

***I am convinced that the nations and people who master the new sciences of complexity will become the economic, cultural, and political superpowers of the next century.***

***Heinz Pagels, The Dreams  
of Reason***

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# I

## Entering the Intelligence Era

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*This chapter introduces some significant changes taking place in the world that are affecting all categories of human organizations, as well as all individuals. The appropriateness, importance and exploitation of certain properties of Chaos and Complexity Theory are also examined briefly. Human systems are recognized as complex adaptive systems. In particular, the fact that the edge of chaos is an unexplored space embedded with new opportunities is highlighted. This observation and recognition indicates that a recalibration of understanding is essential. A change in era and mindset is also inevitable. The new era is the intelligence era. The primary focus of the new mindset is to organize around human intrinsic intelligence.*

**Key Words:** Chaos; Complexity Theory; complex adaptive systems (CAS); edge of chaos; intelligence era; organizing around intelligence; raplexity; intelligence paradigm; biotic structure; connectedness/interconnectedness; cosmic mind; consciousness; complexity; connectivity; dissipation; emergence; complex adaptive dynamic (CAD); deterministic disorder; local center; emergent dynamic; Butterfly Effect; unpredictability; adaptive; self-organizing; Red Queen race; punctuated equilibrium; smarter evolver; emergent strategist; strange attractor; intelligence strategy; evolution; far-from-equilibrium; biosphere (Gaia); complex-adaptive/intelligence mindset.

## 1.1. Introduction

Over the last three decades, the entire world economy has been drifting from a machine-based (Newtonian–Cartesian mindset) setup to an information-based environment. This is a significant recognition that has to be analyzed and comprehended. More recently, certain highly developed economies/nations are in fact directing their attention and resources towards establishing a knowledge-based structure. As the reward for high-value-added knowledge and information-intensive activities is much greater, inevitably in the new millennium, all of humankind is gravitating towards the nucleus of the information era, **the intelligence era**.

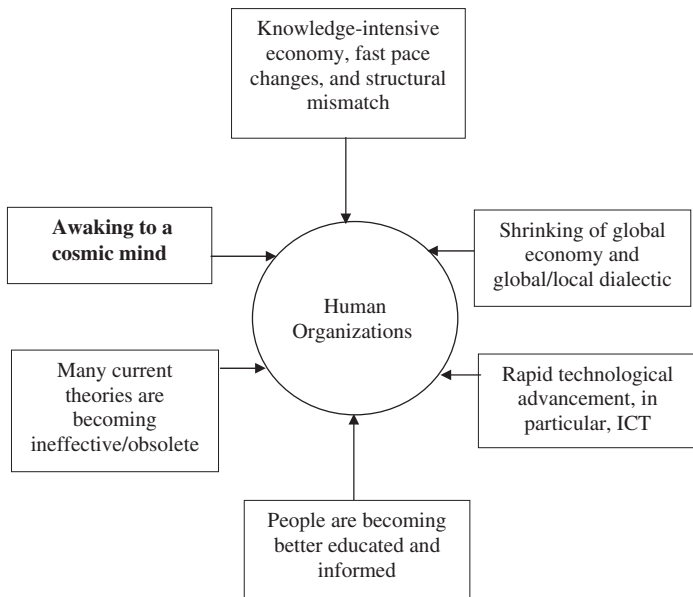
The rampant (rapidity) and enormous (complexity) changes sweeping across the world cannot be dealt with simply by means of superficial cosmetic surgery (rapidity + complexity → **raplexity**). The immense and unprecedented impact experienced requires more than just some ad hoc structural alterations. To accommodate the formidable developments, accumulation of new knowledge and a transformation in mindset is necessary. For all human organizations (businesses, education institutions, military setups, communities, economies, nations), the fundamental change in strategy indicates that **organizing around intrinsic intelligence** (rather than around machines, functions or processes) is the new fascinating focal path. Complexity, evolution and intelligence, and the human thinking systems are new knowledge domains that need to be scrutinized and more optimally exploited. This development leads to the emergence of a **complex-adaptive/intelligence mindset**.

