Introduction

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1. Intellectual biography of René Thom[1]

René Thom was born is Montbéliard (France) in 1923 (2nd of September). Until 1940 he lived there with his parents, his brother and several grand parents. In 1940 the brothers went to Switzerland to escape the war, but they were brought back to Lyon, where René Thom passed his "baccalauréat. In 1941 he entered the preparatory classes of the Lycée Saint-Louis in Paris and was inscribed in "Higher mathematics and special mathematics".[2] His favored professor was teaching ancient Greek; this remained a center of intellectual concern during his life. In 1943 he entered the elite college ENS (École Normale Supérieure). After some difficulties at the end of the war (he was forced to work for the German troops to fortify Belfort) he returned to the ENS in Paris and then went to Strasbourg to finish his "Agrégation des sciences mathématiques" (his teacher was Henri Cartan) in 1946.[3] Between 1947 and 1951 he was a lecturer and a research assistant at the CNRS (the French association of research).[4] In 1949 he published his first scientific article, "Sur une partition en cellules associée à une fonction sur une variété". At the same time he wrote a short novel which was only published in Thom (2003). In 1951 he made his PhD in Mathematics. Title: "Espaces fibrés en sphères et carrés de Steenrod" at the University of Strasbourg. From 1952 Thom had a scholarship at the Graduate College in Princeton (USA) and met Claude Chevalley at Columbia University. After 1953 Thom was first a lecturer and later (from 1954–1963) a professor at the Faculty of Sciences in

1 I have used some information contained in the biographical note by Michèle Porte, in Thom, 2003.

2 Preparatory classes specialize students after high-school (bac) and prepare them for the entrance exams to one of the elite colleges ("grandes écoles").

3 The "Agrégation" enables the students to teach at a college.

4 In Thom (1996/2003) he remembers a talk given by Whitney in Strasbourg (1947) on singularities in the plane, a topic which is basic for catastrophe theory.

Strasbourg. In 1957 he was a guest-professor in Bonn (Germany) and in 1958 he received the Fields Medal at the International Congress of Mathematics in Edinburgh. In the sixties he had scientific contacts with a group of mathematicians (Peixoto, Lefschetz) who worked on "structural stability" in the U.S.A. In 1962 he received the "Prix des laboratoires" of the French Academy of Sciences, and from 1963 to 1988 he was a permanent professor at the "Institut des Hautes Études Scientifiques" in Bures-sur-Yvette (Paris). This institution of Advanced Research allows excellent professors their concentration on research at an international level and receives many guests from all around the world.

From 1966 to 1968 René Thom wrote his book "Stabilité structurelle et morphogenèse" which was only published in 1972 (and translated into English in 1975). In 1966 he had published his first article in Theoretical Biology, and in 1967 he had presented the list of seven catastrophes (also called "elementary catastrophes") which are the basis of most applications in biology and the humanities. In 1969 he met Pierre Delattre, a physicist, who founded the Society of Mathematical Biology, which he directed until his death (after that date René Thom took over the direction of this Society). The members met at the Abbey of Solignac in the South of France. The years 1970 to 1976 saw the international success of the applications of catastrophe theory (CT) to many sciences. In 1974 Thom published a series of articles as paperback: "Modèles mathématiques de la morphogenèse" (the edition of 1980 was translated into English, cf. Thom, 1983). While Thom got many international prices and honors, a controversy concerning the application of CT by Christopher Zeeman began (cf. Sussmann and Zahler, 1978). It stopped the rapid application of this type of model building in some fields of applied mathematics. Nevertheless, a large group of scholars from about all disciplines came together at the conference in Cérisy (1982) to discuss René Thom's work (cf. the volume "Logos et théorie des catastrophes" edited by Petitot in 1988).

