50 years of a scientific life

by

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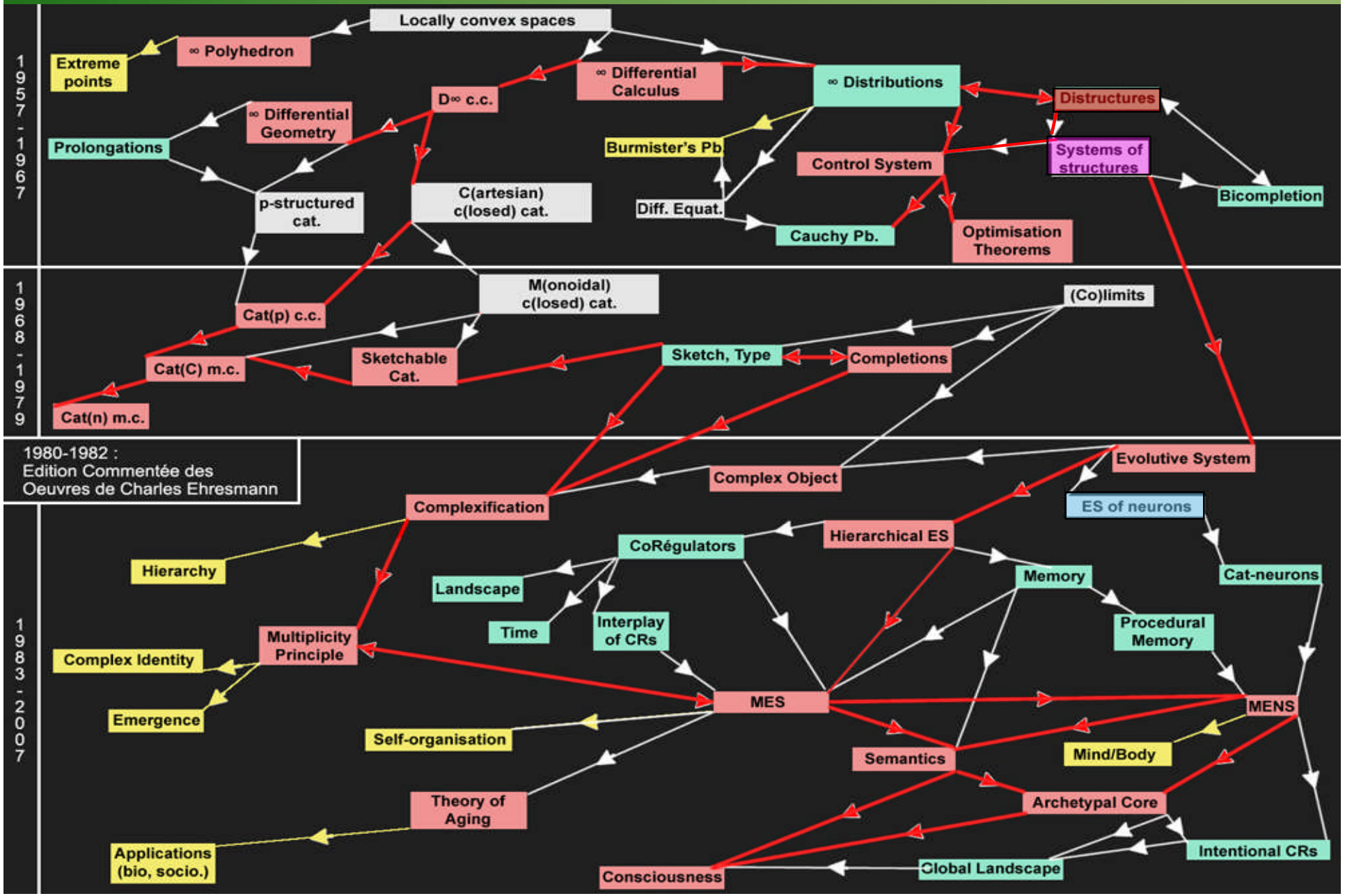
DIAGRAM OF MY RESEARCH WORK



