CINDYNICS : THE SCIENCE OF DANGER

Georges-Yves KERVERN

SUMMARY

An historical perspective of Cindynics, as Sciences of Danger is given. The seven axioms of Cindynics are explained. The main concepts of Cindynics : Cindynic Hyperspace, Cindynic Situation, Cindynic operators, dissonances, potential and complexity are defined.

Risk management's future development may be greatly aided by Cindynics. Cindynics is derived from "Kindunos" the Greek word for danger, and refers to the new science of hazard identification. The latest developments in Cindynics were discussed at a roundtable held in 1994 during the RIMS National Conference in New Orleans, based in part on "Chaos Theory", an article written by Tony Burlando and published in Risk Management in April 1994. The results of this discussion have been published in a paper issued in March 1995 in RISK MANAGEMENT.

The science of cindynics, by placing an emphasis on the proactive management of assets and liabilities as opposed to a management approach based on maintaining quarterly or yearly profits, cindynics represents a new managerial philosophy. Through cindynics, effective risk management lies in scientifically analyzing the risks threatening a company's financial and physical assets. In his paper "Rethinking Risk Management" from the Geneva papers on Risk and Insurance, July 1992, Felix Kloman stated "the holistic development of risk management appears to be inevitable." Mr. Kloman's statement pointed out the holistic approach leading to a systemic approach to hazards and perils. The Science of Systems is one of the main support of the new Sciences of hazards, perils, dangers, injuries : CINDYNICS.

The basic concepts of cindynics are difficult to understand without first opening a perspective on the three historical era of human awakening to the causes and prevention of hazards. These three phases are : 1) the philosophical phase (1755 to 1940) ; 2) the technological phase (1940 to 1980) ; and 3) the scientific phase (1980 to now).

The philosophical phase was intitiated by a landmark event in 1755. Before 1755, the concept of applying methodologies of science to hazards and perils -- with the exception of health problems, which the budding science of medicine was just beginning to address -- was not yet in practice. At that time, the solution for natural - and human-made catastrophes included numerous practices that today's scientists might refer to as "magical thinking". Thus, in primitive societies, hazard prevention techniques could include animal and in some cases even human sacrifices. In these societies, it was believed that shedding the blood of animals or young girls or boys provided a preventive remedy for catastrophes - an even more efficient hazard prevention solution than today's meetings of risk managers with brokers insurers, firemen and City planners. And in the most advanced civilizations of that time, prayers and religious rituals, notably processions of communities, were very common anti-catastrophe practices.

Then, in 1755, a catastrophic earthquake struck Lisbon, Portugal, causing more than 100,000 fatalities. Surprising every one, the French philosopher Jean-Jacques Rousseau attributed the responsibility for the fatalities to errors in human decision-making. He questioned, for example, why 20,000 houses with six to seven floors were located in a notably seismic area. Rousseau's comment led to a lot of discussion between philosophers (Voltaire opposing Rousseau) and politicians, and gave birth to the philosophical basis for a science of danger. This debate continued throughout the 19th century, but technological advances to further a scientific basis for a science of hazards did not occur until World War II.

Then, from 1940 to 1980, the technological phase began. War and electronic systems forced scientific methods to accidents/failures control. For example, in the 1940s, British air authorities made the first attempts to quantify the frequency of air traffic accidents by accumulating data on accidents and developing the first standards for identifying air traffic accident frequency. Loss Reporting and Loss Control were born.

Then, in the 1950s, the U.S. Department of Defense developed and financed electronic components reliability techniques during Korean War operations. In 1952, the Advisory Group of Reliability of Electronic Equipment (AGREE) was started.

In 1954, the Association of Electric/Electronic Engineers (AIEEE) placed great emphasis on reliability and maintenance techniques, publishing milestone documents on these topics in 1961 and 1965. In 1954, the first "Reliability and Maintainability Symposium" was organized in the United States. Then, as noted by Mr. Barlow in April 1994's Risk Management Issue the term risk manager was proposed in 1955 by Wayne Snider, professor of insurance at Temple University. This proposal was confirmed in 1956 in a job definition for the risk manager written by Russell Gallagher in the Harvard Business Review (Vol. 34) which initiated a continuous series of discussions on the nature of risk management activity. In 1961, the AVCO Tables, which were the first statistical evaluation of probability of human errors, were published.

