On the linguistic import of catastrophe theory*

JEAN PETITOT

Introduction

Here we would like to specify *philosophically* the nature of the contribution of catastrophe theory to linguistics. (For mathematical details see Petitot 1982a, 1985a, 1985b.) In order to do so, we shall focus our attention not so much on technical questions arising from the construction of models[1] as on the epistemological questions arising from the use of *topological* concepts in linguistics. We shall therefore take our stand at the level of fundamentals, and shall attempt to outline a critique of the formalist dogma that dominates contemporary linguistics. We shall discuss in particular some aspects of the deep version of Culioli and Desclés' (1981) thesis.

Position of the problem

It is undoubtedly justified to believe that there are two very different aspects of language, each one referring to specific phenomena, levels of apprehension, techniques of observation and of formalization, methods of explanation, and problematics of elucidation. The first concerns 'the adequate description of language activity grasped *through* languages' (Culioli 1971: 2). With regard to it, we can speak of 'systematic empirical linguistics'. The second is concerned not with the finer points of the organization of this activity but with its conditions of possibility, its ontogenesis, its rootedness in perception and action, as well as with the constraints which the structure of the external world exerts on it. With regard to it, we can speak of 'pure' linguistics (in the way that Kant spoke of 'pure' physics) *conditioning* systematic empirical linguistics.

As an experimental discipline, systematic empirical linguistics possesses the following features:

i) It assumes linguistic facts to be given as phenomena.

ii) Its aim is pragmatical and, by means of a construction of observ-

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ables, it consists in organizing the diversity of the empirical data.
iii) Its attention is directed toward fine problems manifesting, in its specificity, the complexity of the linguistic facts.
iv) Its relationship to formalization is operational: it aims to construct the formal instruments able to modelize adequately the description of the observed phenomena.

On the other hand, insofar as it is an eidetic discipline, 'pure' linguistics possesses the following features:
i) It does not assume the linguistic facts to be given as phenomena, but endeavors first of all to *establish* them as such.
ii) Its aim is therefore foundational; it is of critical nature and consists in forming, deducing (in the Kantian sense), then schematizing the *a priori* categories of the linguistic field, so as to secure their objective value and to define linguistic phenomena as *objects of experience* (still in the Kantian sense).
iii) Its attention is focused on the eidetic characters that condition the existence and the manifestation of these objects.
iv) Its relationship to formalization is not empiricist, but rationalist; it is concerned with assigning an ontological content to mathematics, the function of which is to render linguistic reality *intelligible* and to reveal in it some necessity (what Thom has called 'the reduction of arbitrariness').

Of course, just as there is an irreducible gap between 'pure' physics and the details of the empirical system of physical laws, so also there is an irreducible gap between 'pure' linguistics and the details of systematic empirical linguistics. However, without the elaboration of the former, the latter would not attain the rank of a truly scientific theory. We cannot, therefore, neglect the foundational problem. Contrary to the current idea, the systematic organization of empirical diversity is insufficient to constitute the regional ontology of a theoretical object, to make its level of reality autonomous and to establish its intelligibility (i.e., its apodictic mathematical understanding). Access to a truly theoretical level presupposes for any empirical discipline a *founding abduction*, which could not be derived from mere observation but only from the identification of a 'regional essence' (in the Husserlian sense) *coupling specific mathematical objects with the* a priori *categories of the region considered.* In more modern but less precise terms, one might say that such an abduction presupposes the choice of a paradigm of intelligibility (in the Kuhnian sense).

Chomskyan rationalism, which marks the emergence of formalized theories in linguistic matters, represents the first successful attempt (and the only one before Thom) to lay the foundations of 'pure' linguistics. It eminently satisfies the four features referred to above. The category whose

objective value it attempts to secure is that of (syntactical) *connection*; the eidetic character it identifies in language is that of generativity; mathematics (the theory of language-accepting automata) becomes constitutive of the phenomena and transforms them into objects of experience; finally, its founding abduction consists in seeking out the principle of linguistic facts within the paradigm of recursiveness. However, as has become increasingly manifest, the Chomskyan conception cannot fit with systematic empirical linguistics without modifying its paradigm and thereby weakening considerably its objective value. This intrinsic limitation is due to deep-rooted reasons connected with certain phenomenological characteristics of natural languages.

i) The generativity of formal languages is 'free'. The iteration of their deduction rules is not constrained, whereas the generativity peculiar to natural languages is both constrained and of short range. As Gross has observed, their creativity stems essentially from lexical combinatorics and from the action of transformational devices on kernel sentences (Gross 1975). This fact proves that recursiveness is not an eidetic character of natural syntaxes. For this reason, one can assert along with Thom (1971) that 'the pure and simple idolatry' of the generative virtue of formal structures must be questioned, for, as far as natural languages are concerned, 'it is the self-limitation of the generative capacity of syntax that is to be explained'.

ii) Natural languages cannot be axiomatized. There are no global grammars for them, only local grammars the gluing of which (the passage of local to global) constitutes one of the main problems facing linguistics.[2] Indeed, just as Culioli and Desclés have pointed out, the extension of the corpus leads to the prolongation of the appropriate grammars, but such prolongations cause a *diverging* of the grammatical system (Culioli and Desclés 1981: 7).

iii) The axiomatic conception of language leads to the immersion of natural grammars in a universe of formal ones where there is no longer any possibility of characterizing their sub-class in a formal way. We shall say that this conception does not satisfy *the condition of descent*. There is no principle available in it for deducing the kernel sentences used as inputs of the transformational devices, nor for handling the cognitive conditioning of grammatical structures (cf. for example the formal universals dealt with by Chomsky in TLTA 1979: structure-dependent rules, linked anaphors, specified subject condition, etc.). This shortcoming is mitigated in Chomsky by innateness hypotheses. But such a solution is unacceptable, since it is no more than a consequence of a dogmatic option concerning formalism. Instead of seeking out the specific mathematical tools that conform to the eidetic character of natural

languages, Chomsky has opted for the reduction of syntax to formalism. Consequently, he has been led to reinterpret the *a priori* dimension in innatist terms. It is fallacious to infer an ontological proposition from an internal limitation of descriptive formalisms. It would only be justifiable if these formal descriptions had been previously established as ontologically determinant. But in Chomsky this is far from being the case (cf. Petitot 1979c, 1982a, 1985b).

The intrinsic limitations of the formalist conceptions of language (inherited from Hilbertian axiomatics) may, broadly speaking, be defined in the following way. If we assume that a grammar consists effectively of a set of generating mechanisms (automatisms of competence) attributing a semantic interpretation to phonetic sequences, then we will be led to think of syntax as a system of formal constraints conditioning the mediation between phonetic and semantic representations. In this sense, a formal grammar must be able to associate a structural description (such as those advocated by Tesnière or Bloomfield and Harris) with each sentence and, more precisely, to select and enumerate an infinite number of descriptions. For that, there is no need whatsoever to presuppose — in the pretransformational component that acts as a basis for the grammar — a categorial component that would generate, through a generative grammar, the syntactic indicators of the kernel sentences whose semantic interpretation determines the deep structures. In fact, on the one hand, the essence of generativity escapes the categorial component, and on the other, the main role of the initial syntagmatic indicators is to allow a *configurational* definition — i.e., a *positional* definition in terms of dominance — of relations and grammatical functions. Now for that, it is *sufficient* to dispose of arborescent *morphologies*. The possibility of deriving these from an iteration of re-writing rules is therefore superfluous.