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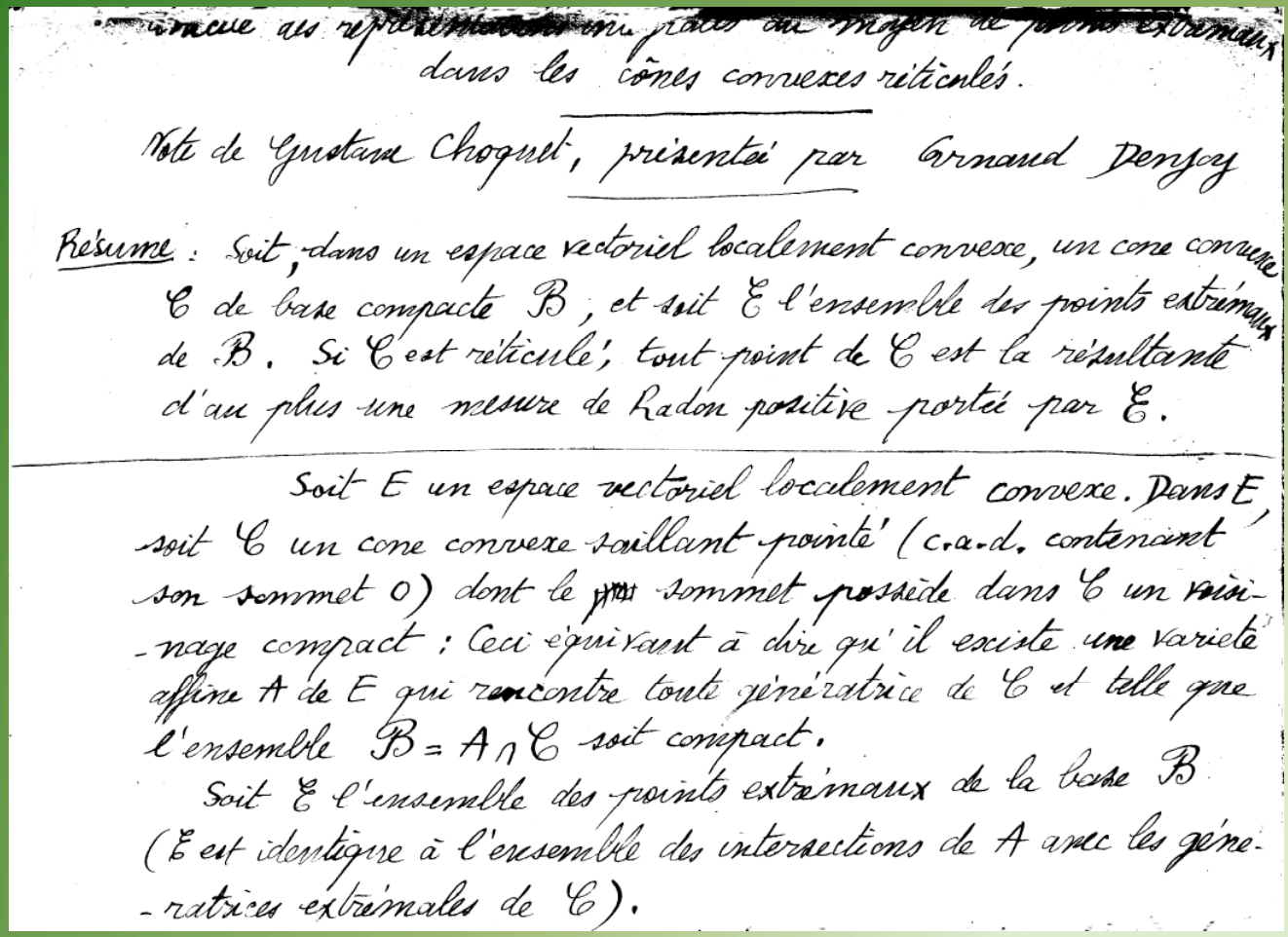
1. THE INITIATION



dans les cônes convexes réticulés.

Note de Gustave Choquet, présentée par Arnaud Denjoy

Résumé : Soit, dans un espace vectoriel localement convexe, un cone convexe C de base compacte B, et soit E l'ensemble des points extrémaux de B. Si C est réticulé, tout point de C est la résultante d'au plus une mesure de Radon positive portée par E.

Soit E un espace vectoriel localement convexe. Dans E, soit C un cone convexe saillant pointé (c.a.d. contenant son sommet 0) dont le sommet possède dans C un voisinage compact : Ceci équivaut à dire qu'il existe une variété affine A de E qui rencontre toute génératrice de C et telle que l'ensemble $B = A \cap C$ soit compact.

Soit E l'ensemble des points extrémaux de la base B (E est identique à l'ensemble des intersections de A avec les génératrices extrémales de C).

In 1956, first research under the direction of Choquet on his now well known Theorem on extreme points of convex sets (above photo of the 1st draft of his 1956 Note). Long discussions with him were a good training. and made me familiar with the intricate properties of infinite dimensional locally convex spaces (to which I could not transpose a new proof I had found in the finite case). This was decisive in my selection of the subjects of my following work.

