

# **PROBLEMOLGY A METHODOLOGY FOR THE DISCOVERY AND MANAGEMENT OF COMPLEX PROBLEMS**

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Intellectuals solve problems, genius  
prevents them.  
(Albert Einstein)

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## INTRODUCTION

### The Problem with “problems”

#### 1. Ignorance of problems

Ignoring that one has a problem is probably the worst of all problems.

The first and generally catastrophic consequence of such ignorance is the sudden explosion of a critical situation that seemed in no way predictable.

Of course, in some cases, particularly natural disasters, it is sometimes not possible to foresee the problem in any defined way and precise time. However, even for this type of events (for ex. earthquakes or tidal waves), some general precautions can be very useful.

A good example was the mud avalanche from the colombian volcano Nevado del Ruiz, which some years ago killed more than 20.000 people, as various villages and small towns were buried under a layer of ice and mud various meters deep in just few minutes of time.

Shortly before and considering the potential danger of an impending eruption of the snowed up volcano, somebody urged to evacuate the valley... but nobody decided anything in due time. This could be named Cassandra's syndrome: Impending doom prophets are never popular... and are frequently hated and damned..

Interestingly, two more or less similar cases took place in the Caribbean area, under the menace of the eruption of a volcano. In one case evacuation was decided and took place. In the other case such precaution was not taken. Finally, there was serious trouble in neither case. However in both cases, opinions were divided and either before, or after the respective eruptions each band virulently criticized the other, arguing in one sense or the other.

Indeed, as will be seen further on, the prediction of the possible consequences of some events can be very difficult and debatable. Accordingly, social and political leaders find themselves frequently confronted with awkward dilemma, taking ... or not taking dubious and costly decisions that may be strongly criticized... after the events, and specially by all those who were not burdened with any responsibility.

Situations of this kind also frequently appear in business management and sometimes the choice is only between seemingly lesser or worse evils. Or even, it may be very difficult to know which course of action is really on the safe side.

Until a dangerous situation does materialise, precautionary steps (when they can be taken !) are generally debatable - if not fiercely debated - as they would frequently be very costly. They may sometimes finally appear premature or even unjustified. Managers of all kinds may always be in risk to be “crucified”, rather than glorified.

Anyway, it is always safer for them to ask themselves: Wherefrom could the ill winds start to blow? And when the menace looms, what could and should be done? And could some low costs precautionary measures be taken “just in case of...”?

## **2. Not knowing which is the problem**

This is also a very riskfull situation.

It is the case of a sick person who does not seek, or obtain a proper diagnosis, in which case the situation may become very serious and even turn irreversible.

It could be also the case of a businessman who observes a progressive degradation of the activity of his business and does not understand the deeper causes of the crisis.

The wider causes of these perceptive and managerial deficiencies are explored hereafter.

## **3. After discovering the problem, not being able to discover its causes**

A medical diagnosis remains unconvulsive and generally useless if only the pathological symptoms are described, without an adequate investigation of the deeper causes of the illness. It is for example perfectly possible to attend high blood pressure in itself, but it is much better to find out its causes and try to reduce or eliminate them.

In a similar way, a deep and protracted collapse of sales, or a significant growth of current debt in a business are generally mere symptoms of a less visible crisis. If the deeper causes of the problem are not discovered early and well understood, the situation could easily deteriorate more and more, even if some “cosmetic” measures are taken.

The foreign debt burden, a problem that afflicts many countries, is of the same nature. While it is generally supposed to be a financial, or economic problem, it has frequently much more deeper roots. It can be the result of ill management of the national budget, due for instance to inefficiency in the allocation of resources, or corruption, or squandering in “prestige” projects of dubious value, or even outright fraud or theft.

And, ultimately, the “causes of the causes” are frequently of cultural, ethical and, or ideological nature. As such, they are difficult to investigate and evaluate, because they are generally concealed behind inconsistent, demagogical, obfuscating or interested discourses, collective illusions, which can even be sometimes mutually contradictory..

An apt management of real situations implies in fact the ability to cross through a more or less dense mist or thicket of pretenses and appearances.

## **4. Not being able to circumscribe the problem within clear limits**

This is a consequence of the former problem

While a correct diagnosis is an absolute prerequisite, two more complementary conditions for efficiency are needed.

Corrections, reforms or amendments should not merely be a mere patching up, ignoring the deeper causes of the unsatisfactory state of affairs. On the contrary, such superficial tinkering most generally aggravates the trouble.

Neither ill-conceived or ill-applied corrections implying new risks should be introduced, or at least and in extreme cases or highly critical circumstances, tentative and possibly dubious action should not be taken without a careful evaluation of its possible drawbacks.

This relates to the well known costs-benefits model. But this model implies in itself not only physical, material or economic values, specially in critical cases in which human lives - sometimes many of them - are endangered.

Moreover, values are personal, even if founded and accepted in a specific culture, and even at specific moments in a culture (as for example in war time or during a revolution).. Of course, in decisive moments, previous training and personal bravery and character become many times the decisive assets.

However, even so, valuations may always be questionable because, in many cases, they imply subjective appreciations not clearly justified, nor stated... or accepted by other people.

## **5. Running after the problem**

When the deeper nature of a problem is not well understood, there is a serious risk to merely manage its symptoms, and still worse, to manage them one by one, merely when they succesively emerge.

This method - if such “jerky” behavior can be called a “method “ at all - does not normally produce useful results. It usually and merely displaces the difficulty or, in cases, it complicates still more the situation. Moreover, it may sometimes lead to the useless squandering of valuable, and sometimes crucial, resources.

Unfortunately, this behavior is quite universal. Proof of this is that specific terms exist in many languages to describe it:

- in english: “tinker”, “tinkering”
- in french: “chipoter”, “bricoler”
- in spanish: “emparchar”, “chapupear”
- in german : “stümperen”
- in dutch: “knutselen”, “knoeien”

## **WHAT IS A COMPLEX PROBLEM ?**

### Definitions

#### What do we call a “problem” ?

What we do perceive as a “problem” - personally, or as members of a group - is some situation which we view as damaging, harmful (to us !, even if useful for other people), or could become so in one or another way, in some sense, at some time.

This generally implies an evaluation in accordance to our personal expectations and criteria about “good” or “bad”... which is of course mostly subjective and not necessarily shared by all others participants in the situation.

Moreover, something may be “good” in one case and not so good in another more or less similar one.

Accordingly, we need a way to evaluate our own criteria about “good”, “useful”, “bad”, “dangerous”, etc... that should as far as possible be free from our own prejudices, illusions (optimism versus pessimism, for example), irrational wishes or desires, personal interests, clans or political parties, ideologies, etc...

Obviously, all these conditions are quite demanding ... and most frequently ignored.

### **What do we call a “complex problem” ?**

It is any more or less conflictive situation - be it clearly perceived or not - in which numerous elements take part, and interact through multiple and varying processes in one or various entities during a more or less extended period.

In a complex situation, or problem, numerous different causes, of variable weight are continuously breaking lineal and simple cause-effect sequences. These are replaced by a number of simultaneous complex non-lineal reverberating retroactions, i.e. multiple and more or less interconnected cybernetic feedbacks. Such a situation is difficult to understand, and is even frequently not clearly perceived.

Its clearer understanding can be obtained from specific models, for example using Ricardo Rodriguez Ulloa’s Soft systems dynamics, which inserts Forrester’s Systems Dynamics into the psycho-social environmental conditions, that Forrester forgot to bother with.

Of course, the fact that some problem is not soundly perceived, specially by those who should take charge of it, makes it generally more critical and hasardous.

Moreover, a frequent and dangerous characteristic of complex problems is that they use to explode suddenly, in a surpressive way, after a long incubation, invisible to the eyes and minds of the many.

Farsighted people remain generally unheeded, or seen as tiresome pessimists and sometimes marginated, ridiculed, or even harassed or persecuted. This could be labelled as the “Cassandra syndrome”, in remembrance of the hapless Troyan prophetess.

### **How to distinguish a complex problem from a simple one**

Simple problems can be described as corresponding to a *simple causal chain*, whose characteristics are:

- a well defined cause produces always a well defined effect
- such a cause is normally unique and can be clearly distinguished from all environmental circumstances.
- the same cause will produce the same effect in the same circumstances (this is the “...et ceteris paribus” condition)
- normally, suppressing the cause, the effect can be eliminated

This type of problems is in most cases more or less easy to solve. It corresponds to a causal strictly lineal determinism, or to a functional dynamics of direct proportionality. An example could be regulating the flow of a tap.

On the contrary, complex problems characteristics are partly, or completely different from the former ones. They are related to evolving situations and conditions:

- in which, in a process, some effect may at some time modify the cause, which however remains active (this being a cybernetic feedback);

- proper to a network of numerous elements in multiple interactions, variable as well as simultaneous, and of unequal propagation in space and time.

Such processes respond to a general complex determinism (i.e. non-linear) and mostly lead to effects difficult to foresee. In fact, the mix of many interfering causes can take place in a great variety of ways and in many different places and times.

A good example is the volatility of petroleum's price, that obeys to multiple direct and indirect causes, related to multiple political and economic agents, and simultaneously triggers multiple different effects, in a variety of places, and any moment, but also sometimes indirectly and much later on.

Another somewhat similar case is the future of Internet, whose development and consequences seem to be still wide open.

Moreover, some seemingly simple problems may easily be mere symptoms of some latent or emerging wider one, neither yet obvious, nor well understood.

Whatever the case, an early perception of the problem and its understanding, as complete and clear as possible, are the pre-conditions of any efficient action.

## **Perception of complex problems**

### **Complex natural situations: Some examples**

Complex situations always existed in history. Some became "problems" when men and cultures became entrapped in them... or even created them through ignorance or misunderstanding.

Archaic minded people were generally surprised, dismayed or terrified when confronted to unusual, strange, powerful and frequently disastrous natural phenomena or events. When finding themselves without any obvious rational causal understanding, they tended to seek, and invent mythical supposed explanations. In many cases, they believed the trouble to be a result of their own misbehavior, and a god-willed retribution.

Hereafter, some examples.

#### **1. Massive migratory locusts flights**

This has been since a remote past a more or less periodical devastating plague - in the Middle East, in Africa and in East Asia. Let us remember that, according to the Bible, it was one of the seven plagues inflicted by Yaveh on the Egyptians.

In fact, the real natural mechanism of the shaping of these massive flights was discovered during the first half of the 20th. C. (by the south-african entomologist Uvarov and his belgian colleague Brédo, in Zambia, Zimbabwe and south-eastern Congo). Only then did it become possible to design and apply efficient biological controls... when these were not hindered or obstructed by political, financial or bureaucratic factors... these modern plagues, (mostly) unknown in the Bible.

## **2. Great pandemics**

Historical examples have been cholera and the bubonic plague. And nowadays, AIDS has swiftly turned more or less pandemic. This also the case with the Ebola virus in Africa, and the bovine encephalitis in cattle.

The correct management of these complex pathological situations in vegetal, animal and human ecology depends on a very good knowledge of numerous geophysical, biological, economic and social factors.

Even nowadays, the control of epidemics and epizootics remains difficult because it is in need of a very good and complete coordination between many people, practising different disciplines, members of different cultures, speaking different languages and living in many faraway places. Moreover, such a coordination is generally difficult to obtain due to a variety of mental and psychological orientations and biases and also, frequently, because of divergent interests proper to a varying number of pressure groups.

This explains why many problems run out of control, as a result of belatedly action.

## **3. The great oceanic transgressions, as for example “El Niño” in the south-west Pacific ocean area.**

Only in recent years a better knowledge of the mechanics of oceanic waters circulation has been gathered. And we are still very far to obtain an adequate and complete previsibility of its multiple indirect consequences: for instance, droughts in South America, forest fires, great floods in central and south-eastern Brazil and in north-eastern Argentina (i.e. thousands of kilometers away!).

