imaginary regulation which is manifested as the apprehension of meaning in semio-narrative structures. It all happens as though the deep semes, first of all intero-ceptive then proprio-ceptive and thymically invested, were non-representable pregnancies, "*drives*" which could only be apprehended and subjectivized through the intermediary *of an actantial localization and diffusion* governed by the circulation of the objects in the syntactic disposition. In such a parallelism, the "coupling" of these deep intero-ceptive semes with the figurative semes of the discursive level becomes the exact analogue of the coupling of the biological pregnancies on the perceptively salient forms which localize them. Therefore, if intentionality is governed by pregnancies, its object is nonetheless "de-programed" by figurative localization, a "de-programing" which can be taken as a definition of desire. Desire is not reduced to a lack of object. It also consists in a structurally constrained intentionality of intending, not pregnancies, but "suffused" figures of pregnance. This irreducible gap between the being of the object and the aura of meaning which renders it subjectively significant as an object-value renders desire necessarily misapprehensible. In myths and tales, the axiologization of values by transcendental senders has the *ontologization* of desire as correlate, i.e., the interpretation of the aura of meaning in terms of objective being. Hence the vital importance of *veridiction* which guarantees such a possibility by reducing misapprehension to an interplay of secret and lie (cf. Petitot, 1982, a, and 1983, b).

VI. ON SOME POSSIBLE EFFECTS

Let us briefly mention a few possible avenues of exploration.

1. *The movement from the local to the global*: The problem is to know how an understanding of the *dynamic synthesis* of catastrophes can permit us to move from the actantial model to the global actorial structure of a complex narrative (theory of the narrative schema).

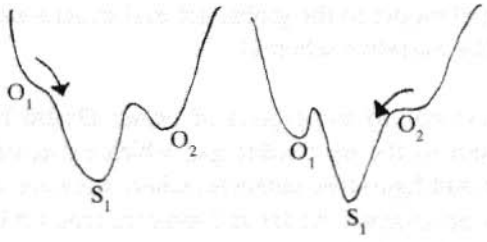
2. *The meaningful selection of the objects of value*: Desire being misapprehension with respect to the irreducible gap which exists between deep semantic pregnancies and figurative saliencies where they are invested, the objects of value must be *selected*. As far as I am concerned it is in the project of establishing a "logic" of selection that semio-narrative theory of necessity meets up with meta-psychology (cf. Petitot, 1983, b) and even, as P.A. Brandt has shown, with the Lacanian notion of the *signifier* (cf. Brandt, 1982, a and b).

3. *The meta-psychological interpretation of the butterfly*: To complete the study of meta-psychological conversion, it is necessary to extend to the butterfly the interpretation proposed by Thom of the cusp as the regulatory catastrophe of actants in the schematism of predation (cf. Thom, 1983).

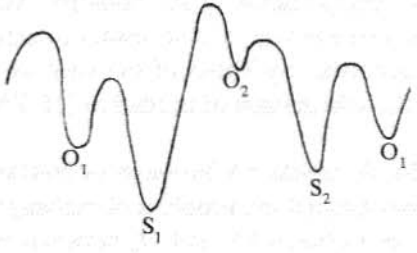
4. *The double transfer*: In his article "A Problem of Narrative Semiotics: Objects of Value", Greimas tackled the problem of *exchange*, that is to say of the communication of *two* objects O_1 and O_2 between two subjects S_1 and S_2 (cf. Greimas, 1973). What we are dealing with here is with a *tetra-actantial* structure where the exchange $S_1 \cap O_1 + S_2 \cap O_2 \longrightarrow S_1 \cap O_2$ and $S_2 \cap O_1$ can be considered to be realized only if O_1 (resp. O_2) ceases being a value for S_1 (resp. S_2) after having become a new value for S_2 (resp. S_1).

If we accept catastrophe schematism, then this structure turns out to be *complex* and also turns out to be the title of *a non-resolved problem of modelization*.[5] As a matter of fact, if we attempt to modelize it by means of potentials with 4 minima, we must resort to a catastrophe, the external space of which is of the dimension of 6 (reducible to 5) and the geometry of which is not at all trivial. Through formal conversion, we encounter a con-

siderable number of possible variants, which is borne out by experience. Moreover, for the subject S_1 (for example) to be able to have a relation of *dual* junction with the objects O_1 and O_2, its place must be "framed" by the places of O_1 and O_2 to permit captures of the type:



But, for the sake of symmetry, the same must hold for S_2 and therefore the potential generators must be of the type:



Now this requires that the latter be defined *on a circle*, no longer locally on a neighborhood of the origin of the straight line but on a *global* (compact) space. Such *cyclical* structures still remain to be explored.