Let us state this important point more precisely. The notion of syntagmatic indicator goes back to Tesnière's *stemmas*. Adopting a foundational, rationalistic point of view, Tesnière sought to abstract the principles of a 'pure' structural syntax; in order to do so, he had to set out its pure intuitions and objective categories. For him, the main category of structural syntax was that of connection — which, let us note, specifies Kant's third category of relation, namely the category of community and reciprocal determination. But precisely because the concept of connection is a *category*, the connections constitutive of the concrete structure of the sentences are not perceptible phenomena. They are 'incorporeal' and can only be grasped by the mind (cf. Tesnière 1959: §1 and the reference to Humboldt's '*innere Sprachform*'), although they do constitute the 'vital' organic principle of the linguistic 'energeia' (Tesnière 1959: §§1.8, 3.11).[3] For them to occur as objects of experience, it is therefore necessary (a) to

show how a concept can become *inherent to objects* (i.e., acquire an objective value) and (b) to *schematize* the category of connection — that is to say, to 'construct' it in an intuition, in this case a spatial intuition. For Tesnière, this schematizing operation took the (weak) form of a *diagrammatic* representation. Let us recall that the stemma graphically represents the structural connections and their relations of mutual interdependence. It is 'the visual representation of an abstract notion which is none other than the structural scheme of the sentence' (Tesnière 1959: §3.10). It is at the same time, as a tree, a graphic representation and, as a scheme, the expression of the activity of talk.

Therefore, just as modern logic is born out of Frege's ideographic turn (Imbert 1969, 1971, 1979), so structural syntax is born out of Tesnière's stemmatic turn. The formalist attitude can be characterized by the 'evidence' that *stemmatics must be converted into a formal system.* What is to be gained by such a conversion is quite obvious: the possibility of developing a *calculus* of symbolic assemblings. However, what is lost is proportional to what is gained. Indeed, stemmatics is *a compound of a spatial intuition and a literal one.* Its conversion into a formal system dissociates this compound, eliminating the spatial intuition and developing the literal one exclusively. But in so doing, it makes an irreversible break with the spatial schematization imperative which Hjelmslev (in connection with the localist hypothesis to which we shall return later) made the key to any theory of structural connections: 'the spatial notion is inevitable if one wishes to give a tangible and flexible interpretation to relations in the abstract. To confine oneself to abstract relations without giving them a support by which they can be represented is to ban from the outset a clear, evident explanation of the facts' (Hjelmslev 1935: 45).

Therefore, in linguistics, the formalist conception 'bans from the outset' the passage from a general to a *transcendental* logic able to deal with the objective content of empirical phenomena. Therein lies its intrinsic limitation.

It is not because mathematics is *also* a language (formal logic, set theory, universal algebra, category and topoï theory, etc.) that mathematical linguistics should be conceived as a game of more or less adequate, more or less complete, reciprocal translation between it and natural languages. The structure and function of mathematical languages are basically dependent on the nature of mathematical *objects* which, unlike the linguistic ones, are always explicitly constructed. In linguistics' major reference to Hilbertian axiomatics, it is not to be forgotten that the latter aims at establishing and characterizing fields of *objects.* The 'recovery' of axiomatics by logical positivism is to be particularly denounced because as Lautman observed in the 1930s:

For Wittgenstein and Carnap, mathematics is nothing more than a language indifferent to the contents it expresses.... If we try to understand the reasons for this progressive fading-out of mathematical reality, we may be led to the conclusion that it is the result of the deductive method. By wanting to construct all mathematical notions from a small number of primitive logical notions and propositions, *one loses sight of the qualitative integral character of the established theories*.... The quest for primary notions must give way to a synthetic study of the whole. (Lautman 1977: 23–24, emphasis added.)

The logicians of the Vienna School claim that the formal study of scientific languages should be the sole object of the philosophy of science. For those philosophers who consider their main task to establish a coherent theory of the relation between logic and reality, that is a difficult thesis to accept.... A philosophy of science that would not be related to the study of interdependence between areas of research methods would be singularly lacking of interest.... The Vienna School logicians still assert their total agreement with the Hilbertian school. Nothing however could be more debatable. Following in Russell's footsteps, the logistic school is endeavouring to find the atomic components of all mathematical propositions.... Hilbert's axiomatics and that of his disciples aim, on the contrary, at abstracting a system of axioms for each domain studied such that, when the conditions implied by the axioms are fulfilled, they give rise both to a domain and to the operations valid within that domain.... The attention given to purely formal mathematics must give way to the dualism of a topological structure and functional properties relative to that structure.... The object studied is not the total set of propositions derived from the axioms *but organized, structured, complete entities having an anatomy and physiology of their own.* The overriding point of view here is the synthesis of necessary conditions and not the analysis of primary notions. (Lautman 1977: 281–283, emphasis added.)

If, as we are doing, one adopts this anti-logistic stance (and anti-formalist if, as has become the rule, one surreptitiously identifies formalism and logicism), one comes to the conclusion that *there is a conflict between formalization and mathematization* in linguistic matters. Far from being confined to developing the possibilities of translating natural syntaxes into formal ones, mathematical linguistics has on the contrary to seek out the specific mathematical theories which, in terms of their contents (their 'qualitative integral character', their own 'anatomy' and 'physiology'), conform to the eidetic characters of the regional linguistic essence.

At the origin of the eidetic type of formal syntaxes there is the fact that mathematical objects are constructs. The possibility of disjoining syntax (deducibility) and semantics (interpretation and validity) in model theory is based on this fact.[4] It is because relations in mathematics are always inherent to the terms that they can be syntactically reduced to a literal symbolization the semantic of which is purely denotative. The same does

not hold true at all in linguistics. As Culioli has stated, 'there is nothing to allow the semantics of natural languages to be reduced to the interpretative semantics of formal systems' (Culioli 1971: 7); one can imagine that 'at a very deep level (probably pre-lexical) there is a grammar of primitive relations where the distinction between syntax and semantics makes no sense' (Culioli 1971: 8). At this level the main problem is that of expressing the '*a priori* conditions of the creation of linguistic forms' (Granger 1980). It is that of universals, and

> an essentially syntactic conception of these universals suggested by a logicist theory of natural language, would screen the moment[5] of content. In fact, it seems to us that the distinction between syntax, semantics and pragmatics, while absolutely necessary for the analysis of the state of a language, is subsequent to the universals. The latter are indissolubly at one and the same time acts of enunciation, 'natural' categories of the objects of the world and abstract rules of symbolic sequency. (Granger 1980)

If, however, it is true that the formal essence of natural syntaxes is different from that of formal syntaxes, mathematical linguistics must break away in part from its 'evident' formalism, return to 'the things themselves', transform its conception of 'pure' linguistics, and, from there, open out its effort at a new mathematical reconstruction until it links up again with systematic empirical linguistics. This does not appear to be the case. Whether it be by refining extensional logic into an intensional logic of possible worlds as in Kripke, Montague, or Creswell, or by refining the theory of types in the categorial grammars of Ajdukiewicz, Montague, or Šaumjan, or again by refining the quantification and logical analysis of the various determinants; whether it be by the use of combinatorial logic, which (as J. P. Desclés insists) allows us to treat syntactic operations independently from their realization in operations within particular object fields, or by the use of the theory of categories and topoï allowing the diversification of 'natural' intuitionist logics, or again by its connection with computers, formal linguistics, whatever its profound progress may be, is still developing excessively along formalist lines. That is why it is often artifactual and constantly at risk of 'de-realizing' linguistic reality. According to this it can be identified with one of the most typical tendencies in modern science. However, 'this tendency ... is not without drawbacks. It often creates a surplus, phantom-like ontology on which a frequently elegant formalism is worked out, but where reality has some difficulty in showing through' (Thom 1981)

In short, constrained to separating syntax and semantics, formal linguistics denies itself a true understanding of the *formal semanticism* of

primary relations. Constrained to translating structures into literal assemblings so as to be able to develop a calculus from them, it denies itself a true understanding of the dynamic Gestalts of language. Constrained to separating competence and performance, it denies itself a true understanding of language as a dynamic process as well as of its roots in perception and action. That is why, because of its *formal nature*, it is merely *half*-linguistics and must be completed by another type of 'pure' linguistics, involved not in algebrizing the automatisms of competence *but in deducing the formal semanticism of primary relations within the framework of a dynamic theory of performance.*

In two important articles (Thom 1973, 1978), Thom proposed positioning grammatical categories (parts of speech) in a bi-dimensional squish.[6] The X-axis of the squish arranges the categories[7] in the following order: Nouns–Verbs–Adjectives–Numerals–Possessives–Deictics–Logical Functions and Quantifiers. If we then bring the semantic variability of the categories (i.e., the interval between the maximal concretion and maximal abstraction of their representatives) onto the Y-axis, we can make the following observations:

i) Semantic variability diminishes along the squish and breaks down at the numeral zone crossing. It is considerable for nouns and verbs and null for logical functors.

ii) The squish extends from a 'categorematical' pole to a 'syncategorematical' one. Taking up Pike's etic/emic opposition, Thom hypothesized that the first is an etic objective pole concerned with the simulation of phenomenological reality, while the second is an emic subjective pole concerned with the automatisms of competence:

> it can be seen that the linguistic entities are of different kinds. With the noun, we are dealing with an entity endowed with a certain autonomy: the referent occupies a portion of space that it defends against disturbances from the environment ... the grammatical auxiliaries, on the contrary, owe their meaning alone to an all but ritualized activity of the speaker, totally immersed in the automatisms of language. (Thom 1978: 79)

iii) The central zone of the squish where semantic variability breaks down represents a sort of *threshold* between the etic–objective pole and the emic–subjective one.