2. FIRST PUBLICATIONS

The above photo shows Charles and Choquet at the Congrès des Mathématiciens d'expression latine (Nice, 1957) where began my 22 years long close relation with Charles.

At that time, I was completing the writing of my 3rd cycle thesis which deals with convex geometry and applications Its main result gives a new definition of a polyhedron which extends to the infinite dimensional case, namely as a convex set such that each supporting cone is closed. This result is exposed in my first publication, a Note to the CRAS just 50 years ago.

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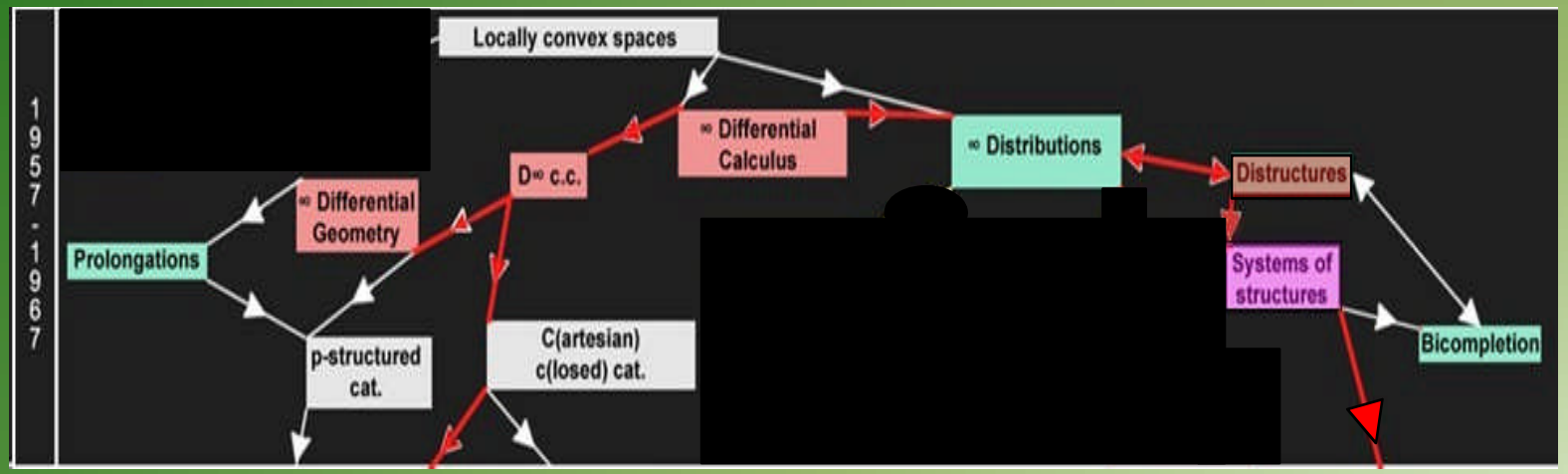
3.. MY THESIS