A shift in mindset is an extremely important phenomenon in human history. Such a transformation marks the end of an existing belief and the beginning of a new understanding. It is tantamount to a change in era. The change from a machine mindset to an **intelligence paradigm** indicates that human civilization is entering a new level of consciousness. The higher level of consciousness, if

accomplished, will render certain obscurities explicit. The new understanding will identify new territories for exploration and will lead to fresh opportunities/niches. Eventually, the deeper comprehension of evolution and co-evolution of **complex adaptive (living, intelligence and learning) systems (CAS)** and their composite complex adaptive system (including their **complex adaptive dynamic (CAD)**) will lead to the establishment of a higher order of existence.

### 1.2. Some Major World Changes

In this respect, it is imperative to identify and examine more rigorously the key developments that initiate the above transformation. Some of the crucial events identified to have exerted unprecedented pressure on human civilization are as follows (illustrated in Fig. 1.1):



**Fig. 1.1.** Some major changes affecting humankind and its organizations.

- a. All of human civilization has drifted rather deeply into the information era but many of the socio-economic systems, structured like machines that support the requirements of the industrial era, are still intact. Thus, there exists a glaring mismatch between new visions and the present structure of human organizations. And accomplishing these new visions is difficult, if not impossible. Consequently, compared to biological systems, existing human organizations appear to be semi-paralyzed. A **biotic structure** is therefore more appropriate.
- b. In addition, a global economy has been emerging and competition is no longer confined locally. The global/local dialectic is a new challenge that both individual and organization are experiencing. Being able to adjust to the new perspective is crucial. The rapid pace of the global environmental changes (increasing complexity) is an added area of concern. Comprehending and reacting swiftly to environmental changes has become a universal critical success factor (speed is also associated with the ability to recognize the shortest path). Being able to be environmentally proactive, that is, being able to influence the environment, is a new advantage. Today, many human organizations are still not intelligent enough to act and react in the desired manner.
- c. Next, the rapid advancement of technological developments, in particular, information and communications technology (ICT), has substantially increased the potential of better connectivity. Quality connectivity is a significant property of intelligent systems. Understanding connectivity and establishing well-connected networks spreading across geographical boundaries are new challenges. The present focus on connectivity is very much restricted to the level of the physical structure. Many organizations are still ignorant as to how the connectivity of the deep structure (intangible) can be better established and how virtual team can be nurtured. They are not fully aware of the implications and significance of effective **connectedness (interconnectedness)**.

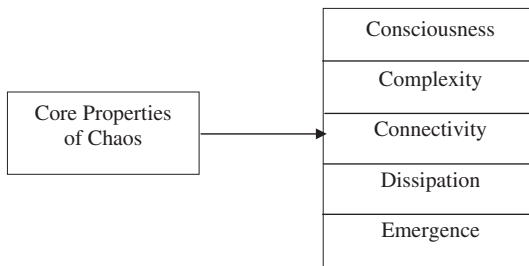
- d. Next, people (especially the younger generations) are also becoming better educated and informed, more so in highly developed countries (more complex and heterogeneous). This is due to better education, the emergence of the e-landscape and the impact of the wireless communication technology. Consequently, their thinking, expectation and outlook in life are different from their ancestors (more simplistic). The organizational dynamic with the younger generations (generation Y and Z) as interacting agents is therefore rather dissimilar. In this respect, they will have to be managed and led rather differently.
- e. Besides, the current economic theories of equilibrium, perfect rationality and decreasing returns are incapable of explaining the highly dynamic global economy. The existing organization and decision theories that concentrate on linear models, such as game theories and business process re-engineering, are also revealing in their inadequacy (for instance the current financial crisis). In general, the expansion and domination of the standard reductionist analytic approach of Newtonian deterministic science is manifesting its limits. Therefore, new scientific concepts in the Einsteinian/Quantum and Complex-Adaptive domains must be used to explore and optimize the socio-economic and political phenomena. Beyond physics, the Quantum-Relativistic and Complexity Theories are still fresh and unexplored knowledge areas.
- f. The sixth and extremely important factor is the **awakening to a cosmic mind** and its nonlinear dynamics. Humankind is beginning to realize and understand that the universe is more a mind than a machine. The human world together with its entire socio-economic and political systems and subsystems, congruous with the natural biological and physical systems, has both linear and nonlinear components. They are complex adaptive systems in which order and complexity co-exist. Such systems consume new information and learn to adapt continuously. It appears that the entire cosmic world and its microcosm, including