These remarks enable us to understand why contemporary formal linguistics is only half-linguistics. It is because it is derived from *exclusively emic* 'pure' linguistics with no way of approaching truly the etic dimension of language. The principles of 'pure' *etic* linguistics are still to be worked out and developed mathematically. Their complementarity with the principles of formal emic linguistics are still to be established,

and from there an attempt is still to be made in catching up systematic empirical linguistics. We can now posit the contribution of Catastrophe Theory to linguistics in the following way: just as Chomsky laid the foundations of 'pure' emic linguistics, so Thom has laid the foundations of 'pure' etic linguistics.

Contents of the problem

What is first brought out in 'pure' etic linguistics is the regulation of the three basic grammatical categories[8] — nouns, verbs, and adjectives.

As regards the regulation of nouns (and more precisely of concrete concepts), it is assumed that 'there exists a certain isomorphism between the mechanisms of the psyche that ensure the stability of a concept Q and the physical and material mechanisms that ensure the stability of the real object K represented by Q' (Thom 1973: 247). Therefore, contrary to all the existing viewpoints in formal linguistics, one takes into account first the neuropsychological mechanisms of performance, conceived not in a reductionist but rather in a Gestaltist fashion, and then the referential function, conceived not as a language/reality correspondence but as *a constraint imposed on language by the reality it can simulate* (realism): a concrete concept is a complex, regulated, dynamic psychic entity whose regulation figure (Thom's *logos*) is partially *isologous* (isomorphic at the logos level) with that of the referent. Such an affirmation refers implicitly to a phylogenetic hypothesis on the biological origin of language: the first concepts must have been those entities the recognition of which was fundamental for survival (prey, predators, sexual partners) and, in this sense, 'the logos of living beings has served as a universal model for the formation of concepts' (Thom 1980a: 131). It correlates semantics with a general theory of regulation (particularly valid for biological regulation) and posits that '*in implicit and structural form*' language is structured like a biology (Thom 1980a: 84).

The regulation figure of a concept C is intimately linked to its verbal spectrum. The regulation catastrophes bounding the domain of existence of C in its substratum space are identifiable with the verbal interactions in which C can play the role of an actant. The neo-Tesnièrian conception of the verb that occurs here is that of an 'organizing center' — that is to say, of an event distributing actantial places. It could perhaps be traced back to Stoic philosophy, according to Deleuze (1969). Insofar as they describe processes (that is to say 'an eminently transient activity of the subject' — Thom 1980a: 248), verbs possess in themselves the reason for their stability. They do not, strictly speaking, have any regulation other than

structural stability, and (as we shall see further on) have as their source and model the simulation of elementary actantial interactions realizable in space–time. Through them language is, still in implicit and structural form, structured like physics.

Finally, the regulation of adjectives that localize substantives in qualitative spaces is reduced to the *categorization* of semantic spaces, as for example the field of colors.

The development of *formal* etic linguistics thus needs a mathematical theory of (a) the regulation of concepts, (b) verbal valence, and (c) the categorization of semantic spaces. This theory must, moreover, *respect* the phenomenology and the cognitive organization of perception and action. Indeed, as Osgood and Luria have observed: 'It seems perfectly reasonable to think that much, if not all, that is universal in human language is attributable to underlying cognitive structures and processes.... Perceptual and linguistic sequences must, at some level, share a common representational (semantic) system and a common set of organizational (syntactic) rules, cognitive in nature' (Osgood 1971). 'We must look for the roots of basic linguistic structures in the relations between the active subject and reality and not in the mind itself' (Luria 1975). As Wildgen has more recently reaffirmed, this requirement is the core of Catastrophe Linguistics:

> We assume that the dynamic principles governing the semantics of words are intricately connected with basic propositional structures. This is especially true for verbs. Our dynamic treatment of verbs [i.e., the catastrophic one] starts with a consideration of the dynamic principles underlying the perception of space and time and of changes, motion, locomotion and action in space and time.... In a general semantic theory our archetypal and dynamic component would be a basic stratum whose influence becomes weaker as we progress to the levels of syntax and text (conversation). (Wildgen 1981: 235)

This point of view is by no means incompatible with that developed by Culioli and Desclés, according to which linguistic categories must be *constructed* (specifically so for each language) in abstract, metalinguistic systems of representation, from language invariants, in a principled way. It diverges from Culioli and Desclés', however, as concerns the role of the mathematical tool. Indeed, in our opinion, the question of formalization cannot be reduced to the knowledge of 'which are the good mathematical concepts required for the construction of the various grammatical categories and for the development of a coherent language able (by the aid of an appropriate notation) to note the elementary components of the categories and their modes of construction' (Culioli and Desclés 1981: iv). Nor can it be reduced to the formal translation of descriptive metalanguages in ideographic and algorithmic terms, to an algebra or a

calculus of operators and operants (Culioli and Desclés 1981: 75). It is also and perhaps above all that of *abstracting the principles of a (transcendental) deduction of linguistic universals on the basis of a mathematical theory of regulation.*

So, from an etic perspective, *the linguistic object is no longer autonomous.* The regulation of the concept is linked to biological regulation, the verbal valence to the physics of actantial catastrophes, and the categorization of semantic spaces to that of control spaces — as for example in the critical phenomena of phase transition. The object's loss of autonomy may indeed seem unacceptable to many linguists. However, it must be recognized that this loss is dictated by experience and that with it etic linguistics is not dissolved into an unfindable bio-socio-psycholinguistics. On the contrary, it connects linguistics to another, more fundamental and objective autonomy, that of a regional ontology. Indeed, it is easy to ascertain that the phenomena to be explained (and not only metalinguistically described) are precisely those that are, in the strict structuralist sense, *structural* phenomena. Just as there is a rational unity (a regional essence) to the dynamic problem underlying empirical disciplines as different in their object and methods as ballistics, cosmology, fluid dynamics, and quantum microphysics, so also there is a rational unity to the structural problem underlying the structuralist (anti-neo-Darwinian) conception of biology (cf. Goodwin and Webster's remarkable 1982 article), as well as the Gestalt theory (cf. Guillaume 1979, Piaget 1974) or Saussurean–Jakobsonian–Hjelmslevian conception of semio-linguistic organization (cf. Petitot 1985b, 1986). *And it is within this rational unity that the founding abduction of 'pure' etic linguistics is to be sought.*

In order to do so, the eidetic characters linking linguistics to the structuralist regional ontology must be isolated. The first of these is that *paradigmatic organization constrains syntagmatic organization.* Without a previous mathematical understanding of the paradigmatic dimension, it would be impossible to develop 'pure' etic linguistics. The latter presupposes in its turn a schematizing operation, since (as we have already remarked) from Saussure onwards the paradigmatic dimension expresses none other than the linguistic validity of the Kantian category of reciprocal determination.[9] The second eidetic character concerns the nature of *primitive* syntactic relations. These are not purely grammatical; they are semantic relations — whose semanticism, however, is not substantive but *formal* — expressing the form (in the Hjelmslevian sense) of content. As Greimas asserts, the recognition of this fact establishes a fundamental dividing line between the two possible conceptions of syntax: formalist and structural.