Then, in 1964, A.D. Swain, a researcher with Sandia Corporation in Albuquerque, New Mexico, developed Techniques for Human Error Prediction (THERP). The RISK MANAGER JOB was born.

The period from between 1980 and 1995 represents the third, or scientific, phase. During this period, numerous human-made catastrophes forced corporate executives to try to assess the impact of risk management programs and technologies on the magnitude and frequency of major technological failures. Principal examples of the catastrophes included the Bhopal incident in 1984 and the Chernobyl catastrophe and the Challenger disaster, both which occurred in 1986.

In October 1986, "Les Annales des Mines," a EUROPEAN MAGAZINE founded in 1794 traditionaly centered on security in mining operations, issued a special survey on the concept of major technological risks. Five main chapters : 1) risk assessment methodology ; 2) industry's position towards major risks ; 3) risk regulation and prevention ; 4) crisis management ; and 5) risks and their impact on society. Based on this special survey, the French executive club "Association des Cadres Dirigeants de l'Industrie (ACADI)" decided to organize the first international and inter-industry congress that discussed technological risks in light of scientific causes. Sponsored by UAP, the French insurer, this congress took place in the UNESCO Building in Paris in December 1987. Attendees came from 13 countries, 30 different industrial fields, 320 companies and 90 universities and labs.

The congress confirmed the commonalities that exist between the risk assessment and prevention approaches used in the apparently different industries such as the airlines, electronuclear field and the chemistry industry.

The main committees of this congress deserve attention because their work provided the basis for cindynics. During the preparatory work for the congress, seven committees pioneered the following developments : Advances in the development of safety for large technological systems ; human factors in security and reliability ; large-scale ecological risks and their control ; management training for disaster recovery and crisis management ; day-to-day household and workplace risks ; and risk transfer and financing techniques. The preparatory work of these committees led to several new developments in Europe. First, a permanent Association body was created to provide interested parties with the opportunity to continue discussing the ideas developed by the seven committees. This resulted in the birth of the Cindynic Institute in Europe, thereafter known as CIE, and chaired by Pierre Tanguy, the main expert for security in the French electric utility EDF. Secondly, a book was published that defined and described all of the concepts and methods advanced during the 1987 congress (Réf. L'Archipel du DANGER - ECONOMICA PARIS 1991). A series of similar congresses was then organized in Europe. For example, in September 1990, professor A. Kuhlmann, chairman of TUV Rheinland in Germany, organized the First World Congress on Safety Science. Then, in January 1992, Mr. Tanguy chaired "Cindynics 1992" in Cannes, France, presented by CIE and containing 250 experts and 80 sessions. On October 5 to 9, 1992, the British Health and Safety Executive Council (HSEC) with the co-operation of the European Economic Community (EEC), the Organization for Economic Cooperation and Development ; and the World Health Organization (WHO), organized a similar congress on Cindynic matters. Many universities in Europe have developed training and degree programs in cindynics. Then, in April 1993, the WHO selected cindynics as the main topic for World Health Day. A multidisciplinary program was developed in Paris on this occasion known as the Crossroads of Health, Medicine and Cindynics.

The first conceptual analysis of the WHO concept of a Community Safety Program (CSP), demonstrated great potential for cindynics in the application of risk management for urban problems. Due to the costs arising from disasters and acts of violence in large cities in Europe and North America, discovering ways to respond to these topics remains a first priority.

In November 1994, Cindynics' 94 was held in University la Sorbonne in Paris, and involved the participation of leading experts in risk management, risk assessment and risk prevention. In preparation for the conference, Cindynicians contacted a network of practitioners, which included risk managers from many European multinational companies.

The WHO developed the world program on injury control under the guidance of Dr. Claude Romer. This program is now centered on the analysis of concepts as the HADDON MATRIX and the DISEASE MANAGEMENT CONCEPT.

The participants in Cindynics' 94 received the book entitled "Latest Advances in Cindynics," published in 1994. The book summarized the developments of cindynics in a set of new fields : Cindynic Epistemology ; Cindynic Phenomenology ; Cindynic Research and Development ; Cindynics in Health and Urban Safety ; and Cindynic Psychosociology. In this paper we try to update the reader on those developments until 1996, FIRST QUARTER.

