

**KNOWLEDGE TO MANAGE THE
KNOWLEDGE SOCIETY: COMPLEXITY
AND THE SYSTEMIC CONCEPT OF *CRISIS***

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INTRODUCTION

This article intends to clarify theoretically the concept of *crisis*.

The purpose is to ensure, from a more precise theoretical systemic understanding of the concept of crisis, suitable interventions.

Some scientific issues relating to crises typical of the science of complexity should be *transformed* into culture, knowledge to manage the knowledge society which today still uses the knowledge of the industrial society.

It is not matter of *divulging*, but, rather, of making such concepts usable, for instance, by educators, entrepreneurs, managers, and politicians, by inserting or updating current language with new available meanings corresponding almost to their original scientific meanings.

CRISIS

The term crisis has a wide variety of different possible disciplinary meanings.

A first possible understanding

of the concept of crisis occurs when *within* an on-going process under study one observes the occurrence of events such as anomalies, discontinuities or degenerations.

The original process *deviates* from its path and the sequence of deviations is understood as the process of crisis.

In this regard, within a process one may consider a crisis as a sequence(s) of *changes*, e.g., in the values of a variable over time, considered *negative* as they involve, for instance, degeneration, instability, or collapse and leading, for instance, to malfunctioning, loss of current coherence(s), exhaustion, loss of sustainability, and loss of convergence.

A second possible understanding

of the concept of crisis occurs when single *critical events* take place, having as a consequence the activation of a process of crisis,.

This process of crisis superimposes, perturbs, or even replaces the on-going processes.

When non-stochastic, such subsequent changes constituting a crisis may be sufficiently correlated, coherent to establish a process.

We consider henceforth *crises as processes of crisis* being aftermaths or changes almost correlated.

However, this does not mean that a process of crisis might not lead to a new situation understandable later as a *radical development*, as a *game change*.

Types of crisis from a systemic point of view

We may consider types of crisis as given by their characteristics, for instance, whether they are convergent in different ways e.g., linear, non-linear, or stochastically leading to a final, ideal or real, catastrophic event.

Considering various types of crisis also allows one to better recognise them.

Non autonomous crises: sequences of linear or uncorrelated deviations

We consider here the case where subsequent changes, deviations within current process(es) are linearly correlated. Deviations are linear.

Another case occurs when subsequent changes, deviations within current process(es) constituting the crisis, are *uncorrelated*.

In this case changes or deviations are uncorrelated events, i.e., they constitute only *sequences* and it is not possible to speak of processes.

Crisis as an autonomous process: sequences of correlated changes

An interesting case occurs when the autonomous evolution of crisis processes which are parasitic of the current ones, as considered in the previous case, exhibits *similar characteristics or properties*.

We consider here the case where a crisis consists of subsequent non-linearly *correlated* changes.

Here, deviations, or changes from the hosting dynamics acquire their own specific evolution, e.g., changes may increase in intensity, succeed one another with increasing speed, slow down or acquire non-linear sequences.

Crises as autonomous processes acquire their own identities and forms of independence from the original, hosting, parasitized one(s)

Single or multiple crisis processes may occur, with or without correlations between them, both autonomous and non autonomous.

Autonomous crisis processes may *combine or interfere*, both in linear and non-linear ways, with the hosting process or even superimpose it until, possibly and at different levels, *replacing* it leading to degenerative or transformative transitions.

Autonomous crisis processes may *develop on their own*, acquiring emergent properties.

The term *systemic crisis* refers to cascading effects due to interdependencies in a system, such as those of markets or finance, where the crisis or failure of single entities or clusters of entities can diffuse.

The case of coherence

We consider here the particular case of crisis as an autonomous process when deviations, changes in the hosting dynamics, acquire *coherence*.

A first localised crisis regarding an aspect of the hosting process then affects cascades of other aspects subsequently acquiring their own coherence, e.g., long range correlation, falling into the basin of an attractor, or following power laws.

Conversely, we may consider the case of crisis possessing the *same* coherence of the hosting process, but leading in different ways to the losing of such coherence. Coherence is maintained but in such a decreasing way to lead to its disintegration.

Changes as non-crises, non-processes

It is matter of changes occurring as *unique events*, exhaustive of the entire change rather than activating processes of subsequent changes converging to the final change, such as a catastrophe:

- so-called *intrinsic* or *radical emergence*. Examples include: phase transitions (from water to ice, from paramagnetic to magnetic phases), protein-folding and collective behaviors);
- spontaneous symmetry breaking considered in Quantum Field Theory (acquisition of superconductivity, superfluidity);
- the constitution of morphological catastrophic patterns (due, for instance, to volcanic eruptions and earthquakes);
- the formation of temporary dissipative structures, dynamically *stable* far from equilibrium, due to the dissipation of matter and energy, such as whirlpools and hurricanes.