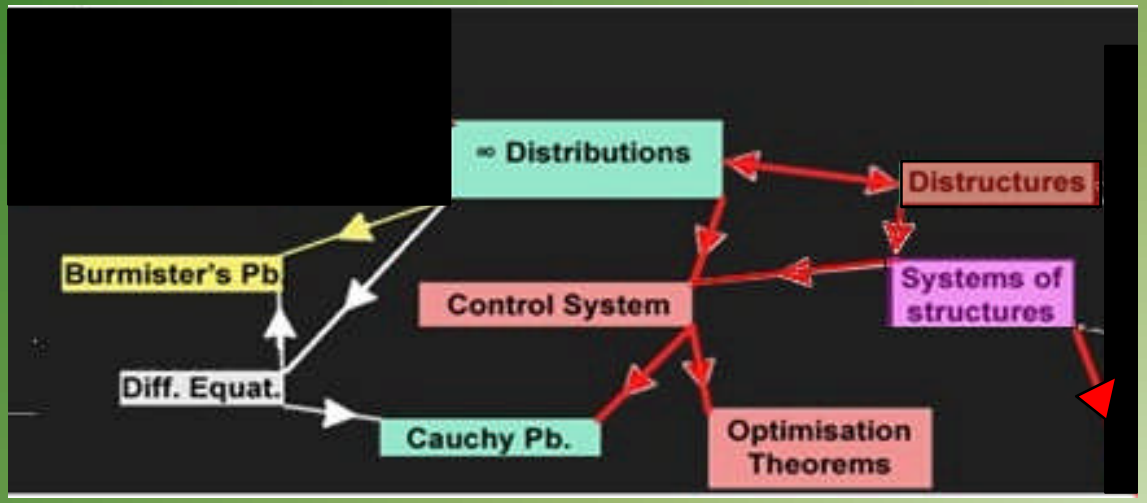


Interested in functional analysis and differential equations, I was attracted by the strength of Schwartz' theory of distributions and fixed on transposing it to define (vector) distributions on infinite dimensional spaces. That required to develop a good enough differential calculus in these spaces, which I did in the first part of my thesis (1962) and a subsequent paper (1964, J. Ana. Math. Jérusalem), later taken back by Keller, Frölicher and others. The second part of the thesis introduces the concept of *distructures* as a unifying tool for 'generalized functions'.

The adaptation to analysis of the few category concepts I knew of (through Charles' work) paved the way for our future research on 3 points:

- 'enriched' semi-actions of categories and their extensions into actions,
- concrete internal categories (called p-structured categories by Charles),
- construction of Cartesian closed structures on categories of differentiable maps, and later on categories of internal categories.

4. CONTROL SYSTEMS



In 1963, after leaving the CNRS, I had a contract of the DGRST to study control problems. Drawing on my former use of semi-actions of categories, I 'internalized' the concept in Top and Diff to define Control Systems which provide a categorical frame to model Cauchy boundary problems and variation problems. The main results (exposed in 4 internal reports and summarized in a short 1966 paper) develop the theory of infinite dimensional vector distributions begun in my thesis and, with its help, give optimisation theorems (drawing on Bellman's dynamic programming approach) for solutions of a control system.

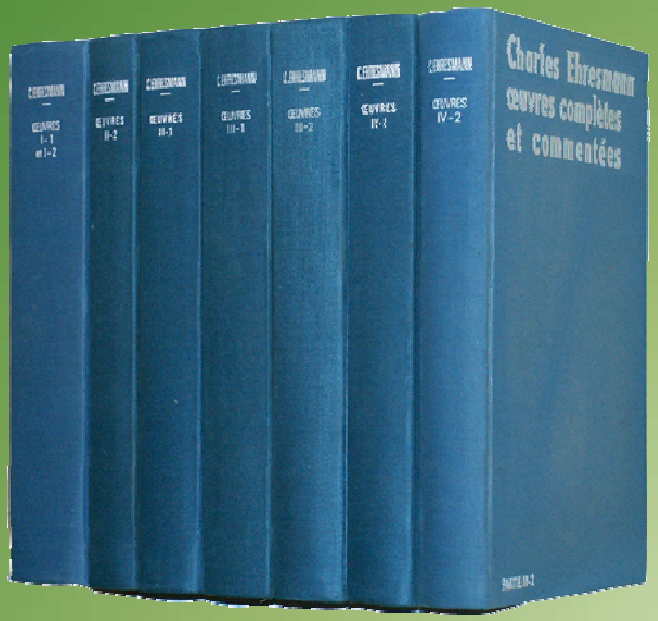
During these years, with Charles we specialized more and more in category theory. And he progressively transformed the "Cahiers" from the proceedings of his seminar to the proper journal it became in 1967.

5. 10 YEARS OF JOINT WORK

From 1968 to Charles' death in 1979, our joint papers have to do with sketches and the categories of their models. Sensibilised by my former experience with functional spaces, we were specially interested in the existence and construction of cartesian or monoidal closed structures on sketchable categories, in particular on categories of internal categories. Our last joint series of papers is a thorough study of such structures on the categories $Cat^{(n)}$ of n-fold categories.

In 1970 we created the Paris-Amiens research team "Theory and Applications of categories" which organized regular meetings and 3 Conferences on categories (e.g. in 1975 when the above photo was taken in Chantilly).