Still less are we able to control all these effects, ... and much less even to reach the very improbable possibility to be able one day to control the main phenomenon itself.

### **A first summary ... and some key question marks**

In short, earthquakes, tidal waves, hurricanes, volcanic eruptions, great plagues... are the consequences of natural processes, mostly at very long term (years, or even centuries), still not well understood and explained and, consequently, very difficult to forecast.

Notwithstanding, it remains obvious that - in all cases - the previous discovery of symptoms of imminent trouble and their interpretation in due time, as well as the understanding of the processes dynamics and their critical thresholds are an absolute must.

Only in this way can we hope to devise the steps that should be taken toward any useful interventions... within the limits of what can be done - or not - with the available resources and at an acceptable cost.

We should thus now state for our own sake some basic question marks, valid for all complex situations;

- How can we observe and state symptoms (normal, or abnormal)?
- Which are the origins of these symptoms?
- Which are the significant processes at work?
- How can we discover and characterize the dynamics of the processes?
- How can we discover the critical thresholds in the processes?
- Which are the triggers of the processes?
- How do they act?
- Which are the causes-effects sequences in the processes?

These question marks should also be extended to the properly human sides of the processes (i.e. physiological, psychological, cultural, sociological) and to their interferences with the natural processes.

### **Man, a maker of complex problems**

Man, as a result of his intelligence and capacity to apply it to real situations, is the maker of a new class of problems, which could be seen as “artificial”, even if they remain somehow part of nature .

Prehistoric and archaic men could merely introduce some local and limited changes, as for example:

- depletion, or exhaustion of a not very extended zone of hunting or extensive harvesting of some useful plants. This could be seen until very recently in Central Africa as practised by semi-nomadic groups who were periodically wandering in the equatorial forest or savana in a cyclical and more or less circular way (see note: Ecological use of soil by natives in Central Africa)

- periodic burning - sometimes catastrophically running out of control - of some forestal zone in order to obtain an area for cultivation.

- More or less extended soil erosion due to excessive pasturing by an excessive number of cows or goats.

In more recent history - Antiquity and medieval times - men acquired somewhat more powerful technical means and could thus create quite serious and extended problems for themselves, even sometimes in a permanent way, as for instance:

- Erosion and partial desertization of quite extended zones in the Middle East. A well known case has been the destruction of the cedar woods of Lebanon, used for shipbuilding.

- Desorganization and fall of empires due at least partly to the lack of understanding of the limits of available material resources and of the need for maintaining organizational and administrative coherence in highly complex and diversified political and social structures .

- Ignorance of the transcultural conditions of relations between conquerors and conquered. This problem was probably the basic general cause of the downfall of european colonial empires during the 20th Century.

In our own time, man - with his extraordinary technical progress and his explosive demographic expansion - is a prolific shaper of all kinds of complex problems

Some of these are becoming really and massively overbearing and more and more difficult to control and manage. This is mainly a result of two interrelated factors which, since the 19th Century grew at an accelerated pace.

The first one was a wave of great scientific discoveries, mainly in physics and chemistry, with momentous possibilities for practical applications.

The second one was the exponential growth of fossil fuels use, as a concentrated source of energy, at first coal and more recently oil and natural gas. We thus acquired a matchless transformation power on nature, without any comparison in the whole history of humanity.

We are however still far from any good understanding (and even perception!) of many of the unwanted results, nor of the many new problems that we thus generate. Particularly significant are the growing instabilities triggered by these extreme growth dynamics, as they acquire their own momentum. In most cases, we behave like unsophisticated check

players in our supposedly clever way of handling that natural environment on which we do absolutely depend.

### **Four paradigmatic cases**

#### **1. The creation of a new pharmaceutical product**

In 1960, such a process normally required about 2 years of laboratory work and an investment of around 500.000 pounds. In 1985, it needed by and large 8 years and some 30 millions pounds. A similar evolution is still taking place.

The difference results from growing technical complexity of basic research, and from the evermore demanding process of production development, legal approval and marketing. Moreover, very serious problems can emerge, even after a thorough trial process, and even sometimes after quite a long period of use. A well known example has been the one of talidomid in the 1980's. This medical product, administered to pregnant women, was after various years identified as the cause of very grave malformations in newborn babies.

Such a disaster can affect thousands of patients, involve and complicate many doctors and biochemists, private and public enterprises, public sanitary administration and also a wide public opinion, justice and the press. And, of course, the implicated enterprise generally suffers enormous losses and the dire effects of negative publicity, which are very difficult and costly to reverse.

Moreover, the growing costs and the profitability expectations lead to higher selling prices and discriminate the low resources populations of the world. A perverse consequence is that pharmaceutical companies may be reluctant to invest strongly in new medical products mainly directed at third world populations, considered as probably unable to pay any remunerative price.

#### **2. Fighting malaria and the vector mosquito.**

In many parts this is now a very difficult and may even be an hopeless endeavour.

While the anopheles mosquito becomes resistant to one after the other insecticide, the plasmodium falciparum parasite that causes malaria, acquired resistance to successive anti-paludic medicaments.

The unhappy result of this unexpected experience of darwinian selection is that we bred the "super-mosquito" as the carrier of the "super-plasmodium". And of course, malaria is constantly on its way to reconquer the ground lost in every continent. It is an on-going war, that, possibly, can never be won, once and for all.

Many similar effects have been witnessed or are in the making in the struggle against a number of other pests and pathogens. The Koch tuberculosis agent, or the stafilococcus aureus, as a pathogenic evolved hospital bacteria, are other examples of this type of problems.

#### **3. The shipwreck of the "Herald of Free Enterprise"**

This was a ferry ship that sank many years ago, some few minutes after leaving the belgian harbour of Zeebrugge, on its way to England. Tens of lives were lost in this unexpected and quite sudden shipwreck. The subsequent inquiry demonstrated that the disaster had been a result of incorrect operative processes: After boarding the vehicles through a wide back ramp that could be opened for the purpose, some ferries were sailing into open sea before having completed the rise and closure of the ramp. This was a way to

save some minutes at every crossing, which of course was the purpose of the shipping company. It is however risky, because - for some accidental and unexpected reason - water may invade the hold ... which is not always well balanced in relation to the freight it carries. Moreover, in any case, some culpable, or scapegoat, can always be discovered, for example the captain, mostly if he perishes in the shipwreck and thus be unable to present his side of the history.

Among other complex problems - not necessarily suddenly catastrophic, but sometimes with slow and deep running economic and social negative consequences - which emerged during the 2nd half of the 20th Century, we may list:

- technical disasters as, among others, the loss of the space ferry "Challenger"; the awful chemical explosion at Bhopal in India; the gas explosion that destroyed a great part of the city of Guadalajara in Mexico and the nuclear catastrophe at Chernobyl. (Already in 1912 the dramatic loss of the "Titanic" was a call of attention whose general meaning was largely ignored)

- the decadence of coal mining in Western Europe (1950-1970)
- the steel making industry crisis, also in Western Europe, confronted to new world wide producers
- the deep crisis of the asbestos mining after the discovery of its ill health effects.

... and of still more general causes of concern:

- the progressive warming of the Earth atmosphere due to massive fossil fuels burning
- the partial destruction of the high atmospheric ozone layer produced by the fluoro- and chloro-carbonated gases emitted by industrial processes

In all these cases, causes are many: Ignorance of unsuspected collateral and after-effects; bad design; inconvenient operative processes; faulty maintenance; erroneous business procedures; defective adaptation to technical innovations; etc...

Also, in most cases, the fortuitous event, or the exceptional sequence of errors which started the crisis or disaster, was merely a circumstantial trigger.

Accordingly, the general mechanism of these sudden, unforeseen and critical transformations should be much more widely monitored and studied.

## **1st Part: HOW DOES A COMPLEX AND POSSIBLY CHALLENGING SITUATION EMERGE AND TAKE SHAPE**

### **Some recent cases**

It is quite interesting to consider how and why some complex situations and so-called "problems" did appear all along the 20th Century. It can be seen that they frequently "silently" and slowly evolved and remained unperceived by great majorities, and even to the sight of some generally far-seeing people.

Of course, complex issues emerge also frequently from growing and progressive interferences between a variety of conditions and factors formerly unconnected because they had not yet reached a critical level or extension of activity.

While many of the effects hereafter mentioned are clearly negative, this should not be taken as a stand against qualitative - and even in many cases quantitative - progress or development. What we really need is a better prognosis of **all** the possible effects of the changes that we introduce in our way of life... and not only those that we seek and would like. It is basically a matter of balance.

### **1st case: The advent and development of the automobile**

In the eighties, it emerged as a baffling hybrid between a cart or a wagon and a strange new invention, the explosion engine using gasoline. In Dutch it was at the time called “snellpaardeloos rijtuig” (“fast vehicle without horses”) ... a curious way to describe a wondrous and somewhat perplexing novelty.

At first it seemed to be merely a very costly “plaything” for dilettantes equipped with a very well provided... or even munificent wallet.

This situation started to evolve when the far-sighted Henri Ford created his famous T model, that transformed the “motorcar” into a tempting consumer good, within the reach of hundred of thousands more or less affluent people and, quickly, tens of millions of them.

Shortly, it can be said that the car, the lorry, the bus and the tractor... and even the motorcycle, changed the way of life and perspectives of the whole humanity in less than a century, ... and altogether the global environmental conditions in every continent.

Within a flash of historical time we witnessed the emergence of a gigantic material infrastructure, worldwide:

- hundred thousands miles of paved highways;
- big factories, repair shops and networks of licences;
- oilwells, tankers, gas and oil pipe-lines, oil and gas tanks, petrol and gas pumps;
- registration offices and technical control shops;
- traffic lights and parking places
- new general rules and codes related to the uses of newly defined public space

Of course all these new infrastructures developments created jobs for people by the millions:

- engineers, mechanics, workers in the great factories as well as in repair shops;
- a wide array of administrative office workers for vehicles registration, drivers licensing, taxation and control;
- traffic policemen, magistrates specialized in monitoring traffic infringements;
- lawyers specialized in traffic regulations and highway codes.

Many other activities and organizations would never have developed without the enormous growth and ubiquity of all kinds of automotor vehicles: massive tourism, a specific insurance business, peripheral services as roads building, specialized ferry ships (constructed in specialized shipyards), complex equipments for oil extraction, refining and distribution... and of course, generally, anything related to bulk or passengers transportation.

However, the most significant changes are possibly of a second order degree, and have still been much more portentous and less predictable than the direct ones:

- the massive use of any kind of motor vehicles (including airplanes) in wars, with the resulting tactical and strategical innovations... and the enormously destructive power and increased costs of such conflicts;
- the emergence of gigantic - but altogether excessively scattered - urbanized spaces which produce considerable problems of access... and congestion;

- a massive atmospheric pollution and its nearly unavoidable long term effects on the global planetary and regional climates;
- the unexpected and extended political power obtained by some formerly quite insignificant local political leaders in the Middle East;
- the multiple economic and financial problems generated at all scales either by our nowadays universal dependance on fossil fuels, or by the enormous masses of paper money generated as representation of a product that disappears readily and irreversibly when used, leaving mainly negative and more or less permanent effects in its wake.

### **2nd case: The advent of the aircraft**

It is not really necessary elaborate on this other case: It would be quite easy to list a number of direct and indirect effects of air traffic, analogous with those of the terrestrial motor vehicles.

### **3rd case: Computers and Internet**

In less than 30 years, since 1980, the enormous computers constructed after 1945 (ENIAC, Mark IV, etc...), equipped with thousand of fragile diodes have been widely displaced by the small, but ever more powerful personal computer, thanks to transistors and micro-chips. The computing power and the design capacity have been exponentially multiplied, resulting in deep transformations of many professions and businesses and creating a number of new ones. This is a typical case of “creative destruction”, as expressed by Schumpeter.

Moreover, the existence of millions of personal computers worldwide, fostered by the long distance telecommunications led to the emergence of Internet, a planetary web of communication in practically real time among millions of people.

