TITULO: **Complexity – summary of main concepts and implications for organizational life**

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The root of complexity, seems to be in the nature of the Universe itself. The Universe seems to have two different and contradictory impulses: One towards chaos and disintegration and the other towards order and organisation. On one hand, each of the elements of nature, strives towards its own individual progress and growth, independently of the rest of nature. This movement, taken to extreme, is the root of chaos, for there is no apparent co-ordination between elements to a common guided evolution. At the same time, there seem to be, in nature, a drive towards organisation and order, as elements group and re-group creating coherent structures.

There is, then, a tension between these two distinct trends in nature: order and chaos. If the system does not have the drive towards chaos – e.g. the impulse to develop, grow and evolve – will die. At the same time, if this evolution is not organised in some way, it will plunge into chaos, making the system unmanageable and destroying itself.

This tension, however, seems to be the fertile ground in which life can create itself. The molecules, even being independent entities, present an example of self-organisation: they interact, get together, organise themselves and thus they create life. Physical and chemical rules, however, regulate the system and provide a framework to this self-organization.

On this thin line between chaos and order that we can call "the edge of chaos" or, more scientifically, bounded stability, lies complexity, a theory that takes us beyond the theory of chaos.

These concepts can be applied to living systems in which many elements interact, but not to the individual elements, because these are properties of the relations that are created among elements and not of elements themselves. Is precisely this internal life that makes the difference between a system that is complex and an individual thing that can be plainly complicated. A single thing can be very complicated in its construction and features, but that still doesn't give it the sort of internal and complex life that characterises a system.

Studying the wrong thing

For centuries, science has been studying each element of the world in order to dissect it and arrive to their basic components: Molecules, atoms, neutrons, protons, etc. This dissection was utterly necessary for us to understand what matter is made of, and what are the potentialities of each of the basic elements of nature, however it failed to explain the way in which systems, and nature as a whole, act and react. Now, that we arrived to discover these basic components of matter, the key is to study how these things interact with each other and what's their complex network of relationships.

The key to understand the world lies not with matter itself but it seems to be a function of how matter organises itself, and of the web of relationships they create. Neurology is a good example of that. We won't understand how memory works by studying the neurones, because memory doesn't depend in neurones themselves, but is a function of the relations between them – what in neurology is called synapses. In most of the cases, we cannot understand a system unless we focus in the connections between elements. In a complex system, a tiny mutation in one of the components can affect the whole system. The DNA chain is a good example: the whole chain can be interpreted as a collection of switches which when turned on or off affect the whole organism. Moreover, the changes in the individual elements produce a « positive feedback » with changes happening in other elements. That creates a sort of « synergetic effect » in which the sum of the parts is more than the whole.

An insufficient assumption

Science was built upon the basic assumption that there's a linear dynamics, a linear cause- effect relationship that can explain the phenomena of the world. Now we are realising what we knew instinctively for ages, that the world is based on « non-linear dynamics ». Life is more a flux than a chain. In economics, for example, all the « linear » classical theories failed to explain the major economic changes of the last decades, because their theoretical frame does not take into account the degree of impredictibility and messiness present in the world of human behaviour. Even if economics is one the clearest example, because of being so based upon human behaviour, we can observe this major failure of the science in many fields. Most of the times social sciences are based upon the expectation of rational behaviours from people. The little problem is that people don't always act rationally. The classic "cetteris paribus" principle (the rest of the variables remain unchanged while we change one of them) is a false of assumption, because a change in one of the components of a complex system will trigger changes in other elements and in the system as a whole.

Nothing that is alive functions linearly. Life always « emerge » from the confusion of the Edge of Chaos, in this zone in which we can see a mixture of messiness, upheaval and spontaneous self-organisation. Complex systems live and thrive on this thin line between order and chaos. There's a certain balance on the edge of chaos, an area in which « Systems never quite lock into place neither dissolve into turbulence ». A balance between enough stability to let the system be self-sustainable and enough creativity to create life. In this balance the systems can be alive, adaptive and learn. They are organised enough to store information but fluid enough to transmit it. A laser beam for example, is in fact a sum of individual light waves that organises itself in a special way. The laser beam is a complex self-organising system, in which the individual waves find a specific way of getting together. Of course the context helps the light beams to self-organise, but the main factor that creates the laser is the drive of the light beams towards self-organisation. The natural tendency of systems in Nature is to become more complex and to self organised as if this

would be the only way in which a system can adapt to the environment and survive.