While the symbol-units of formal syntax form an alphabet (that is to say, an

inventory, often incorrectly called 'structure') which is then governed by a set of operation rules, the units of conceptual syntax are organized into a taxonomy (a sort of elementary morphology) within which the syntactic operations are carried out. (Greimas and Courtés 1979: 378)

To be more precise, as Fuchs and Pêcheux have made clear with reference to Culioli's *lexis* schemata, the places defined by primitive relations 'have in themselves a meaning with regard to one another, that is to say, independently of the semanticism assigned to them' (Fuchs and Pêcheux 1970: 27). Now, how are we to conceive that places — positions defined by a system of connections and reciprocal presuppositions — can acquire a purely positional content? In our opinion, this is a major difficulty, perhaps even *the* main critical difficulty in elaborating an authentically structural syntax.

The difficulty is at the center of case (actantial) conceptions of deep structures. The epigenetic primacy of actantial relations (of a semantic and cognitive nature) is experimentally verifiable (cf. Schlesinger 1971, Brown 1973). It is therefore Chafe's and Fillmore's case-based grammars that are to be founded theoretically. In order to do so, four problems (at least) must be cleared up.

i) As regards the primitive actantial relations that select semantic roles, and contrary to the case grammars already proposed, the definition of their formal semanticism must not be managed by attributing to them a notional (categorial) content. In fact, the categorial definition of deep cases leads to a dead-end alternative. If we think of cases as substantive universals defined once and for all by notional contents, then, as Willems has pointed out, case roles become too abstract. They 'end up by losing all semantic value' (Willems 1978: 247). They are no longer able to make clear the relations between syntax and semantics, and at the deep level, the theory falls back into the vicious circle it denounces in the old theories seeking to define notionally surface (morphosyntactic) case forms. But if on the contrary one tries to preserve the case syntactic selection function, then the cases start to proliferate and there is no longer any principled way by which they can be deduced.

ii) For this reason we must conquer a *configurational* (not a categorial) definition of cases (just as in a syntagmatic tree, grammatical functions are configurationally defined). For that we need *relational morphologies* — which Wildgen proposed calling propositional Gestalts (Wildgen 1981: 263) connecting case positions and converting them into *positional values* (in the structuralist sense of the term 'value'). The positional content of a case place will therefore depend on where in the morphology it is situated. It will thus be *relative*, not absolute, and *topological*, not notional.

iii) Here we need a guiding principle that would lead to a (transcendental) deduction of the propositional Gestalts. Only by such a deduction can case conceptions escape from the vicious circle of an interpretation of deep structures.

iv) For that, it is necessary to come back to Tesnière's stemmatic intuition and go beyond the algebraic notion of verbal valence, despite its dogmatic predominance (cf. for example VSG 1978). Insofar as there is no *formal* criterion *to constrain a priori* the structure of an abstract operator, there can be no algebraic case deduction. Since they are prelexical, relational case morphologies may be thought of as lexis schemata; they are, however, lexis schemata whose form is not logical but *topological*, and they should be derived from a sort of *'pure' structural* 'physics'.

'Pure' etic linguistics depends, then, on the rational unity of structuralism through the following critical points:

i) the schematization of the ontological categories of reciprocal determination and connection;

ii) the mathematization of the categorizations that constitute paradigmatic systems;

iii) the configurational determination of deep cases as positional values in relational morphologies; and

iv) the deduction of these propositional Gestalts (which are, in the Whorfian sense, 'cryptotypes of verbal action').

It is easy to see that these four points finally refer to a *positional geometry*. However (Buffon and Kant had already deplored that), such a geometry 'is absolutely lacking in our mathematical sciences'. It is an 'unfindable' science. Its lack has therefore been the major obstruction (in Bachelard's sense of epistemological obstacle) to establishing a 'pure' etic linguistic that would condition the *objectivity* of formal linguistics. Owing to this, the structuralist concepts and categories have, although empirically valid, remained *without objective value and far-reaching explanatory effect*. To use Kantian terminology, one can say that they have remained heuristic concepts of a *reflecting* nature without even being able to become *determinant* for the transformation of linguistic phenomena into theoretical objects (cf. Petitot 1982b, 1985b).

Outline of a solution to the problem

Categorization and stratification

What is a paradigmatic system? It is a *classification* where the global system determines the value of the elements, that value being identified with its

position in the system. Now, as Ducrot has reminded us, the main problem posed by the purely positional content of the paradigmatic dimension is that of the *identity principle*. In a paradigm, identities are relational, not substantive. The global organization of the system is *implicitly* present in each element, and is therefore a component of it (Ducrot 1968). The domain of each term spreads out until it comes into conflict with other domains. In other words, value is only defined *negatively* by the boundaries, the thresholds demarcating its domain. It is in this sense that position is the identity principle of linguistic units (Ducrot 1968: 101).

In order to understand the nature of the paradigmatic dimension, we need then something more than a simple taxonomy regrouping the already defined units into equivalence classes from a distributional syntagmatic analysis. This is especially clear in the case of phonology (cf. Petitot 1985a). Jakobson has repeatedly asserted that identifying phonemes with mere equivalence classes of allophones is artifactual, that phonemes possess an *ontological* status in their functional (criterion of the discrimination of meaning), eidetic (invariant Gestalts), and structural (bundles of distinctive features) definitions, and that *qua* Gestalts, they are dependent upon an eidetic phenomenology (cf. Holenstein 1974).

A general paradigm can be described in a relatively precise way.

i) A paradigmatic system is above all a qualitative substratum 'space' W categorized (differentiated) by a system of thresholds — that is to say, by an *interface morphology* K. This morphology defines the domains of W, and delimits the positional values of its elements.

ii) The whole problem is then to understand how the categorized space (W,K) underlying a paradigm can be generated *dynamically*. The guiding idea developed by Thom consists (a) in introducing an *implicit* generating process (a 'black box'), (b) in supposing that the internal states of this black box are reciprocally determined by a *global entity* (as opposed to discrete formalisms of the automata theory type), and (c) in treating W *as a control space* for the deformation of these internal states. Let X be the internal dynamics of the black box, and $A_1, \ldots A_n$ the states it defines (if X is a dynamic system on a differentiable manifold M, the A_i are thus the attractors of X). Being controlled by W, X is dependent on it. Let $w \in W$. One state (A_1) is selected as the *actual* one while the other states are *virtualized*. Due to (b), these are identifiable with *presuppositions* of A_1. When w varies in W, the actual state A_1 is transformed both in its internal structure and in its competitive relationship with the virtual states. Due to (b), there will then be in general singular points of W where A_1 will be catastrophically substituted by another. These singular points make up the categorizing morphology K. In other words, K is the *trace* on W of the destabilizations of the actual internal states.

iii) This general model (which in each case can link up with the empirical data only by specifying process X and control W) respects and clarifies all the eidetic characters of the paradigmatic dimension, in particular those of substitution and synchronic copresence. If a paradigmatic system does exist (with the implicit presence of the global organization in each element), it is because there is a global entity which reciprocally determines the internal states and their conflictual relations. Each domain of W delimited by K is the domain of existence (of actualization) of a state, and all the states are co-situated, co-positioned in W. This is the synchronic copresence aspect. However, by changing domains the initial actual state is virtualized and catastrophically replaced. This is the substitution aspect. Thus, if we can speak of positional value, it is because a state (an element) is expressed not only through its internal structure (i.e., its substantial identity), but also through the 'geography' of its existence domain (i.e., its relational identity). So, insofar as the notion of discontinuity (threshold, difference) is a component of the categorizing morphologies K, it acquires an objective value and an ontological status.

iv) Furthermore, the general model makes it clear why the formalist treatment of paradigms does not respect their eidetic characters. It is based on a discretization replacing each domain with the correlative dominant state and disjoining it from the alternative states with which it is in competition. But in so doing, everything that is properly structural is quashed. In order to recover a semblance of structure it must then be assumed that the elements enter into *interaction* by virtue of their *substantial* identity. The catastrophist conception, inversely, can not only mathematize the paradigmatic dimension according to 'the things themselves', but can also explain *the spontaneous subreption from the structural interpretation of the category of community (paradigmatic system) to its standard formalist interpretation (system of components in interaction)*.

v) And if we go back from this standard formalist interpretation to the structural one, we can locate the nature of the catastrophist contribution. The main ideas are as follows:

(a) The observable invariance of the substantial identity of an element is an invariance for some sort of interpretant (for example, a perceptive interpretant in the case of phonemes). The real phenomenon underlying the manifested element may therefore include '*hidden parameters*' whose variation is unobservable and so does not affect the observable invariance. In other words, the elements must be considered as deformable forms whose *qualitative* features only are observable. Consequently, the notion of identity must be replaced by that of *qualitative type*.