- CINDYNIC EPISTEMOLOGY

In the nuclear energy, airlines and chemical industries, and in modern cities, complex activities generate numerous perils, hazards and risks. It is impossible, however, for anyone to understand the in-depth nature of these risks without first developing a conceptual framework that outlines the complex nature of the operations within these industries.This fact creates the need for abstract conceptual exercises that describe the basic assumptions about the "operating systems" of complex organizations and systems so that risk professionals can better undestand the nature of these systems' harzards. Thus, cindynicians have developed a series of axioms specific to cindynics. These AXIOMS allow the Building fo Cindynics Key concepts : the concept of "hyperspace" (which centers on the production of hazardous conditions within a human network) ; the concept of cindynic situation ; the concept of operator -- an operator transforms a cindynic situation ; the concepts of ambiguity and dissonance ; the concept of cindynic potential and the concept of cindynic complexity.

1. CINDYNIC AXIOMS

Using an approach consistent with the work of Nobel Prize winner H.A. Simon, cindynicians have developed seven axioms that can be easily identified in many hazardous situations :

AXIOM 1 : RELATIVITY

This axiom states that risks cannot be quantified absolutely. Thus, the measurement of risks is relative to the location of the actor quantifying the risk within a network. The network's time and space limits affect also the risk measurement process.

AXIOM 2 : CONVENTIONNALITY

Risk measurements are dependent upon "conventions" -- that is, social agreements on definite sets of goals, rules and values -- between the actors in a system.

AXIOM 3 : GOALS DEPENDENCY

The goals or strategic objectives of an organization affect the RISK assessment/evaluation process. Poor goals explicitation is one of the main source of catastrophes.

AXIOM 4 : AMBIGUITY

Risk measurement is subject to five sets of "ambiguity", which means fuzziness in the description/assessment/evaluation that prevents a complete description of five spaces. "Space" is a mathematical concept meaning a set that has either an algebraic or geometrical structure. These five sets of ambiguity are : 1) teleological ambiguities, which concerns the goals. 2) epistemic ambiguities, which concern the models. 3) statistical ambiguities, which concern facts and figures. 4) deontological ambiguities, which concern rules and standards and 5) axiological ambiguities, which concern values.

AXIOM 5 : AMBIGUITY REDUCTION

Post-accident or post-catastrophe reports and Loss Reporting Technologies reduce the ambiguities listed in Axiome 4.

AXIOM 6 : CRISIS

A crisis is a disruption of networks. Crisis management is the construction of networks substitute of the disrupted networks and the progressive rebuilding of former networks.

AXIOM 7 : AGO-ANTAGONISTIC CONFLICT

Here, "ago-antagonistic" refers to two effects that are strictly opposed. Any human action has two conflicting components : a "cindynolytic" component that reduces danger ; and a "cindynogenetic" component that creates or increases danger.

2. CINDYNIC HYPERSPACE

As noted, Cindynic Axiom 4 introduce a series of five ambiguities that make risk assessments so difficult. This axiom define five spaces : 1) a space for memory or for statistics ; 2) a space for modeling ; 3) a space for goals ; 4) a space for standards and rules ; and 5) a space for values. The combination of these five spaces creates the CINDYNIC hyperspace (See Exhibit 1).

From the systematic survey of post accidents/catastrophe reports, cindynicians have established a list of ten empirical Systemic Cindynogenic Deficitis (SCDs) which are gaps or defaults within a system that create hazardous conditions. The presence of three or four SCDs in a technological system is sufficient to generate a significant accident or catastrophe. The concept of the cindynic hyperspace allows a generalization of the empirical SCDs that can affect an organization. Twenty-seven theoretical SCDs have been deduced from the five elements in the cindynic hyperspace :

- Five SCDs (SCD 1 through SCD 5) result in the absence of one of the elements in the Cindynic hyperspace (for instance, SCD 5 is the absence of goals). (Exhibit 2).
- Five SCDs (SCD 6 through SCD 10) result from a "hole" -- or gap -- in a space (SCD 8, for example, is the absence of a model in the epistemic space). (Exhibit 3).

