White Paper (version 1.0):

Creating a European Institute for Complexity Studies (EURICS)

This document discusses the rationale behind the foundation of a new international institute for research, education and training. The institute is devoted to a better understanding of complex systems, with an emphasis on real-world problem solving. The paper outlines the institute's philosophy, focusing on why such an approach is urgently needed, and what distinguishes it from similar approaches.

Why do we need a new approach?

The present situation:
The world seems to become more complex and changeful with every year that passes. This is the result of a variety of mutually reinforcing socio-economic forces, including:

- scientific and technological advances producing ever more advanced knowledge and more diverse products and services,
- ICTs making available ever-larger amounts of potentially relevant information,
- growing interconnectedness of individuals, organizations and countries via global communication networks.
- growing diversity in the educational, cultural and social backgrounds of the people we interact with,
- globalization of markets, governance and ecological changes.

The problem:
While most of these developments are for the better, increasing people's wealth, health, freedom and level of education, acceleration and complexification have a number of serious negative side effects. For individuals, such unpredictable and uncontrollable change together with an overload of choices produces uncertainty, stress, and a general feeling of meaninglessness or lack of direction. This may explain the increasing number of burnouts and depressions[1], and the appeal of fundamentalist ideologies. Organizations too find it difficult to formulate long-term visions while adapting to on-going innovation—overwhelmed as they are by the need to react to short-term changes and to take into account a myriad of potentially important factors. On an even larger scale, accelerating change together with increasing mutual dependency creates instability in networks, markets and the global system. This may result in cascading failures, such as electricity blackouts, pandemics, and financial crises.

It seems that the environment in which we live has become too complex and unpredictable for our old ways of tackling problems. New ideas, methods and tools are urgently needed. Indeed, existing approaches are still largely based on classical, Newtonian science, which tackles all problems by reducing them to independent, static elements that follow deterministic laws. Recently, the new *sciences of complexity*[2] have risen to the challenge, proposing a wealth of inspiring new concepts that can help us to understand complex systems and their evolution. Their approach, which emphasizes networks, non-linearity, co-evolution, emergence, self-organization, and collective intelligence, is very different from the Newtonian one.

However, as these sciences originated in a variety of independent disciplines—from physics to social science and from biology to computing—their theories are as yet still fragmented and incoherent. Moreover, because of ongoing research, existing theories continuously need to be updated or reformulated. In sum, complexity science itself suffers from too much complexity and change.

The proposed solution:
To tackle these problems, we propose to integrate the ideas from complexity science in the form of a concrete and coherent conceptual framework, based on principles that are as simple and as general as possible. The resulting framework should help individuals and organizations to better

- understand the complex situation in which they live,
- cope with complexity and information overload,
- formulate clear goals and values for long-term evolution,
- navigate across increasingly turbulent currents,
- harness self-organization.

This framework can be implemented according to the mechanism of distributed cognition: the collected knowledge should be made available via intelligent web tools, so that we can use it interactively whenever we want, without needing to memorize large amounts of information.

The Mission of the Institute

The objectives of EURICS are fourfold:

(1) to investigate theories of complex systems and their evolution

First of all, we wish to survey, explore, refine, and test the most promising theories of how complex systems function. For this, we will use the traditional academic methods of multidisciplinary research, including literature reviews, discussions among experts, gathering and analysis of empirical data, mathematical modeling, and computer simulation. The emphasis will be on models of real-world issues, and on the development of systems that can support collective intelligence or distributed cognition.

(2) to synthesize the results into an encompassing conceptual framework

Our intention is to develop a coherent "ontology" of complexity, i.e. a formal taxonomy or semantic network of concepts, connected by relationships. In that way, each concept can be clearly defined and situated within its context of related concepts. Practically, we will try to implement this network as a self-organizing semantic web, i.e. an intelligent "encyclopedia" that is structured in such a way that it can autonomously answer simple questions. On a more intuitive level, this conceptual system can be interpreted as a "worldview", i.e. a broad philosophy that explains our place in the universe, and that gives meaning to our actions by situating them within the global evolutionary context.

(3) to show how this framework applies to real-world problems

A general conceptual framework is not yet sufficient if it is not clear how you can apply it to the concrete problems that you have to deal with. Therefore, we intend to assemble an extensive collection of problems from the everyday world as experienced by individuals and organizations, and to show how each of them can be tackled with the help of our system of concepts and principles. Thus, each abstract concept in the encyclopedia will as much as possible be illustrated with concrete, practical examples and applications, while each problem will be linked to the concepts and methods that may help us to deal with it.

(4) to disseminate this conceptual framework as widely as possible

Our final objective is to make the knowledge gathered as a result of the three previous objectives known by an as wide as possible audience. This audience will include interested students, fellow researchers and academics, practitioners wishing to better understand their organizations or markets, and finally the general public at large. The rationale is that all of these people will sooner or later be confronted by complexity that is too great for them to deal with. Therefore, all of them can profit from the insights we hope to develop.