Complexity in Organizations

Any organization consists of a web of complex relationship in which a one-sided linear approach would fail to understand and explain the phenomena we observe. As in the DNA chain, a tiny change in one of the components of the Community Systems will affect the whole.Usually we tend to focus on each function in itself rather than in the nature of the relations between parts of the system. In organisations, as in nature, life is a flow more than a chain.As in the example described above, the changes in one part of the system create a positive
feedback with changes happening in other components. When we implement a multiple approach in an organisation, by affecting different components of the system with different strategies, we are trying to create this synergetic effect. We aim to produce a sort of chain reaction, that potencies the changes in the whole Community.Our understanding of the Organisation should shift from a collection of discrete programs to a
complex network in which the development in each element has an effect on the others. In Nature, organisms never evolve, they Co-evolve. They prey evolve, and the predator needs to evolve accordingly. In human life the same phenomenon happens and exquisite social and economic webs are formed. Also in the organisational life we can see this type of co-evolution, that needs to be taken into account when planning and organising. This co- evolution is both internal and external (the changes within the organisations can even change the environment as a whole).

Messiness upheaval and self-organisation are indeed the characteristics we can see in a vital organisation. An organisation without that degree of messiness is not vibrant enough to produce meaningful change and learning in a complex world. Many times, we also failed to provoke deep changes, because we assume there will be a linear reaction to our effort, instead of that, we should take into account the « messiness, upheaval and spontaneous self organisation » of the organisational life and not expect immediate effects to specific initiatives.

If we try to over-organise a dynamic complex system – an organisation -, we'd drown its vitality, however if we incentive its dissolution into chaos, the system will loose its identity and will die as such as well. The key is to maintain the appropriate balance. This takes us to the question of how to operate in this kind of systems.

Operating in Complex Systems.

The question is, in first place, whether we can study, understand or predict that kind of systems. Is there a set of rules that allow us to understand and analyse the non-linear dynamics of the complex systems? In the attempts to simulate in

the computer the creation of artificial life, a certain « factor of vitality » was found. An index that measures how much and how fast the cells and the systems change. This vitality factor could explain the dynamism of the system as a whole. (In the experiments, the artificial life was created in the edge of chaos, that is: when the « vitality » factor was in its highest point before the system gets chaotic). We could invent a sort of « Organisation Vitality Index » that would measure how vibrant and healthy an organisation is, in terms of its ability to thrive and grow as a whole in a turbulent environment.

Despite these efforts, still no clear rules have been developed to understand the interactions within complex systems. Still, we can learn some things from the complexity science to manage better our organisations.

In complex systems, life is never created from the top, ei from a sort of Engineer that masterminds it. Instead, it emerges bottom up, from the interactions of the individual components of the system. The brain functions, for example, emerge from the interactions between neurones. In organisations we should be encouraging the emergence of programs and ideas bottom-up.

The key to that is to use this drive of the system towards self-organisation. This drive to self-organisation can be the drive towards growth and adaptability in organisations. Many of the meaningful changes may "emerge" from interaction between team members. The culture of the organisation must provide the framework that facilitates self-organisation as a rapid reaction to changes and threats. In fact, the organisation functions as "fractal structures". A fractal structure is an system in which each sub-system replicates patterns of the whole. In an oak tree, for example, the stem of the leaf is similar to the trunk of the tree, and the veins in the leaf have a pattern that is comparable to the branching from the trunk.An organisation can build on fractal structures to generate a system that can change direction quickly. In a business in which self-similarity of values and beliefs has emerged at all levels and in all areas, effective teams can be assembled very quickly to take advantage of sudden opportunities or handle unexpected threats.

Here another term of biology can be helpful: Autopoiesis. Autopoiesis are the unique set of characteristics that living systems. An autopoietic system is a slef-organising system that creates its own boundaries and reserves and renews itself over time. An organisation leader should encourage his organisation to be autopoietic:
Self bounded: able to distinguish clearly what its business competencies are and are not. As it organises and reorganises. Self regenerating: able to regenerate itself easily by replacing people as they leave and able to add new people and functions as its environment changes. Self perpetuating: capable of developing a strong culture with a self-similar – fractal belief system.