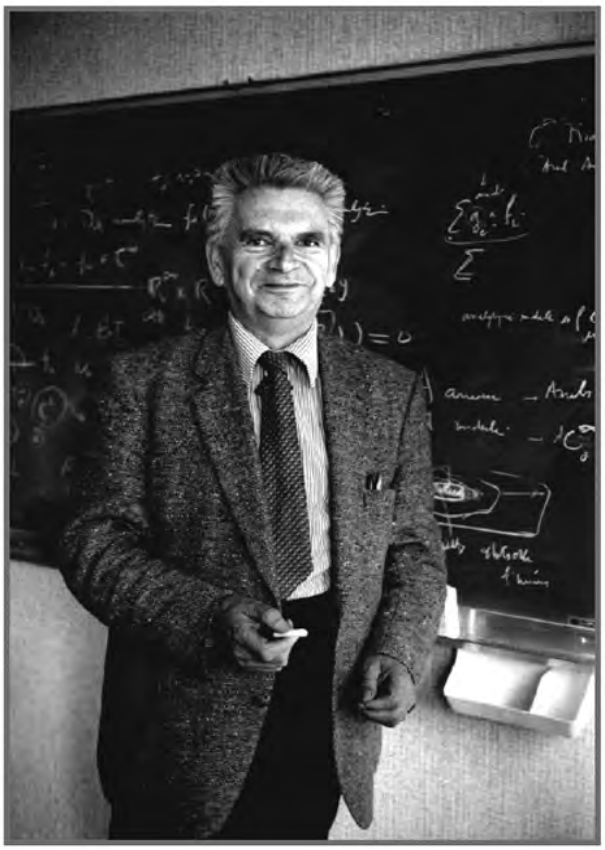

Figure 1. René Thom in action (as a mathematician).

In 1988 an international mathematical conference in honor of René Thom took place in Paris and Thom presented his new book "Esquisse d'une Sémiophysique". In 1990 he published the book "Apologie du Logos". He received further honors in Poland, France, and Brazil. In 1994 a last congress was dedicated to René Thom's work in the fields of: philosophy, psychology, cognitive sciences, biology, and linguistics. It took place in Paris (cf. Porte, 1994). After 1995 René Thom's health declined and he died on the 25th of October 2002 at Bures-sur-Yvette.

2. The rise and decline of catastrophe theory: Chances for the future

René Thom calls catastrophe theory the *application* of specific mathematical results in the field of differential topology and the theory of singularities.[5] These applications concern rather specific problems in different sciences (from the physics of light, cf. caustics, to biology, neurology, psychology, sociology and linguistics). The underlying mathematics have been further elaborated, e.g., in chaos theory, but they did not become the object of a controversy, i.e., they just followed a general line of further sophistication.

The first phase of CT beginning in 1967 has been dominated by Christopher Zeeman's scientific imagination. He invented a large number of applications reaching from models of the brain to the field of flight/attack in dogs and finally to prison insurrections. At the International Conference of Mathematics in Vancouver (1974), Zeeman had to repeat his presentation for an audience of journalists who received his ideas enthusiastically. As he proposed more and more models (cf. Zeeman, 1977), in which CT was used in different manners (interpreting the internal and external parameters in different ways) his procedure became an object of controversy. It concerned first the partial and often very specific interpretation of the variables in the mathematical model and secondly the fact that no quantitative or statistical test of the hypotheses was given or advocated.

René Thom (in 1996) argues that applied mathematics were at that time (1974) dominated by people using either computers (coming from the information sciences) or statistics (as in economy and psychology). The qualitative nature of Zeeman's models was not acceptable to them. Later, when the qualitative dynamics of Poincaré were again an object of discussion, a better theoretical understanding was reached, but the original impetus or euphoria of catastrophe theoretical modeling was lost or at least weakened. The controversy stopped as soon as 1980, when Smale, whose views had been transported by Sussmann and Zahler (1980), published a review of Zeeman's

5 Remark bis Marc Chaperon (letter): Singularity theory has also been influenced by the observation of unexpected caustics in dimension 3. In this sense, applications have influenced the further development of mathematics.

collection of articles (Zeeman, 1977).[6] Fifteen years after the catastrophe controversy (in 1993), the Dutch mathematician Floris Takens judges:

> Exaggerating somewhat, one can say that where applied mathematics used to be confined to investigate the equations, and their solutions, given by the accepted mathematical models, for the different phenomena, the work of Zeeman showed a much more liberal attitude towards the choice of these models. In this sense he paved the way for abstract parts of mathematics to the applications. (Takens, 1993: 256)

Insofar as Thom was not immediately concerned by the critique of Zeeman's model building in applied mathematics he neither reacted to the critics nor changed his own strategy.

In the domain of mathematics, his proposals were more or less restricted to the field of singularities of a potential, i.e., to gradient dynamics. He agreed that after his early contributions, American and Russian mathematicians (Mather, Milnor, Smale, Arnold) had further advanced the theory of singularities (cf. Thom, 1973/2003: 4), but his primary aim was to further unfold the morphodynamic intuitions he had described in his basic book: "Stabilité structurelle et morphogenèse" (1972). Thom's and Zeeman's proposals had shown that the mathematical results in singularity theory and dynamic systems theory not only had deep historical sources in mathematics (ibidem) but that they were very promising for future applied research.

After the controversy, the tandem Zeeman/Thom separated, and both engaged into different directions, though with a similar intellectual background. Zeeman contributed to the conference on Thom in 1982 (cf. Petitot, 1988: 298–309) with an article on perception ("Sudden Changes of Perception") and he continued his work avoiding however applications in sociology and in other politically sensitive disciplines. In the late seventies, Thom returned to Aristotle and his theory of genres and introduced the terms "prégnance" and "saillance", which make up the heart of his "Semiophysics" (cf. Thom, 1988; Petitot, 1992, and several articles in this volume).