all human organizations, are driven by intelligence. In this respect, the universe is a mysterious space embedded with infinite sources of intelligence (including the recent discovery of a huge percentage of dark energy and matter).

### 1.3. Chaos and Complexity Theory

The last factor mentioned above arises from the science of Chaos. This new scientific theory was first recognized and investigated by Edward Lorenz, Stephen Smale, Benoit Mandelbrot and many others in the 1960s and continued into the 1970s (Mitchell Feigenbaum, Philip Marcus, James Yorke and others). Consciousness, complexity, connectivity, dissipation and emergence were identified as the five core properties of this universe and its microcosms (see Fig. 1.2). The first property consciousness (a shift from a machine world to a living world mindset) indicates the significance and presence of intelligence in this universe and the other properties provide a better understanding on the dynamic that is continuously changing in the human world (see Appendix I for more discussion).

A decade later (1980s), the focus was shifted to Complexity Theory, which concentrates on complexity (the deterministic aspect of Chaos), CAS and CAD. The central axiom of the theory

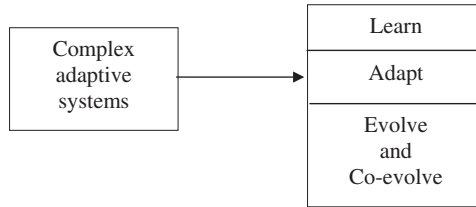


**Fig. 1.2.** The primary set of properties of Chaos.

(encompassing both Chaos and Complexity) is the inseparability of order and complexity, that is, the universe is inherently chaotic and intrinsically orderly at the same time. In addition, from the human perspective, the universe is a tapestry of thought produced by the ability/constraint of the human mind and its sensory system. This realization indicates that the whole of humankind, including its systems and environment, is merely a creation of human consciousness (Heisenberg's Uncertainty Principle).

The primary dynamic of Complexity Theory indicates that order can be reinforced by comprehending and exploiting the latent structure of **deterministic disorder** (complexity). Order is still of fundamental importance in the new context. Order provides the core stability for survival and existence. Certain types of order must be further strengthened and enlarged to prolong the existence of a system. This desire can best be achieved by tapping into the innovation and creativity embedded in the space of unexplored complexity.

The dynamic between order and complexity is intriguing. It is accepted that the universe as a whole is expanding and hence entropy and disorder are increasing at all moments in time. This phenomenon is captured in the Second Law of Thermodynamics. However, in the midst of chaos, countless centers of order emerge, each serving as a **local center** for structure and order of different kinds to be created and enforced. Lives and systems of various forms and levels such as unicellular organisms, human beings, ecosystems and human organizations, are products of this dynamic. All these systems are complex, adaptive and evolutionary in nature. These systems learn, adapt, and evolve in the process. These basic abilities of complex adaptive systems are captured in Fig. 1.3. The **emergent dynamic** of evolution sustains and prolongs the existence of such systems. Systems that fail to maintain this dynamic dissolve into the mainstream expansion and vanish. Such appearing and disappearing acts are taking place perpetually in the universe.



**Fig. 1.3.** The basic characteristics/abilities of complex adaptive systems.

## 1.4. Some Properties of Complex Adaptive Systems

The term **Complex Adaptive Systems (CAS)** is first used by the pioneers at the Santa Fe Institute (SFI) in the early 1990s. SFI was founded in 1984 by George Cowan and seven other scientists mainly from the Los Alamos National Laboratory including Murray Gell-Mann, John Holland, and Doyne Farmer. Subsequently, many prominent researchers from greatly diversified disciplines (Natural Sciences, Computer Science, Economic, Sociology, Anthropology, Archaeology and others) and Nobel Laureates such as Brian Arthur are also attracted to SFI.