As a result, some unforeseen consequences already surfaced

- the growing worldwide interconnection and unification of all markets
- the possibility to quickly organize planetary nets for political or social action
- the near impossibility of control of these nets by nations-states
- the emergence of a new code of good communication behavior and a new kind of technical standards
- the sudden obsolescence of many traditional techniques and processes
- the radical shortening of amortization periods of many goods and equipments
- an oversaturation of information due to the excessive flow of data and the increasing difficulty to select the really relevant ones.
- the abusive uses of the web (spam mail, viruses, pornography, overbearing propaganda and publicity)
- the progressive dominance of english as a “planetary” language
- the impact of improper diffusion of patents
- the much amplified possibilities for work at a distance
- new ways of doing business

## **MULTIPLICATION OF COMPLEX ISSUES**

A complex issue is basically a set of multiple interconnected “knots” of interrelations among a considerable number of elements.

As already observed, many natural situations respond to this definition.

However until very recently the common human minds were unable to perceive complexity and to relinquish unilateral and simple-minded explanations used for example when trying to cope with individual or collective disasters.

A good example are locust flights: A well understandable chain of causes has always existed, and only local circumstances and conditions were somewhat variable. But, as this was not perceived, nor understood, God's anger was invoqued. And of course this approach never led to any solution.

Nowadays, however, complex problems are multiplying as results of our own collective undertakings and it becomes evermore urgent to understand how and why they emerge

We now discover connexions and interactions formerly ignored or misunderstood and we are becoming more able to integrate them in coherent networks. We discovered for example that, in South East Asia, severe droughts and forest fires are, at least partly, a faraway result of the Niño events in the Pacific Ocean... which altogether triggers also numerous climatic disturbances in other regions.

On the other hand, our human species, fostered in his endeavours by intelligence (Homo faber, managed by Homo sapiens... or supposedly so) created and still creates in an ever accelerated way, innumerable new interrelations between elements formerly unconnected.

The history of the motor car is a good example of exponential (or "explosive") complexification.

It has in some sense shrunked space and time of the human activities, but at the same time it has expanded the fabric of economic and social structures to limits that our forefathers could never have imagined as possible.

The systemic view corresponds to the emerging conscience and deepening of our understanding of the portentous transformation of nature that humankind started as if casually.

## **GENERAL CHARACTERISTICS OF COMPLEX PROBLEMS**

The general characteristics already described in the introduction can easily be perceived in the described cases. They may be summarized as follows, as:

### The feedback dynamics of the complex problem generation

- Any man-made complex situation generally emerges from some innovation - technical, in most cases - introduced by one person, or at most by a very reduced group, at first completely unknown.

- The appearance of the innovation does not initially seem to harbinger any kind of deep changes and remains widely ignored by the groups that could be affected later on.... and even by the very innovators themselves.

- The innovation generally spreads slowly... until it catches on, and starts to propagate in an accelerating way, suddenly generating wide embracing and deep transformations, many times over considerable distances. The mathematic study of the dynamics of networks now allows a better understanding of this typical systemic phenomenon, which includes apparently very different processes as for instance rumours diffusion; pandemic propagation of diseases (as for example the recent cases of AIDS and porcine flu); or the explosive expansion of forest fires in many cases by mere wind flying embers; or international stockmarkets panics, etc.

- Through synergies with other factors, the novelty frequently sparks completely unforeseen effects and may invade fields at first sight without any relation to the original one.

- The propagation process in human groups may seem mostly anarchical as a growing and finally enormous number of individuals seem to act on their own, in ways that they deem favourable to their own personal and immediate or short term benefits

- The consequences of the initial events multiply and become highly diversified.

Some seem to us positive and other negative. But the valuation criteria are seldom obvious, clear and generally shared. This can be a recipe for costly errors and the seed of serious conflicts.

- Interferences between the variety of consequences lead to the emergence of new processes, some of them wide ranging and frequently escaping any control by individuals or organized groups, who may find themselves having played the role of sorcerer's apprentices.

- Generally the real nature of the new situations is not easily, nor promptly perceived by a majority of people. Eventual or possible negative consequences remain usually ignored or denied, until they become absolutely obvious, as considerable inconveniences, if not disasters, do take place. Possible positive aspects are also frequently ignored and are thus not exploited.

- Effects - whether useful or damaging - may affect haphazardly some groups and not other ones and can neither be controlled, nor put to good uses.

- When negative effects become obvious, nobody wants to assume any responsibility and still less to pay the costs. Culprits and scapegoats are more easily discovered than useful remedies.

- Frequently, nothing useful is done until the situation becomes critical, and even sometimes irreversible... in which "witch-hunting" may eventually take place.

- When finally, some action is taken, in many cases mere patches are tentatively applied, by trials and errors either because nobody has a clear idea about the nature of the problem, or because the would-be managers are trying to mend things as cheaply as possible..

- In many cases, the true creators of the problem at hand - who are frequently difficult to identify - try to charge the incurred costs of this "progress by trials and errors" to some other people or groups, if not to the collectivity as a whole.

- Finally, a general and automatic re-ordering frequently emerges... and can be damaging in some aspects and for some stakeholders, as a result of the lack of any good previous understanding and well planned decisions.

- Positive or negative consequences become "inheritances" for the following generations, as they may become clearly visible and active only after long time.

The variable and confusing mixes of all these elements and circumstances explain the multiplication of complex problems, their genesis and their escalation.

This historically recent trend is mainly a result of the accelerated technical progress, together with the planet wide demographic explosion; the swift erosion of traditional ethics that formerly tried to control overbearing mercantilism and power lust; and the development of a worldwide terrestrial, maritime and aerial communication network during the 2nd half of the 20th Century.

It seems obvious that we should consider these new emerging higher order phenomena

as a new kind of challenges and seek specific and useful ways to understand and manage them.

## **2nd Part: WHY DON'T WE EASILY PERCEIVE COMPLEX SITUATIONS ?**

### **Mental, psychological and cultural hindrances**

Unconsciously, we remain under the influence of limiting mental and psychological factors which in some cases severely restrict and, or impair our perceptions and understanding. This is still frequently worsened by the deeply ingrained prejudices proper to any culture, as a result of historical conditioning unwittingly and uncritically transmitted to the mass of citizens by public education itself.

### **Mental conditioning**

In the western world cultural sphere, we believe that we have a very wide embracing mental worldview, which however, in fact, remains quite self-limiting under some respects.

Five basic tenets of western approach are as follows:

- Empiricism and practical experimentalism, which imposed themselves very strongly since the end of the Middle Age, in most cases through some specially enlightened spirits:
- Observation of “nature” and eventual applied technology as for instance:
  - Mechanics and architecture, with Leonardo da Vinci, among others,
  - Astronomical observation, with Galileo
  - Mineralogy and mining, with Agricola (original german name Georg Bauer)
  - Anatomy, with Vesalius
- Elaboration of rational theories about specific aspects of “nature”  
(Curiously enough fake rational methodology was practised earlier in some cases as, for instance, in the “Malleus maleficorum”,... a treatise that at the end of the Middle Ages, was supposed to compile “techniques” to discover “witches”)
- A growing use of mathematical abstraction - geometry and, specially algebra - in accelerated development with Fibonacci (Leonardo de Pisa: 1175-1240; Nicolas Oresme (1320-1382); Nicolas de Cusa (1401-1464); François Viète (1540-1603) among many others.
- Logical reductionism, introduced by René Descartes (1596-1650), i.e. the way to divide for the sake of methodical simplicity, the study of the more complex situations and entities, into more manageable reduced parts.

Combining these diverse trends, it became possible to clearly specify methods and models leading to the privileged study of some subjects ... but also of course to neglect and indifference unto others. Desarticulating complexity allows for the better understanding of many causal sequences, but may somehow obscure the perception of many simultaneous interrelations. This lead to a definition of the scope of research by limiting the mode and type of research considered legitimate, or at least acceptable as practically manageable..

This can be seen clearly in some prescriptions of the rational methodology as established by Descartes and his successors:

- "... considering all other conditions as remaining equal", a very restrictive - and sometimes misleading - way for the practical study of many situations;
- "... neglecting non-linearities" ... which however characterise practically all complex situations including various feedbacks, generally acting in an interactive way
- Newton's and Leibniz use of the concept of limit in infinitesimal calculus, whose results must also be used with caution.
- the unending search for some "theory of everything", introduced by Laplace and aiming at some kind of "true", complete and universal scientific knowledge of the cosmos as a whole and of its "parts" (supposedly without any need for any "God hypothesis", in the famous answer of Laplace to Emperor Napoleon, who asked him about the place of God in his theory: "Sire, je n'ai pas besoin de cette hypothèse!").

The global result of this worldview ("Weltanschauung", in the more eloquent German word) is our wide and selective mental blindness about some types of problems, and more specifically the hypercomplex ones.

Most of us remain mired in a tangle of enmeshed situations that we are unable to clearly perceive, and still less to understand. We run behind the events without knowing what to do, why, and how or when; or merely trying tentative reactions or makeshift improvisations. Some illuminists may advocate ideological pseudo-solutions devoid of any well-founded grounds and, still worse, start to denounce some supposed culprits.

If some of them secure enough power, they may become socially very dangerous - even in good faith - because of the serious mistakes they can make through ignorance or misunderstanding of the real roots of the problems they pretend to solve.

### **Socio-cultural conditionings**

The worldly dominant culture is still the Western one, for now mainly in its North-American and European version. With some resistances and variations it also rules in Latin America, in Australia and widely influences great regions of Asia and Africa.

Some of its aspects explain, at least in some measure, the genesis of many complex economic, social and political situations ... but also the near invisibility or insights into these for the great majorities.

The Occidental ideology is rooted in the Christian will of transcendence, specially in its Protestant form. One has to "strive", to be "meritorious", even "virtuous" in order to become worthy of the future celestial paradise, even if the nature of the needed "merits" may be controversial, according to age, class, education, learning, activities, etc...

This existential stance is deeply at variance to the Buddhist one, for example, whose basic aim is to escape from the dreaded "wheel of reincarnations", through meditation and abstraction from the vain glories and heavy pains of this world.

It also deeply differs from the view of numerous archaic groups who somehow perceived the necessity to maintain themselves in a sustainable equilibrium within their environment and translated this feeling in placating and propitiating rituals.

Samewise, it is foreign to the attitude proper to the Western culture, obviously derived from the Christian sacred scriptures: ... "God gave the Earth in inheritance to his people and instructed them to "grow and multiply". Accordingly Westerners believe themselves to be the "owners" of this planet and its "conquest" has been considered as a justified and even a virtuous and glorious endeavour.

As a result, our respect and care of our environment has quite a low priority in our daily behavior and way of living, since we became quite unable to distinguish between use and abuse of natural resources.

A kind of terrenal transcendence emerged from the progressive laicization of the western world, under the guise of the notion of “progress”. We should however also remember some significant antique skeptical greek myths, which so ironically depicted mankind’s follies . as for example, the history of Prometheus, the one who “thinks before”, the herald and optimistically unwitty iniciator of supposedly always happy futures... and next, his brother Epimetheus, the one who “thinks after” acting, who married Pandora, the girl whose small box contained all the ills of the world and would never have been opened if not for the insistence of unwise Epimetheus.

Later on, and in a different cultural perspective, for European Protestants self-serving good conscience, material success even became a proof of God’s benevolence. So, the myth, through Prometheus, doctor Faust and other similar incarnations led us to beliefs according to which: “Knowledge is power” (to do what?), “Through science, everything is possible” (including the nuclear bomb); “There are no limits to science”, or “Progress cannot (and should not) be stopped” (whatever its results).

A kind of scientific and technological insolence (similar to the “ubris” of the ancient Greeks) started thus to permeate ever more our societies: A trend emerged to consider necessary and legitimate to do anything that seems practically possible, becoming a kind of psycho-social intoxication.