6 After an article in Nature, the replies by mathematicians, physicists, and biologists were unanimously in favour of catastrophe theory (cf. Zeeman, 1993: 268). Smale has at least not made the many mistakes his pupils had shown in the controversy.

3. René Thom's work in linguistics and semiotics

René Thom's interest in linguistics started in 1970, and he mentions (cf. Thom 1996/2003: 29) that his first contacts with linguists had been deceiving, because they rejected the idea of language universals. It was only with the success of Chomsky's and Jakobson's ideas (in the U.S.A. in the sixties; in Europe after 1970) that these linguistic concerns were taken seriously. In Tesnière's grammar, Thom found an application of graph theory to grammar, and thus an intuitive topological model. The basic idea that at the center of the sentence one finds a heavy kernel (the verb), around which lighter elements (nouns and nominal phrases) are turning, invited a gradient-dynamic model (cf. ibidem: 31). This intuition, which Thom also found in Peirce's writings (at a later time in his intellectual evolution), is the starting point of his proposals for a topological semantics. Many of his basic articles on linguistics written between 1968 and 1974 were assembled in the volume of 1974 (reedited in 1980 and translated into English in 1983). The PhD theses of Wildgen (1979) and Petitot (1982) have elaborated these ideas and broadened their field of application (cf. in English Wildgen, 1982, and Petitot, 2003).

Already in 1982, David Ruelle, one of the founders of modern chaos theory, showed the continuity existing between CT and Hopf bifurcations on one side and CT and Feigenbaum fractals on the other (cf. Ruelle, 1988: 103). The so-called "generalized catastrophe" described in Thom (1972) was a cover term for all systems later described in the domain of fractals and chaos theory. However, the rather simple structures of gradient dynamics around one central attractor were not sufficient, insofar as in many domains of application either higher dimensions of attractors (on a circle, a torus, etc.) or chaotic attractors have to be considered (cf. Wildgen and Plath, 2005). The applications of CT therefore (at least after 1982) had to consider further domains of dynamic systems theory. In a collaboration which started in Cérisy-sur-Salle (at the conference on Thom's work in 1982), Laurent Mottron and the present author undertook such an expansion, which led to the book "Dynamische Sprachtheorie" (Wildgen and Mottron, 1987), where the first part dealt also with Prigogine's and Haken's applications of "dissipative systems" and "synergetics" to the humanities. In Petitot (1992: chapter 5) this evolution of the field was also acknowledged.

The intellectual situation in France in the seventies brought about that only the Paris semiotic school (directed by Greimas) became interested in

Thom's work. Petitot and Brandt were both concerned with Greimas and Thom (cf. Petitot 1992, chapter 7, and Brandt, 1992). In the context of the European "Groupe Sigma" and its conferences and at meetings at the Center of Semiotics in Aarhus (Denmark) and Urbino (Italy), the research on dynamic modeling in semiotics and linguistics had been continued, and several authors (Brandt, Petitot, Wildgen) tried to establish a link with west-coast linguistics (Fillmore, Lakoff, Talmy, Langacker). This cooperation was blocked by the rejection of mathematical modeling by this group known as "cognitive semanticists". More recently Per Aage Brandt succeeded in introducing topological thinking into the American school of "Blending and Conceptual Integration" (cf. Brandt, 2004, and the journal "Cognitive Semiotics"). The book series "European Semiotics" (Lang, Bern) in which this volume is published also has a focus on semiotics in the spirit of René Thom.

It would be an interesting topic in the epistemology of science to explain why Chomsky's mathematical linguistics, which was widely ignored or rejected by linguists in the late fifties and early sixties (in Europe until the seventies) could have such an effect in theoretical linguistics and why the even more radical mathematically based hypotheses of Thom (and its later elaborations by linguists) were not successful to the same degree. Chomsky was in fact not a mathematician, although his dissertation (Chomsky, 1955) had the appearance of a mathematical (or logical) treatise. His innovation however fitted the general atmosphere dominated by the information sciences (cf. Thom's remark on the catastrophe controversy 1976–1978). The Brussels school of Prigogine and Haken's series of Applications in Synergetics learned the lesson of the catastrophe controversy and avoided the humanities as domains of application. Only in the late eighties did Haken enter this field with a preference for experimental psychology and neuroscience (cf. Haken and Stadler 1990; Stadler and Kruse 1995; and Haken 1996).