6. PUBLICATION OF CHARLES' WORKS

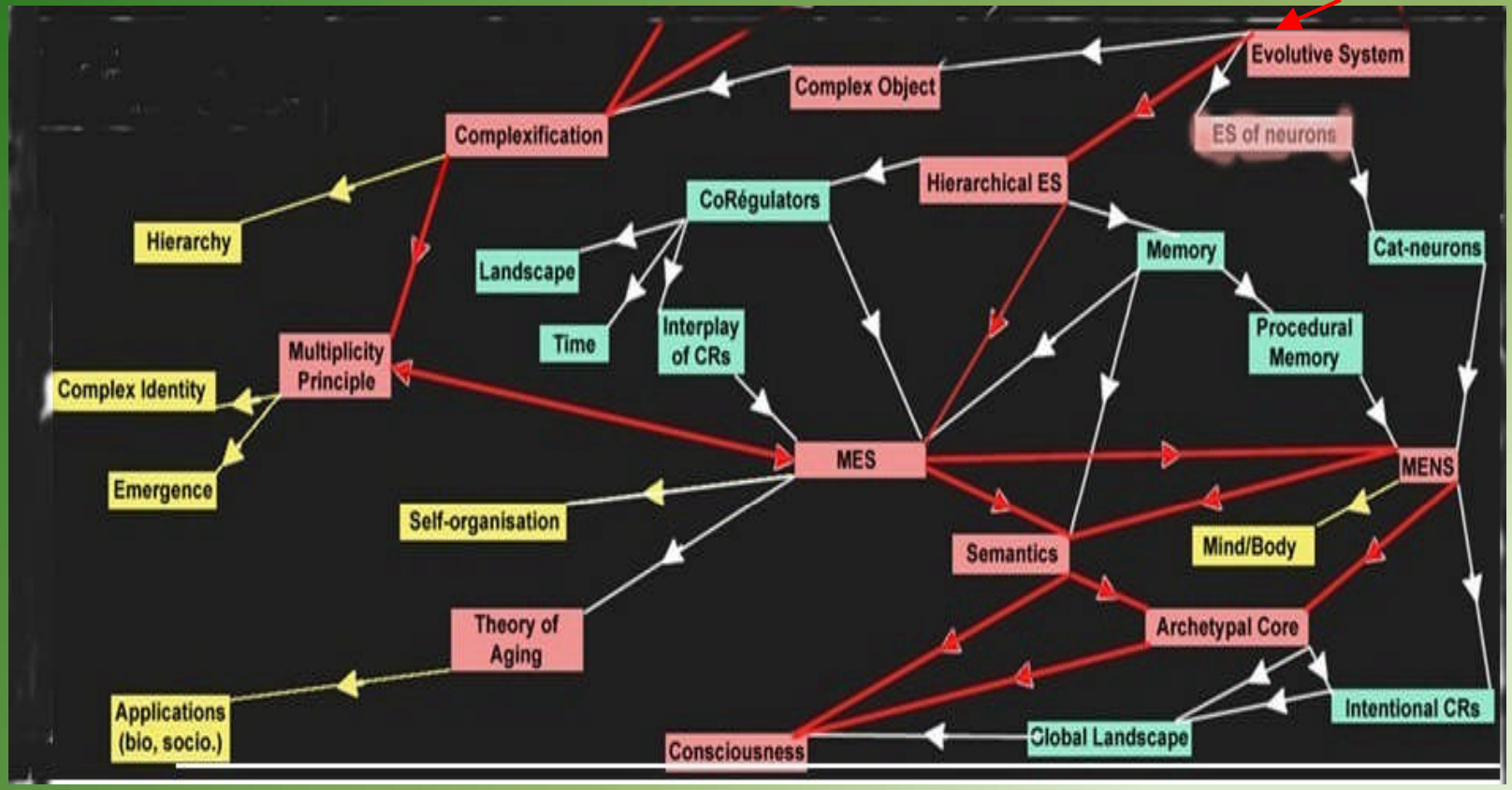


In 1980, to make the papers of Charles more accessible, I decided to edit his complete works, with a large number of comments (which I wrote in english) to 'translate' them is a more usual terminology and indicate their relations with other works. The 7 volumes of the "Oeuvres" have been published from 1980 to 1983 as supplements to the "Cahiers".

During these years, the "Cahiers" also published the proceedings of a large Conference dedicated to Charles which I organized in Amiens.