- Eight SCDs (SCD 11 through SCD 18) refer to dislocations of the hyperspace (SCD 14, for instance, refers to the separation that can occur between models and statistics, thus creating hazardous conditions). (Exhibit 4).

- Five SCDs (SCD 19 through SCD 23) refer to the lack of organization -- or "degenerescence" -- within one space (for example, SCD 23 is the lack of prioritization in the goals space). (Exhibit 5).

- Five SCDs (SCD 24 through SCD 27) result from obstacles to regulations within hyperspace common to two of the five spaces (SCD 25, for example, refers to ethical dilemmas arising from conflicts between values and rules). (Exhibit 6).

The 27 theoretical SCDs are the confirmation of the ten empirical SCDs. Adding other SCDs to the list will create a useful checklist for the detection of hidden perils in complex systems. Thus, the cindynic hyperspace is a very useful concept for the production/legitimation of frequently used in prevention programs (for example Injury control programs of WHO).

3. THE CINDYNIC SITUATION

A cindynic situation is defined by three "sets" : 1) a set of networks ; 2) a set of the Cindynic hyperspaces associated with each of the networks ; 3) a set of time and space boundaries. Any actor acting in a situation is a member of one or several networks included in the first set. To each network is associated a space for statistics ; a space for models ; a space for goals ; for rules ; and for values. These five spaces are combined in the hyperspace associated with each network. Time and space boundaries limit the ability to describe a situation, whether by making the description shorter or easier or by reducing the number of actors/networks included in the situation.

These boundaries, however, can be misleading. By excluding some actors or networks from the situation, the boundaries may inadvertently ignore other dangers. Thus, the concept of a cindynic situation is similar to the chaos theory concept of Initial Conditions. Choosing the content of a cindynic situation is defining the Initial Conditions.

4. OPERATORS ON CINDYNIC SITUATIONS

The three sets of a cindynic situation can be changed intentionally or non-intentionally. The transformation of an initial cindynic situation "ΣC_0" leads to a new Cindynic situation "ΣC_n". Let "$T\Sigma C$" be the transformer. We can write "$T\Sigma C (\Sigma C_0) \rightarrow \Sigma C_n$ for the transformation of the situation from ΣC_0 to ΣC_n.

Cindynics define two different categories of Cindynic Operator. The first is intentional. This category includes "man-made" intentional transformations of Cindynic situations : either negative (agressions, terrorism) or positive (prevention and protection programs, injury control programs). The second category refers to unintentional operators. This very wide category includes our day-to-day life : accidents, catastrophes and disasters.

5. CINDYNIC DISSONANCES

In his book "A Theory of Cognitive Dissonance" (Stanford University Press, 1957), L. Festinger introduced the concept of cognitive dissonance, which refers to psychological conflict that occurs when an individual is facing contradictions between facts and norms or values or goals. Thus, Festinger's "actor" is forced to change his or her values standards and goals when the facts show that the real situation is in plain contradiction with his/her set of goals, standards and values. This concept of dissonance explain the central interest of the Cindynic hyperspace. For example, after a transformation of the Cindynic situation by an operator.

Five types of dissonance are created (Exhibit 7A) :

- "S" : Statistical dissonance, or change in the database.
- "E" : Epistimic dissonance, or change in knowledge base (models).
- "T" : Teleological dissonance, or change in goals.
- "D" : Deontological dissonance, or change in the system's rules.
- "A" : Axiological dissonance, or change in the system of values.

6. CINDYNIC POTENTIAL

A description of the impact of a catastrophe or disaster is not complete if it does not include an assessment of these dissonances. Some of these dissonances -- mainly "D" and "A" -- may create very painful "aggiornamento" -- or the conversion process mentioned earlier -- between the actor's mind sets. Thus, if CH1 is a cindynic hyperspace that is more adapted to the environment, and if CH1 is not adopted by the actors in the network, the five dissonances will increase in magnitude. Cindynicians have developed the notion of a Cindynic Potential (CP) as a function of the five dissonances. CP (S, E, T, D, A). Suppose there is a substantial increase in the dissonances in a system. If the actors of the network remain with the inadequate cindynic hyperspace CHo, the CP increases and crosses certain thresholds, beyond which the probability for catastrophe is very high. The unintentional transformation is triggered after the increase of the CP beyond "unacceptable" limits. On the contrary, intentional transformers -- loss prevention programs, for example -- represent voluntary interventions of actors in an attempt to reduce the dissonances before disaster results.