Symptoms

We distinguish here between crisis processes involving single systems or collective interactive systems establishing communities.

In the case of *single systems*, we may consider the appearance of deviations, *irregularities* in current processes of the system under study.

Correlated irregularities may finally *converge* to a resulting dominating general irregularity having possibly final effects on the hosting process, such as a catastrophe.

In the second case, where collective interactive systems establish *communities*, their correlation properties provide a significant indicator.

It has been found, for instance, that before obvious symptoms of crisis appear within the community, *correlations within that community increase and, at the same time, so does its variance.*

ACTIONS ON CRISES

After the considerations introduced above we can take into account types of intervention having different contextual suitability for the complexity level of the process of crisis under study.

Similarly to complex problems, crisis processes (not always easily distinguishable from the hosting process) should be *managed*, i.e., channelled, hindered, in case induced, influenced, oriented, perturbed, decelerated or accelerated, or varied, rather than *solved*, i.e., converted, removed, stopped, or suspended.

Actions on causes

Causes are intended as being identified in *constructivist* ways, depending on the variables and models considered which are *available* to the observer.

Actions on causes, such as their removal or changing, may have both linear and non-linear *expected* outcomes except when the crisis process becomes autonomous and independent from the initial cause.

When the process of crisis is due to the continuous presence of a cause, then some *regulatory hypotheses* are plausible.

In the following, we briefly mention some possible *reorienting* (as opposed to *regulatory*) approaches when the crisis processes are assumed to have possibly acquired autonomous properties such as having adaptive, reconfiguring, restoring, and self-repairing abilities.

Actions on steps

Local actions on steps of the crisis process usually have *local reparative* purposes.

Supposed regulatory, modifying, and restoring actions on steps are usually the preferred options, being the more intuitive and urgent to deal with current negative effects.

Local modifying interventions may be intended to adjust local values *as if* they came from occasional and unfortunate deviations from the on-going regular processes in the hope of restarting the usual process, activating a *return to normality*.

Actions on dominance

The experimenter should have tools available to detect and reveal the dominant components of the process of crisis, such as *statistical properties* detected using suitable techniques such as Principal Components Analysis(PCA), Recurrence Quantification Analysis (RQA), Multivariate Data Analysis (MDA), Cluster Analysis mentioned above, Principal Component Analysis (PCA), Time-Series Analysis, Pearson Product Moment Correlation Coefficient (PPMCC).

While actions on the dominant one, intended as the *consequent, resulting*, in some way *acquired* one, are expected to have consequent, cascade, and distributed effects, in turn actions on interactions and interference (e.g., environmental by changing the available energy and by inserting noises and perturbations) are expected to have effects on the dominance itself, affecting its occurring and the identification of the dominant process itself.

Actions through antagonistic interventions

The strategy in this case is to *contrast* the process of crisis.

This intervention may have the purpose of weakening, or extinguishing the crisis process with the hypothesis that the crisis *is* the problem, with the purpose of *clearing the field* for the (re-)emerging of other more welcome processes.

Ex. injections of liquidity in weak economies.

The source of the unwanted crisis process may remain unidentified and neglected once made inoffensive.

Otherwise *the strategy is to change the game in some way*, even though the new game cannot be *completely decided nor understood (avoid side effects)*.

Actions through invasive corrective interventions

The strategy in this case is to invasively *change* the crisis process.

The assumption is that the process can be *distinguished* from the original hosting processes.

This simpler, invasive intervention consists of artificial changes on steps of the crisis processes as introduced above.

Possible interventions may be assumed to have *perturbing finalised purposes* such as the start of other contextual contemporary, interfering processes having the desired nature, trying to make them dominant.

Actions through incompatibilities

This approach is conceptually based on possible well-known incompatibilities such as in economy acting on deflation, inflation, increase in interest rates, and increase in employment.

We consider here incompatibilities as possible constraints for the appearance or reduction of degrees of freedom of the processes of crisis.

It is possible to insert incompatibilities, for instance, by suitably changing sequences of steps of the crisis processes *as if* the crisis process were different, e.g., liquidity injections from the desired one (in this case actions on steps are not reparative but finalised to give a different orientation to the crisis process itself).

TYPES OF CRISIS FROM A SYSTEMIC POINT OF VIEW

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Crisis as an autonomous process: sequences of correlated changes

Crises as autonomous processes acquire their own identities and forms of independence from the original, hosting, parasitized one(s)

The case of coherence

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ACTIONS ON CRISES

Actions on causes

Actions on steps

Actions on dominance

Actions through antagonistic interventions

Actions through invasive corrective interventions

Actions through incompatibilities

Thank you!