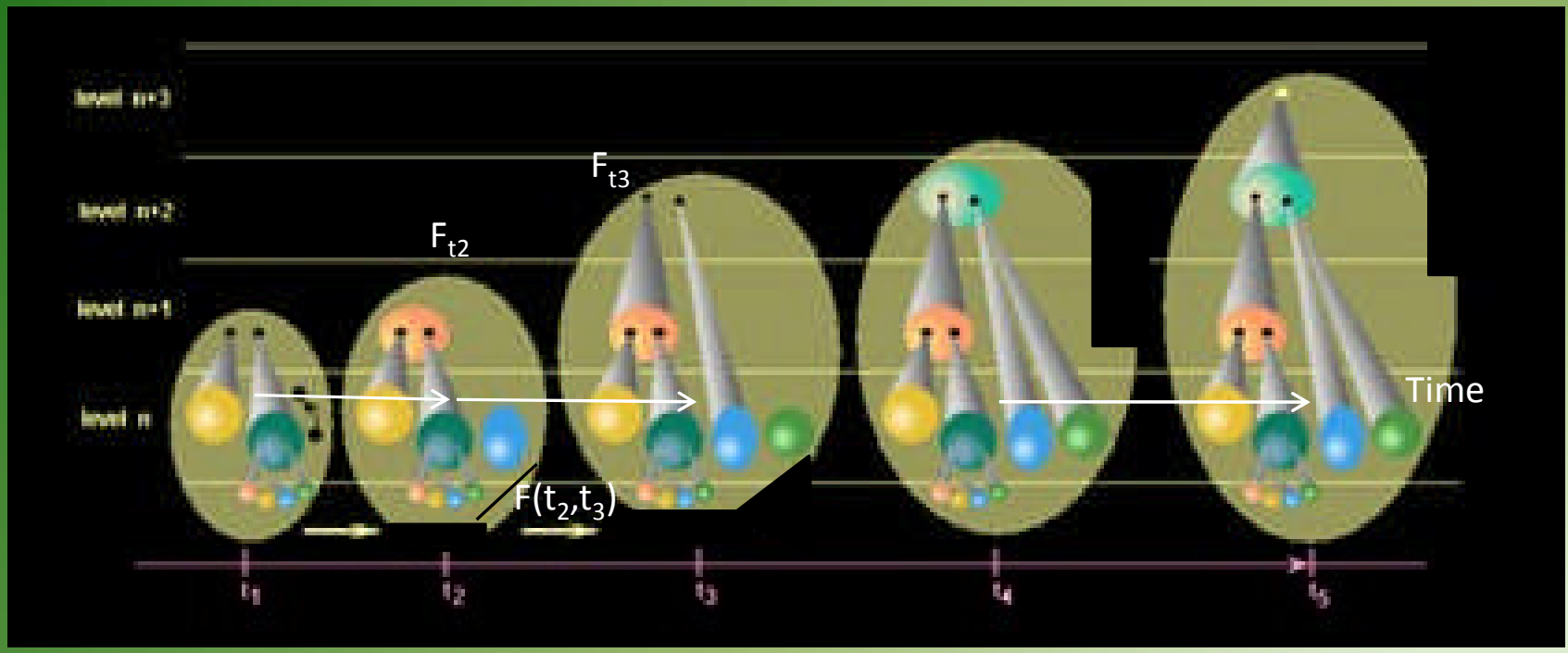
In 1983 the title of the "Cahiers" was slightly modified by adding the word "catégoriques" and an Editorial Board was created to help me in the selection of the papers.

7. A NEW ORIENTATION



After the publication of the "Oeuvres", I felt the need of a change, triggered by discussions with a physician, Jean-Paul Vanbremeersch, which convinced us that categories could be an adequate tool for modelling living systems. Whence the beginning of a 25 years long collaboration which has led to the development of the Memory Evolutive System. Three main steps can be distinguished in their development, as follows

