Conclusion

In the present report we have attempted to show how *chance* and *information* need to work together so that ordered structures, like complex systems and in particular living bodies, are allowed to emerge *locally* starting from unorganized matter.

The role of some driving *information* has appeared essential in order to direct the evolutive trajectories of any system towards an organized ordered structure resulting as an *attractor*. *Matter* and *energy* alone prove to be not enough to generate order, because of the second law of thermodynamics, which compels any matter-energy system towards disorder and thermal equilibrium. Even if, locally, some partially ordered structures may emerge, by chance, the probability of such an occurrence is very very small and the entire age of the universe would not be sufficient to produce an organized system comparable to the living beings which actually we observe on our planet. The number of the ordered possible combinations of particles is too small compared with the huge number of disordered combinations. Moreover, even if an ordered configuration might occur by chance, its *stability* in time would be even more and more unlikely.

A further governing principle like *information,* which is *neither matter nor energy* (according to N. Wiener) seems to play an essential role in the process of order and organized systems emergence from matter.

We have shown how *algorithmic information* (in the sense we have proposed just from chapter 1) can operate in order to generate complex systems like *fractals* either starting from an already *ordered sequence of initial conditions* or starting from *random initial conditions,* leading to the same geometry of the resulting objects, as *attractors* towards which the evolutive trajectories are led thanks to information.

Of special interest, in relation to biological systems, has been revealed *cellular automata* since they add to the driving algorithmic information the constraint that any daughter cell is located in contiguity with its mother cell. No matter if the choice of the near location of the daughter cell is chosen by chance. What is relevant is the role of the *law* (*information*) according to which the daughter cell is born.

The techniques implemented to generate fractal shapes have been, finally, applied also to a biological system like a human organ, *e.g.,* the heart, in order to simulate the generation or regeneration of its tissue by a stem cell. We saw how a simple program (*compressed string*) allows to obtain only a rough model of an heart shape, while a true realistic anatomic shape seems to require to know the full (*uncompressed*) list of the co-ordinates localizing the single cells, even if they are schematically represented by small spheres. An intriguing question

arises if a biological organ belonging to a living body can be generated by an algorithm which can be compressed within a relatively short program string, or if an *incompressible* string of data is required to describe each single cell or constituent part of the whole system. Is the *DNA,* and more generally the biological code responsible of a living body generation, more resemblant to a compressible or to an incompressible string of code?

In principle one could guess to model the whole universe as a set of nested attractors.

In the present investigation we have limited ourselves only to attack the problem of the emergence of complex boundary geometrical *shapes* of bodies (like fractals and a living organ) thanks to the concurrence of some *information* (*i.e.,* something resembling an Aristotelian *form*). A More intriguing matter would be, beside that of the generation of the external and internal organized structure of complex systems, that of modeling their behavior along time, *i.e.,* their *dynamics.* So timidly approaching the matter of their *nature* (in the Aristotelian Thomistic sense of the word, *i.e.,* operational ability), together with the matter of their *essence* (*i.e.,* existing ability as organized ordered structures).

Further researches will be required in future to widen the present program of investigating the role of *information* (*form*) as an immaterial principle of *organization* and *activity* of matter-energy. We hope that the *INTERS project on "Form and information"* may offer a suitable context to develop such a stimulating search and will be albe to provide some more relevant results.