Novel Contributions

While the above objectives may appear compelling, the reader may wonder whether something similar has not been attempted before. Indeed, since about two decades there exists an active research community within the domain of complex systems. This includes organizations such as the *Santa Fe Institute for the Sciences of Complexity* (SFI), the *New England Complex Systems Institute* (NECSI), the European *Complex Systems Society* (CSS), the UK-based *Complexity Society*, and the *Center for the Study of Complex Systems* (CSCS) at the University of Michigan. We will now summarize the features that distinguish our approach from these others.

- integration of very diverse concepts and theories

While most complexity researchers start from a particular theory or paradigm, such as non-linear dynamical systems, networks, or complex adaptive systems, we wish to take into account an as broad as possible range of potentially relevant theories, concepts and approaches. These should include at least: general systems theory, cybernetics, self-organization, systems dynamics, chaos theory, complex adaptive systems, multi-agent systems, evolution of complexity, artificial intelligence, collective intelligence, and distributed cognition.

Synthesizing such a diverse array of specialized approaches is a challenge. But in our experience up to now, if you analyse the underlying ideas deeply enough, you will find remarkable similarities in their underlying way of thinking. Our goal then is to make these shared concepts and principles come out clearly, by developing a consistent terminology, proposing clear definitions, pointing out the relationships between hitherto separate ideas, and thus weaving them all into a coherent conceptual system.

- in a way understandable by non-specialists

It will not surprise anybody if we note that typical applications of complexity science are abstract, technical and difficult to understand. Models and simulations of complex systems mostly rely on specialized terminology, formal methods and advanced mathematics. If you want to predict and control the behavior of a specific system as accurately as possible, such complex modeling techniques seem to be unavoidable.

However, prediction and control are often not only not necessary, they may be intrinsically impossible. The full complexity of biological, social or psychological systems simply cannot be captured by exact, quantitative models (although they of course may illuminate important aspects). In those circumstances, we should better aim for *understanding* and *management*, rather than *prediction* and *control*. Understanding a system does not mean that you know precisely what it will do next. It means that, if something happens, you will not be taken by surprise; you will know what it means, and therefore be prepared to react appropriately. This is what we call “navigating” complexity: you may not know exactly what you will find on your journey, but you have a general sense of direction; moreover, whatever you encounter, you will know how to deal with it because you can situate it within the larger scheme of things.

To achieve such understanding, you do not need complicated technical models, but basic and general concepts. Most of the fundamental concepts of complexity science are in essence simple, and can be explained by means of concrete, intuitive examples that everybody understands. For example, some of these concepts are “agent”, which is a generalization of our intuitive notion of somebody who acts in order to achieve a goal, “fitness”, which refers to the ability to function successfully in a given environment, and the “butterfly effect”, which is a more precise expression of the well-known observation that small causes can have large effects. We plan to further reformulate all the most important concepts of complexity science by means of such intuitive explanations. This will allow intelligent laypeople to understand the essence of this new scientific perspective—without the need for years of specialized study.

- applicable to everyday life

Most research in complexity science is focused on highly technical applications, such as self-organizing swarms of robotic agents. While such applications may be interesting and potentially useful, they tend be far removed from the daily problems that we have to deal with in work and personal life. Yet, these real-life issues are just as pressing, complex and dynamic, if not more so, than the highly technical projects that tend to attract most funding.

The institute we envisage will focus first of all on these real-world problems as experienced by individuals and organizations. These issues include learning to deal with information overload, effectively managing the ever changing knowledge, showing true leadership in uncertain circumstances, fostering sustainable innovation, creating efficient institutions to coordinate individual activities, building more robust and adaptive organizations, and devising a workable system of governance for the global economy and ecosystem.

These problems typically cannot be tackled by mere technical advances or sophisticated gadgets: they require understanding how general patterns emerge from a multitude of interacting factors. While a few complexity theorists have started addressing such problems[3], their recommendations as yet remain rather vague and disconnected. However, progress in complexity theory is swift, and therefore we may hope to advance substantially beyond these first attempts. Developing concrete strategies to tackle real-world problems will be our most important and difficult challenge.

Notes

[1] Schwartz, B. 2005. The paradox of choice: Why more is less. Harper Perennial.
Geyer, F. 1994. Alienation, participation and increasing societal complexity. Kybernetes 23: 10-34.

[2] Waldrop, M. M. 1992. Complexity: The Emerging Science at the Edge of Order and Chaos. New York.
Holland, J. H. 1996. Hidden order: How adaptation builds complexity. Addison Wesley Publishing Company.
Mainzer, K. 2007. Thinking in Complexity: the Complex Dynamics of Matter, Mind and Mankind. Springer.

3 e.g. A. Battram (1996): Navigating Complexity: The Essential Guide to Complexity Theory in Business and Management.
R. Axelrod & M. Cohen (1999): Harnessing Complexity: Organizational Implications of a Scientific Frontier.
Y. Bar-Yam (2004): Making Things Work: Solving Complex Problems in a Complex World