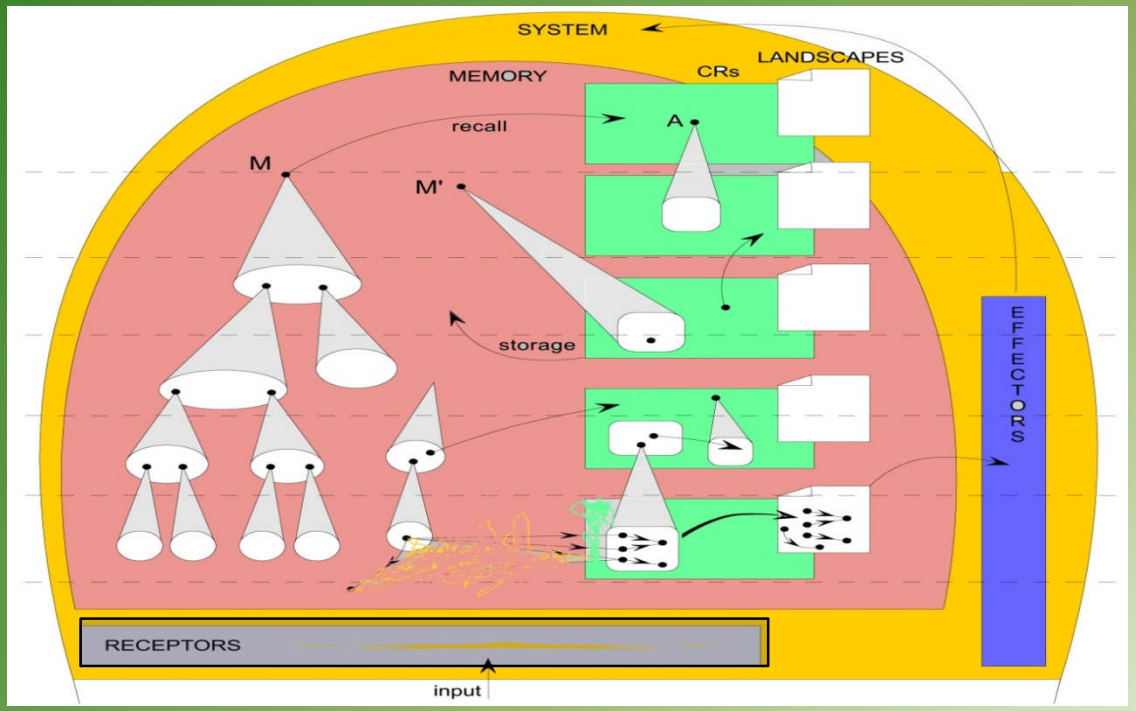
8. HIERARCHICAL EVOLUTIVE SYSTEMS



The first step 1985-19988) was to define a *Hierarchical Evolutive System* or semi-sheaf of hierarchical categories over a category Time, which models the successive configurations of a complex natural system with a hierarchy of components of increasing complexity.

Its 'transitions' model the change of configuration of the system from t_i to t_j and correspond generally to a completion process (we say '*complexification*') to add and/or suppress particular limits and/or colimits. It gives a model for the emergence of new objects or properties. In particular we show that the emergence of strictly increasing complex objects is characterized by the *Multiplicity Principle* (existence of objects which are the colimit of two 'non-equivalent' diagrams).

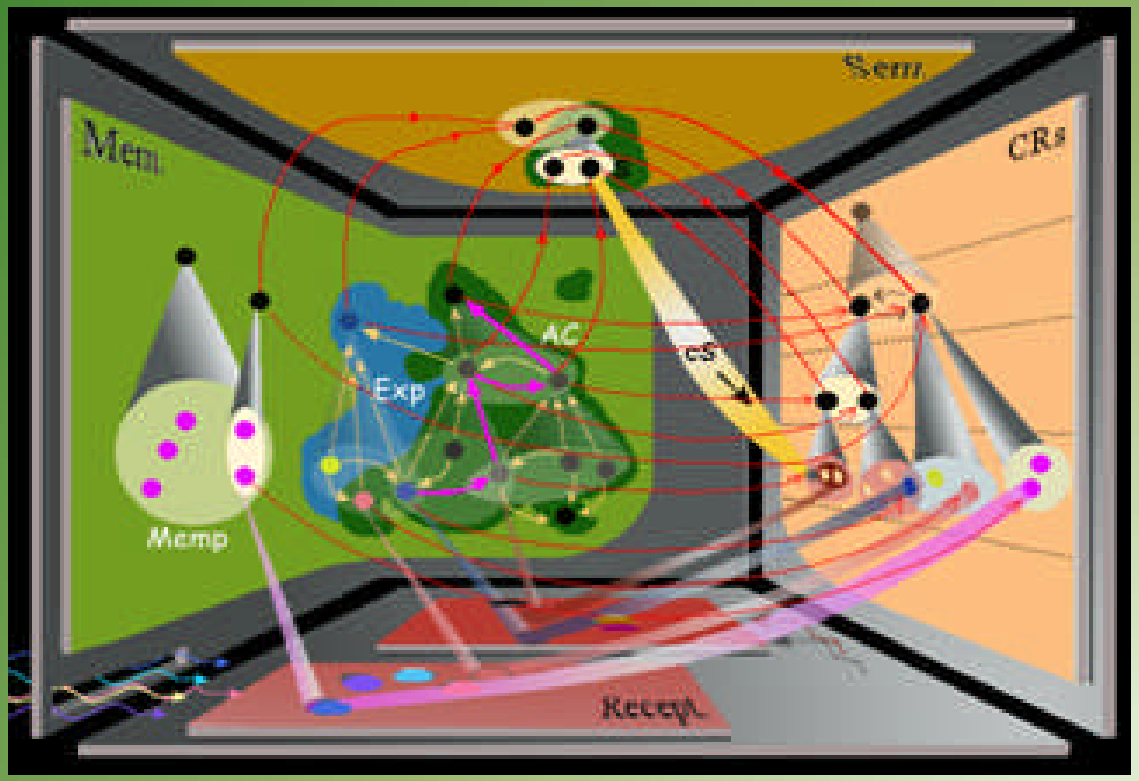
9. MEMORY EVOLUTIVE SYSTEMS



To model the self-organization of living systems, we defined a *Memory Evolutive* System by equipping a HES with a net of sub-systems, the Coregulators, which model specialized internal regulation organs, and a sub-system, the Memory, related to a learning process. Each CR acts on its own landscape and with its own timetable, but the 'strategies' of the various CRs must be made globally coherent, with a risk of 'fractures' for some CRs. As an application, we have proposed a *theory of aging as a 'cascade of desynchronisations at increasing levels.*