(b) Form spaces are generally *functional spaces*, and the qualitative type

is defined in them by some *group action* which is itself a functional one. For that reason, paradigm mathematization depends on the mathematical theory of functional group action on functional spaces. This theory is extremely complex (one must only think about the fact that the action of a Lie group as simple as the additive group of real numbers on a differentiable manifold defines a dynamical system and that the qualitative theory of dynamical systems [global analysis] is still a long way from being achieved).

(c) An understanding of the paradigmatic dimension rests therefore *upon the synthesis between the concept of taxonomy and the concept of generalized space*, or, to be more precise, in quasi-Kantian terms, upon the 'construction' of the taxonomy 'category' in the functional space 'intuition'. The action on a functional space $\mathscr{F}$ of the group G defining the qualitative type of elements *classifies* the qualitative types. An element f of $\mathscr{F}$ will be *structurally stable* if all the elements $g \in \mathscr{F}$ sufficiently close to f are of the same qualitative type as f — i.e., if the orbit $\tilde{f}$ of f under the action of G is locally open in $\mathscr{F}$ at f. Let $\mathscr{K}$ be the set of structurally *unstable* elements of $\mathscr{F}$. $\mathscr{K}$ categorizes $\mathscr{F}$ since in order to pass directly from one stable qualitative type to another, it is necessary to cross it.

(d) It is essentially the discriminant systems $\mathscr{K}$, intrinsically linked with the *geometry* of functional spaces, which the catastrophic conception unifies with the paradigmatic dimension. The connected components of $\mathscr{F}-\mathscr{K}$ correspond to the elements which the standard conception treats in a purely formalist (non-geometrical) way. In good cases (theory of universal unfolding) one can, locally at $f \in \mathscr{F}$, reduce to *finite* dimension and substitute to the too complex situation $(\mathscr{F}, \mathscr{K})$ a 'good' situation (W,K) where W is a finite-dimension space and K is derived from a *Lie* group action (reducing G in finite dimension). 'Good situation' means that, locally at f, $(\mathscr{F}, \mathscr{K})$ is the direct product of (W,K) by the orbit $\tilde{f}$ of f in $\mathscr{F}$.

(e) Moreover, in 'good' elementary cases, the decomposition of W in orbits under the action of G is geometrically given by a *stratification* of K. The stratification concept is fundamental. It permits the structural categories of relation and taxonomy to be geometrized (schematized). Through it, the abstract paradigm concept converts itself in a *supplement* of geometry, and the epistemological act of Catastrophe Theory (an act that lifts the epistemological obstacle of a lacking positional geometry) consists essentially in making use of such a supplement in order to modelize the *morphological* aspect of the structural region.[10]

In the catastrophe sense, a typical *physical* case of a paradigmatic system is provided by *phase diagrams*. This allows us to formulate the first founding abduction of 'pure' etic linguistics: *the objective essence of the paradigmatic dimension is to be sought in an abstract theory of phase*

transitions and, more generally, of critical phenomena. This abduction can be validated experimentally in the case of phonology. It is known that the link between the audio-acoustic substratum of phonetic perception and its phonological relational form is provided by *categorical perception* where, contrary to what happens in continuous perception (as for example the perception of colors), the discrimination of two neighboring stimuli presupposes them to be identified as different. Categorical perception is, as its name indicates, categorizing and discretizing. It enables the phonological information coded in the acoustic flux to be decoded as discrete. As Stevens has implicitly suggested, categorical perception phenomena are perceptive cases of critical phenomena, due to the fact that the acoustic cues control the qualitative features of the percepts in a nonlinear fashion: through catastrophic destabilization, the variation of the former can induce the bifurcation of the latter (cf. Stevens 1972). Through the use of adequate catastrophist models, this viewpoint can be justified (cf. Petitot 1982a: chap. I, 1985a).

Topological syntax, actantial schematism, and localist hypothesis

Let us now turn to the second part of 'pure' etic linguistics. It is concerned no longer with paradigmatic categorization but with deep actantiality in structural syntax. One of the most important results of the Catastrophe Theory approach is to have succeeded — on the basis of a syntactic interpretation of elementary catastrophes[11] and of their classification theorem — in deducing relational morphologies (propositional Gestalts) and consequently a configurational definition of the formal semanticism of case universals. The steps are as follows.

In order to conceive of the actants as syntactic positional values, it is necessary to go back to one of the most important (yet up to now least developed) hypotheses of linguistic tradition — namely, the *localist* one.[12] According to this, a case is always doubly manifested: as abstract and grammatical when concerning an actant, and as concrete and local when concerning a spatio-temporal position. In other words, in order to understand actantial relations, we must posit an *equivalence* between actants and spatio-temporal positions. In the nineteenth century Wüllner, under Kant's critical influence, gave a precise epistemological form to this point of view:

(1) the linguistic phenomenon is 'subjective' in the transcendental sense;
(2) there must be only one abstract 'idea' underlying a linguistic form so that the use of the form may be deduced from it; and

(3) the idea underlying case form is the *spatial conception* applicable to spatio-temporal interactions as well as to syntagmatic rection.

We consider this hypothesis to be decisive for the following reason: once spatio-temporal actants (that is to say, actants whose identity *is reduced to localization*) are taken into consideration, the abstract actantial relations can be identified with the possible interactions between spatio-temporal positions. *These are not arbitrary*; they are constrained by space–time geometry. It is then possible to classify them and thereby achieve a case deduction. The localist interpretation of actantial relations thus breaks the vicious circle of a semantic interpretation of grammatical deep structures and provides a *schematization of deep actantiality*.

It should not, however, be thought that by referring to space–time this schematization is naively reintroducing into the syntactic field a reference to the world. In a spatio-temporal event of actantial interaction it reduces the actants to their localization — that is to say to a *principle of identity* as abstract as the one logic and algebra allow themselves when they symbolize an entity by a letter. We therefore do not see why formal translation of verbal nodes into operators $R(x_1,\ldots,x_n)$ (and their consequent immersion in a formal universe where the condition of descent can no longer be satisfied) should be so easily admitted, while a geometric schematization that is just as abstract (and has the great advantage of *satisfying the condition of descent*) would be rejected. Localism does not refer to the world; it extracts topological *syntactic* infrastructures from the pure intuitions that condition objectivity.

Since spatio-temporal actants can be pure places (loci), we will refer to them as *proto-actants*. They do not take place directly in space–time $\mathbb{R}^4$ but in an abstract, ideal space $\wedge$ underlying the stemma that connect them. In a second move, $\wedge$ is embedded into $\mathbb{R}^4$ by an embedding $j : \wedge \rightarrow \mathbb{R}^4$ that locates both the actants and the loci in which the proto-actants are specialized.

The case contents defined by proto-actantial interaction in $\wedge$ (i.e., by the *geometrization* of the stemma defining them configurationally) are purely positional. We will call them *local* contents. The specialization of the proto-actants as actants (animate or inanimate), loci, 'forces', influences, signs, etc. is described by categorial (notional) case contents. We can therefore assume that case semanticism combines a local formal semanticism with a substantive categorial one. This permits us to understand better the intrinsic limitation of the case grammars that have been elaborated up to now: *they attempt to express in terms of categorial contents irreducibly local ones*.