Meanwhile the innovative era of information sciences is closing, insofar as the new technology is a kind of general tool used in all sciences and has lost the character of a generalized metaphor of the human mind. The neurosciences with their window to the mind and genetics took over the role of zones of rapid growth. In a certain sense, modern neuro-dynamics give a more precise and experimentally more sophisticated view on the mind than Zeeman's articles did in the late sixties. But the general prospect to develop dynamic models of the human mind, of thought and language, persists. Thus, the endeavor of Thom and Zeeman, and of their colleagues in biology, psychology, and linguistics, was not lost. Their enterprise was just a long jour-

ney and in the eighties and nineties the scientific community was not eager to wait until they could come nearer to their goal.

It cannot be the intention of this introductory chapter to make guesses for the future, but one can already feel the overall changes that reduce the charm of mechanical (computer-based) models in the humanities. This can either trigger an (impossible) return to folk-models of the mind and language (cf. my critic of cognitive semantics in Wildgen, 1994: chapter 1 and in Wildgen, 2008: chapter 8 in German) or lead to a renaissance of dynamic model building in the humanities (surely with better empirical data and more advanced conceptual tools). The general chance of this direction is that it introduces new mathematical models that have been successfully applied in the natural sciences and uses them to reshape traditional questions and strategies for their solution in the human sciences.

4. An overview of the contributions in this volume

The contributions to this volume are elaborations of papers given at a conference with the same title organized by the editors in Urbino (Italy), 18th to 20th of July 2005. Some of the contributions which were in Italian and not specifically linked to René Thom's work were not considered, other contributions were invited after the conference.

I all cases, the work of René Thom and in many cases his personal influence had been crucial for the contributors in some phase of their academic life or throughout. Therefore many of contributions are a kind of testimony (cf. the title of Marc Chaperon's paper) of the impact René Thom had in the field of semiotics and linguistics. The majority of papers are in English or have been translated into English; they form the first part of the volume. Two papers are in French, and they stand in the second part. As Thom's oeuvre is written in French and many of his books and papers have been translated into English, such a bilingual volume seems to be adequate.

The first chapter by Marc Chaperon is written from a mathematical perspective and describes the intellectual itinerary of René Thom in the light of one of his students. He also comments the controversy about the applications of catastrophe theory (mainly those of Christopher Zeeman) in the late seventies.

The second chapter by Svend Østergaard concerns the recognition of forms and its contribution to cognitive (and pragmatic) realism. Singularity theory is shown to be decisive for a theory of human (and animal) form recognition.

The multiple sources of Thom's semiotics, mainly his "biosemiotics" are enumerated and commented in the chapter by Peer F. Bundgaard and Frederic Stjernfelt. They refer to ideas taken from: Waddington, Uexküll, Saussure, Jakobson, Tesnière (and Aristotle), Köhler, Pike, Greimas, Greenberg, and Durand. Thus they can show the multiple roots of Thom's semiotics and his capacity to integrate a great variety of proposals in a multidisciplinary field and to put forward a mathematically founded theoretical architecture which could bring all these endeavors together.

The search for relevant intellectual sources is continued in the chapter by Wolfgang Wildgen, who concentrates on the notions of "saillance" and "prégnance" and the proximity they show to concepts proposed by Pavlov, Lorenz, Uexküll, Gibson, and Cassirer ("symbolische Prägnanz"). Cassirer's objections against a strict parallelism between notions in modern geometry and the dynamics of human perception are considered in the light of Thom's proposals. The notion of "diffusion de prégnance" is reconsidered in the context of evolution and questions about the origin of grammar (and syntax).

The chapter by Isabel Marcos applies basic proposals of Thom to structural geography and the morphogenesis of towns. She exemplifies the type of morphogenetic analysis based on the historical evolution of Lisbon and she tries to find some morphological "universals" of urban evolution.

Angel Lopez Garcia gives a rather critical reading of Thom`s proposals related to verbal semantics and the structure of basic propositions. He compares Thom's specific analysis of verbs with the tradition of structuralism (Hjelmslev, Jakobson, Halliday, Chomsky) and the models: "Liminar Grammar" and "Topological Linguistics" proposed by himself. Finally, the question of the neurological plausibility of these proposals is put forward.

The chapter by Jean Petitot (in French) begins with a "testimony" of Thom's intellectual development since the end of the sixties and addresses the central question in Thom's linguistic thinking: How can predication be conceived in a "morphological" (topologico-dynamic) perspective, and how is it related to the classical "logico-centric" models. Jean Petitot starts from Husserl's "Erfahrung und Urteil" and introduces specific mathematical concepts like "faisceaux" and "topoï". They allow for an elaboration of the logical treatment of predication as it was put forward by Kripke and others by adding a "morphological" dimension.

The chapter by Per Aa. Brandt (in French) returns to a less formal treatment of "prégnance" and meaning in an elaborated structural design based on Saussure's dichotomy of "signifiant" and "signifié". He expands the idea of "diffusion de prégnance" towards a model of double "flux" between "signifiant" and "signifié".

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