The drive of organisations towards control may many times shallows the power of self- organising systems. There is a vicious cycle that starts when the organisation tries to reinforce command and control: Fear to change engenders

mistrust, which decrease commitment, which limits learning and growth. That creates unhealthy interaction that reinforces the fear and soon.

On the other hand, a leadership based on trust and commitment generates the opposite virtuous cycle: Trust engenders a deeper commitment that enhances an open learning system and start a responsible interaction that generates creativity in the system, that reinforces trust and fortifies the drive towards self-organisation and learning. As is being already suggested, organisations can use the complexity theory to their advantage
by developing this type of self-organising systems. For that, a big cultural change is needed. Every employee needs to be seen – and to think of himself as an autonomous agent in a complex system, agents that see themselves as parts within the organisation co-evolutionary system. Control must be distributed and redefined and the resiliency of the system as a whole should be enhanced. The leadership of such a system should be also different: enhancing self-organisation, reducing the artificial, designated power hierarchy and enabling
natural organisation and leadership. Every self-organising system has also a catalyst, someone that can trigger changes and give the necessary push to self-organisation. That not always can be done by the leader of the team, whose main task will remain to co-ordinate co-evolution. Responding to the linear sciences, many times, change is seen as a cycle: Frozen situation – Crisis that triggers the change – Refreeze. Instead, it should be seen as a flow, as a continuous process that flows along an ever-changing complex reality.

Universities are somewhere else

Understanding organisations in these terms requires an intellectual framework that we lack today. Universities and Schools are generally very conservative places and aren't ready to challenge basic assumptions and to adopt a different approach that puts in the centre the complex nature of social and natural systems.

The creation of the Santa Fe Institute (an experimental scientific institute that tries to re-think science along the complexity models) allowed an interdisciplinary approach to understand sciences from a non-linear perspective. In it, the complexity theory was applied to the generation of knowledge : Get some very talented and smart people together and see what happens ; what kind of theories emerge from the interaction among them. In organisations, we lack this kind of interdisciplinary approach to understand organisations as a whole. In the scientific world there's a need to recreate a sort of « Renaissance man », not over-specialised but understanding systems in an holistic way. May be this is the type of business leaders and consultants we need to have in order to deal with these complex realities. We need to learn to look at organisations in terms of evolution, learning, multiple equilibrium, emergency and complexity.

Although science always took into account cases with an unsteady and not well-defined environment, now that needs to be converted in the centre of its basic assumptions. Evolution doesn't ask whether its context is clearly defined, simply happens.

In that kind of situations we need to settle for the « workable alternative» instead of the « perfect » one, though it may not look very tidy for academics. A « try and error » approach is needed in order to arrive to provoke change that is sustainable in an unsteady equilibrium.

And what with Human Resources Management?

If we can build a continuum that goes from a linear approach to chaos, passing through complexity we can locate our ways of operating in a given area and thus asses our own approach in HR management. Here go two brief examples.

Linear approach Chaos Complexity

Compensation Based on individual achievements and maturity.

Regular adjustments based on nflation and time.

No salary structure at all, individual agreements and random perks.

Team incentives, structure that reinforces interactions among teams and recognizes individual and team commitments.

Career development

Based mainly on maturity.

Progression along salary levels and hierarchical ladder.

Specialisation.

No career planning at all.

Progress made according to random successes in professional assignments.

Horizontal growth, job enrichment.

Balance between specialisation and generalism.

Planning of different careers challenges.

Continuous interdisciplinary training

If we analyse in this way and also take a look at the virtuous and vicious circles that we have in our own HR management we can state what's our "co-evolution fitness level". Since the present paper is not a handbook for implementation, we won't go further in concrete example. However, the main point of these lines is to share a new way of understanding organisations.
Our understanding of organisations is based upon the metaphors we have at our disposal. When men developed machines, we used machines as a metaphor to understand organisations, thus developing a linear, mechanical understanding of organizational process. Now we have the new metaphors that biology and complexity science provide us. May be there is much in there to enrich our understanding and enhance our performance as individuals and as teams.