A complex adaptive system comprises a group of dynamically interactive and changing heterogeneous agents. It is an open system in perpetual motion. Even a set of rules governing its dynamic are evolving. New information modifies the dynamic of the system as it tries to adapt by **self-organizing** and co-evolving. Its ability to anticipate, respond to, and influence the change in environmental conditions is vital, as a slight variation in initial conditions can lead to a totally unpredictable surface phenomenon. The surface phenomenon may be unpredictable because of the large number of feedback loops in the systems.

Thus, an important property of such systems is the **Butterfly Effect**. Complex adaptive systems can be highly sensitive to initial conditions. As stated above a small variation in initial conditions can

lead to a totally unpredictable output. Lorenz was the first to observe this interesting property during his weather forecasting computation, which renders weather forecasting beyond a few days meaningless. However, comprehending and exploiting the Butterfly Effect is extremely crucial when managing human complex adaptive systems.

Another property of complex adaptive systems is **unpredictability**. The fact that their present state cannot be measured with absolute accuracy is vital (as such systems usually have infinitely large numbers of input points or interacting agents). Besides, their evolution trajectory may not be described accurately. This characteristic exists in human organizations too. As the systems are highly sensitive to initial conditions and yet the present state and developmental path cannot be accurately and completely defined, exact solutions in the form that are commonly understood (with a machine mindset) do not exist. It has a critical impact on prediction or forecasting. This is a significant observation that leaders and managers of human organizations must learn to handle.

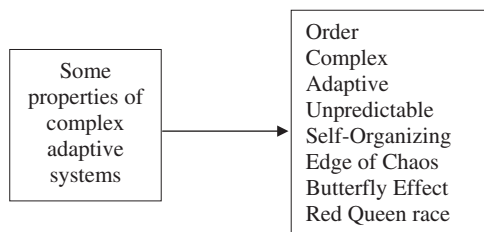
Next, complex adaptive systems are **adaptive**, that is, they continuously consume new information and react on it, if necessary. Such systems learn and evolve. Adaptation is a significant property of such systems, and they can only survive if they undergo dissipation and emergence as well. In addition, complex adaptive systems must co-evolve with the environment. The latter is usually a composite complex adaptive system with respect to the original system. An economy and its businesses, and a nation and its education institutions/schools demonstrate such a relationship.

As stipulated earlier, complex adaptive systems comprise both spaces of order and complexity. These systems possess the ability to exploit complexity to reinforce order with the aim of sustaining and prolonging their existence. Such a system exhibits strange states (to be illustrated again later in the chapter) similar to the

Lorenz attractors. In all human organizations, these spaces of high complexity or the **edge of chaos** (its discovery is credited to Steve Wolfram, Stuart Kauffman, Christopher Langton, Per Bak and Norman Packard: it was Norman who coined the term, edge of chaos) can be embedded with gold nuggets.

Thus, recognizing and exploiting the presence of punctuated points/edge of chaos is extremely significant. Human complex adaptive systems are marked by stasis, a stable pattern of activity lasting for a period of time, and disrupted by short periods of rapid changes, known as punctuation points. **Punctuated equilibrium** makes it difficult for a system that is not adaptive to survive for long. Such a system tends to be complacent during a period of calm and cannot adjust fast enough when the situation turns complex. A highly adaptive system, on the other hand, is always dynamic, innovative, reactive and even proactive. In this respect, a **smart evolver** is an **emergent strategist**.