The problem then is how to define the interaction morphologies

defining local contents. In order to do so, we shall start from the following hypothesis, saying that etic linguistics is, as we have seen, concerned with the conditioning of the syntactico-semantic form of language by the qualitative structuration of reality:

> Strict geometrico-topological analysis enables to associate with every spatio-temporal process certain combinatorial invariants ... that can be reasonably thought to play an essential role, because of their basic character, in the verbal description of the process. We believe that such is the origin of the primordial schematism that governs the linguistic organization of our vision of the world. (Thom 1980b: 24)

The hypothesis then is that

> the primordial function of language [being] to transcribe the phenomenological catastrophes of the external world, in particular those deemed important for the safeguard of the individual or the social group, in a way that is communicable by our sense organs, *the message carrying an autonomous signification inherits the structure of the external catastrophe it claims to signify.* (Thom 1972a: 329)

It is strictly localist since it posits that the interaction schemes linking positional proto-actants have been used as the matrix — the 'universal pattern' (Thom 1980a: 164) — for primitive (proto-grammatical) syntactic structures and that, when a proposition effectively describes such an interaction, there is *a pictorial similarity between the catastrophic infrastructure of the latter and the syntactic structure of the former.*

Let us emphasize the fact that this is the main difficulty encountered up to now in formalizing actantial relations. We are so accustomed to the descriptive function of language that it seems to stand to reason that relations can be both *formal* and *objective*. But the only way they can be so is to be true because they are inherent. This, however, is *not* the case for actantial relations. One cannot then — by miming the syntax/semantics relation found in the logical theory of models — abstract them, give them a formal translation, and then project them back onto reality as valid or not valid. Contrary to the dogma of logical empiricism, it is not possible to proceed from formality to reality. The order of procedure must therefore be *reversed* and the *objective* content of the connections between proto-actants put forth in priority. From there, the denotative function of language may be grounded in an 'isomorphism' between syntactic structures and *objective* structures of states of affairs.

Thom's hypothesis is a realistic one that consists in *rooting meaning in the forms of objectivity*. 'Can we not admit ... that the factors of phenomenological invariance that give the observer the sensation of meaning come from *real* properties of objects in the outside world, and manifest the *objective*

presence of formal entities linked with those objects and that will be said to be "carriers of meaning"' (Thom 1980a: 170). However, in order to be able to uphold *de jure* such an affirmation it is necessary to establish beforehand the objectivity of the phenomenological invariants. *Given the correlation between phenomenology and meaning, only the synthesis between phenomenology and objectivity enables us to anchor meaning in objectivity.* In this sense, etic linguistics is subordinated to the solution of one of the most recurrent and delicate problems in the history of science.[13]

More precisely, Thom has sought, given a spatio-temporal process implying actants, to abstract a structure that is *both objective and syntactic.* To call it objective means not that it is physical, but that it is geometrical. To call it syntactic means it is relational and formal and says nothing of the material specificity of the process. The mean term, the 'common root' between objectivity and syntax, is provided by the *actantial graph* notion, which is derived from a reduction of the actants to their localization identities.

To take Thom's standard example, let us consider a capture process of an actant S_2 by an actant S_1. The corresponding graph is presented in Figure 1.

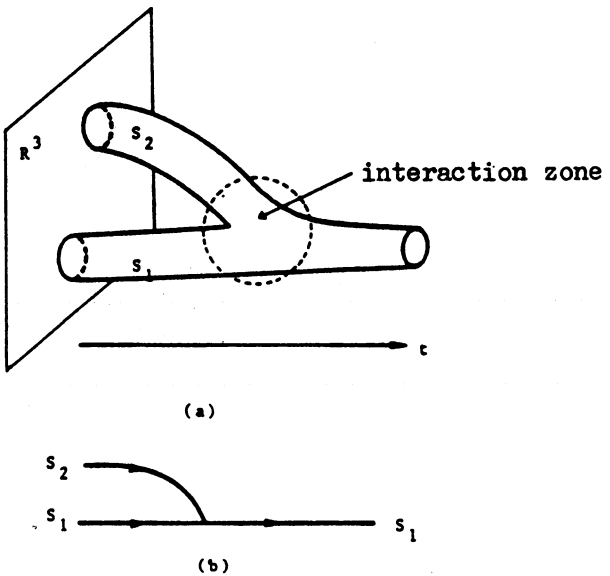

Figure 1. *Actantial capture graph: (a) Temporal evolution of the domains S_1 and S_2 and the interaction zone; (b) Reduction of the capture process to its actantial graph: the edges symbolize the actants and the vertex the capture interaction.*

The space–time involved in Figure 1 is not the physical global space–time endowed with its invariance group, but a local map $\wedge$ endowed with a 'poor' differentiable structure embedded in $\mathbb{R}^4$ by the embedding $j : \wedge \rightarrow \mathbb{R}^4$ evoked above. Spatio-temporal localization corresponds to j. Localization in $\wedge$ is of a completely different kind; it concerns the immanent spatio-temporality of the process and not its positioning relative to a coordinate system in $\mathbb{R}^4$.

The capture graph is objective, but in a *residual* sense (the physical specificity of the process is put into parentheses). Interaction is reduced to its catastrophic infrastructure, and it is this reduction that leads from the objective to the syntactic level.

The kernel sentence describing the capture process is syntactically isomorphic with its actantial graph. The deep case structure of the sentence is made up of a verbal node, an Agent, and an Object which, according to the rules of subjectivization and objectivization, will be grammaticalized by a transitive sentence SVO.

However, the actants' cases are defined here in a configurational way because the subject (Agent) is the actant that survives the catastrophe of the process, symbolized by the vertex encountered down the time axis (Thom 1980a: 207).

The capture example shows clearly the proto-grammatical nature of the archetypes described by the elementary actantial graphs. The capture graph corresponds to a proto-verb associated with a *canonical semantic*, which is not a semantic in the traditional sense but a *reduced (residual) one which generates syntax* and corresponds to the internal dynamic of the catastrophe associated with it. We see that, reinterpreted in catastrophist terms, localist idealism introduces an indissolubly semantic *and* syntactic intermediate level between the grammatical and lexical levels, a level where semantics generates syntax and syntax expresses the form of content.

Actantial graphs are generic and realizable in space–time. *Their local morphological complexity is therefore drastically limited by space–time dimension.* This essential fact may be considered as an explanation of the intrinsic (non-contingent) limitation of verbal valence. As Thom has recurrently affirmed, the limitation of verbal valence is a profound phenomenon which is the linguistic aspect of the phase rule in physics.

In order to be entitled to speak of case deduction, it is necessary to generate actantial graphs which, owing to their very generation, could legitimately be called *archetypes*. It is in the solution of this problem that the linguistic import of the Thomian point of view is fully revealed. If indeed we consider an elementary catastrophe $\chi : \Sigma \rightarrow W^{14}$ and follow a path in its external space W, we can naturally associate with it an actantial