Another interest of the concept of CINDYNIC POTENTIAL is that it gives a Cindynic content to a couple of key concepts of Cindynic psycho-sociology

TRUST/DISTRUST

Cindynics define DISTRUST between Actor A and Actor B as the Cindynic potential created by the dissonances Δ between the five spaces of the hyperspace of Actor A and the hyperspace of Actor B (Exhibit 7B).

$$\text{DISTRUST (AvsB)} = CP(\Delta S_A^B, \Delta E_A^B, \Delta T_A^B, \Delta D_A^B, \Delta A_A^B)$$

TRUST is the contrary of Distrust.

TRUST and DISTRUST are therefore defined by a Cindynic Potential between two actors or two networks facing eachother.

7. CINDYNIC COMPLEXITY

FACING HAZARDS, PERILS or DANGERS gives a feeling of complexity. Many R-D people try to define Hazards, Perils, Dangers and RISKS. It is so complex to achieve, that some, perhaps with some distress, have put forwards propositions of the kind "X does not exist" with X = Hazard, Peril, Danger or RISK.

Cindynic complexity is there, certainly. We can improve our understanding of perils, hazards and dangers by considering four main sources of Cindynic complexity :

Source 1 : Limits of any Cindynic situation

It's always possible to restrict the scope of a RISK ASSESSMENT to the actors, the networks, the portion of space and time that is within our reach, for instance because information is available or the elements included in the Scope. Unfortunately, danger is very often outside this first "window". On the contrary, by enlarging the Scope of a RISK ASSESSMENT, we face barriers of flexibility and of costs.

Source 2 :

Cindynic AXIOM 7 tells us that any corrective step is perhaps increasing the probability and gravity of unwanted undirect effects. It is the huge field of perversity in human actions.

Source 3 :

Any Cindynic situation includes networks. But these networks are intertangled. Complexity is very often defined in Systemic approach as an intertanglement of networks. INTERNET as a network of networks is a wonderful example of this intertanglement.

Source 4 : Multidimensionality of Cindynic events

A Cindynic event has a complex multidimensional structure. For example, crisis management experts know that they have to define the crisis event from many different perspectives, or "dimensions." The first is the dimension of time. This includes ascertaining the historical origins of the events and wheter they are progressive or sudden, and the time period for wich the events will have effects. Second is the dimension of space. For example, are the effects of the event local, national or global ? Third is the dimension of the public authorities who are affected by the event.

These include counties, cities, states, countries, the federal government and international and worldwide organizations. The fourth dimension is the domain of scientific fields including, among others, physics, chemistry, health and geology. Analysing a Cindynic event leads progressively to the conclusion of Source 3 above. We are in fact facing actors of very different nature caught themselves in an intertanglement of networks. Restricting the scope of the survey leads to the difficulties listed in Source 1. Any therapy, any diagnostic is threatened by the perversity described in Source 2.

It's why Cindynics are one ot fhe most fascinating field for R & D, today. Many recent developments show the huge potential of the Cindynic approach of human organization.

Developing very fast are :

CINDYNIC PSYCHOSOCIOLOGY : Systemic therapy of families uses now the hyperspace as a tool for description of collective behaviour of the actors within the family. Systemic therapy is in fact a WORK on dissonances in order to reduce the DISTRUST and the VIOLENCE in family. Production of violence within the family explains widely the probability and gravity of injuries within the family, in the streets in our cities : CINDYNICS 97, an international congress in Paris planned for the beginning of 1997, will focus on RISK and VIOLENCE in the Society.

URBAN CINDYNIC is developping by the adaptation of RISK MANAGEMENT TECHNOLOGIES, as created by industrial organizations, to the field of local communities, little and big cities. Networks in the cities being stimulated and changed by the INTERNET Revolution, an electronic risk management of the cities is in full development. INJURY CONTROL or SAFE COMMUNITIES PROGRAMS as promoted by WHO will certainly widely beneficate fo the advances in URBAN CINDYNIC.