Finally, complex adaptive systems (as well as their interacting agents) can be locked in a **Red Queen race** (first used by Leigh Van Valen in this context). In this situation a competitive advantage can only be sustained for a very short period. Thus, a niche created does not last long. In such an environment, the approach to survival is to develop continuously temporary advantages. In the Red Queen race, the winners are the faster runners. The winning positions must



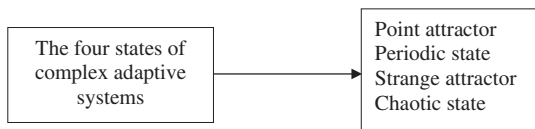
**Fig. 1.4.** Some properties of complex adaptive systems.

be renewed at all times. As there is also no ultimate destination, being trapped in such a situation does not appear to be too pleasant or comfortable. However, the reality is many human life journey is the Red Queen race itself (see Appendix 2). A summary of the common properties is listed in Fig. 1.4.

## 1.5. Managing Complex Adaptive Systems

It is now apparent that a complex adaptive system can have infinitely large numbers of points of crisis, each of them with the ability to magnify small changes, as these points can be highly unstable. The whole situation appears to be highly complex. At first sight, the sensitive dependence on initial conditions and other characteristics observed seem to render long-term forecasting/strategic planning of human organizations totally meaningless. Nothing can be organized and accomplished in such a situation.

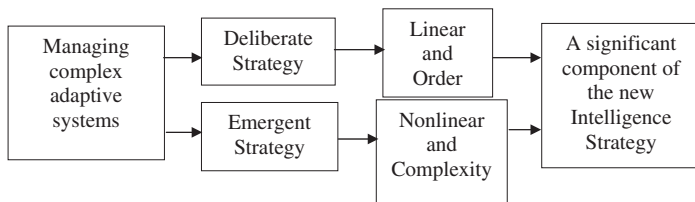
However, when the output states of complex adaptive systems are examined, the perception is modified. Nonlinear complex adaptive systems exhibit only four different output states, namely, stable, periodic, deterministic aperiodic (**strange attractor**), and chaotic states (see Fig. 1.5). The complexity theory concentrates on the third state which is highly complex and yet at the same time deterministic. (The term strange attractor first appears in a paper by David Ruelle and Floris Takens.) In this state, the system is at the edge of chaos. Today, in most human organizations the richness of this state is neither fully understood nor exploited.



**Fig. 1.5.** The four states of complex adaptive systems.

In addition, in reality, the variation in output of many complex adaptive systems tends to be small most of the time, with large fluctuations occurring only occasionally (the power law). This may be a comforting observation. It indicates that for humanity all that have been put in-place throughout history is not totally irrelevant or obsolete. Although a change in mindset is essential, the transformation from the past to the future does have some continuity. But extra caution have to be taken when making the above statement. Destruction/discontinuity occurs at punctuation points. Besides, the current rapidly changing environment indicates that the world and its subsystems are moving into the third state more frequently.

In this respect, to manage complex adaptive systems effectively, fundamentally a combination of deliberate and emergent strategies must be adopted. During the formulation of deliberate strategy, planning is the key function, forecasting is linear, and accuracy is high. However, when disequilibrium sets in, the emergent component, which emphasizes fast (collective) learning, adaptation and evolution, becomes the key approach. In this event, complexity characteristics such as self-organization, bio-diversification and co-evolution become critical. The new integrated approach in strategic management and leadership, as a component of the *intelligence strategy*, is illustrated in Fig. 1.6, is highly important.



**Fig. 1.6.** Intelligence strategy: The new leadership and management approach for handling complex adaptive systems (a basic component).

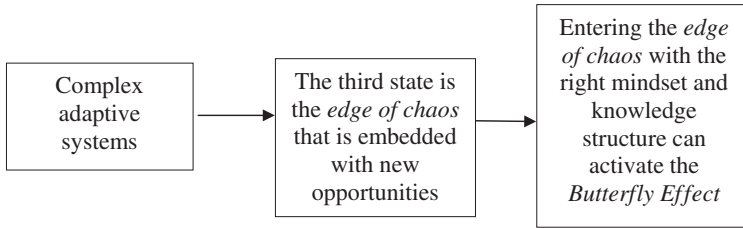
## 1.6. Edge of Chaos: An Unexplored Goldmine

The recognition that human organizations are complex adaptive systems stipulates that Chaos and Complexity Theory are new domains that must be better comprehended and effectively utilized. And in complex adaptive systems, the **edge of chaos** is the most critical territory that must be carefully understood, explored and exploited. This space is embedded with maximum computational capability, maximum information manipulation, maximum fitness, as well as maximum evolvability.