Many scientists and technicians remain unconscious or indifferent to any possible collateral effects of their business and, particularly those that may result from an abusive and irresponsible use of their discoveries by some profit anxious mercantilists. They merely create “tools” and do not bother about eventual economic or social consequences of their uses, considering that these are not their business.

In fact, this mechanism implies multiple feedbacks, because any innovation in any technical or scientific field generally triggers, soon or later on, more changes in other fields.

Moreover, another chain of feedbacks tends to take shape between science and finance, of course mainly for the benefits of the last. The most easily and generously funded research is the one which seems promising the biggest financial profits, and this is not always necessarily the most useful for society as a whole.

Finally, this basically utilitarian vision becomes so dominant that it also shapes the political management and control of society,... and this frequently through corrupt practice. The system tends finally to perpetuate itself through the most powerful structures of encroaching bureaucracies, rules and ever self-multiplicating (and costly) controls.

Administrative and political theories and models tend to explain and justify the whole system, while in fact such knowledge does not warrant any wide open and global understanding of the general dynamics of events (as frequent unforeseen crisis take nearly everybody, including the self-styled experts, by surprise)

Shortly, our present level of understanding does not warrant any deep wisdom, nor ethical consciousness, nor responsibility, nor good foresight.

Only recently, some fiction writers, essayists and social philosophers, belated heirs to doctors Faust and Frankenstein, started to worry for possible big collective misfortunes. The hypothetic or mythical false steps thus described seem to symbolically express the uneasiness of some far-sighted small social groups who start to watch distrustfully many

scientific, technical, but also political and economic initiatives, widely taken without much care for their possible unforeseen long term effects.

Not less significant is the evolution of concepts.

Historically, a first sequence of technical advances took place during the Middle Ages and until the Renaissance eve, related to the slow development of philosophical rationality. This generated the notion of progress in sciences and techniques, emerging from numerous casual practical betterments in different trades. At the same time, reason was becoming more independent from the sacralized view of life and world.

As an example, Galileo's astronomical lens, associated to Copernic and Kepler's astronomical models, eliminated the traditional Ptolemaic cosmology. This also led to the clear and definitive emancipation of astronomy from astrology. The first one became an evolving science, replacing a kind of immutable and unquestionable credos which variously included mythical beliefs (as for example in Zeus and the Gods assembly in residence at Mount Olympus in the north of Greece). Let us remember that Aristarcos of Samos, this early antique precursor of Copernic and Kepler, was branded as sacrilegious when he dared to propose even no more than a heliocentric model of the "world".

The Cartesian Method, that proposed to study any complex entity by subdividing it into more elemental parts in order to enhance its understanding, was in fact the birth act of modern sciences (please note the plural!).

The invention of a growing number of new instruments for direct observation and measurement was a crucial factor, as it allowed possibilities of direct experimentation in the most diversified domains. Examples are the microscope, the barometer, the thermometer, the chronometer, the vacuum pump.

Thus emerged specialized disciplines and the numerous specific techniques derived from the same.

Two ever more powerful intellectual trends also emerged consequently:

1. Through a kind of centrifugal mental and social explosion, the sciences became more diversified, as the available technical means relentlessly progressed.
2. The techniques derivated from sciences started to subdivide into evermore numerous, but also segregated specialisations, which in turn deeply modified the living conditions of growing masses of people.

Some of the most significant results have been:

- the demographic population explosion at the planetary level, due to the worldwide advances of hygiene and medicine;
- the evermore massive use of non-human nor animal energies;
- the massive diffusion of information and knowledge (genuine, adequate and significant ... or not) by printing and, recently, electronics;
- the extension of waking time (and consequently of study and work possibilities) through general and efficient nocturnal lighting

"Progress" thus acquired a mostly material significance, that became statistically evaluated by all kinds of quantitative indexes of growth.

However an invisible conceptual substratum of this wholesale mental evolution is the silent postulate that available natural resources of all kinds are inexhaustible - being, or not renewable - even if used in an exponentially growing way. Such a mental blindness is a first obstacle to the perception of a basic contradiction, at least in the long run: Any quantitative and geometric or exponential progression should be grounded on the steadiness of its own basic growth conditions... while in fact tending generally to the accelerating destruction of these very conditions.

Another blindspot of our technocratic culture is related to the consequences of scientific and technical relentless specialization. The growing contradictions between many results of the multiple and competing ongoing developments remain ignored until they lead to some dead end.

A good example can be the growing conflicts now emerging among the numerous distinct users of water resources: irrigation, industrial and domestic uses, navigable water courses, hydro-electric energy production, etc...

Another case of conflict is geographic: The uses of waterways in western Europe, as for instance the Rhine waters in Switzerland, France, Germany and the Netherlands had to be carefully regulated by the respective governments and jurisdictions..

A third blindspot is the lack of perception and understanding about the medium and long term results of the savage plundering of the so-called "commons", as for instance in the case of oceanic fishing, or the worldwide uncontrolled destruction of the tropical and equatorial forests.

The implicit belief currently admitted seems to be: "What is common property is nobody's personal property... I can thus use it" (this is the root of what Garret Hardin described as the "Tragedy of the Commons"). Many other examples could be given.

A specially illustrative and significant one is the accelerating disappearance of codfish from the Newfoundland's sea. In this case the three basic causes already mentioned can be readily observed.

Technical progress - the use of sonar to locate the codfish shoals and the use of massive cold storage on ships, combines with specialized processing ships led to a massive increase of "efficiency", i.e. of unrestricted (practically, if not legally) abuse of the resource. Great fleets of modern specialized ships of various countries concurred to the fishing banks and, as the yields markedly increased, the codfish stocks quickly started to dwindle to depletion. Accordingly, the yields started to decrease. Vain explanations were invoked as for example the excessive population of seals (while of course, there were always seals, normally in fluctuating equilibrium with their prey, the codfish).

When the crisis became really acute, canadian fishermen obtained from their government a prohibition of foreign fishing ships. Themselves of course did not consider a limitation of their activity.

Finally, the long term effect of unrestricted plundering settled in: the codfish stocks collapsed and nearly disappeared and the fishing industry was ruined for everybody. At the time, nobody knew if the codfish population would recuperate its former levels in due time ... or if a new ecological equilibrium would settle in definitively in the northwestern Atlantic ocean, possible in favor of other fishes species with or without market value.

Only after such a disaster did the canadian and foreign fishermen became conscious of their own responsibility. The same process has also taken place in other rich fishing seas in different oceans. In the Pacific during long years, ultra-deep fishing nets 32 kilometers

wide have been used to “clean up” the abismal deeps of the whole of its living content, edible or useful in any way, or not, trowing away, dead of course, most of the “useless” creatures.

The only, but universal motive for all this is of course sheer quick profit in purely immediate economic terms, without consideration or understanding for any other possible conditions, limitations or consequences.

Obviously, baring a global vision of all these complex situations, all kinds of inconveniences and disasters will multiply.in accordance to our ever growing material and technical means of action.

On the other hand, ethnical and religious prejudices prevailing in most people and all cultures are also an inordinately efficient barrier against a sound understanding of the deeper nature of complex issues.

In fact, even worse are the consequences of prejudices when widely shared, since they can sometimes completely obnubilate human reason and even sheer decency and humanity in great masses, as well as in dividuals. Numerous historical examples are known of collective massacres generated because of lack of understanding and tolerance of cultural differences, and the resulting intents to destroy the “aliens” through the use of criminal violence.

Some particularly cruel examples have been the medieval hunting of supposed witches and the periodic anti-semitic pogroms. A particularly tragic and nasty case occured during the great world pest pandemics (1347-52) that killed nearly a third of European population in five years, when it was infamously rumoured that the cause was that the Jews had poisoned the drinking water wells..

Another example has been the recurrent massacres between Muslims and Hinduists in India and Pakistan during the second half of the 20th. Century

One of the direst characteristics of these socio-cultural pathological epidemics - any kind of them - is that they spread in the same way as infectious diseases, from person to person and from group to group. This generates a kind of reverse psychological immunology, as it renders victims as well as victimizers absolutely impervious to anything that does not seem to reinforce their closed way of thinking and behaving.

In fact, as stated by Jean Fourastié: “There is something worse than ignorance, and it is ignorance of one’s own ignorance”.

### **Conceptual freezes**

Adhesion to inmutable structural models, without perception of the provisional character of any structures - always necessarily inscribed within adaptive and evolutive transformationes - could be a consequence of the “anatomical” nature of the Cartesian methodology: Dividing difficulties into parts.

Moreover, existing political, economic or cultural structures seem strong to us, even when they are undermined in a not quite obvious manner, due to the not clearly visible erosion of their conditions of permanence.

Another conceptual hindrance, as formerly observed, is our mental difficulty to perceive and understand multiple and simultaneous transformations. Confused by our belief in the necessity to discover “the” cause of some observed change, we have completely forgotten

Aristotle's "material", "formal", "efficient" and "final" causes. This is possibly altogether another consequence of Descartes "Discours de la Méthode" and the progressive development of an excessive reductionist view of functional relationships, as it became very obvious in mathematical analysis as strongly prescribed during the 19th Century, by Fourier for example. Of course and doubtless, analytical method has been and still remains a prodigiously efficient mental tool.

However, really complex situations and processes may lose their essential meaning when we sever - for the sake of supposed simplicity - most of the internal and, or external interactions they may maintain. That which is interesting to us is frequently only a small part of what is really interesting and significant in more embracing terms. Enclosing us in the narrow limits of some simple, but unilateral mechanism, we exclude ourselves from any access to a wider understanding.

This is quite insufficient, unsatisfactory, and sometimes dangerous, when it leads us to merely mechanistic and more or less automatized models of man and societies.

### **Psychological freezes**

We do not easily perceive complex situations or entities because we are psychologically, and even possibly to some extent, physiologically, quite restricted in our abilities to simultaneously manage any number of different sensations or impressions. At any instant, we focus our attention on some specific object, perceived as "central", and thus defining a main perceptive level. In this process, environmental circumstances become components of a mere background, at a more or less unconscious level, until they eventually erupt as a strong perturbation into our momentary center of interest.

This stance was defined as "perceptive intentionality" - i.e. selective attention - by the German psychologist Franz Brentano.

As a result, it becomes quite difficult to us to obtain what could be called "multiple perceptive interconnectivity". It seems also to be the root of cultural differences in perceptive ways. An example is the different ways to represent spatial perspective in the western world (by lines confluent at a skyline), or in far-east cultures (by landscapes successive echelons) (see annex: "Limits to perceptions" figures").

Our western perceptive way makes us elements classifiers and good specialists but seriously limits our ability to embrace whole fields and integrated wholeness. This is obviously the root of many of our misunderstandings and conflicts.

Neither do we very efficiently perceive time, specially historical time. We are not much interested in what happened more or less long time ago, even if it could explain what is happening now. Similarly our future medium or long time horizon does not worry us.

In J.M. Keynes eloquent words: "In the long time, we all will be dead". This, of course, avails exactly to a declaration of no-responsability about our medium and long term heirs.

Even if he himself insisted in the necessity to rein in monetary emission in bonanza times, Keynes' pronouncement has been universally used by pseudo-keynesian economists everywhere to practice a never ending "anti-cyclical" economic policy based on lax monetary creation, thus frequently triggering inflation bouts. We should remember France's king Louis the 15th and his famous "After us, the flies". He was right: many flies feasted on the corpses of the subsequent French Revolution (and napoleonic Empire).

We all are generally “here and now “ people. This makes us very poor “chess players” in complex situations, as we continuously submit to the evanescent impression and the immediate advantage temptation... even if it may be detrimental to our own future. This is also reflected by our lack of interest about the past as the bedrock of the present, as well as our indifference toward the not absolutely immediate future.

This has been quite jockingly described some years ago by an english humorist, who asked: “Why should I be concerned about my descendants ? Did they ever did anything for me ?”. Lacking such a “time-binding” capacity - in the words of Alfred Korzybski - we moreover add to our temporal disconnection, a lack of space- binding in our present with a kind of short-sightedness that condemns us to sheer improvisations, and useless slapdash arrangements, proper to irresponsible tinkerers.