5. *The dual cusp as a universal structural space*: Another way of dealing with this problem of exchange would be to advance the hypothesis that the junctions subject-object occur on *two internal independent* dimensions. Each junction being organized by a cusp, all we have to do is to *couple* two cusps defined *on two different internal spaces* (and not, as in the case of the butterfly, on the same internal space). The combined catastrophe is called the *dual cusp*. The dimension of its external space is 8

(reducible to 7) and its geometry is so complex that it still is not completely known. This is a marvelous example of what mathematization brings to a theory. At the *conceptual* level, the expression "interaction of the two junctions subject-object" is vague and not controllable. We know simply that it subsumes great empirical diversity without in any way being able to establish the link between its content and this diversity. On the other hand, if we adopt catastrophe schematism then we can translate its conceptual content into a mathematical model (in this case that of the dual cusp) which is precise and controllable. And mathematical theory henceforth allows: i) deriving a *constructed diversity* (mathematical and not empirical) which can be confronted with empirical diversity (confirmation/refutation of the models); ii) acceding to a complexity *which goes beyond the resources of intuition and language*.

In fact, we can even ask (Petitot, 1977, a) if, by formal conversion, the dual cusp cannot be considered as a *universal structural space* which would classify narrative structures. Indeed, it exactly corresponds to the "universal formula" of myth proposed by C. Lévi-Strauss in *Structural Anthropology*.

VII. CONCLUSION

Developed in this way, catastrophe formalization of Greimassian theory leads to a notable epistemological revision. It is not only a question here, following Hjelmslev, of equating the formalization of a formal expression of indefinable structural categories, and then of developing an "algebra", a calculus of forms. It is a question of schematizing the indefinables so that the derived concepts can be rendered geometrically. In my opinion, it is essential to understand that in the expression "algebra of forms", it is the term "forms" which conditions the term algebra and not the contrary and that it is therefore the mathematical content assigned to the primitive "form" which *determines* the algebraico-combinatory organization of the structures.

Obviously, this attempt to constitute structural objectivity and regional ontology as a "Physics of meaning" is still greatly, much too greatly, incomplete. It opens up onto a research program that shall make use of experimental data. Here I remained on an essentially theoretical level and I attempted to show how and why C.T. can be seen as a revolution for struc-

tural disciplines. The unifying point of view which it makes possible is not without importance if we think that it comes from formalisms which play a determining role in fundamental Physics. Through it we can perceive the possibility of extending the rationalism of Physics to structural rationalism, all the while integrating its phenomenological and semiotic banished components. We can perceive the possibility of shifting the break between phenoumen and noumen *within meaning itself* and therefore, by making it autonomous and by objectivizing it, *naturalizing* a dynamic dimension of meaning which until now has oscillated between its formalistic reification and its dialectic manipulation. Ontological in the sense of transcendental idealism, this new division will, I hope, make the "North- West Passage" something quite different from a labyrinth.

NOTES

1. This article is a brief (and very incomplete) presentation of my doctoral thesis (Doctorat d'état) *Toward a Schematization of Structure. On some semiotic implications of catastrophe theory*, which was defended on January 28, 1982. The thesis committee was composed of the following: R. Thom (President), A.J. Greimas (Director), A. Culioli, U. Eco, Mme. C. Imbert, Ch. Morazé and P. Rosenstiehl.
2. For more details, c.f. for example Thom (1975), (1983), Zeeman (1977), Petitot (1977), (1978), (1979, a).
3. Cf. for example my analysis of Saint-George in Petitot (1979, b).
4. For a translation of this term we have followed the example of W.M. Brookes and D. Rand who translated R. Thom's book *Mathematical Models of Morphogenesis*, Chichester, Ellis Horwood Limited, 1983 "Translators note: the use of the word 'prégnante' to describe such a morphology can only be translated into 'pregnant'. It is linked with the Gestalt phenomenon of 'pragnanz', the tendency to completeness and permanence of form", p. 224.
5. Such problems only exist in *mathematized theories*.

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