Basically, the human thinking systems must be raised to a higher-level of consciousness where by the nuggets embedded at the edge of chaos can be creatively or innovatively mined. To date, the **edge of chaos** has always been avoided by human organizations because of the higher risk involved, that it is foreign, and the current mindset is not prepared to mine it.

So, what is the **edge of chaos** in the physical and mental perspectives? When does an adaptive system move into such a state? What are its characteristics? The **edge of chaos** (also see Appendix 2) is a space with high complexity. Nonlinearity, complexity and sensitive dependence on initial conditions alone are not enough to create chaotic conditions in a CAS. Chaos develops in nonlinear systems where the elements are also interdependent on one another. Besides, such a system is also **far-from-equilibrium**. Far-from-equilibrium means that the system is constantly changing and not returning to any previous states.

Many human organizations are observed to exhibit all the above characteristics (see Fig. 1.7). Thus, all human systems encompass different types of edge of chaos (for instance, tsunami, a new research and development domain, the environment/state before the disintegration of USSR). When USSR disintegrates, it had moved into the fourth state, the chaotic state, and had gone beyond the



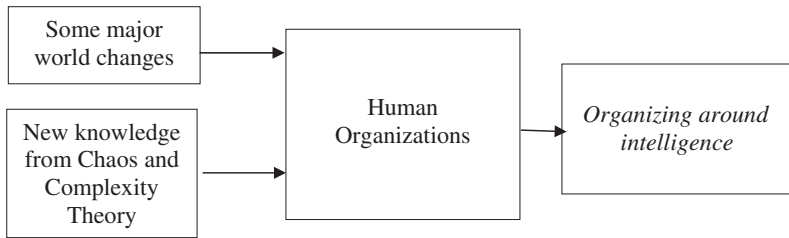
**Fig. 1.7.** Gold nuggets embedded in the edge of chaos can be mined with the right mindset.

edge of chaos. They had not been able to see a surface structure in the space of high complexity and diversity when they were at the **edge of chaos**. They did not manage to strengthen themselves into a more robust structure for better existence. Human systems as they evolve drift into the **edge of chaos** constantly. Those systems that managed to reap some benefits from that space move back to a state with greater order and higher stability. This dynamic is continuous and part of the complex-adaptive scene.

Thus, the exploration and exploitation of the **edge of chaos** requires a redefined mindset with a fresh mental dimension. The human mind must be nurtured to venture into this unexplored, non-linear, complex and also rich territory with a high quality knowledge structure and calmness (will be dealt with again). The organizational (societal, corporate) culture must also be supportive to such an endeavor. As the journey can be haphazard and risk-taking, failure must be accepted with a more positive mindset. It must be taken as a learning process. The reward may be the enormous returns from a small investment when the **Butterfly Effect** is activated.

## 1.7. Conclusion

The above discussion succinctly endorses that the entire **biosphere, Gaia** (Jim Lovelock) and its microcosms, and the artificially



**Fig. 1.8.** The new direction points towards organizing around intelligence.

created human systems (businesses, schools, militaries, communities and nations) are complex and adaptive (living, intelligence and learning). They increase in complexity (for instance, from village to small town to cosmopolitan city) with evolution. Thus, understanding CAS and CAD, and being able to adopt and apply some of the concepts of complexity theory to the management of human organizations are crucial in the knowledge-intensive and fast-changing environment. Apparently, humanity is venturing into the intelligence era. The driving force of the complex adaptive dynamic is intelligence. This fresh comprehension reveals a new direction, a new paradigm that human organizations can be structured, managed and led. ***The new paradigm advocates that organizing around intelligence and nurturing high collective intelligence (the intelligence and complex-adaptive mindset) is the new fundamental principle. Human organizations must be “made” more intelligent (see Fig. 1.8).***