It is interesting to note that the north-american essayist Harold Bloom described this growing incoherence as at least partly a result of universalised merely commercial television, which transforms us into passive visual spectators of a kind of permanent caleidoscopic world movie and deprives us of time to read and pose to reflect about our personal and social historical and cultural settings. Just remember all those many enraptured viewers of all this untranscendent daily fodder of pseudo-events; confusing news with information, and information with knowledgeable understanding.

In this way, we ignore or loose our historical roots and references and will have to learn all the time everything anew by trial and error. Even upper class people sometimes show real deep ignorance, through the guise of appearent superficial and uncriticized information.

This understanding deficit leads us to many seriously mistaken appraisals of our surroundings and circumstances. It hinders our capacity to distinguish appearances from realities and to clearly focus on the true nature of the problems we may have to face.

A good example is the case of a businessman excessive reliance on banking credit, whose interests may become an unsustainable load and lead him to bankrupcy.

Another quite common trap is the psychological recourse to self-justifying explanations for a self-induced problem. As this disguises realities, it becomes conducent to block any correct understanding of the situation and even possibly to try pseudo-solutions that may be as costly as useless.

Of course, the most unfortunate and pernicious psychological trait is the self-denial to confront some unpleasant reality, mostly because of our own prejudices and erroneous views, which again hampers a correct evaluation of any situation and may lead us into some dead-end. An aggravating condition is excessive love for our own opinions. In some rare cases, maintaining our own dissenting views, even against a majority, could be correct. This is however quite infrequent, while going against general consensus is in many cases merely unjustified and risky stubbornness.

However, there are also cases of erroneous consensus, that may persist during long years. A typical socio-economic case of collective short-sightedness - or even blindness! - is about the deeper causes of inflation, i.e. further on than the common technical explanations. Increased salaries, illusory high interests, fantasious over-optimistic budgets that could never be respected, are in fact mere ways to conceal the true socio-political roots of the problem and in most cases make the situation still worse.

Moreover, such anomalous situations, that generates tensions and distortions, frequently lead to parallel or hidden activities, which are self-induced compensating feedbacks, as reactions of some excluded or defrauded socio-economic sectors. This is obviously the

case of informal or more or less clandestine markets in socio-economic systems disturbed by bureaucratic abuses or artificially induced inequalities in the uses of resources.

In even a more general sociological terms, the resurgence of irrational pseudo-sciences and new religious sects in our societies, could be a symptom of the growing inability of most individuals to come to terms with the accelerating changes: “The shock of the future”, in A.Toffler’s words.

What seems to be wanting in all of these cases is an aptitude to evaluate our own evaluations, i.e. our implicate mental and psychological presuppositions, as tooted in our culture.

It is important in this sense to become aware of the psycho-social pressures induced by the prevailing socio-cultural reflexes proper to any specific culture. For this reason, charismatic leaders may become very dangerous for the society they belong to. They can trigger kinds of massive mental avalanches and even collective criminality that we had to witness various times during the 20th. Century.

On the other hand, any transculturated person must learn, understand and take into account in his behavior the deceptive certainties that any culture takes for granted and obvious, and tries to impose to everybody - sometimes by force, if needed. This is, for sure, the deeper meaning of the old popular saying: “In Rome, behave like the Romans” - i.e. “Don’t dare to dissent, if you want to avoid trouble”.

Conversely, most people are not psychologically able to take any distance from their own culture, which can also be a very serious problem. If the “Romans” do not try to understand the ways of the “Barbarians”, they put themselves at risk to be destroyed by them.

In fact, the worst psychological defect is possibly to be unable to perceive the prejudices and defects of one’s own culture, as the result of a sclerosed mental frame, or still worse, through faintheartedness, not wanting or being able to face uncomfortable realities and responsibilities.

A person thus affected becomes unable to manage any complex situation and probably so, in a definitive way. This is most critical if the affected individual is a business or political leader. Anyone who is aware of such a psychological dead-end, should urgently try to give a helping hand or even, in desperate cases, to assume control... or hastily run away. Of course, such a person would frequently be viewed as an unwelcome meddler.

### **A Cure: Mental and psychical re-education**

The first step toward a mental re-education is a re-appraisal of the so-called “facts”.

... And, in turn, the first step in this way is to understand that these so-called “facts” are, to a large extent, mental and psychical constructions. We must of course postulate the obvious existence of a reality external to our own being, in order to avoid non-sensical and self-sterilizing and self-enclosing solipcisms, which would lead us to sheer absurdities.

However, the “facts”, as we register them, are merely products of our nervous system in reaction to our perceptions, as conditioned by a number of physiological factors (H. Maturana and F. Varela). Common examples are our imperfect auditive perceptions (we do not hear infra- or ultra-sounds), or the visual or tactile illusions that sometimes confuse us.

On the other hand, some privileged individuals may acquire much higher refined perceptions than most of us. Renoir knew much more about hues of colours than common

people and the Indian musicians - Ravi Shankar for instance - are able to put to best use subtle ninth of tones harmonics in their Ragas.

Moreover we should take in account the psychological biases described by Merleau-Ponty as “perceptive intentionality”. We nearly always insert the “facts” as we perceive them, within conceptual frames, oriented and constructed according to pre-determined and more or less conscious purposes. This is even the case in scientific work. For example temperature, atmospheric pressure and hygrometric data are used within different frames in meteorology and in climatology, as we insert them in different time scales corresponding to disciplines whose aims and needs are also different.

Shortly, the observational data gather new significance (or lose it) in relation to the ways they are used. They become “information” when interconnected according to some specific projected action. Indeed, the “fact”, as interpreted through our perception, acquires new meanings related to our aims. Thus, only the tentative integration of many data, or “facts”, in various mental frames leads to knowledge, which may in turn lead to effective action, be it useful or not.

This is also true for abstract “facts” as for example national central banks interest rate, exchange rates, or custom tariffs.

Finally, no isolated “fact”, out of context, makes much sense, as reflected by Ortega y Gasset comment on the person: “I am myself,... and my circumstance”. So, “facts” must be, and are registered by specific people in specific moments and places. We need urgently to become aware of this necessary and unavoidable condition in order to understand - once and for all - that any reference to “facts” implies much more than a simple passive and superficial reception of some event or data, devoid of some explicit, or implicit evaluation criteria.

### **Constructing more efficient mental reference frames**

This, in turn, justifies the necessity to create more coherent reference frames and acquiring a corresponding adequate mental technique.

Our reference frames are generally unconscious. They are products of some training or learning, aiming at the instauration of the many simplifying mental - and physical - automatisms we need to more easily overcome the multiple complexities we must face in everyday life. They also correspond to already existing tools and techniques which put us on track in our society... and spare us any need for critical reflexion and wavering when facing situations that can even be dangerous or require urgent action.

However, in such a way, our reference frames tend to solidify and lose a wider adaptive value, in front of eventual unprecedented circumstances and, or, new concepts or knowledge. There is obviously a need for balance between past experience and the management of new challenges.

A clear conscience and a frequent critical renewal of the channels of our thought processes are our only antidotes against sterilised mental automatisms, an incomplete vision of real situations and all kinds of deformations resulting from preconceptions, or unconscious illusions and beliefs. Again, we need to guard ourselves from “the ignorance of our ignorance...” (Jean Fourastié)

Considering the present acceleration in all transformation processes, we need a technique of review and readjustment of our reference frames.

This should include:

- Defining the domain covered by our inquiry, its limits and its environment

- A method for the discovery of all possible significant interrelations within the domain under scrutiny (“What is related to whatever else”).
- Criteria to make sure that nothing important could have been neglected or ignored
- A method for revision of existing frames of references, when new data and, or new internal or external conditions emerge or are introduced.

### **Being distrustful of abstractions and possible hidden resistances**

It is also necessary to remain somewhat distrustful about abstract concepts and models, and still more so when they suddenly crop up without visible and solid grounds.

Theories and formalisms are of course useful in many cases. However, sometimes, a real ignorance, or misunderstanding, or even misrepresentation of the situation under consideration may remain hidden under high sounding abstractions or verbal fireworks.

Even an excellent methodology may not guarantee correct evaluations if misused.

Systems analysis value, for instance, as a useful technique, depends basically of a good previous understanding and appreciation by the analyst, not only of the situation at hand, but also of the needs, wishes, abilities, possibilities and understanding of the “owner of the problem”.

It may even happen that - for some more or less covert reasons or conditions - a very convenient solution for a problem will not be accepted or correctly applied. It is of course debatable if a consultant must necessarily take in account psycho-social aspects of apparently technical or management problems. Still, solutions prescribed without consideration for these seemingly unwarranted aspects may prove useless or even disastrous. And the consultant may find himself discredited by the very organizers of a mess they created themselves.

### **Acquiring the perception of medium and long term change**

A clear differential - but coherently integrated - perception of short, medium and long term perception of changes and adaptations is a fundamental necessity (with clear definitions of what we understand by short, medium and long term)

This is essential to obtain at least a minimum of predictive ability, avoiding crass errors, and consequently making unfortunate and detrimental decisions for short term profit, that could lead later on to great losses or downright disaster.

(to be developed!)

### **Avoiding ideological contagion**

Ideological contagion corresponds to a psychological phenomenon of leaving oneself being dragged along. This can even been witnessed in small groups. J. Warfield, for example, described “clanthink”, while Allport and Postman established a “psychology of rumors”.

Such movements are quite common in masses, wherein individuals seem to near completely lose any use of their own critical reason. These phenomena of psychical polarization, and their frequently tragic consequences were already studied more than one

century back by Gustave Le Bon (French) and Scipio Sighele (Italian) and somewhat later on by Ortega y Gasset (Spaniard). However, and in spite of all warnings, ideological mirages have been triggered and used practically by all the great charismatic leaders of the 20th. century, with the awful consequences that we all know. And, unfortunately, the beginnings of the new millenium seem to produce still more cases of the same collective mental illness.

In such socio-cultural conditions, everyone bears - knowingly or not - his own personal responsibility to maintain his good sense and a true control of his own behavior.

### **Avoiding abusive simplifications**

Not less avoidable is the absolute necessity to distinguish between ideas and ideologies or even mental fads in order to avoid high sounding, but unsubstantial proposals - most importantly when these last contaminate business or administrative systems.

While "common sense" does not necessarily makes good sense, it always usefully allows us to remain close to the "facts", without however leading us to unsound simplifications. Anatol Rappoport, one of the systemic approach leaders, made the point as follows: "Seek simplicity, but distrust it!"

To aptly distinguish ideas from ideology, a reflexive strenghtening of our mental references frames is the best containing wall against irrational psychological pulls, which can lead us easily and by commodity or mental laziness, to believe what is to our liking, rather than face sometimes bitter truths.

### **Some more remarks about gaining knowledge**

Beyond the already mentioned various kinds of limits to perception, it may be useful to consider the positive value of being confronted to widely different points of views.

Anyone who has been in more or less close contact with members of other cultures, does normally vastly enlarges his own references frames.

This is more so when such contacts have practical implications, as for example making some contract with Africans, Moslems or Chinese, or establishing an agency in some other country or continent. Whatever the language used, in any aggreement, convention, treaty or arrangement, any participant, when reading, interpreting, or fulfilling it (or not !), does so in accordance to his own cultural psychology and understanding. As a result, semantic misunderstandings - unconscious, or even deliberately induced - are always a risky possibility, that should never be ignored.

Another potential trap is related to our memory, which is in some cases a very doubtful mirror. It is of course an archive of recollections, one's own and those of many others. It is however, at any moment, only a reduced and selective collection of "facts" (or true or false impressions), not yet forgotten. This archive is, moreover, mostly personal, constructed within the limits of one's own frames of references: Memory is not neutral but, on the contrary selective and interpretative. We use it in fact to maintain our psychological coherence and continuity in our transit from past to future. It is good to remember that the past "facts" had sometimes the same more or less ambiguous meaning as the present ones. They also become less and less verifiable - or directly unverifiable - as time flows on.