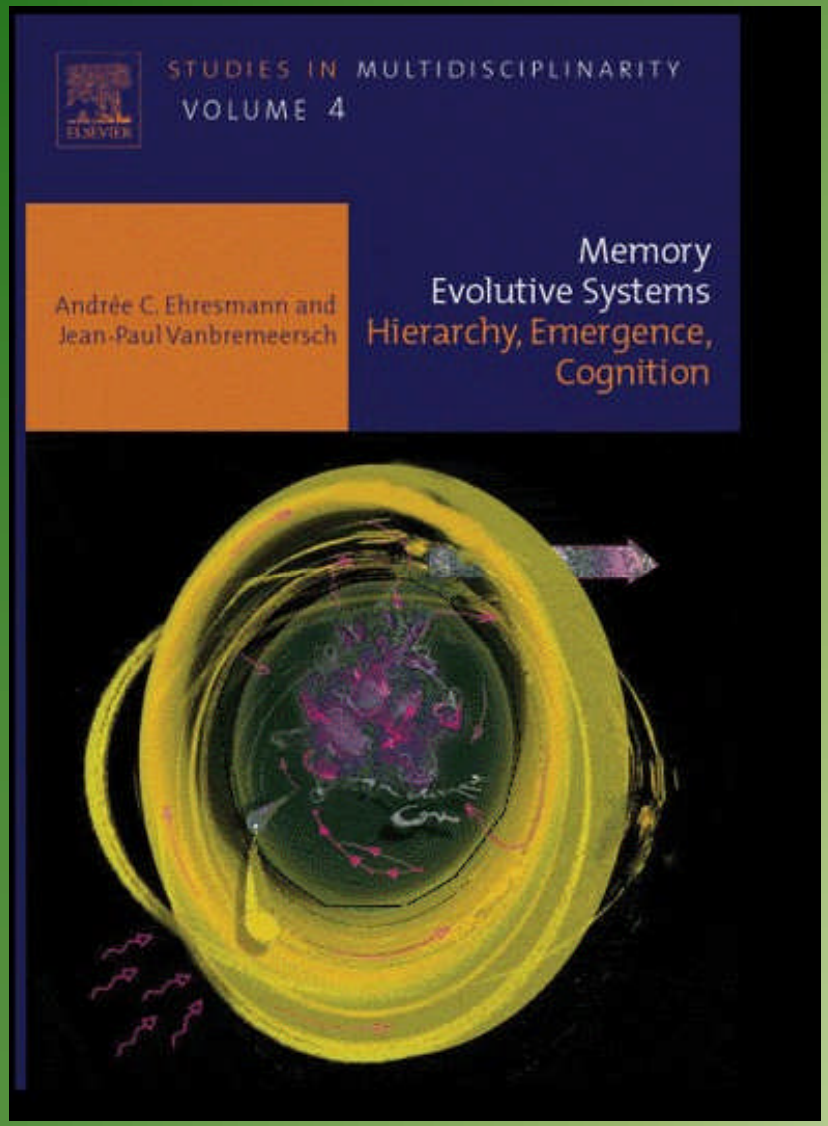
This step was developed from 1989 to 1996. In 1996 we organized the multidisciplinary Symposium ECHO in Amiens.

10. THE MENS MODEL FOR COGNITIVE SYSTEMS



The last step (1998-2007) consisted in introducing the model MENS (Memory Evolutive Neural System) of a cognitive system. It is a MES obtained by successive complexifications of the ES of neurons modelling the neural system of an animal. We describe how a procedural and a semantic memory develop and lead to the formation of an interconnected personal memory, the *archetypal core,* essential to the emergence of an internal global landscape at the basis of conscious processes.

In 2005 we organized in Amiens the International Conference "Charles Ehresmann: 100 ans" to commemorate the 100th anniversary of Charles.



This book (Elsevier, 2007), whose authors figure above, develops our 24 years of research on Memory Evolutive Systems. Its cover illustration, drawn by Jean-Paul Vanbremeersch, gives his synthetic view of our model,