1. Introduction

The notion of evolution, although originating in and mostly referred to biological issues, is highly significant for any processual world view. Thus the concept of a temporal evolution of variables of a system should be considered of very general relevance. As a consequence, a formal approach would be most desirable which leaves a high degree of freedom regarding the interpretation of the variables as well as the interactions between them. The present contribution aims toward the development of such a general evolutionary theory based on physical concepts.

In the framework of physics, there are two basically different types of evolution which might be classified into discontinuous and continuous ones. By a discontinuous evolution we think of phenomena such as thermodynamical phase transitions, bifurcations, and instabilities far from thermal equilibrium. The "synergetic" approach of Haken mainly concerns these fields. A huge number of examples has become popular. Just to give an arbitrary selection (ordered by decreasing common experience) we mention freezing water as a typical phase transition phenomenon, the formation of collective action as an instability in laser systems, and even such fundamental problems as that of quantum mechanical measurement.

Continuous ("smooth") processes constitute the main body of evolving physical systems in the sense of classical mechanics. During the last decade, a very general class of processes has gained a lot of interest in this field. They provide an irregular temporal evolution of their variables although be-
ing described by deterministic equations (hence the catchword "deterministic chaos"). Historically, the first studies of such processes date back to Poincare.

The present article is devoted to various properties related to this class of smooth evolutionary processes. The reason for this interest originates in the fact that such processes can be shown to introduce a temporally directed flow of information, a crucial criterion for evolution in general. This point is obviously related to one of the main unresolved mysteries of contemporary sciences: the problem of irreversibility. The formalization of a time-directed information flow is thus extremely important in this context.

An additional paradigm of evolution is that of increasing complexity. From a physical and mathematical viewpoint, the number of approaches toward complexity increases self-similarly. In order to pay an artistic tribute to biological complexity as a specific phenomenon of a general evolutionary theory we refer to Escher's inspiring image "Verbum" reproduced in Fig.1.

Figure 1: M.C.Escher's lithography "Verbum" as a famous artistic creation on the paradigm of evolution (© 1989 M.C.Escher Heirs / Cordon Art – Baarn – Holland).