(See annexed nota: “The past in our present conscience”)

Altogether, some comments about “natural intelligence”, and our new “artificial intelligence” may be useful.

Of course, the computer does not “learn”, and still less “think” as the human being. It is “programmed”, and “works” in ways that reflect the concepts and the intentions of human producers of the software and the inputs of data collectors. As a result, we should never forget that axiom about “Garbage in, garbage out”: Our computers do not reflect merely our knowledge, but also our errors, and are in no way responsible of, nor do sanctify the dubious interpretations and uses we may give to their outputs. So much should be obvious.

It is however useful to ponder all this, because we could in a near future see new types of computers really able to learn in a more “human” way and, even, who knows, produce a new type of “real” original knowledge. This could lead - and possibly are leading right now - to automata endowed with more and more autonomous behavior and even with a capacity for collective automata social behavior.

Such strange innovations would, for sure, deeply transform our ways to manage human affairs, and.... who knows, having to share somehow our powers with our electronic creatures.

We should also consider the evolutive acceleration (in the words of the french biologist François Meyer), evermore obvious in all fields of human life. This implies that creativity, inventivity and adaptability may come to more and more replace known recipes, hackneyed formula and static certainties.<sup>2</sup>

Not only learning has to become permanent, but even also our psychological and mental personal evolution, requiring continuous rejuvenation of any of us, until and including our old age. (“Every five year, I become another person, even if I seem to be the same one”).

The effective leaders of the future will be those who understand this new condition and know how to adapt to it. Those who can't would become psychological and social living fossils and may, in the end, become an enormous social and cultural deadweight.

### **3rd Part: The SYSTEMIC VISION OF COMPLEX PROBLEMS**

#### **General features of complex problems**

Indifference of the majority of people

Nota: This 3rd part includes some elements of a systemic methodology, while however it is not the aim of the present work to widely develop that subject

Complex problems remain in most cases unperceived by the great majorities. Various causes are at the roots of such mental blindness. The main ones can be listed as follows:

- Most people put their faith in apparently simple solutions. Their motto is the well known formula. “It will be enough to ....” .. Frequently in cases where precisely it will not be “enough to...”.

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<sup>2</sup> Fuschl Group Seminar on “The acceleration of human communities evolution”.

- Many people are overwhelmed by their personal problems, that leave them no time and in no mood to bother with anything else.
- Most people remain indifferent to those events and circumstances occurring outside of their direct and very restricted sight. Many times they outright ignore them... at their own costs
- Many lack the intellectual capacity and the knowledge needed to understand complex situations and tackle them in a useful fashion, even in the very restricted area of their own business. Even so, these ignorants can be clamorous and even vociferous in their opinions and claims.
- Many have not been educated in order to perceive a feeling of ethical and civic responsibility to contribute to the good management of social processes in which they find themselves interested, or are even unwilling or unable to use merely good common sense
- Many are in no mood to collaborate or debate with leaders who they consider - rightly or not - either incompetent, or directly corrupt and dishonest

### **Slow perception**

Complex problems gather frequently in a slow and insidious way. Some may remain latent for long years, or even centuries before turning dangerous or nasty.

As only very few people pay attention to possible trouble in the making and are able to “read” ominous symptoms of economic or social stress, most disasters struck suddenly and in a completely unexpected way.

In the faraway past, old experienced individuals and in some cases, chamans and wizards were at times good at “reading” ominous premonitory “signs” of mishaps in the making, through the lore of some significant ancestrally remembered past events.

But, this kind of wisdom was closely linked to situations, generally natural - but also sometimes socio-cultural as a result of human interactions with the environment - that repeated themselves more or less periodically. (see in annex the curious tale “Mr. Fagès tabac” - which in fact really happened many years ago in Central Africa... and also reveals a case of acute transcultural misunderstanding).

In our time, complex problems are mostly products of our own mistakes.

Moreover, they are frequently new situations, that may mature for long time before exploding. As our technical cultures are much more complex and innovative than the old tribal or traditional ones, we have no knowledgeable “chamans” to toll the bells for us... but only unexperienced ... experts, many times confronted to unexpected messes.

Lacking relevant historical references, our perceptions may moreover be slow and tentative, leading to a protracted and late understanding of critical happenings.

An aggravating factor is that, in some cases, managers in charge try to evade uncomfortable foreboding signals, as the decisions that should be taken are frequently painful, costly and, or politically impopular. In cases, there is even a kind of bet or wager with risk: “Well, probably nothing at all will happen!”, “Let us wait and see”, “This is not really my responsibility”, ...

Moreover, pessimists (described as “prophets of doom”), are generally not listen to, specially among politicians, even when they produce very strong arguments. Even among possible victims, disagreeable and unpleasant predictions are unpopular or seem unbelievable.

## **Human actors and their ways to face complex problems**

The human framework that builds up around any complex situation leads in itself to serious complications.

What is complex does generally involve numerous individuals, who may be - or not - conscious of being enmeshed in a conundrum, being however, in Bela Banathy's apt expression "co-owners", or "stake holders" of the situation, problem or mess at hand.

These multiple participants are generally subdivided in different and heterogeneous groups. The dominant one, of course, gathers those who detain the effective power of decisions and, as such, are able to ignore, or even repress the dissidents (those who differ for conceptual or economic reasons.- or at times, ideological ones)

In many cases, the problem implies a conflict of interests, generally related to the defense of acquired (or sought...) advantages . For instance, potential beneficiaries in the case of a construction of a hydroelectric dam, and people negatively affected, would very probably oppose each others in a severe conflict.

Moreover nearly all of them would ignore or would deny any adverse long term ecological or other effects. Numerous case studies have already made this clear in the most varied situations.

Conflicts among the very beneficiaries may even emerge, if the various expected benefits become conflictive or incompatible. In such cases, a strong temptation appears to serve or save oneself at whatever costs to anyone else.

Among the various interested and intervening groups, differences and oppositions easily surface. Many times these are mainly a result of either shared or incompatible prejudices that may even contradict well conceived interests, as well as a true understanding of the situation and its likely future developments. John Warfield describes this as "Groupthink", and, in its most negative form, "Clanthink", which may lead to the total obfuscation of all perceptions and even to complete inadequacy in decision and action (3).

Those affected by the situation can be mere isolated individuals, or very small groups, facing great collective "actors", not always easy to precisely identificate... or even institutional ones, difficult to contact and sometimes unreceptive and immune to any different views, or superciliously not amenable to any debate at all.

Conversely, in many cases, even outsiders completely alien to the matters at hand, are trying for their own reasons to meddle (or invited to do so), while remaining in a later future utterly detached and aloof from the results of their interventions, or proposals.

A typical example is the so-called consultant, or "expert", appointed by some stakeholder in some considered situation. Such expert, of course, would be mostly sensible to (if not biased by) the intentions and needs of those who hired him... and possibly altogether to the aims (visible, obvious... or hidden) of any organization which happens to support him.

Moreover, in most cases, the consultant is a specialist in some specific kind of projects - for example hydroelectric dams or nuclear power stations - but may be unaware, or even purposely choses to ignore some possibly "uncomfortable" side aspects of the project.

Contractors, in turn, are merely in charge of its practical execution - in a way and price considered satisfactory by the "owner". They consider - rightly ? - that they do not have any other responsibility to bother about.

Great public works are also an excellent hunting ground for financiers who seek to grant big and secure loans, without to take in account the supposed profitability of the projects, always, of course, widely thus proclaimed by their generally most personally interested

sponsors, in economic or political terms. Indeed, their main concern is to charge and cash interests, and even capitalise them ad infinitum, on so-called more or less reconducted “performing loans”. During the Middle-Ages, this was called “usury” and frequently led the slow payers or defaulters to serfdom...

The global result frequently is a confuse cacophony of which the true deciders do not really care, or eventually use to impose their own agenda.

Obviously, these quite different viewpoints do not easily lead to an equanimous and well founded perception of the complex situation. Nor are they useful to discover the eventual symptoms of some mess in the making.

### **The structure of complex problems**

A typical case: the drainage of water in the argentine “Pampa Humeda” (“wet Pampa”, i.e. great central plains)

The “Pampa humeda” includes most of the wide open center of Argentina. It is a depressed zone, in many places even 2 to 5 meters below the sea level. This seriously hinders the drainage of superficial waters, specially during heavy rainy periods, which are frequent in this region. Even, in spring, non permanent lagoons and swamps do appear, but, in normal times disappear during the summer through evaporation.

**(Nota.** There is a curious small pampean fish, called cynolebias which hatches from an egg, grows, matures and spawns during the spring and summer rain season and, before dying, leaves its eggs in the mud that dries up at the end of the rains, awaiting for the next rain season.)

Waters slowly flow from west to east, i.e. toward the South Atlantic Ocean, over hundred of kilometers. During the main rainy season, when rains are abundant, lagoons tend to vastly expand and inundate enormous extensions of grazing pastures and cultivable grounds, whose constant permanence is always somewhat doubtful. The old indian toponimy - hereafter translated - is quite significant about the nature of many of these locations: “big waters”, “lagoon of the ducks”, “where the waters converge” (Chascomus), “inside island” (Guamini), “where there is much water” (Chivilcoy), etc...

The first white colonists adopted in cases for their new towns the indigenous names of the locations, without any understanding of their implicate meaning... which is another interesting case of inadequate transculturation, sometimes resulting in very costly inconvenience, emerging suppressively after very long years of supposed normality of climatic and ecological conditions.

To make easier and accelerate the draining of waters in the Pampa, a complex grid of waterways - some of them various hundred kilometers long - were constructed, east oriented toward the Atlantic ocean. However, during great rainy periods, widely extend floods covering thousand square kilometers of supposedly agricultural land, are common.

In fact, this problem can never be optimally managed -and still less permanently solved - because it depends from irregularly recurrent climatic conditions, that man can never perfectly predict, nor control

Moreover, some unfortunate or ill-conceived human interventions did unwittingly complicate them.

To begin with, long railways had to be established in order to connect Buenos Aikes to coastal south eastern cities like Mar del Plata, Pinamar, Necochea, and to Bahia Blanca. 700 km. to the south.. Later on, long north-south roads for evermore massive vehicular transit were to be added. Moreover, and precisely because of frequent flooding, many of these rail- and motorroads have been constructed on embankments, which, obviously and also in many places, became new obstacles blocking or hindering waterflows, specially in zones ill-connected with the artificial waterways system.

Another problem situation - difficult to precisely evaluate - is the ascent of the subterranean water table. This is believed to be a result of the subterranean draining flow of the massive man-made irrigation grid (from andean waters) in the formerly semi-desertic western plains of the San Juan, San Luis and Mendoza provinces. Moreover, a river that provoked damaging floods in the central province of Cordoba, the Rio Quinto, was also derived toward the pampa plains.

Shortly, human interventions made still more complex an existing natural problem...

In this case history, some deep hidden human psycho-sociological factors of individual or collective decisions, sometimes unconscious or more or less willfully ignored are clearly at work:

- In a recently colonized country, the 19th Century Argentina, the arriving inmigrants had no information, nor knowledge about the long term meteorological and climatic dominant or recurrent conditions. During the second half of the 19th. century, many people acquired vast plots of seemingly optimum agricultural pampean land ... in supposedly normal times.

(A significative, and in retrospect, generally ignored or forgotten testimony of Darwin, when he visited the argentinian pampa is his report on the "arroyo de los huesos", i.e. the "brook of the bones"... a small dried up brook, where hundreds of cows and horses went to seek some last drops of water during a dry spell of three years in the early 19<sup>th</sup> Century, only to die miserably on the spot)

- Every individual, or pressure group, damaged in some way, or seeking some new vantage, presses his own interests, in favour or against some specific project. Very few are aware - or want to take in account - when making arrangements suitable to them, of the negative consequences for others that may result.