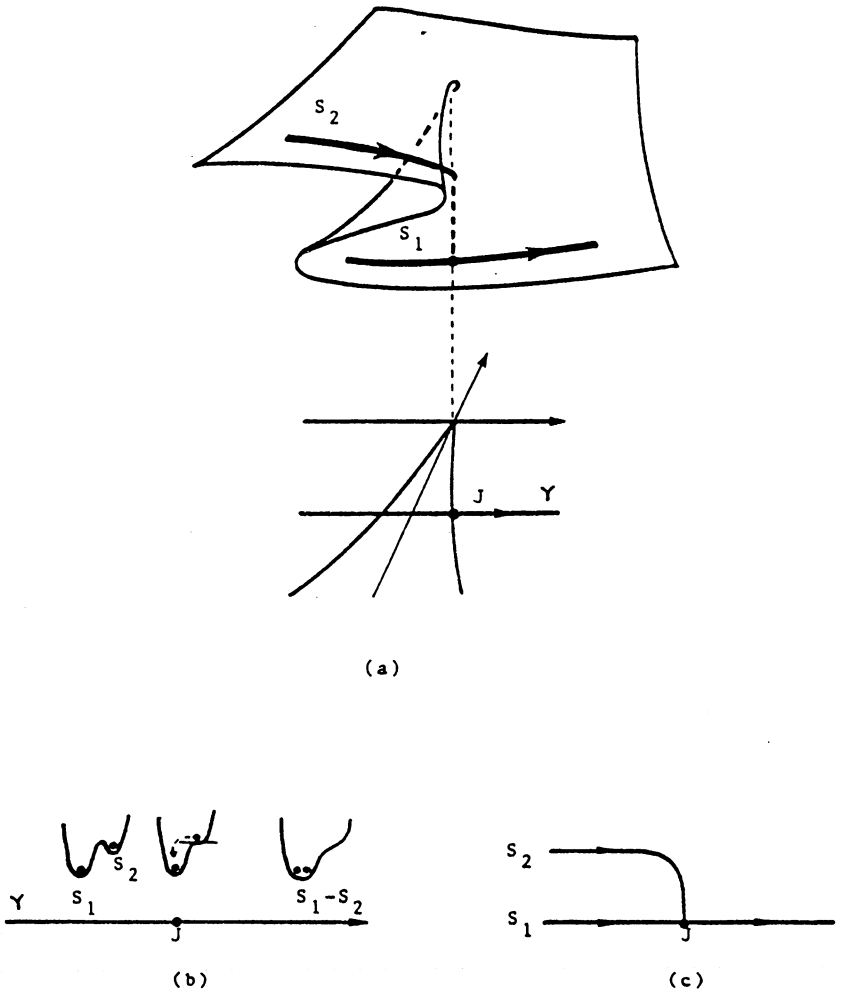

Figure 2. *Generation of the capture actantial graph by the cusp catastrophe: (a) Path γ in the external space of the fold; (b) Evolution of the minima actants; (c) Corresponding actantial graph.*

graph describing the interactions between the 'actants' that are the minima of the generating potential. For example, as Figure 2 shows, the actantial capture can be generated by a path in the external space of a cusp catastrophe. Whence the following cogent idea:

By interpreting the local stable regimes as [actants], it is possible to give a semantic interpretation expressed in ordinary language to the qualitative outline of the

catastrophes. If the external coordinates are taken to be exclusively spatial, then the catastrophes are interpreted by substantives. If time is introduced, they are interpreted by verbs.... More generally speaking, it is useful to consider plane sections of dimension one or two in the universal unfolding of any catastrophe. We will then get what I consider to be the universal structural picture containing all types of elementary sentences, that is to say, carriers of an autonomous signification that is indecomposable into smaller units with the same property. (Thom 1972a: 330)[15]

This is a cogent idea due to the classification theorem of elementary catastrophes. Indeed, by rendering explicit the geometric constraints imposed on the interaction between local proto-actants, this theorem actually *solves the problem of deduction.*

Let us make a few more observations on this catastrophist generation of archetypal syntactic morphologies.

i) It meets up with case theories from a general theory of regulation and stability and so from the rational unity of structural ontology.

The structure of the elementary interactions which are derived from paths in the bifurcation space of elementary catastrophes, defines different roles which can be roughly compared to the '*schémas actantiels*' proposed by Tesnière and to the 'case frames' classified by Fillmore. The basic difference between these structures and the semantic archetypes consists: (1) In the *preverbal* character of archetypes. The structures proposed by Tesnière, Fillmore and others are only generalizations of linguistic structures found in natural languages. (2) The foundations of the classification of archetypes in a formalism which is supposed to be basic for many biological systems. It is therefore universal in a very deep sense and is of interdisciplinary relevance. (3) The semantic archetypes are *irreductible* Gestalts. They are not composed in a single combinatorial way. This fact constituted a major difference in Thom's theory against all theories proposed up to now. Some of these have tried to describe field-like structures, but as no tool for consequently doing so was available they all drove away irresistibly attracted by the static-logical paradigm. (Wildgen 1981: 264–265)

ii) The difference between the actantial graphs schematizing the interactions between local proto-actants and the archetypal graphs derived from elementary catastrophes is that in the latter, the actants are defined by the same *global* generating potential (global relative to the actants, even if it is only defined locally on the internal and external spaces). This potential ensures the *reciprocal determination* of the actants — that is to say, their structural order of coexistence and their interdependence as positional values.

iii) Owing to the fact that catastrophist models are models of paradigmatic systems, in the catastrophe schematism *the syntagmatic*

dimension is a conversion (in the Greimasian sense) of the paradigmatic dimension, and is therefore constrained by it. This schematism, then, conforms to one of the main eidetic characters of structural ontology. Conversion consists essentially, as we have seen, in introducing the *time* dimension (paths in external space) and in treating local regimes as actants (i.e., as *individuated* entities).

iv) Given a catastrophic model $\chi : \Sigma \rightarrow W$, there will be as many associated actantial graphs as there are homotopy classes of generic paths in the complement in W of the strata of codimension ≥ 2 of K, the events corresponding to the (transversal) crossing of the strata of codimension one. There would generally be *several* homotopy classes. In other words, by conversion from the paradigmatic to the syntagmatic dimension, catastrophist models naturally generate *variants* and *transformations* of variants having singularities of codimension 2 as organizing centers.

v) Let (W,K) be the universal unfolding of an organizing center f, and let us consider a section H of W not going through f and transverse to K. The intersection $H \cap K$ is a gluing of unfoldings of organizing centers of a weaker codimension (because they are less singular); that is to say, an aggregate of local models in a *global* one. But as this global model can be generated by f, it is a sub-model of a *local* one. The dialectic between local and global linked to the transitivity of universal unfoldings is a major eidetic characteristic of catastrophe models: catastrophes constitute a universe where the classical oppositions simple/complex, irreducible/composed, component/system, and so forth are not relevant. In catastrophe 'logic', we are provided with a *double* relation going from the simple to the complex. On the one hand, we have the classical relation of composition interpreted in terms of gluing and on the other, we have the *non-classical* one of unfolding. The associated syntactic archetypes inherit from the local/global dialectic (unable to be formulated within a formalist framework), so that we can understand for example how a trivalent verb like 'to give' can be an irreducible archetype and at the same time be composed of an emission and a reception archetype ('to give' as a causative of 'to have').

Case deduction allows us to develop a theory quite similar to the one advocated by Fillmore (1977) — that is to say, a *scene* theory where case roles are relativized to prototypical situations.

i) A scene Σ is made up of: (a) a semantic isotopy I (for example, 'commercial' in the commercial exchange scene analyzed by Fillmore); (b) a global actantial graph G of interaction between positional proto-actants P_i defined in an underlying immanent space $\wedge$; and (c) P_i specializations in actants (subjects or objects) and loci.

ii) Σ defines the case roles of the process configurationally because of (b), notionally because of (c), and semantically because of (a).

iii) Generally speaking, when it is linguistically expressed, Σ will be positioned in space-time $\mathbb{R}^4$ by embedding $j : \wedge \rightarrow \mathbb{R}^4$. Through j, the proto-actants specialized in loci become spatio-temporal actants, and the proto-actants specialized in actants become positioned through adverbials or deictics.

iv) The linguistic description of Σ consists in *covering* G, either partially or totally, by archetype graphs $\Gamma_1,\ldots,\Gamma_k$.

v) Lexicalization enables complete though partial descriptions by involuting certain actants in the lexical semantic (for example, in the commercial exchange scene, the use of the verb 'to pay' allows one to dispense with the actant 'money').

vi) In general, there will be several ways of gluing archetypes Γ_i to cover Σ. The gluing operators are *anaphors* and the variants so obtained are paraphrastic equivalences.

vii) The choice of an archetype Γ_i — that is, a morphism $h_i : \Gamma_i \rightarrow G$ — is manifested via the semantic isotopy I by the lexical choice of a verb V_i (to sell, buy, pay, cost, and so forth). Through its semantic (the commercial deal), the verb evokes Σ globally. But through its valence, it occurs as a verb of type Γ_i.

viii) What Fillmore calls the *salience hierarchy* determines the minimal part of G that must be covered so that it can be said that the chosen sentence expresses Σ correctly.

ix) *Case hierarchy* determines the way in which the actants of $h_i : \Gamma_i \rightarrow G$ are taken over by the grammatical relations.

x) The part of G that is not covered can be described by other sentences (with anaphorization) or expressed by adverbs, subordinates, etc.

xi) Once grammaticalized, the kernel sentences associated with the h_i are used as inputs to various transformational cycles.

xii) The different localizing operators and modifiers (adjectives, determinants, etc.), temporalization, the integration of enunciation marks, etc. are then introduced.