CINDYNIC PHENOMENOLOGY focussed on the repressing of perception of risk by individuals and human group.
The natural tendancy of people to settle in places where floods, earthquakes, volcanic eruptions are frequent without taking the appropriate prevention, protection or even financial insurances is a big mystery. Repression -- in the psychanalytic meaning of negation, blindness, evidence refusal and so on -- is at work within individuals and collectivities. Success of sects in cheating their members, destructive addiction to gambles and drugs are also the products of these repressing mecanisms.

FINANCIAL CINDYNIC is also developping not only because of derivatives, or sad stories as BARING BANK COLLAPSE or ORANGE COUNTY DISASTER. The banks are improving their knowledge of perils, hazards and risks, at their expenses. The technology of ALM, Assets Liabilities Management is progessively joining the HOLISTIC APPROACH as defined by risks specialists as Felix KLOMAN. This will progressively improve our capacity to understand better a puzzling financial world. Volatility, Crashes, Light-speed change in the market value of companies are in fact linked to the hazardous conditions that are secretly creating or disrupting their capacity of survival or their ability to create and promote the standards in their marketing niches. The link between market value and the yearly and quaterly results is progressively broken, as shown by Netscape for instance. Benzene in PERRIER water or oil spill for EXXON or catastrophe for CHEMICAL COMPANIES shows that accounting is no longer the best tool for weighing the value of a share on the exchange. The holistic approach of Cindynics will progressively substitute the traditionnal accounting approach of finances.

G.Y. KERVERN

Bibliography

G.Y. KERVERN Latest advances in cindynics - ECONOMICA PARIS (1994)

EXHIBIT 1 - CINDYNIC HYPERSPACE

OR PERILS & HAZARDS HYPERSPACE

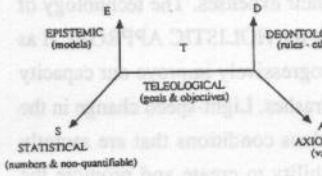

EXHIBIT 2 - ABSENCE OF ONE OF THE FIVE "SPACES" OF THE CINDYNIC HYPERSPACE

Absence of a dimension of Cindynic Hyperspace

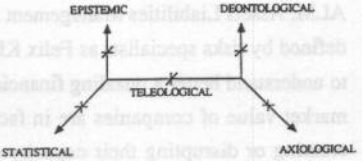

EXHIBIT 3

Gap in Space

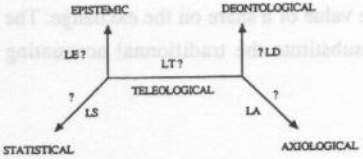

EXHIBIT 4 - DISJUNCTIONS

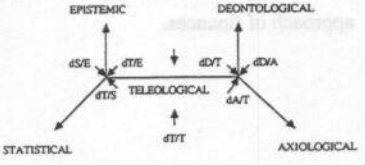

EXHIBIT 5 - LACK OF ORGANIZATION WITHIN A SPACE, OR "DEGENERESCENCE"

Degeneresence or lack of organization ○

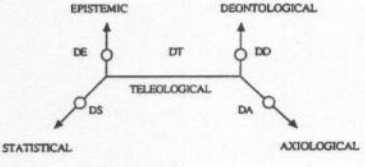

EXHIBIT 6 - OBSTACLES TO REGULATION (OR)

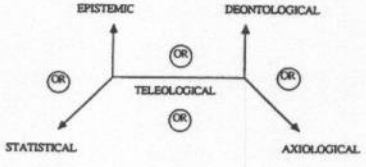

EXHIBIT 7A - DISSONNANCES

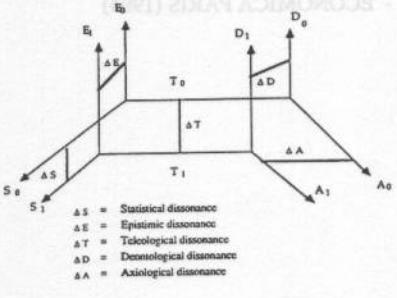

EXHIBIT 7B - TRUST/DISTRUST