- Each branch in public administration, while actively busy to further the projects under its responsibility, and solve its own problems, rarely bothers to coordinate within the wider range of a general planning, nor monitors unforeseen consequences for others of the initiatives it promotes.

It is in such cases that we may more clearly observe these psycho-sociological generally hidden frame of human decisions.

Here we see practically all aspects and every behavior that characterise complex problems. More specifically, the widely dominant short term and limited vision is the most general aspect of the way matters are registered and managed.

Other interesting features can be observed in the foregoing examples.

The structure of the system is most frequently the virtual main cause of the problem.

The Pampa is a well defined and quite well known ecosystem, with specific and more or less long term periodic climatic variations. The Indian groups who in older times sparingly

populated this vast region ignored our system of property rights. They had no permanent settlements and wandered freely in a more or less cyclical manner, according to the needs of their cattle and the state of the natural pastures. By and large, this ecological regime was stable and self regulated.

On the contrary, the white immigrants, from the 18th century on, slowly evolved from group wandering toward sedentary settlement, determined and dominated by the concept of registered individual property. In this way the settlers became much more closely dependent of regular - and irregular - climatic variations. They had to accept these and try to adapt, if possible, to irregular but recurrent extreme conditions - long and severe droughts or indordinate wet spells that would last months or even various years.

The deeper and most permanent feature of this situation is, accordingly, the relation between the variable natural ecosystem and its human users. It is in fact, in systemic terms, the very general relation between subsystems, systems and metasystems, as theoretically described by John van Gigch.<sup>3</sup>

Any deeper study should monitor the long term environmental conditions of the considered situation, i.e. optaining a good knowledge of these, in order to anticipate any possible more or less periodical trouble or disorder.

Most of the unexpected problems that we have to face, emerge from our ignorance of the dynamics or variability of some more or less hidden environmental factor that makes the depending system vulnerable. In fact, any situation at any time is a mere episode in a continuous readaptation, cyclical transformation or evolution in an also more or less protracted process of perpetual change. As a result, considering at first sight any situation as simply "normal", may lead to misleading evaluations and potential dangers.

Any subordinate system, itself always a part of some wider environment, has an internal structure that makes it more or less adaptable. For example, at times of great floods in the wide argentine Pampa (due to excessive rains), it may be better to sell the cattle, even at very unsatisfactory price, than let the animals drown or die for lack of fodder... if there should be no practical possibility to transfer them to some safer place. Of course, what should be done in such extreme cases depends of the ingenuity and rressources of the breeders as well as any eventual positive or negative circumstance that could have been foreseen... or not.

In fact, this is generally true in many different guises in every kind of business or situation. Indeed, it becomes a practical necessity to consider those general conditions - normal or exceptional - that may sometimes turn critical: A general understanding of the ever changing relations of any specific system of whatever kind with its environment has now become a practical need in our evermore interconnected world.

The "what if?" question mark may sometimes become a critical tool for survival.

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<sup>3</sup> "Decision Making about decision making: metamodels and metasystems" - Abacus Press, Cambridge, Mass., 1986.

"Applied General Systems Theory". 2 ed. Harper & Row, N.Y., 1978

### **Pathological symptoms in complex systems: a significant case history**

A good perception and understanding of significant pathological symptoms is a must, in the most different kinds of systemic situations. A system may, in cases, be simultaneously affected by various of these symptoms, as these are frequently linked as complementary aspects of some abnormal situation.

The first hurdle is that pathological symptoms may begin to appear in an insidious way. When they start to emerge, very few people perceive that “something is going on”... and still less so, what could be the meaning of this “something”.

On the other hand, soon as some particular or private interests seem to be at risk, their owners start to seek escape ways of their own, at any costs. Two cases during the last century are startling examples of these dangerous dilatory tactics. One has been the AIDS epidemics and the other the “mad cows” case.

Let us give a look on this last history and its psycho-sociological aspects.

1. Around 1980 some british doctors started to register a growing number of cases of the so-called Creutzfeld-Jacob disease, which leads to a progressive cerebral destruction in people, and was formerly very rare. Those of them who scrutinised the possible cause, remained anyhow mystified. The population as a whole was completely unaware of the matter at that time.

2. More or less at the same time some british veterinarians observed a significant number of cows also affected by a problem of cerebral destruction, formerly known only in sheep as the so-called “scrapie”. This too remained strictly a specific and limited professional concern.

3a. Somewhat later on, somebody emitted the hypothesis that the new Creutzfeld-Jacob cases could be a result of the human eating of brains and other organs of animals affected by scrapie. This view also was generally ignored.

3b. Someone hypothesized that cows, partially fed with animal flours made from rests of carcasses, particularly from sheep possibly affected by “scrapie”, could have become infected in this way. Nearly nobody paid heed to these warnings, save some very few professionals, who where unable to shake from their indifference those official organisms which should have been vigilant.

4. A newspaper echoed the hypothesis of the human contamination from affected cattle.

This triggered a massive panic from part of the british consumers of bovine meat (and even some european importers and consumers). It led soon to a drastic reduction of consumption of bovine meat in England... and to immediate inflamed denials from the national health authorities about any possible risk of human contagion. The Health Minister, with remarkable courage, did even eat meat in front of a television transmitter station. It was also proclaimed that “the cause of the mad cow disease was not yet scientifically established”.

Such denials are typical during a more or less extended period of time when some problem emerges that may harm commercial interests, or negatively affect politicians popularity.

5. As the disease has a very long period of latency (up to ten years, which was not known at that time), it was only later on that the number of cases started to climb significantly.

Thus, the true and devastating significance of the situation became only lately and clearly perceived.

In fact, in such cases the most clairvoyant people's advices remain generally unheeded. And even, if they insist in their warnings, they are sometimes ridiculed, or even hostigated.

6. Scientific inquiries finally proved that the worst fears were justified, ... and still at that later moment, there were yet some denials. However, Stanley Pruziner had discovered the pathogen that caused the disease: an abnormal protein, the so-called prion. At least, he received a Nobel prize, for his discovery... and even without much delay. Even so, Pruziner's discovery was still strongly scrutinized, until it could be finally definitively confirmed.

All this is quite characteristic of the common vacillations in this type of situations.

7. British health authorities finally admitted the validity of the scientific research work and resolved the massive elimination of tens of thousands animals that were presumably infected. They also prohibited the use of animal feeds produced from carcasses.. Even so, an unproved suspicion remained that some cattle owners did not send some dubious animals to the slaughter houses, or may still have used some possibly infected feeds.

In any case, the british government had finally to spend sideral sums to compensate the numerous cattle owners for their losses.

According to a very general rule, belated acknowledgement of a problem and delayed intervention do considerably increase the complexity and the costs in such cases.

8. This was not even the end of this affair.

The continental european authorities forbade the importation of british animals and meats... and declared safe the continental meats.

9. However, the facts showed successively in France, Germany, Portugal , etc... that this was not true, and the problem surfaced in Europe, with the same controversies, denials, and delays of critical decisions... and the same costs, when finally honest good sense prevailed. This shows the weight and the final cost of the common trend to evade realities and responsibilities, even when clearly established, ... so frequently observed in troubled circumstances, when economic or political interests are at stake, and when stupid or dishonest people or groups try to block or slow down uncomfortable but necessary decisions.

This is very serious, since poor decisions and pseudo-solutions are frequently irreversible. They can thus usher chronic problems that may eventually turn unavoidable a final disaster.

### **A tentative listing of problems symptoms in complex systems**

Symptoms described hereafter in general terms are in fact common to many different situations and systems. Moreover, the following listing does not pretend to be complete.

Adaptability (Lack of):

Systems tend generally to react to stimuli in typical ways. However, such reactions do appear in specific forms according to cases that, at first sight, may appear as quite different. Responses may become stereotyped and repetitious, even when new adaptations would be necessary. This could be named the "syndrome of the damaged record plate"

Asphyxiation syndrome

Due to a lack of needed inputs (generally when its sources become depleted, either naturally, or due to excessive use), the system may be in danger of destruction.

A similar effect can be caused by an excess of harmful outputs into the environment of the system (sinks or markets over-saturation)

It may also be a result of damaging and unsustainable competition between systems depending of the same sources of inputs.

#### Autonomy (Lack of)

This may be the case of a system - whose stock or hold of some critical form of matter, energy, or information becomes insufficient to face some crisis - is unable to obtain some external help (whose costs could be so high as to be unbearable, or would bring unacceptable consequences). Technological updating, for example, implies such a situation in some critical cases.

#### Babel Tower effect

The lack of a good internal communication language in a system leads to confusions, conflicts, inefficiencies and even catastrophes within the system.

It can also disturb its relations with its environment.

#### Bureaucracy (Encroaching)

Excessive bureaucracy is frequently a result of the sclerosis of automatized responses to some types of situations that seem to repeat themselves. Some standardization of procedures is normally useful. However, with time, “bureaus”, “offices”, and “organisms” tend to restrain and even to destroy adaptability, by instauring and imposing rigid procedures, supposed to be normal, but also exclusive solutions to supposedly well known “problems”.

However this may - and many times, does - restrict, or even suppress innovation and creativity, and thus creates damaging delays and dead ends.

Moreover bureaucracies tend to proliferate, turning voracious and more or less sterile consumers of resources. Still worse, they frequently create significant opportunities for corruption.

#### Circle (Vicious)

A repetitive automatic behavior without any functionality may appear in some cases.

This can lead to a useless squandering of the system's resources, which weakens it and may even endanger its future existence.

#### Communication lines (Excessive length of)

... frequently leading to excessive delays in decision making.

This pathological situation was, in former centuries, a result of slow communications in more or less geographically over-extended organizations or systems. It was certainly in past times, one of the main causes of great empires decadence, even yet during the first half of the 20th Century.

However, better and faster communications have also been a mixed blessing. For example, telegraph and aircrcrafts seriously limited the autonomy and responsibility of colonial administrations in Asia and Africa. While better control was thus secured, on the

other hand local initiative and decision power were severely restricted in opposition to the well known and useful principle: "Trust the man on the spot".

Another aspect of this problem is the multiplication of intermediate links in the management structure, which may lead to inordinate delays and increases risks of misinterpretations by one or another of the participants.

A revealing case was, during the nineteen eighties, a crisis at the well known multinational company Philips, whose basic cause was a quite rigid norm which obliged all of the numerous branches of the firm in the wide world, to refer to the head office in Eindhoven (Netherlands) for many decisions that could have been taken by local boards. The Eindhoven head office became even jockingly known overseas as the "Kremlin".

A frequent cause of this type of situation is the "obesity" of central bureaucracies which tend to become stuffed by superfluous clerks in redundant functions, even sometimes through mere influential familiar of political accomodation.

This corresponds to one of the ironical administration mock "laws" enounced by the english sociologist Northcote Parkinson: "1=3", which means that any self-respecting "Boss" or "Chief" should at least have two subordinates, since these should "necessarily" be more numerous than the "Chief". Moreover, as everyone must justify his function, the best way to do this is to ingeniously invent some new supposedly indispensable procedure.

Unfortunately, the psycho-sociological roots of such a behavior are, at the same time, quite universal and more or less unconscious.

#### Cycles (Uncontrolled)

In some systems, uncontrolled oscillations may appear in a more or less irregular way, as for example extreme accelerations, followed by strongly recessive phases. Such phenomena can be dangerous and damaging. They result from an automatic and uncontrolled amplification of some feedback between the system and its environment. This effect can be modelled through Forrester's Systems Dynamics. It is sometimes mentioned as the "pigs cycle", which describes an example of a succession of countervailing shortages and excessive production.

#### Decay (Slow)

A progressive and unperceived degradation of the activity and performance of the system.

Such a process does not show early and obvious cues of ill being, at least in any way noticeable for an observer devoid of suitable criteria and monitoring method adapted simultaneously to slight short-term changes and long-term evolution.