Conclusion

Although this positing of the catastrophe linguistic conception is very incomplete, it is sufficient, we hope, to show in what way this topologico-dynamic conception is *complementary* to the traditional ones. Its level of reflection is situated at a deep pre-linguistic — biologically rooted — level and, at least for the present, it has little to offer to the 'fine' problems of systematic empirical linguistics. But that does not prevent it from being

relevant to semio-linguistic theory. Indeed, as we have shown in detail (Petitot 1982a, 1985b), Thomian 'biolinguistics' fits perfectly with Greimas's theory of semio-narrative structures. It is an outstanding fact which reveals that, at a broadly supra-phrastic level, the semio-narrative structures are as a permanent memory of the biological origins of language. They are concerned with phylogenetic root of language which precedes the process of autonomization through which

> language can function on its own (in language games), create its own opportunities for discourse (in literature, for example), proliferate on itself for its own sake (language generates language) and construct its own referential universe (or systems of referential value) what is sanctioned by lies, products of the imagination and all artistic or scientific creation. (Culioli and Desclés 1981: 24)[16]

This being said, our criticism of the formalist dogma should not be seen as a questioning of the essential progress that has resulted from the mutual action of natural and formal languages. We have merely attempted to justify the claim that semio-linguistic theory requires us to go beyond the axiomatization of descriptive metalanguages. Indeed, it is perfectly legitimate to construct empirically valid *conceptual* metalanguages and in particular, as Culioli and Desclés suggest, to construct linguistic categories from linguistic invariants and universal principles. However, every conceptual metalanguage rests finally upon *undefinable* primitive concepts 'that can be considered hypothetic universals' (Greimas and Courtés 1979: 225) and that possess the status of 'formal *a priori* categories'. As Pavel has recalled in relation to Chomsky:

> this solution [the definition of notions on the basis of primitive notions] put unsurmountable questions. As Putman had already observed in 1960, by choosing certain notions as primary, Chomsky precisely avoids defining them.... These categories are at the 'dead centre' of the theory. (Pavel 1980: 19)

It is for that very reason we consider it insufficient to reduce formalization to: i) giving the undefinable primitives a formal expression; and ii) elaborating on those grounds a set of axioms and a calculus enabling linguistics to be produced as an algebra of forms. It is clear that in the expression 'algebra of forms' it is the term 'form' *that conditions that of 'algebra' and not the reverse.* In other words, *it is the mathematical content assigned to the primitive notion 'form' that must determine the algebraic–combinatorial structure of the universe of forms that will be used to formalize linguistic phenomena.*

But, of course, if we want to develop a 'structural physics' of semio-linguistic forms (i.e., formal 'etic' linguistics), then the whole problem is to

identify a principle justifying this mathematical content. Otherwise, the theory would be reduced to an ungrounded use of analogy. We must go beyond the alternative opposing on the one hand a merely analogical 'structural physics' and on the other an 'axiomatization' without any ontological value.

There is, however, a principle that would let us out of this alternative, that might act as a guideline to a 'structural physics' of linguistic forms. It is the celebrated Kantian principle of the *schematization of undefinable primitive categories.* By 'constructing' categories in an intuition, an internal generativity can be derived from the semanticism. As Kant has deeply theorized, schematization reveals *properties not contained in the concepts while at the same time belonging to them.* In our opinion, this transcendental conception of generativity is fundamentally correct, and it is not because it has been partly outdated in physics that it is not essential for the human sciences.

We have met a noteworthy example of it with the notion of stratification, which 'constructs' in a geometric 'intuition' the concept of taxonomy (paradigm) and the structural category of relation (connection and reciprocal presupposition). Once schematized, this basic structural category is expressed in a *geometrical* 'supplement' that allows empirical diversity to be modelized. It is, we believe, the 'supreme principle' governing the relations between mathematics and reality: *the mathematics used to modelize the phenomena of an ontological region must derive from the forms of intuition conditioning their apprehension and allowing the constitutive categories of their ontology to be schematized.*

It is because physics is based on this principle that it has been able to develop into an objective *mathematical* science. And it is because Catastrophe Theory has succeeded in schematizing the structural categories that it has been able *de jure* to set the foundations of 'pure' etic linguistics and to develop *de facto* into a *structural* 'physics' of semiolinguistic forms.

Notes

* Translated by Teresa Keane.

1. For details about catastrophist modelizing (in linguistics in particular), see for example Thom 1970, 1972a, 1978, 1980a, and b; see also Wildgen 1981 and Petitot 1977, 1978, 1982a, 1985a and b.
2. On the general problems concerning 'local' and 'global', cf. Petitot 1979a.
3. In this sense, Tesnière's conception is anti-formalist and close to the vitalist–Gestalt conceptions.
4. For an introduction to the logical theory of models (Löwenheim-Skolem's and Gödel's theorems, ultra-filters and ultra-products, nonstandard arithmetic and nonstandard analysis, etc.), see Petitot 1979b.

5. 'Moment' in the phenomenological and not, of course, the temporal sense.
6. The term 'squish' comes from J. R. Ross.
7. The idea of an order in the grammatical categories goes back to Tesnière's criterion of 'translation'.
8. These categories (parts of speech) are regarded here not as entities to be constructed, but as proto-linguistic universals imposed by the phenomenological structure of reality.
9. Indeed, it is because mathematical languages lack paradigmatic dimension that formalism is not an adequate perspective for linguistics.
10. For mathematical details, cf. Thom 1980a; Chenciner 1973, 1980; Zeeman 1976; Golubitsky and Guillemin 1973; and Petitot 1982a: chapter V. For epistemological details cf. Petitot 1982a, 1985a and b.
11. Let us recall that elementary catastrophes are catastrophes where the internal dynamic is derived from a potential function f on a differentiable manifold M (internal space), where the internal states are the minima of f and where the stratified space (W,K) is the universal unfolding of a singularity of codimension ≤ 4.
12. For the history and importance of the localist hypothesis, cf. Hjelmslev 1935. For a first link between this hypothesis and Thomian linguistics, cf. Petitot 1979c. For a link with cognitive sciences, cf. Petitot forthcoming.
13. It goes without saying that all this is only valid for the etic pole and its proto-grammatical and primitive elementary structures.
14. Let f be a potential of finite codimension on a differentiable manifold M. Let (W,K) be its universal unfolding. Σ is the subset of M x W composed of the points (x,w) such that x is a critical point of f_w. χ is the restriction at Σ of the projection M x W$\rightarrow$W, and K is the apparent contour of Σ on W relative to χ — i.e., the set of $w \in W$ such that f_w has a degenerate critical point (and is thus structurally unstable according to the Morse theorem).
15. For this picture, cf. Thom 1972 or 1980a: 188.
16. We emphasize the fact that it is not because 'the use of natural language partially escapes the constraint of all objective reference' (Culioli and Desclés 1981: 24) that the possibility of a description of reality is not constitutive of linguistic forms. Language autonomization is not a primary autonomy, and that is why systematic empirical linguistics could not rest upon a purely 'emic' formal linguistics.

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Jean Petitot (b. 1944) is Directeur d'Etudes at the Ecole des Hautes Etudes en Sciences Sociales in Paris. His principle research interests include semiolinguistics, mathematics,

cognitive sciences, and epistemology. Among his publications are *Pour un Schématisme de la Structure* (1982), *Morphogenèse du Sens* (1985), and *Les Catastrophes de la Parole: De Roman Jakobson à René Thom* (1985).