This type of situations may evolve toward a critical threshold and sudden breaking point, i.e. a "catastrophe", as a result of a slow accumulation of additive, but unperceived damaging micro-effects.

#### Dependence (Excessive)

The situation of a system narrowly controled by some overbearing and determining factor in its environment.

Any strong perturbation affecting such a factor may easily endanger the survival of the system, specially when unexpected or sudden..

Excessive dependence implies an insufficient autonomy.

### Disintegration

The parts of a system may lose slowly or suddenly their ability to participate into complex global processes. They may even enter in hidden or open conflict or pretend to independent behavior. This phenomenon is frequently a consequence of inordinate and excessive growth.

### Drift (Uncontrolled)

The affected system tends toward uncontrolled and, or incoherent activity. Each of its parts behaves according to some proper and, or routine behavior without any understanding or responsibility for possible consequences. This is for example a typical behavior of bureaucracies. It becomes specially damaging when it affects managers, who should precisely be able to act as regulators.

### Effects (Wicked)

Effects of the system's behavior which hinder its own proper activities.

Such effects may be undesirable - and generally unforeseen - consequences of some collective behavior that can, or cannot be eventually corrected or adjusted. They may in most cases be emerging as unheeded results of many small individual effects, seemingly casual and, or insignificant, which derive and converge into some additive mass behavior.

Many kinds of administrative or economic bottlenecks and most of environmental pollutions are results of such processes.

### Gigantism

The excessive growth of a system.

Overgrown systems reach a size at which internal connections and communication lines become too long and intricated and, at the same time too weak to insure the internal coherence of the whole.

Such a symptom can be observed in some multinational organizations or businesses with multiple sectors and branches, sometimes as a result of mismanaged fusions or take-overs.

### Growth (Uncontrolled)

A system, as an autonomous entity, may acquire its own specific dynamics and escape from the control of any regulator. It is thus at risk of reaching conditions that endanger its survival and lead it to self-destruction.

It should be observed here that optimization is quite different from maximization ... and should frequently be preferable.

### Identity loss

This occurs when members or parts of the system do not anymore act in good harmony according to its nature, needs and goals. In many cases, their activity becomes useless, wasteful or even parasitic, damaging and, in cases, destructive for the system.

A biological example is the appearance of cancerous cells in a living being.

Similarly, gangs and mafias start to pursue their own illicit and illegal goals in a covert and cunningly way, and while not anymore accepting their responsibilities within their society, they manage to use its resources for their own profit..

#### Incoherence

The unfocused and haphazard behavior of a system.

This is a frequent result of a lack of a good internal organization of the system in which lax and even contradictory behavior of its elements or - in human systems - stakeholders damages its efficiency and may even endanger its existence.

#### Overload

An excessive level or rhythm of activity imposed to a system, that exceeds its immediate or mediate possibilities.

Such a situation frequently leads to a sudden and generally irreversible breakdown (the so-called last straw that breaks the camel's spine).

However, in some cases, an insufficient load can also be quite damaging.

A well balanced system normally needs a minimal level of activity as well as a maximal one to secure its own survival.

#### Parasitism

The situation by which another system, or even an internal subsystem feeds on the resources of the system without bringing it any real compensatory advantage.

Parasitism is a quite universal natural phenomenon among all kind of vegetal and animal living systems.

In many cases, it leads to the destruction of the parasited system... and altogether of the parasite itself..

From a sociological viewpoint, in human societies, parasitic unproductive and sometimes destructive activities are widely spread and massive, in direct or indirect ways. Examples are the arms trade and the addictive drugs business.

Social health and even survival requires a clear psychological and collective perception and understanding of the various guises of parasitism, in order to improve systemic regulations or controls.

#### Partialism

The inability to understand, and even to perceive and take interest in the viewpoint or situation of other people (who of course are in many cases similarly indifferent)

This is a quite critical social pathology: Individuals and groups thus affected tend to use other ones as kinds of hostages.

Such behavior is a common, but generally hidden aspect in some strikes in critical public services (health care, education, communications, for instance), as many third parties are frequently damaged or harmed.

Red queen syndrome (inspired from Lewis Carroll's "Alice in Wonderland")

Only to maintain itself, and under circumstances which escape from its control, a system is forced to relentlessly accelerate the rhythm of its activity as the only way to escape destruction.

Rigidity

An excess of controls, or their bureaucratic and autocratic management, brakes or blocks processes that are critical to the correct working of the system, thus asphyxiating initiative and enhancing passive and irresponsible behavior of the members of the organization.

Sclerosis

Hardening and growing loss of adaptability and inventiveness of a system and/or of its parts. In human social systems, it results of excessive routine, automatized behavior and lack of personal responsibility of individual members, when challenged in some exceptional situation..

In sclerosed systems, a growing number of elements let matters go from bad to worse, not fulfilling anymore their responsibilities or tasks, or becoming parasites.

In its advanced stages, such a process deprives the system of any defense against any environmental or internal disturbance and may easily lead it to its destruction.

Stress

The reaction of a system - or some critical subsystem - when functioning very close to the acceptable limits of its intrinsic possibilities.

If such a situation subsists for too long a time, there is a serious risk that some process, essential to the survival of the system, may be blocked or even destroyed, putting the system itself at risk of destruction.

In fact, stress should be seen as a protective feedback and accordingly, duly monitored, acknowledged, understood and compensated or controlled.

Tunnel vision

The narrowly limited perception of the condition and environment of a system by its managers.

This is frequently a result of their excessive specialisation, or exclusive attention given to narrow or immediate goals. It leads to the loss of any ability to take advantage of new opportunities, or to an increased risk of being caught by unexpected critical events or aggressions, that cannot anymore be safely managed or controlled..

Variety

The existence of various possible states of a system and/or of its elements.

Variety is a condition that enhances adaptiveness of the system to a wider range of internal or external variations

Variety (Lack of)

The condition of a system that does not count on enough elements or possible states to adapt itself to more or less numerous or severe changing conditions in its internal organization, or in its environment.

This condition is generally related to a lack of stocks, or reserves of energy, matter or information, such as not being eventually available to the system for compensatory feedbacks in critical situations.

#### Wishful Thinking

A way of thinking characterized by incorrect, fanciful and/or blownup evaluations, mostly out of a more embracing and significant context.

Examples in economy for instance are supposed “profits”, “earnings”, big “interests” or wages “increases” in a global situation of more or less hidden and permanent inflation.

More generally wishful thinking feeds on unfounded and irrational hopes.

Such illusions become easily socially ingrained and more or less permanent. They disguise the basic problems and frequently act as damaging feedbacks.

Unfortunately, eliciting false hopes in gullible folks is also a very common and universal socio-political trick.

## **ORGANIZATIONS IN NEED OF SUPPORT**

To begin with, we should admit that to start any practical action, it would be necessary to find significant support either through some substantial and effective sponsorship of another organization, or by action of some coherent groups of our own members within any institution sympathizing with our approach.

Of course, this could only be obtained if we could produce a convincing know-how about the two following topics:

- A new and original way for deciders to look at complex situations
- An effective method for managers to obtain the fully co-participative support of all, or at least most of the stakeholders in the issue

(It is relevant that in practically any complex issue we find an obvious – or hidden – component of some unethical human behavior as the basic trigger of the problem at hand)

On the other hand, any synthetic view of a complex issue needs a proper integration of the specific knowledge of numerous specialists. Our role is surely not to rival, antagonize or criticize them in any negative way, even if and when they would seem to deserve it. It should be much better to try to correlate and harmonize their work and views within a consensus on a more integrative general frame... and in expanded horizons in time, in order to avoid simplistic tinkering, blind-spotted quick fixes and short term pseudo-solutions.

Specific expertise, when needed, could probably be obtained by association, from individual members of our society, who would be linked to teams working on some special aspects of the considered matter.

Even in the case of very global issues, affecting continents, or oceans, or the global atmosphere, the ISSS could at least define a public pronouncement, after due and wide consultation with our members. (through e-mail, which is a practical way).

Some more local or specific issues or disasters can also lead to insights, useful in more or less similar situations in other places. Examples could be control of the direct and indirect causes of flash floods in densely occupied river basins; fighting erosion in cultivated areas; or the creation of deserts through deforestation; organising global management of water supply; coping with transculturation problems linked to massive migrations; limiting imprudent foreign indebtedness, etc...

More than vainly trying to replace specialized expertise, or propose solutions, the real goal would be to plant awkward question marks about possible crises in the making.

Such issues could be considered for example in two different ways:

A. Along their degree of difficulty

1. Very difficult to tackle as for example;

Global ill-defined problems

Problems requiring very many different specialized expertises

Problems involving powerful and insensitive vested interests

Issues in need of wide consensus, but difficult to explain to common stakeholders.

2. Moderately difficult to tackle, as for example:

Interrelating processes that are generally treated as isolated from each others

(for example technically highly efficient oceanic fishing as related to general marine ecological equilibrium)

3. Relatively easy to tackle:

Local or regional aspects of global problems

Problems for which some tentative systemic proposal for better management already exists.

B. According to types

1. Big global problems, affecting the whole planet, or at least whole climatic or geographical zones: continents, oceans

2. Important specific issues, as related to some general aspect of life, as for example insects growing resistance to chemical insecticides; loss of genetic variety; human interferences on life through genetical engineering.

3. More limited issues, affecting some specific areas: Big dams; risky irrigation schemes (as for instance in the Aral Sea area);... or sectors, as for ex. massive overfishing or excessive use of chemicals in agriculture.

Some tentative guidelines for cases studies that could be debated:

1. Define which systems concepts would be most generally useful, as for ex. positive and negative feedback; in cases of runaway processes; collapses; interrelations between short, medium and long term effects; chaotic limits to predictability; synergetic effects; structuration through energy dissipation,... ..

2. Define and describe a methodology to develop systemic viewpoints and lessons from cases studies.

3. Adapt co-participative design to the management of global or local messes already in existence or in breeding.

3. Define in which ways specialized expertise could be effectively called upon for coherent and meaningful collaboration in co-participative design

4. Classify issues and messes by order of social and/or cultural difficulty.

Some tentative guidelines for practical action could also be sought after and scrutinized, as for example:

1. Create models for transdisciplinary communication about complex issues through co-participative conversation (in the Fuschl and Asilomar style)
2. Try to interest specific influential people to the study and discussion of systemic management models: Politicians, business managers, organizations and communities leaders.
3. Disseminate knowledge about the wider causes and remedies of real or potential disasters, using clear information to be conveyed by mass media... without sensationalist distortions!

In any case, we should not be over-optimistic. If and when we become really efficient in these tasks, numerous opponents will probably show up, namely those who benefit from disorder, abusers, social parasites, and those who lack individual or collective awareness and sense of responsibility ... and even simply many short-sighted or lazy conformists.

Non conflictive ways to deal with this type of inconveniences should be in themselves a subject for systemic psychological and sociological study.

We should as well be aware of our own limits.

And we would urgently need people – mostly young – ready to collaborate in such tasks. Of course after committing ourselves first.

## **BASIC GENERAL SOURCES OF INFORMATION AVAILABLE ON COMPLEX ISSUES**

Encyclopedia of World Problems and Human Potential - Edited by Anthony JUDGE for the Union of International Non-Governmental Associations - 40, Rue Washington, B 1050 Brussels, Belgium (judge@uia.be) - Publisher: K.G.Saur Verlag, München, Germany, 1986. This is properly a gigantic achievement.

International Encyclopedia of Systems and Cybernetics (Ed. Ch. François) - Publ. K.G.Saur Verlag, München, Germany, 2004

(There is a former and quite shorter version in Spanish): Diccionario de Teoria General de Sistemas y Cibernética. GESI, Buenos Aires, 1992

email: francoischg@fibertel.com.ar

Encyclopedia of Life Support Systems (EOLLS) Publishers Co. Ltd for Unesco – Editor: Francisco Parra Luna, Facultad de Sociologia, Universidad Complutense, Madrid, Spain.

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